BUDGET JUSTIFICATIONS

The United States
Department of the Interior

and Performance Information
Fiscal Year 2015

U.S. GEOLOGICAL SURVEY

NOTICE: These budget justifications are prepared for the Interior, Environment and Related Agencies Appropriations Subcommittees. Approval for release of the justifications prior to their printing in the public record of the Subcommittee hearings may be obtained through the Office of Budget of the Department of the Interior.

U.S. GEOLOGICAL SURVEY
FY 2015 BUDGET JUSTIFICATION

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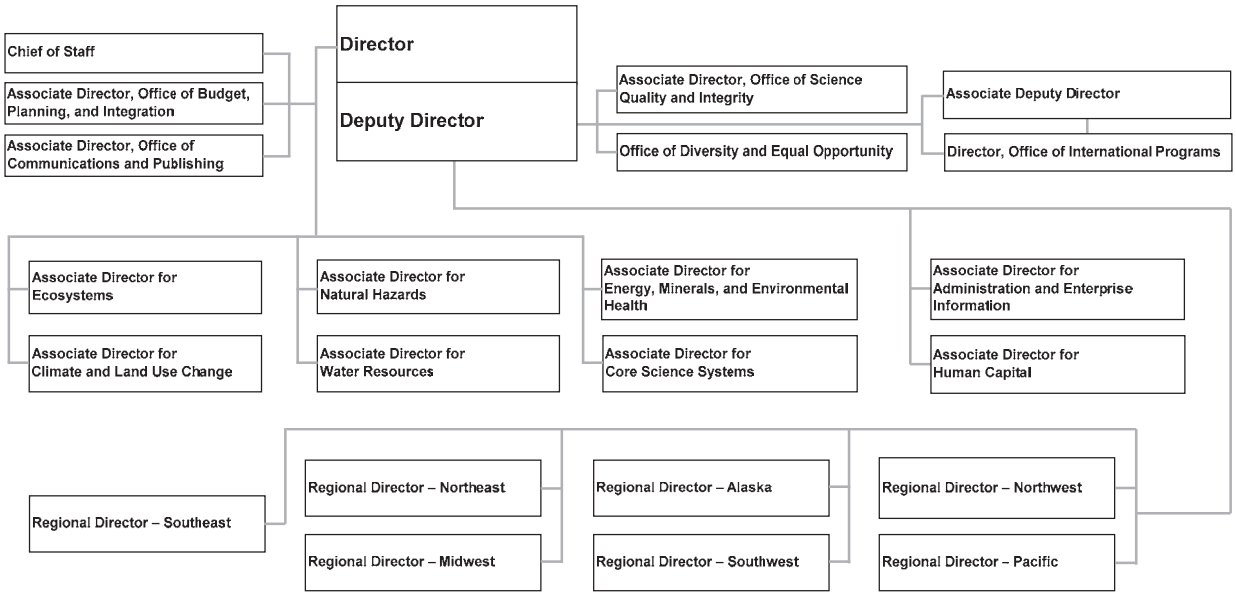
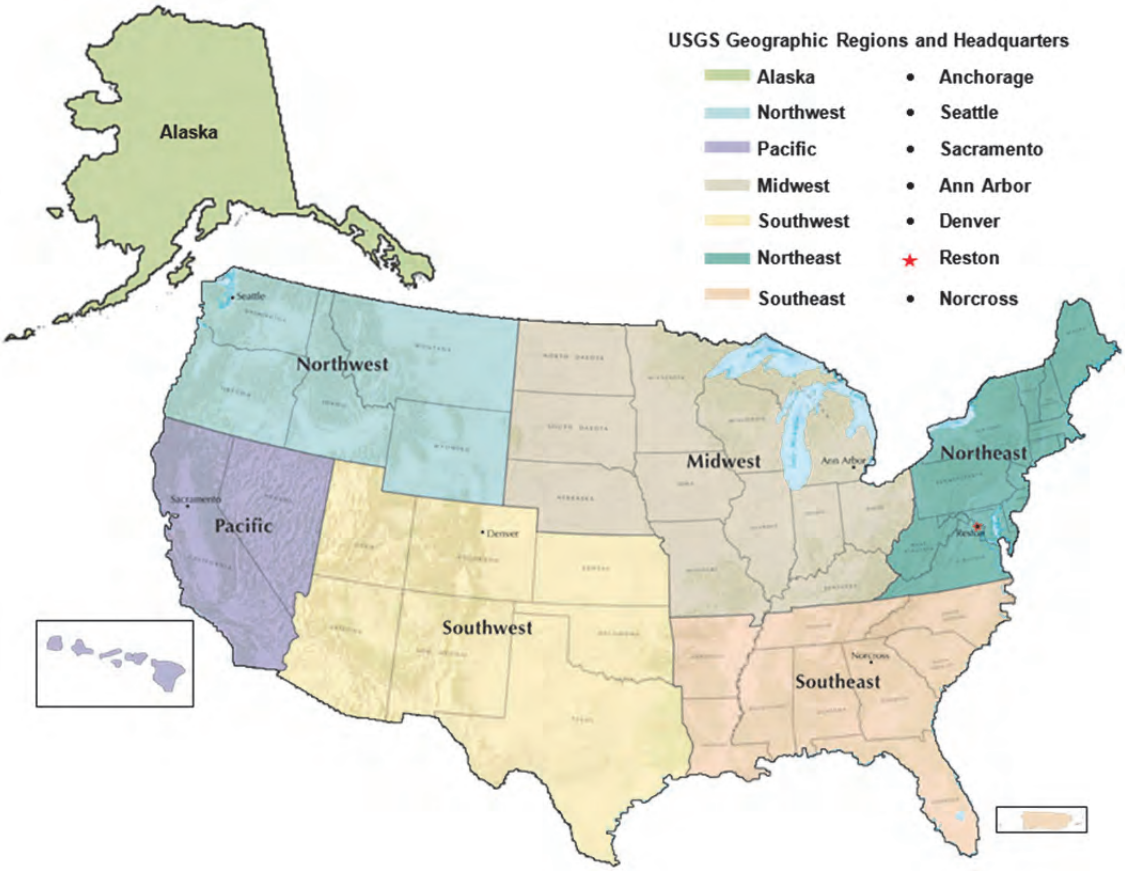
U.S. Geological Survey



USGS Regional Structure



Alphabetical List of Acronyms

AAAS	American Association for the Advancement of Science
AAPG	American Association of Petroleum Geologists
ABC	Activity-Based Costing
ABC/M	Activity-Based Costing/Management
ABP	Asset Business Plan
ACCNRS	Advisory Committee on Climate Change and Natural Resources Science
ACES	Achieving Cost Efficiencies for Science
ACI	American Competitive Initiative
ACP	Arctic Coastal Plain
ACWI	Advisory Committee on Water Information
ADA	Americans with Disabilities Act
AEI	Administration and Enterprise Information
AFS	American Fisheries Society
AFWA	U.S. Air Force Weather Agency
AMD	Aviation Management Directorate
AMP	Asset Management Plan
AMWG	Adaptive Management Work Group
ANS	Alaska North Slope
ANS	Aquatic Nuisance Species (Ecosystems)
ANSS	Advanced National Seismic System
ANWR	Arctic National Wildlife Refuge
APHIS	Department of Agriculture Animal and Plant Health Inspection Service
API	Asset Priority Index
AR	Accounts Receivable
AR5	5th Assessment Report
ARMI	Amphibian Research and Monitoring Initiative
ARRA	American Recovery and Reinvestment Act
ASC	Alaska Science Center
ASIWPCA	Association of State and Interstate Water Pollution Control Administrators
AVHRR	Advanced Very High Resolution Radiometer
AVO	Alaska Volcano Observatory
AWiFS	Advanced Wide Field Sensor
BASIS+	Budget and Science Information System
BBL	Bird Banding Laboratory
BBS	Bird Breeding Survey
BEN	Balkan Endemic Nephropathy
BT	Budget Team
BGN	Board of Geographic Names
BIA	Bureau of Indian Affairs
BIMD	Biological Information Management and Delivery
BIP	Biological Informatics Program (Equivalent to BMID)
BIS	Commerce - Bureau of Industry and Security
BLM	Bureau of Land Management
BLT	Business Leaders Team
BMPs	Best Management Practices
BNP	Biscayne National Park
BOR	Bureau of Reclamation
BPA	Blank Purchase Agreement

BPC	Bureau Program Council
BPI	USGS Office of Budget, Planning, and Integration
BPXA	BP Exploration (Alaska)
BSR	Business Strategy Review
CA	Condition Assessment
CAC	Civil Applications Committee
CALFED	California Federal (Bay-Delta Authority program)
CAP	Cooperative Agreements Program
CARA	Circum-Arctic Resource Appraisal
C&A	Certification and Accreditation
CC	Cost Center
CBERS	China/Brazil Earth Resources Satellite
CBLCM	Chesapeake Bay Land Cover Management
CBM	Coal bed Methane
CBP	Chesapeake Bay Program
CCI	Collaborative Communications Infrastructure
CCOAT	Coast Chesapeake Online Assessment Tool
CCSP	U.S. Climate Change Science Program
CDC	Centers for Disease Control and Prevention
CDR	Critical Design Review (Climate and Land Use)
CDR	Climate Data Record (Climate and Land Use)
CDI	Council for Data Integration
CEN	Climate Effects Network
CENR	Committee on Environment and Natural Resources
CEAP	Conservation Effects Assessment Project
CEGIS	Center of Excellence for Geographic Information Science
CEOS	Committee on Earth Observation Satellites
CEQ/NSTC	Council on Environmental Quality/National Science and Technology Council
CERC	Columbia Environmental Research Center
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERP	Comprehensive Everglades Restoration Plan
CESU	Cooperative Ecosystems Study Unit
CFO	Chief Financial Officer
CIO	Chief Information Officer
CISN	California Integrated Seismic Network
CITES	Conventional on International Trade in Endangered Species
CLU	Climate and Land Use Change
CMG	Coastal and Marine Geology
CMGP	Coastal and Marine Geology Program
CMSP	Coastal and Marine Spatial Planning
CNS	Central portion of the North Slope
CO_2	Carbon Dioxide
COAST	Chesapeake Online Adaptive Support Toolkit
CoML	U.S. National Committee for the Census of Marine Life
CORE	Committee on Resource Evaluation
CPIC	Capital Planning and Investment Control
CR	Central Region
CRADA	Cooperative Research and Development Agreement
CRSSP	Commercial Remote Sensing Space Policy
CRTF	Coral Reef Task Force

CRU	Cooperative Research Units
CRUISE	Columbia River USGS Integrated Science Explorer
CRV	Current Replacement Value
CRWA	Charles River Watershed Association
CSC	Climate Science Center
CSI	Core Science Informatics
CSIP	Cost Savings and Innovation Plan
CSIRC	Computer Security Incident Response Capability
CSMP	California Seafloor Mapping Program
CSRS	Civil Service Retirement System
CSS	Core Science Systems
CTBTO	Comprehensive Test Ban Treaty Organization
CUES	Comprehensive Urban Ecosystems Studies
CUSEC	Central United States Earthquake Consortium
CVJV	Central Habitat Joint Venture
CVO	Cascades Volcano Observatory
CWD	Chronic Wasting Disease
CWP	Cooperative Water Program
CWS	Canadian Wildlife Service
DCIA	Debt Collection Improvement Act
DEM	Digital Elevation Model
DEP	[State] Department of Environmental Protection
DEQ	[State] Department of Environmental Quality
DFRs	Departmental Functional Reviews
DGH	Indian Directorate General of Hydrocarbons
DHS	Department of Homeland Security
DiGIR	Distributed Generic Information Retrieval
DMC	Data Management Center
DMC	Disaster Monitoring Constellation
DMCI	Deferred Maintenance and Capital Improvements
DNR	Department of Natural Resources
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOGAMI	Oregon Department of Geology and Mineral Industries
DPAS	Data Processing and Archiving
DRAGON	Delta Research and Global Observation Network
DROT	Drift River Oil Terminal
DRTO	Dry Tortugas National Park
DWH	Deepwater Horizon
DSS	Decision Support System
EA	Enterprise Architecture
EAD	Enterprise Active Directory
EAL	Energy Analytical Laboratory
ECMs	Energy Conservation Measures
ECO	Energy Conserving Opportunities
ECS	[U.S.] Extended Continental Shelf
ECV	Essential Climate Variable
EDCs	Endocrine Disrupting Chemicals
EDEN	Everglades Depth Estimation Network
EDMAP	Education Mapping Program (in National Cooperative Geologic Mapping Program)

EDRR	Early Detection, Rapid Assessment and Response
EEOC	Equal Employment Opportunity Commission
EFT	Electronic Funds Transfer
EGIM	Enterprise Geographic Information Management
EGS	Enhanced Geothermal Systems
EHP	Earthquake Hazards Program (Hazards Program)
EHP	Enterprise Hosting Platform (AEI)
EI	Enterprise Information
EIR	Enterprise Information Resources
EISA	Energy Independence and Security Act of 2007
EIS&T	Enterprise Information Security and Technology
ELA	Enterprise License Agreement
ELT	Executive Leadership Team
EMS	Environmental Management System
E.O.	Executive Order
EOL	Encyclopedia of Life
EOP	Executive Office of the President
EOR	Enhanced Oil/Gas Recovery
EPA	U.S. Environmental Protection Agency
EPCA	Energy Policy and Conservation Act of 2000
EPM	Ecosystem Portfolio Model
ER	Eastern Region
ERA	E-Risk Assessment
ERAS	eRemote Access Services
EROS	Earth Resources Observation and Science Center
ERP	Energy Resources Program
ESD	Earth Surface Dynamics
ESI	Environmental Sensitivity Index
ESN	Enterprise Services Network
ESPC	Energy Savings Performance Contract
ESRI	Environmental Systems Research Institute
ET	Evapotranspiration
ETM+	Enhanced Thematic Mapper Plus
EVMS	Earned Value Management System
EWeb	Enterprise Web
FAA	Federal Aviation Administration
FAC	Federal Advisory Committee
FACA	Federal Advisory Committee Act
FAER	Fisheries: Aquatic and Endangered Resources
FASAB	Federal Accounting Standards Advisory Board
FBAT	Facilities Budget Allocation Team
FBMS	Financial Business Management System
FBWT	Fund Balance with Treasury
FCI	Facilities Condition Index
FEA	Federal Enterprise Architecture
FECA	Federal Employee Compensation Act
FEDMAP	Federal Lands Mapping Program (in National Cooperative Geologic Mapping Program)
FEGLI	Federal Employees Group Life Insurance
FEHB	Federal Employees Health Benefit
FEMA	Federal Emergency Management Agency

FERC	Federal Energy Regulatory Commission
FERS	Federal Employees Retirement System
FFMIA	Federal Financial Management Improvement Act of 1996
FFS	Fire and Fire Surrogate
FGDC	Federal Geographic Data Committee
FICA	Federal Insurance Contributions Act
FICMNEW	Federal Interagency Committee for the Management of Noxious and Exotic Weeds
FISC	Florida Integrated Science Center
FISMA	Federal Information Security Management Act
FMT	Field Managers Team
FMFIA	Federal Managers' Financial Integrity Act of 1982
FMMS	Facilities Maintenance Management System
FOS	Flight Operations Segment
FOT	Flight Operations Team
FRAMES	Fire Research and Management Exchange System
FRB	Federal Reserve Board
FRPC	Federal Real Property Council
FRPP	Federal Real Property Profile
FSA	Farm Service Agency
FSAM	Federal Segment Architecture Methodology
FSP	Fundamental Science Practice
FTE	Full-Time Equivalent
FWS	U.S. Fish and Wildlife Service
GAAP	Generally Accepted Accounting Principles
GAM	Geographic Analysis and Monitoring Program
GAP	Gap Analysis Program
GAO	Government Accountability Office
GBIP	Great Basin Information Project
GBIS	Global Biodiversity Information Facility
GCDAMP	Glen Canyon Dam Adaptive Management Program
GC-IMS	Global Change-Information Management System
GCP	Global Change Program
GCMRC	Grand Canyon Monitoring and Research Center
GEO	Group on Earth Observations
GEODE	GEO-Data Explorer
GeoMAC	Geospatial Multi-Agency Coordination Group
GEOMAG	Geomagnetism Program
GEOSS	Global Earth Observation System of Systems
GFDL	Geophysical Fluid Dynamics Laboratory
GFL	Global Fiducials Library
GHG	Greenhouse Gas
GIRT	Geospatial Information Response Team
GIS	Geographic Information System
GLS	Global Land Survey
GLSC	Great Lakes Science Center
GNIS	Geographic Names Information System
GOES	Geostationary Operational Environmental Satellites
GOS	Geospatial One-Stop
GPRA	Government Performance and Results Act
GRB	Green River Basin

GHG	Greenhouse Gas
GPS	Global Positioning System
GPSC	Geospatial Products and Services Contract
GSA	General Services Administration
GS-FLOW	Groundwater and Surface-water flow model
GSN	Global Seismographic Network
GWRP	Ground-Water Resources Program
HAZUS	Federal Emergency Management Agency's Earthquake Loss Estimation Program
HBN	USGS Hydrologic Benchmark Network
HDOA	Hawaii Department of Agriculture
HDR	High-Data Rate Radio
HEDDS	Highly Pathogenic Avian Influenza Early Detection Data System
HDDS	Hazards Data Distribution System
HHS	Department of Health and Human Services
HIF	Hydrologic Instrumentation Facility
HLI	Healthy Lands Initiative
HNA	Hydrologic Networks and Analysis Program
HPO	High Performing Organization
HPPG	High Priority Performance Goal
HR	Human Resources
HR&D	Hydrologic Research and Development Program
HRS	Helibourne electromagnetic Surveys
HSPD -12	Homeland Security Presidential Directive 12
HUB	Historically Underutilized Business
HUD	US Department of Housing and Urban Development
HVO	Hawaii Volcano Observatory
HWATT	Hemlock Woolly Adelgid Action Team
I&M	Inventory and Monitoring – NPS
IAGA	International Association of Geomagnetism and Aeronomy
ICAO	International Civil Authorization Organization
ICL	International Consortium on Landslides
ICRP	Internal Control Review Plan
ICWP	Interstate Council on Water Policy
IDWR	Idaho Department of Water Resources
IEAM	Integrated Environmental Assessment and Management
IGPP	Institute for Geophysics and Planetary Physics
IIE	Integrated Information Environment
ILM	Integrated Landscape Monitoring
IOOS	Integrated Ocean and coastal Observing System
IP	Investment Plan
IPCC	Intergovernmental Panel on Climate Change
IPDS	Information Product Data System
IRB	Investment Review Board
IRIS	Incorporated Research Institutions for Seismology
IRS	Indian Remote Sensing Satellite
InSAR	Interferometric Synthetic Aperture Radar
ISO	International Organization for Standardization
ISSP	Information Security Strategic Plan
IT	Information Technology
ITAP	Invasive Terrestrial Animals and Plants

ITILOB	Information Technology Infrastructure Line of Business
ITIS	Integrated Taxonomic Information System
ITSOT	IT Security Operations Team
ITSSC	IT Security Steering Committee
ITT	Information Technology Transformation
IUCN	International Union for the Conservation of Nature
IUCN	International Union of Conservation Nations
JFA	Joint Funding Agreement
JV	Joint Venture Partnerships
KSF	Thousand Square Feet
LAS	Local Action Strategy
LCAT	Land Cover Analysis Tool
LCC	Landscape Conservation Cooperatives
LCS	Land Change Science Program
LDCM	Landsat Data Continuity Mission
LDGST	Landsat Data GAP Study Team
LEAG	Long-term Estuary Assessment Group
LHP	Landslide Hazards Program
LiDAR	Light Detecting and Ranging
LIFE	NBII Library of Images from the Environment
LIMA	Landsat Image Mosaic of Antarctica
LMV	Lower Mississippi Valley
LMVJV	Lower Mississippi Valley Joint Venture Office
LOA	Level of Authentication
LRS	Land Remote Sensing
LSC	Leetown Science Center
LST	Landsat Science Team
LTRMP	Long-Term Resource Monitoring Program
LTWG	Landsat Technical Working Group
LUPM	Land Use Portfolio Model
MARCO	Mid-Atlantic Research Consortium for Oceanography
MBTU	Million British thermal units
MD	Management Directive
MEO	Most Effective Organization
METRIC	Mapping EvapoTranspiration with high Resolution and Internalized Calibration
MHDP	Multi-Hazards Demonstration Project
MMS	Minerals Management Service
MOA	Memorandum of Agreement
MOC	Mission Operations Center
MODIS	Moderate Resolution Imaging Spectroradiometer
MODFLOW	Modular Ground-Water Flow Model
MOU	Memorandum of Understanding
MRBI	Mississippi River Basin Healthy Watersheds Initiative
MRDS	Mineral Resources Data System
MRERP	Mineral Resources External Research Program
MRLC	Multi-Resolution Land Characteristics Consortium
MRP	Mineral Resources Program
MSCP	Multi-Species Conservation Program
MSH	Mount St. Helens
MSS	Multi Spectral Scanner

MTBE	Methyl Tert-Butyl Ether
MTBS	Monitoring Trends in Burn Severity
MUSIC	MIT-USGS Science Impact Collaborative
MW	Megawatt
MWE	Megawatt electric
NABCI	North American Bird Conservation Initiative
NACO	National Association of Counties
NADP	National Atmospheric Deposition Program
NAGT	National Association of Geoscience Teachers
NANPCA	Non-indigenous Aquatic Nuisance Prevention and Control Act
NARA	National Archives and Records Administration
NAS	National Academy of Sciences (Core Science)
NAS	USGS National Non-indigenous Aquatic Species Database (Ecosystems)
NASA	National Aeronautics and Space Administration
NASQAN	National Stream Quality Accounting Network
NatWeb	National Web Server System
NAWQA	National Water-Quality Assessment
NBC	Department of the Interior – National Business Center
NBII	National Biological Information Infrastructure
NCA	National Climate Assessment
NCAR	National Center for Atmospheric Research
NCAP	National Civil Applications Program
NCCWSC	National Climate Change and Wildlife Science Center
NCDE	Northern Continental Divide Ecosystem
NCEP/NOAA	National Centers for Environmental Prediction
NCGMP	National Cooperative Geologic Mapping Program
NCIA	National Competitiveness Investment Act
NCPP	USGS National Coastal Program Plan
NCRDS	National Coal Resources Data System
NDMC	National Drought Mitigation Center
NDOP	National Digital Orthoimagery Program
NED	National Elevation Dataset
NEHRP	National Earthquake Hazards Reduction Program
NEIC	National Earthquake Information Center
NEON	National Ecological Observatory Network
NEPA	National Environmental Policy Act
NEST	National Environmental Status and Trends
NETL	National Energy Technology Laboratory
NFHAP	National Fish Habitat Action Plan
NGA	National Geospatial-Intelligence Agency
NGAC	National Geospatial Advisory Committee
NGGDPP	National Geological and Geophysical Data Preservation Program
NGIC	National Geomagnetic Information Center
NGMA	National Geologic Mapping Act
NGMDP	National Geologic Map Database Project
NGO	Nongovernmental organization
NGP	National Geospatial Program
NGWMN	National Ground Water Monitoring Network
NHD	National Hydrography Dataset
NHWC	National Hydrologic Warning Council

NIEHS	National Institute of Environmental Health Sciences
NIFC	National Interagency Fire Center
NIH	National Institute of Health
NISC	National Invasive Species Council
NIISS	National Institute for Invasive Species Science
NISMP	National Invasive Species Management Plan
NIST	National Institute of Standards and Technology
NIWR	National Institutes for Water Resources
NLC	National League of Cities
NLCD	National Land Cover Database
NLlC	National Landslide Information Center
NLIP	National Land Imaging Program
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Aerospace Defense Command
NORTHCOM	U.S. Northern Command
NOSC	National Operations and Security Center
NPN	National Phenology Network
NPRA	National Petroleum Reserve Alaska
NPS	National Park Service
NRDA	Natural Resource Damage Assessment
NRIS	Natural Resource Information System
NRC	National Research Council (United States National Academies)
NRC	Nuclear Regulatory Commission (United States NRC)
NRCS	Natural Resources Conservation Service
NRMP	National Resource Monitoring Partnership
NROC	Northeast Regional Ocean Council
NRP	National Research Program (research organization in USGS Water Resources)
NRPP	National Resource Preservation Program
NSDI	National Spatial Data Infrastructure
NSF	National Science Foundation
NSGIC	National States Geographic Information Council
NSIP	National Streamflow Information Program
NSLRSDA	National Satellite Land Remote Sensing Data Archive
NSMP	National Strong Motion Program
NSPD	National Space Policy
NSTC	National Science and Technology Council
NSVRC	Northern Shenandoah Valley Regional Commission
NTN	National Trends Network
NVCS	National Vegetation Classification Standard
NVEWS	National Volcano Early Warning System
NWAVU	National Water Availability and Use Assessment
NWHC	National Wildlife Health Center
NWIS	National Water Information System
NWQL	National Water Quality Laboratory
NWQMN	National Water Quality Monitoring Network
NWRC	National Wetlands Research Center
NWS	National Weather Service
O&M	Operations and Maintenance
OAEI	Office of Administration and Enterprise Information
OAFM	USGS Office of Accounting and Financial Management

OAG	USGS Office of Acquisition and Grants
OAP	Ocean Action Plan
OBIS	Ocean Biogeographic Information System
OBIS	USGS Office of Business Information Systems, (AEI)
OCAP	USGS Office of Communication and Publications
OED	Office of Employee Development
OEPC	Office of Environmental Policy and Compliance
OES	Office of Emergency Services
OFDA	Office of Foreign Disaster Assistance
OFEE	Office of the Federal Environmental Executive
OFR	Open-File Report
OGC	Open Geospatial Consortium
OHC	USGS Office of Human Capital
OIA	Office of Insular Affairs
OICR	USGS Office of Internal Control and Reporting
OIG	Office of the Inspector General
OGDB	Organic Geochemistry Database
OLI	Operational Land Imager
OMB	Office of Management and Budget
OMS	USGS Office of Management Services
OPA	USGS Office of Policy and Analysis
OPM	Office of Personnel Management
ORPP	Ocean Research Priority Plan
ORPPIS	Ocean Research and Priorities Plan and Implementation Strategy
OSHA	Occupational Safety and Health Administration
OSM	Office of Surface Mining
OSQI	Office of Science Quality and Integrity
OSTP	Office of Science and Technology Policy
OWRS	Office of Western Regional Services
PAGER	Prompt Assessment of Global Earthquakes for Response
PBO	Plate Boundary Observatory
PBX	Private Branch Exchange
PCR	Polymerase Chain Reaction
PDA	Personal Digital Assistant
PDF	Portable Document Format
PDR	Preliminary Design Review
PES	Priority Ecosystem Science
PFM	(Department) Office of Financial Management
PI	Principal Investigator
PII	Personally Identifiable Information
PIP	Performance Improvement Plan
PIP	Program Improvement Plan
PMO	Project Management Office
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
POA&M	Plan of Action and Milestone
PP&E	Property, Plant, and Equipment
PRB	Powder River Basin
PSNER	Puget Sound Near Shore Ecosystem Restoration
PSS	Perimeter Security Standard
PTWC	Pacific Tsunami Warning Center

PWRC	Patuxent Wildlife Research Center
QOL	Quality of Life
R&D	Research and Development
RASA	Regional Aquifer-System Analysis
RCM	Regional Climate Models
RCOOS	Regional Coastal Ocean Observing Systems
REE	Rare Earth Elements
REMS	River Ecosystem and Modeling Science
RFP	Request for Proposal
RGIO	Regional Geospatial Information Office®
RIF	Reduction in Force
RIM	River Input Monitoring Program
RISA	Regional Integrated Science and Assessments – NOAA
RPM	Real Property Management System
RSAC	Remote Sensing Application Center
RSSI	Required Supplementary Stewardship Information
RTS	Reports Tracking System (Water Resources)
R/V	Research Vessel
RWRPC	Regional Water Resources Policy Committee
S&T	USGS Status and Trends Program
SAC	Stakeholder advisory Committee (Climate and Land use)
SAC	USGS Science Advisory Council
SAFOD	San Andreas Fault Observatory at Depth
SAFRR	Science Application for Risk Reduction
SAIN	Southern Appalachian Information Node
SAP	Synthesis and Assessment Product
SAR	Synthetic Aperture Radar
SAUS	Storage Assessment Units
SBFD	San Francisco Bay and freshwater delta
SBSP	South Bay Salt Pond Restoration Project
SCEC	Southern California Earthquake Center
SCR	System Concept Review
SDI	Spatial Data Infrastructures
SDR	Subcommittee for Disaster Reductions
SDRT	Supervisory Development Review Team
SES	Senior Executive Service
SETAC	Society of Environmental Toxicology and Chemistry
SFBD	San Francisco Bay Delta
SFMP	Strategic Facilities Master Plan
SFWMD	South Florida Water Management District
SHC	Strategic Habitat Conservation
SLC	Scan Line Corrector
SGL	Standard General Ledger
SIR	Surveys, Investigations, and Research
SOGW	Subcommittee of Ground Water
SoIVES	Social Values for Ecosystem Services
SOW	Statement of Work
SPARROW	Spatially Referenced Regressions on Watershed Attributes
SPN	Scientific Publishing Network
SPOC	Security Point of Contact

SPOT	Satellite Pour L'Observation de la Terre
SPRESO	South Pole Remote Earth Science Observatory
SRR	Systems Requirement Review
SRTM	Shuttle Radar Topographic Mission
SSRIs	Selective Seronin Reuptake Inhibitors
STATEMAP	State Mapping Program (in Cooperative Geologic Mapping Program)
STEM	Science, Technology, Engineering and Mathematics
STIG	Security Technical Implementation Guides
SWPC	Space Weather Prediction Center
TAA	Technical Assistance Agreements
TANC	Transport of Anthropogenic and Natural Contaminants
TCOM	Tahoe Constrained Optimization Model
TDWG	Biodiversity Information Standards
TIC	Trusted Internet Connection
TIRS	Thermal Infrared Sensor
TM	Thematic Mapper
TMDL	Total Maximum Daily Loads (Clean Water Act requirement)
TRIGRS	Transient Rainfall Infiltration and Grid-Based Regional Slope-Stability Analysis
TRIP	The Road Indicator Project
TROR	Treasury Report on Receivables
TRPA	Tahoe Regional Planning Agency
TSP	Thrift Savings Plan
UAS	Unmanned Aircraft Systems
UHM	University of Hawaii-Manoa
UIC	Underground Injection Control
URISA	Urban and Regional Information System Association
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAID	U.S. Agency for International Development
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USDOE	U.S. Department of Energy
USFS	U.S. Forest Service
USGCRP	U.S. Global Change Research Program
USGEO	U.S. Group on Earth Observations
USGS	U.S. Geological Survey
UMESC	Upper Midwest Environmental Services Center
USNG	United States Nation Grid
VANS	Volcano Activity Notices
VBNS	Very Broadband Network Services
VCP	Vegetation Characterization Program
VDAP	Volcano Disaster Assistance Program
Veg	Vegetation Characterization
VegDRI	Vegetation Drought Response Index
VHP	Volcano Hazards Program
VHSV	Viral Hemorrhagic Septicemia Virus
VOIP	Voice over IP Systems
VONA	Volcano Observatory Notifications for Aviation
VSIP/VERA	Voluntary Separation Incentive Payment/Voluntary Early Retirement Authority
VTC	Video Teleconferencing

WAN	Wide Area Network
WCCI	Wyoming Cooperative Conservation Initiative
WCF	Working Capital Fund
WCMC	UNEP-World Conservation Monitoring Center
WERC	Western Ecological Research Center
WFRC	Western Fisheries Research Center
WLAN	Wide Local Area Network
WLCI	Wyoming Landscape Conservation Initiative
WNS	White-Nose Syndrome
WNV	West Nile Virus
WPA	World Petroleum Assessment 2000
WR	Western Region
WRD	Water Resources discipline (formerly Water Resources Division)
WRIR	Water Resources Investigation Report
WRRA	Water Resources Research Act
WRRIs	[State] Water Resources Research Institutes
WSC	[USGS State] Water Science Center
WSWC	Western States Water Council
WTER	Wildlife: Terrestrial and Endangered Resources
WUI	Wildland-Urban Interface
YMP	Yucca Mountain Program
YVO	Yellowstone Volcano Observatory

General Statement

Total 2015 Budget Request
(Dollars in Thousands)

Budget Authority	2013 Actual	2014 Enacted	2015 Request	Inc (+)/Dec(-) from 2014 Enacted
Current	$1,012,168	$1,032,000	$1,073,268	+$41,268
Permanent	$925	$975	$748	-$227
Total	**$1,013,093**	**$1,032,975**	**$1,074,016**	**$41,041**
FTE	*5,202*	*5,222*	*5,204*	*-18*

FTE	2013 Actual	2014 Enacted	2015 Request	Inc (+)/Dec(-) from 2014 Enacted
Direct	5,202	5,222	5,204	-18
Reimbursable	2,787	2,787	2,787	0
Working Capital Fund	226	226	226	0
Allocation Account	36	36	36	0
Contributed	6	6	6	0
Total	**8,257**	**8,277**	**8,259**	**-18**

Overview

The 2015 U.S. Geological Survey (USGS) budget request is $1.1 billion, which is $41.3 million or 4.0 percent above the 2014 Enacted level. Reflecting the President's ongoing commitment to scientific discovery and innovation to support decisionmaking in addressing critical societal needs and supporting a robust economy, the budget proposes increases in research and development to foster the sustainable stewardship of natural resources. This includes the stewardship of energy and mineral resources, water, ecological systems and important landscapes, environmental and species health, climate resilience, and the mitigation of hazards, among others. Fundamental knowledge of the land and its resources is a basic need for effective government, a productive economy, and sustainable resource management. In 2014, the USGS celebrates 135 years of providing the Nation with reliable scientific information used to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, ecosystem, energy, and mineral resources; and enhance and protect quality of life.

The President's 2015 budget demonstrates the Administration's commitment to advancing science, research and development, Earth observations, and the availability and usability of data—the foundations of scientific discovery, technological innovation, economic well-being, and sound decisionmaking. The USGS is among the leading Federal Earth science agencies and provides information and tools used by Federal, State, tribal, and local entities across the Nation and across the globe. The 2015 budget builds on the core mission of the USGS, increases research and development (R&D) funding by $35.6 million to advance priorities in science-based resource management and the protection of public health and safety from hazards, and focuses existing resources on science priorities identified in the USGS Science Strategy.

The 2015 budget provides targeted increases to address the Nation's highest science priorities, particularly in support of sustainable natural resource stewardship. To responsibly optimize investments of taxpayer dollars, the budget prioritizes these activities while shifting resources and reducing funding for other activities.

Budget Change Summary ($ in Thousands)	
2014 Enacted	**$1,032,000**
Program Increases	$76,368
Program Decreases	-$41,300
2015 Fixed Costs	6,200
2015 Request	**$1,073,268**

The 2015 budget request for the USGS focuses on developing decision-ready science and tools in support of sustainable natural resource stewardship in the following areas: (1) energy and mineral development; (2) climate resilience; (3) landscape scale ecosystem management, restoration, and protection; (4) water resources management; and (5) biotic protection and health, as well as science and tools critical to informing the readiness and safety of the nation in the face of natural hazards.

Accomplishments

Below are recent USGS achievements that provide the foundation for growth in 2015.

Supporting Safe and Sustainable Energy and Mineral Development. To ensure a balanced domestic energy portfolio, the President emphasizes an "all-of-the-above" strategy for energy development, and the USGS makes important contributions in each component. In 2013, the USGS completed the first-ever assessment of unconventional oil and gas in the Alaska North Slope, and a map of all assessed shale gas resources in the United States. The USGS determined that a larger energy potential exists in the Bakken and Three Forks Formations (located in the Williston Basin in North Dakota and Montana respectively) than previously assessed. The USGS updated its assessment of the Powder River Basin, the Nation's largest source of coal. The analysis quantified coal resources in the basin and the amount of resources

technically and economically recoverable. To help provide a scientific basis for land use and national energy policy, the USGS published an analysis of global uranium resources and continues to develop updated techniques to assess the undiscovered uranium resource potential of the United States and potential environmental health vulnerabilities.

USGS Organic Act

43 U.S.C. 31 et seq. Organic Act of March 3, 1879, as amended, establishes the United States Geological Survey. Provides, among other matters, that the USGS is directed to classify the public lands and examine the geologic structure, mineral resources, and products within and outside the national domain. Establishes the Office of the Director of the United States Geological Survey under the Department of the Interior. The Director is appointed by the President with the advice and consent of the Senate.

Responding to Natural Hazards. The USGS continues to provide information and tools necessary to prevent loss of life and property due to natural hazards. Natural hazards threaten the safety, security, and economic well-being of our Nation's communities as well as impact natural resources and surrounding. The USGS provides scientific information to emergency responders, policymakers, and the public to reduce losses from earthquakes, floods, hurricanes, landslides, magnetic storms, tsunamis, volcanic eruptions, and wildfires. Working with its partners, cooperators, and customers, the USGS delivers actionable assessments of these hazards and helps to develop effective strategies for achieving more resilient communities. The USGS is the Federal agency responsible for monitoring and notification of earthquakes, volcanic activity, and landslides in the United States. For many other hazards, the USGS directly supports the National Oceanic and Atmospheric Administration its responsibilities for providing warnings.

The Science Application for Risk Reduction (SAFRR) project, created in 2011, builds on the successful Multi-Hazards Demonstration Project that innovated ways of applying USGS hazard science. The SAFRR Tsunami Scenario was released in September 2013 and is being used for a planned exercise in California and Washington in March 2014. The next scenario will look at the impact of a large Hayward fault earthquake on the digital economies of Silicon Valley. The SAFRR project will continue to build alliances and work with communities, businesses, research institutions, and governments, to improve the use of existing USGS natural hazards information, to identify needs and gaps, and to develop new products that increase the effectiveness of USGS science.

Last year, during Hurricane Sandy, the USGS assessed rising storm surge levels, conducted airborne light detection and ranging (lidar) to measure coastal topography and bathymetry, forecast coastal impacts to assist first responders, and reported coastal river levels and water quality with real-time monitoring. Immediately following the storm, USGS scientists compiled more than 830 high water marks and data from more than 140 storm-surge sensors to map peak storm tide to direct responders and early recovery efforts, and conducted airborne lidar surveys to quantify storm-induced changes before rebuilding began. Using $41.2 million in Disaster Relief Act funds, the USGS continues to provide scientific information to inform management decisions for recovery of coastal communities and to prepare for future natural hazards. Ongoing USGS activities revolve around five themes from the USGS Sandy Science Plan, including: coastal topography and bathymetry; impacts to coastal beaches and barriers; impacts of storm surge, including disturbed estuarine and bay hydrology; impacts on environmental quality and persisting contaminant exposures; and impacts to coastal ecosystems, habitats, and fish and wildlife.

Supporting Sustainable Water Management. USGS tools provide the water information and science needed to respond to drought and changing climate and water use patterns. The USGS released a report predicting the effects of climate change on water availability in 14 river basins across the Nation. This groundbreaking study demonstrated that many different strategies will be needed to deal with the various hydrological responses to climate change that occur across river basins. The importance of groundwater as a resource increases when surface water supply cannot meet irrigation needs, such as in the water-challenged Klamath River Basin. The USGS provided the Bureau of Reclamation (BOR) with the results of a groundwater management model study that will be critical to ensuring that groundwater in the Klamath River Basin is wisely managed.

Supporting Climate Preparedness and Resilience. Climate change requires that the Nation prepare for an increasingly wide range in temperature and precipitation patterns, and resultant impacts to forest health, wildfire patterns, biodiversity, agricultural productivity, and other climate-dependent resources and industries. Natural resource managers and infrastructure planners face increasingly complex challenges in carrying out routine management actions under changing conditions such as drought and sea level rise, and in planning future responses to climate change. In June 2013, President Obama unveiled a Climate Action Plan to reduce carbon pollution, create more clean energy sources, and minimize the impacts of climate change. The President's Climate Action Plan highlights a number of areas in which the USGS makes significant contributions, particularly in the categories of providing data and tools to decisionmakers; enhancing interagency coordination; providing practical, actionable climate science; continuing to develop reliable science on global change; and developing forest carbon measurement methods and results to support management of public lands.

For example, the Carbon Sequestration Program carries out work that supports the President's Climate Action Plan, which highlights the need for unlocking long-term investment in many energy commodities, and innovative technologies to address the avoidance, reduction, or sequestration of anthropogenic emissions of greenhouse gases. In 2013, the geologic carbon sequestration project completed and published the first-ever comprehensive, fully probabilistic and quantitative assessment of the potential for geologic carbon sequestration in the United States (USGS Circular 1386, *http://pubs.usgs.gov/circ/1386*). The assessment indicates that there are ample geologic storage resources available for carbon capture and sequestration technologies outlined in The President's Climate Action Plan. Also in 2013, the biological carbon sequestration project published their second regional assessment, the Western United States (USGS Professional Paper 1797, *http://pubs.usgs.gov/pp/1797/*).

Sustaining Land Imaging and Landsat Continuity. The successful launch of the Landsat 8 satellite in February 2013 enables continuation of the 40-year Landsat record. In 2014, NASA will meet Congressional and Administration directives to devise an aerospace architecture designed to ensure 20 years of sustained land imaging that will provide data compatible with the past 41 years of Landsat data. As a major part of this effort, a NASA/USGS Sustainable Land Imaging Architecture Study Team (AST) is examining numerous long-term operational alternatives, in consultation with the Landsat Science Team. Under the architecture plan, NASA will develop Landsat-compatible land-imaging capabilities, while the USGS will continue to fund ground system development, post-launch operations, and data processing, archiving, and distribution. Near-term activities will focus on studies to define the scope, measurement approaches, cost, and risk of a viable long-term land imaging system that will achieve

national objectives. Evaluations and design activities will include consideration of stand-alone new instruments and satellites, as well as potential international partnerships. Based on the results of the AST study, the Administration will propose and execute a capable, affordable, sustained system to provide land imaging information for the science and user communities, as a component of the Nation's overall spaceborne Earth observation programs.

Opportunity, Growth, and Security Initiative (Investment Fund)

Complementing the President's 2015 budget request is a separate Opportunity, Growth, and Security Initiative, which shows how additional investments in 2015 can spur economic progress, promote opportunity, and strengthen national security. The Administration proposes a balanced package of spending cuts and tax loophole closers to fully offset the cost of the pro-growth investments. The initiative proposes additional investment relevant to the USGS in research and development.

As part of the President's Opportunity, Growth, and Security Initiative, the USGS is included in a proposed $140.0 million investment in Interior's research and development activities. This investment reflects the President's ongoing commitment to strengthen America's competitiveness through scientific discovery and innovation, and the Department of the Interior's (Interior) capacity to use science to inform decisionmaking to support sustainable stewardship. Through this Initiative, research and development will focus on outcomes, investing particularly in the development of decision-ready tools and information managers can use in the stewardship of natural resources

The USGS has identified $75.0 million in research and development to support scientific objectives in the following areas: (1) energy and mineral development; (2) climate resilience; (3) landscape scale ecosystem management, restoration and protection; (4) water resources management; and (5) species protection and health through the President's Initiative investment. Following are four examples of research contributions relevant to these key areas.

Energy and Mineral Development. Investments in Energy and Mineral Development would support science to advance alternative energy development and permitting in the areas of wind, solar, and geothermal energy. Investments would also help understand, minimize, and mitigate the potential impacts of energy and mineral development on environmental and human health. Work by the USGS at the interface of energy, wildlife, fish and lands in the Arctic are examples of the work which would be supported through this investment. This work would provide information and tools to assist the public, and Federal, State, tribal, and local managers in planning, permitting and development of energy frontiers. As another example, funding would enable biological and ocean science to support decision needs in the renewable energy development in coastal and offshore environments, including the Outer Continental Shelf, which is becoming the focus of potential renewable resource development. The USGS would also complete a rare earth elements (REE) life cycle analysis, started by the Department of Energy (DOE) that focuses on the manufacturing, technology, and recycling part of the REE life cycle. REEs are essential for high-technology applications. The United States was once largely self-sufficient in these critical materials, but over the past decade has become dependent upon imports.

Landscape Scale Ecosystem Management, Restoration, and Protection. Investments in Landscape Scale Ecosystem Management, Restoration, and Protection would enhance USGS science conducted to support land management decisions; develop tools to analyze, visualize, translate and extrapolate science; and lead efforts to apply science at multiple scales and across broad landscapes to inform land and resource planning, policy, management, and mitigation. This science would be shared and leveraged with the work of other Interior bureaus, Federal agencies, State and local governments, tribes, and communities. Work in the USGS on the three dimensional elevation program (3DEP) is an example of the work which could be supported through this investment. 3DEP is a program that is designed to systematically collect enhanced elevation data over the United States over an eight-year period. Improved elevation data would result in significant benefits for Interior bureaus that have identified many needs that coincide over a geographic area such as wetlands inventory and mapping, endangered species and fisheries and habitat conservation, and migratory birds. In particular, enhanced elevation data would dramatically improve precision farming across the United States. A more accurate depiction of elevation would help farmers determine a more accurate rate for applying agricultural chemicals and thus lead to significant cost savings and a reduction in agricultural pollution.

Water Resources Management. USGS research supporting Water Resources Management support Federal, State, tribal, and local managers to make decisions needed to sustain water resources. Work in the USGS WaterSMART initiative is an example of the work which could be supported through this investment. The National Water Census (implemented through the WaterSMART initiative) is a USGS research program on national water availability and use that develops new water accounting tools and assesses water availability at the regional and national scales. Through the Water Census, the USGS is integrating diverse research on water availability and use and enhancing understanding of the connection between water quality and water availability. Research is designed to build decision support capacity for water management agencies and other natural resource managers. The Water Census is investing $5.0 million over the period of 2011 to 2016 to construct the first site-specific water withdrawal database of all 57,000 public supply systems in the United States. This is a significant advancement that is being conducted in conjunction with the U.S. Environmental Protection Agency. With additional funds, the USGS would enhance the National Water Census through investments in databases for municipal and industrial return flows (wastewater discharges), irrigation water withdrawals and return flows, and a geospatial framework to relate water use withdrawals and return flows to stream reaches and water budgets.

Species Protection and Health. The USGS has been conducting research on providing scientific information and methodologies to better prevent, detect, and control Asian carp. The proposed increase would allow the USGS to broaden research capacity and accelerate the deployment of Asian Carp Control Technologies. Finally, an investment in Species Protection and Health would provide tools, research, and monitoring needed to protect the health and survival of animal and plant species. USGS research on the impact of energy development and delivery to rare and endangered species is an example of the work which could be supported through this investment. One of the greatest challenges currently facing Interior is the identification of areas suitable for energy development and delivery that optimizes energy production while minimizing impacts to sensitive ecological resources, particularly rare and endangered species. Effective mitigation strategies can only be developed at a landscape scale using Geographic Information System technology, science-based modeling and analysis, landscape-level forecasting, and

long-term monitoring. The USGS would enhance capabilities and expand research in population and habitat assessments at spatial scales suitable for regional or cumulative effects analyses; develop forecasting tools that would incorporate climate and land change projections; and develop and adapt new technologies, including statistical approaches, to monitor impacts of energy systems on wildlife species and sensitive ecosystems. The USGS research provided to Interior bureaus would help them in identifying potential opportunities and conflicts associated with conservation and resource development goals; and use this information to better inform and guide policy and management decisions.

Climate Resilience. The President's Opportunity, Growth, and Security Initiative includes a proposal to establish a Climate Resilience Fund to help communities across the country better prepare for existing and future threats exacerbated by climate change. USGS research and modeling on the impacts of drought is an example of the type of work which could be supported with this type of investment. Investments in climate resilience would support the development of information and tools to enable resource managers to understand the potential impacts of a changing climate and to plan and adjust their operations to be more resilient in managing the public trust and ensuring sustainable stewardship of resources.

One example of the type of investment that would be made is with the USGS drought monitoring tools. The USGS is a major partner in the Famine Early Warning System Network (FEWS NET) which combines satellite-based indicators of agricultural crop status with long-term weather and climate forecasts to advise international aid agencies' prepositioning of food aid and to inform growers' annual and seasonal planning. FEWS NET's use of Landsat-quality satellite information and integration with long-range forecasts enables early, specific warning of annual and season drought trends. Similarly, in the Western United States, agribusinesses and state water rights authorities rely on Landsat-based estimates of consumptive water use to monitor and manage irrigation during dry periods. However, the existing indicators of drought's impacts to crops are based on lower-resolution satellite data and do not take advantage of the Landsat satellites' higher-resolution eight-day data collection cycle. The weekly Vegetation Drought Response Index (VegDRI) is an operational drought model and map created each week where the information is used by numerous organizations for drought mitigation decision support. These weekly analyses are complementary to data from weather stations and streamgages, and provide drought mitigation decision support including declarations of drought disaster areas. The USGS would invest the new funding in automating the VegDRI weekly updates as well as incorporate higher-resolution Landsat data to improve the specificity of the drought impact estimates and the identification of candidate areas for disaster declarations.

The USGS 2015 Budget Request

Administration Priorities and Secretarial Initiatives

A balanced portfolio is essential to a healthy science agency, ensuring that it can maintain diverse expertise to respond to constantly evolving science needs. Accordingly, the budget request was developed with an eye toward balancing investments in monitoring, research, assessments, technical assistance, information delivery, and partner-driven activities.

Funding for USGS Initiatives				
Initiatives	**2013 Actual**	**2014 Enacted**	**2015 Request**	**Change from 2014 Enacted**
Meeting the Challenge: Climate Change Science for a Changing World	48,410	49,410	67,560	18,150
Ecosystem Priorities	39,516	40,515	52,915	12,400
Hydraulic Fracturing	9,173	10,264	18,600	8,336
WaterSMART	8,052	8,052	14,452	6,400
Data Innovation and Mapping	13,621	14,376	19,612	5,236
Environmental Impacts of Uranium Mining	150	150	3,323	3,173
Earth Scientists for Tomorrow	1,602	1,602	4,302	2,700

The 2015 budget request includes targeted increases to advance Administration priorities such as Powering our Future and Responsible Use of Our Resources; Engaging the Next Generation; Earth Scientists for Tomorrow; Ensuring Healthy Watersheds and Sustainable, Secure Water Supplies (WaterSMART); Building a Landscape-Level Understanding of Our Resources; Meeting the Challenge: Climate Change Science for a Changing World; Ecosystem Priorities; Hydraulic Fracturing; Data Innovation and Mapping; and Environmental Impacts of Uranium Mining at funding levels consistent with the 2014 enacted level or higher. Below are descriptions of USGS efforts for Secretarial initiatives and Administration priorities in 2015:

- **Powering Our Future and Responsible Use of Our Resources** – Through early planning, thoughtful mitigation, and the application of sound science, Interior is working to ensure the Administration's "all-of-the-above" energy strategy includes not only traditional sources, but also the further development of new, cleaner resources to help mitigate the causes of climate change. The President's budget for the USGS proposes $40.7 million, an $8.1 million increase, for energy related activities in support of these objectives. The USGS will continue to provide energy assessments of conventional energy resources, to collaborate in research to understand the environmental impacts associated with hydraulic fracturing, and to assess the impacts of alternative energy production such as wind energy.

- **Engaging the Next Generation: Earth Scientists for Tomorrow –** The USGS has a proud history of mentoring and engaging youth, providing a broad array of research and learning experiences to young people in the Earth and biological sciences, aimed at inspiring the pursuit of scientific careers and increasing science literacy. USGS engagement with youth covers a broad age range. Typically, outreach activities and science camps are aimed at elementary and secondary school students, while internship programs employ students in high school, undergraduate, and graduate school. Programs such as GeoFORCE, a highly competitive pre-college program that provides hands-on science learning experiences for middle and high school students, provide pathways to other geoscience programs, like EdMAP, which trains the next generation of geologic mappers. In addition, programs such as the Cooperative Research Units use its existing cooperative network to work with Interior partners to improve and increase youth involvement in Interior science and resources management. The USGS engages and hires postgraduate students that include young scientists between 26-30 years, as in the Mendenhall Research Fellowship Program. Partnerships, like the USGS shares with the Alaska Native Science and Engineering Program, increase the number of indigenous American students in science, technology, engineering, and math (STEM) degrees. For additional details about youth, please see the Program Changes Section.

- **Ensuring Healthy Watersheds and Sustainable, Secure Water Supplies** – The USGS contributes to Interior's Ensuring Healthy Watersheds and Sustainable Water Supplies initiative in several ways. First is the WaterSMART effort, which involves multiple USGS mission areas and is coordinated with the BOR. As competition for water resources grows for crop irrigation, growing cities and communities, energy production, and the environment, the need for information and tools to aid water resource and land managers grows. WaterSMART, through the combined efforts of BOR in the West and the USGS throughout the entire Nation, provides the foundation for a sustainable water strategy. The USGS streamgage network provides streamflow information and understanding for National, State, tribal, and local economic well-being, the protection of life and property, and efficient and effective water resource management. Research and development into complementary methods of streamflow data collection is important to measure areas in which it is not practical or feasible to place a gage. For more details about WaterSMART, please see the Program Changes Section.
- **Building a Landscape-Level Understanding of Our Resources** – A key component of Interior's work is providing applied and basic scientific research and the development of science products and tools to inform decisionmaking by Interior bureaus and offices and local, State, national, tribal and international communities. Mapping and imagery tools facilitate sound planning and management, and consideration for the functionality of entire ecosystems, the resilience of species and the predictability of decisions for industry. The Geospatial Platform is one example of a decision-making tool that offers an Internet-based platform for sharing trusted geospatial data and provides services and applications for use by the public, government agencies and partners to meet their mission needs. The National Map, a set of databases of geospatial data of the Nation's topography, natural landscape and built environment, is another decision making tool.
- **Meeting the Challenge: Climate Change Science for a Changing World** – The USGS has conducted climate change research for more than 100 years, in an effort to understand and examine the impacts of climate change on humans, wildlife, and the environment. The Climate and Land Use Change (CLU) Mission Area conducts research to inform resource managers' strategies to mitigate and adapt to climate change, through the National Climate Change and Wildlife Science Center (NCCWSC)/Department of the Interior Climate Science Centers (CSC) Program, the Climate R&D Program, and the biological carbon sequestration project based on Landsat satellite data and Landsat-based essential climate variables provided by the Land Remote Sensing (LRS) Program. Continued research that leverages all of these programs' strengths is needed to better understand climate change impacts on natural resources and support decisionmakers responsible for the infrastructure of the Nation. For additional details about climate change, please see the Program Changes Section.
- **Ecosystem Priorities** – The President's 2015 budget request includes strong support for the USGS to contribute to ecosystem landscape restoration efforts in the Chesapeake Bay, Everglades, California Bay Delta, Great Lakes, Upper Mississippi River, Columbia River, Puget Sound, Klamath River, and Gulf Coast. The USGS is also requesting funds for combating invasive species that will go toward eradicating Asian carp in both the Great Lakes and Upper Mississippi ecosystems, and to battle new and emerging invasives. The USGS is working with Interior bureaus and other agencies to provide scientific tools for strategic decisionmaking in

support of restoring clean water, conserving National parks and lands, restoring habitats for fish and wildlife, and better understanding ecosystem services as outlined in the *Sustaining Environmental Capital* report by the President's Council of Advisors on Science and Technology. For additional details about ecosystem priorities, please see the Program Changes Section.

- **Hydraulic Fracturing –** The President's 2015 budget provides continuing support for a collaborative interagency research and development effort by the USGS, the DOE, and the Environmental Protection Agency (EPA) to conduct a national science, research, and development program aimed at understanding and reducing the potential environmental, health, and safety impacts of hydraulically fractured oil and gas resources. The primary objective of this effort is to address the most urgent questions and decision-support needs surrounding hydraulic fracturing. To accomplish this, Interior, the DOE, and the EPA are developing a multi-year National Research Strategy designed to address the highest priority research questions, new and innovative technological opportunities, and community concerns associated with safely and prudently developing resources through hydraulic fracturing. The goal is to produce decision-ready information to ensure the prudent development of energy resources and the protection of human health and the environment. For additional details about hydraulic fracturing, please see the Program Changes Section.
- **Data Innovation and Mapping –** The President's 2015 budget invests in growing needs for high-quality topographic data and for a wide range of other three-dimensional representations of the Nation's natural and constructed features. The Three-Dimensional Elevation Program (3DEP) initiative will systematically collect enhanced elevation data using lidar and other technologies across the United States. A 2012 study funded by the USGS and partners identified 602 mission-critical activities of 34 Federal agencies; the 50 States; and selected local and tribal government, private, and other organizations. The USGS plans to finalize the 3DEP implementation plan by January 2015. In addition, the USGS is working with the State of Alaska and Federal partners to replace the more than half-century-old topographic maps for Alaska. New and accurate geospatial data are used to improve aviation safety; understand and mitigate the negative effects of coastal erosion and storm surges; provide infrastructure for Arctic shipping and resource extraction; and protect biodiversity and habitats. For additional details about Data Innovation and Mapping, please see the Program Changes Section.
- **Environmental Impacts of Uranium Mining –** The President's 2015 budget would begin the implementation of the integrated 15-year science plan by collecting new baseline data, expanding smaller scale studies from previous years, and laying the foundation for future modeling and monitoring efforts. Funding for this initiative supports characterization of baseline radiation and chemical concentrations in sentinel species (e.g., birds, mammals and reptiles) from samples obtained at targeted mine sites before ore extraction. The USGS would complete the uranium baseline assessment by analyzing the pre-mining background levels of uranium in dust water, and biota, and begin modeling the 'natural' transport and occurrence of uranium and radiation in native animals and plants. For additional details about environmental impacts of uranium mining, please see the Program Changes Section.

Technical Changes

In 2015, the USGS proposes a name change for the Administration and Enterprise Information (AEI) budget activity and the two subactivities within it. The new name for the budget activity would be Science Support. The subactivity formerly referred to as Science Support, would now be Administration and Management, and the subactivity formerly referred to as Security and Technology would now be Information Services. More details about the name change can be found in the Science Support Section.

High Priority Performance Goals

Climate Change Adaptation

The USGS is a contributor to the Climate Change Adaptation High Priority Performance Goal (HPPG): By September 30, 2015, the Department of the Interior will demonstrate "maturing" implementation of climate change adaptation, as scored when implementing strategies provided in its Strategic Sustainability Performance Plan. In 2014, progress for improved climate change adaptation and collaboration across the Interior will include pursuing the following significant milestones:

- Establishment of climate change adaptation guidance in all of the Interior land management bureaus, distributed throughout each bureau's regional offices and individual management units.
- Establishment of climate adaptation networks within each bureau and across the Department, with individual performance measures in place.
- New climate change adaptation data and decision tools relating to—
    - predicting and anticipating wildland fire trends,
    - predicting the spread or introduction of invasive species, and
    - tracking changes in wildlife abundance and distribution.
- Integrated vegetation surveys representing the entire lower 48 States.
- Creation of a Web-based searchable database of the vulnerability assessments prepared across all Federal land management agencies.

Bureau Contribution: The CLU Mission Area is the primary contributor from the USGS to this HPPG. The CLU Mission Area conducts climate vulnerability assessments used by Interior land management bureaus to develop adaptation plans. The NCCWSC and the eight CSCs will lead the effort for the USGS to conduct science to support this HPPG. The USGS funding for climate change in 2013 is $54.8 million, $53.6 million in 2014, and $72.0 million in 2015.

Implementation Strategy: The Climate Change Adaptation HPPG presents an opportunity to unite climate change research and science conducted by Interior bureaus. Interior's implementation strategy for the Climate Change Adaptation HPPG includes:

- Mainstream and integrate climate change adaptation into both agencywide and regional planning efforts, in coordination with other Federal agencies as well as State and local partners, tribal

governments, and private stakeholders: All eight CSCs now have permanent Federal directors, and the partner universities' science staffing at each CSC continues to grow, allowing the CSCs to expand their science outputs, ensure effective links with other partners, and conduct effective program operations. All CSCs have five-year strategic plans that outline regional science priorities. These plans, with ongoing stakeholder input, are used to guide annual science planning and funding decisions. In 2015, the CSCs will continue to focus on high-priority science that identifies potential impacts to various natural and cultural resources, and will expand collaboration with other science providers in these focus areas. The NCCWSC has created a draft national science plan to provide a framework for the climate change- impact research conducted or coordinated by the NCCWSC. This plan also establishes a context for regional and national synthesis of science products and information across the CSC network.

- Ensure agency principals demonstrate commitment to adaptation efforts through internal communications and policies: The USGS has established the CLU science strategy that provides a number of high-level goals for CLU Mission Area programs and is a vehicle for scientists and partners to get a general overview of our activities. The plan outlines seven broad goals for USGS climate change science for the coming decade: (1) rates, causes, and impacts of past global changes; (2) global carbon cycle; (3) biogeochemical cycles and their coupled interactions; (4) land use and land cover change rates, causes and consequences; (5) droughts, floods, and water availability under changing land use and climatic conditions; (6) coastal response to sea-level rise, climatic change and human development; and (7) biological responses to global change. In addition, annual guidance documents, issued by the CLU Mission Area, provide field units with operational guidance about priorities and objectives.
- Design and construct new or modify/manage existing agency facilities and infrastructure with consideration for the potential impact of projected climate change: The USGS is working with Interior on a vulnerability assessment tool to address the USGS real property inventory. The focus of the vulnerability tool is to evaluate the effects of climate change such as sea-level rise, storm surge frequency and elevation, air temperature changes, and precipitation changes on the USGS real property portfolio.
- Update agency external programs and policies to incentivize planning for and addressing the impacts of climate change: The USGS provides external funding to support and facilitate climate adaptation. The single largest funding source is the CSCs (e.g., $28.1 million in 2015). Each CSC is a Federal-university collaboration, and develops a science portfolio in consultation with regional resource managers and science partners. Specifically, in 2015, the NCCWSC/CSC Program requests an increase of $8.6 million to strengthen this work, focusing on interagency and regional coordination of climate science and adaptation planning activities; developing actionable science focused on decisionmakers' needs, including providing science to better integrate climate mitigation and adaptation planning; and addressing Native American tribal nations' needs for climate science.

Youth Stewardship of Natural and Cultural Resources

The USGS is a contributor to the Youth Stewardship of Natural and Cultural Resources HPPG: By September 30, 2015, the Department of the Interior will provide 40,000 work and training opportunities

over two fiscal years (FY 2014 and FY 2015) for individuals age 15 to 25 to support the mission of the Department.

Bureau Contribution: The USGS contributes to Interior's goal by engaging youth through meaningful hands-on work experience, training, professional mentoring and graduate research in the natural sciences. Increasing the number of youth hired at the USGS is critical to achieving the USGS mission now and in the future. The USGS budget contribution to Youth Stewardship of Natural and Cultural Resources in 2013 was $1.9 million, $1.9 million in 2014, and is $3.1 million in the 2015 budget request. In addition to this funding, base funding is included in several USGS programs that support Youth activities.

Implementation Strategy: The USGS has a rich culture of mentoring, engaging, employing, and educating youth in the geosciences. The USGS is implementing a Youth and Education in Science component to leverage resources, achieve efficiency, provide a consistent program and process methodology, and increase strategic vision. The USGS is tracking new and current youth hires and youth hired by our partners; is enhancing participation in the sciences by women, Native American, and minority students; is providing training and experiences in the natural sciences outdoors; and is creating science career pathways that reach out to students in grades K-16. The USGS engages in a wide array of collaborative and diverse Youth activities nationwide. For example:

- Through presentations, demonstrations, and hands-on activities, the USGS has encouraged, mentored, and taught children the importance of appreciating their environment and understanding that they are the future stewards of the Earth. The USGS organizes, participates, and partners on hundreds of events every year that reach over 30,000 children and families. These activities have a key educational component that increases the child's knowledge of the environment through physical activity. The USGS encourages youth across the landscape to engage in the outdoors and to reconnect with nature, field trips, science camps, and family workshops.
- GeoFORCE is a powerful, highly competitive pre-college program that provides spectacular, hands-on science learning experiences for talented middle and high school students from rural southwest Texas and Houston. The goal is to encourage underserved minority youth to excel in the sciences and pursue higher education in scientific fields. In 2015, USGS scientists will continue to lead programs in the field, lead tours of USGS Headquarters and laboratories, and financially support the hiring of GeoFORCE counsellors, who are primarily geology majors from various universities. The demographics show that about 80 percent of the students are of minority background including Hispanics, African Americans, Asians, and Native Americans. The success of the program is measured by the fact that 100 percent of GeoFORCE students graduate from high school, 96 percent gaining admission to college, and 64 percent declare STEM majors, many of which go into geology or related earth sciences.
- The USGS and the Denver Mayor's Office initiated a collaborative employment partnership in 2011 aimed at promising inner city, at risk youth. The Denver Mayor's Office screened students and provided life skills training. The USGS interviewed, selected, and provided meaningful work assignments. The USGS also provided a mentor, field trips to the diverse science activities, and group counseling sessions. The initial 2011 cohort had 14 students from either high school or beginning college. In 2012, the Partnership included the Albuquerque Mayor's Office, and a

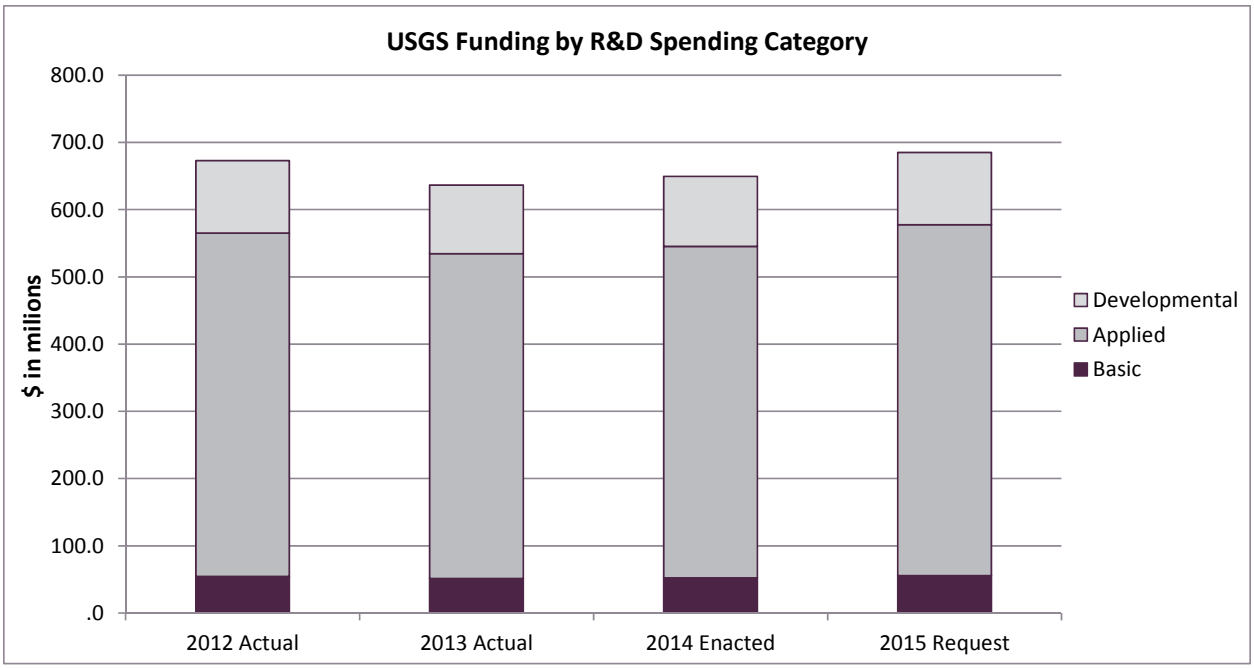
cohort of 21 students. The Partnership was suspended in 2013 due to Sequestration, restarted in Denver in 2014, and plans to expand to Albuquerque and Flagstaff in 2015.

- In 2015, the National Association of Geoscience Teachers (NAGT)/USGS Cooperative Summer Field Training Program will mark the 50th year of what is now the longest running STEM internship program in the Nation. Over 2,200 students have participated in this program, with an impressive number of participants moving on to distinguished careers with the USGS, academia, or industry. While the majority of these interns go on to graduate school, over one-third who have participated in the program became permanent hires of the USGS. The Education Office manages and oversees all aspects of the NAGT/USGS Internship Program, including the collection of evaluations by both interns and science mentors that are conducted annually, with results distributed in an annual report to all cooperating parties.
- The USGS Western Ecological Research Center, in partnership with the Western Region, the Alaska Science Center, and the USGS Diversity Council**,** held outreach sessions at Bret Harte School in Sacramento, CA, and at the Alaska Native Cultural Charter and Aquarian Charter Schools in Anchorage, AK, engaging sixth graders in the Pacific Nearshore Project. The diverse scientific team used videos, specimens, and field equipment to educate youth about sea otters as indicators of coastal health, and raised awareness of scientific pursuits as career options. The students from the three schools then met by Skype in May 2012, where they shared impressions of what they had learned from the classroom sessions. The impact was tremendous. The children were excited to meet their counterparts, some of whom were Native Americans who utilize sea otters as part of their heritage. Conversely, many girls and boys from Bret Harte have never been out of the city. They conversed in native Alaskan dialects, Spanish, Serbian, and inner city slang. The Pacific Nearshore project has produced a diversity-oriented, public relations video, which USGS Scientist Dr. Miles (who initiated the program with his colleagues at the Western Ecological Research Center) and his colleagues deliver as a program twice a year to these and other local schools.
- The USGS funded the Native Youth in Science – Preserving Our Homelands summer science camp for sixth-to-eighth graders from the Mashpee Wampanoag Tribe. The USGS Office of Tribal Relations collaborated with the Mashpee Wampanoag Departments of Education and Natural Resources, the Bureau of Indian Affairs, and the Waquoit Bay Estuarine Research to demonstrate how science topics learned in school relate to Wampanoag culture.

Due to sequestration and the hiring freeze in 2013, the USGS fell short of reaching its Youth target for the first time. The lessons learned in 2013 will allow the USGS to better position itself to meet Youth goals in 2014 and beyond. For example, the Human Resources Office partnered with the Office of Budget, Planning, and Integration to develop an efficient method to track hiring waivers and facilitate an organized and expeditious processing of requests, which will offset any administrative delays experienced in 2013. The Youth and Education Office is announcing the youth funding cost-share opportunities earlier to afford more time for waiver consideration and job posting. The Youth and Education Office put into place a national cooperative agreement with Environmental Stewards, part of Conservation Legacy, which is poised to increase our partnership participation dramatically. The development and startup of the Youth and Education in Science Council for 2015 will further align the Youth goals with the USGS strategic science direction.

National Science Perspective: Addressing National Science and Technology Priorities

Investments in R&D promote economic growth and innovation and ensure American competitiveness in a global market. R&D is the core of the USGS mission. Total R&D funding is $685.1 million, which is 63.8 percent of the total USGS requested budget. This level is a net increase of $35.6 million, or 5.5 percent above the 2014 enacted level.



Of the $685.1 million R&D total, $55.5 million is for basic research, $522.0 million is for applied research, and $107.6 million is for developmental research. All USGS basic, applied, and developmental research ultimately supports the goal of providing the scientific framework for decisionmaking. The increased funding for R&D will advance the USGS's capacity to address emerging societal challenges related to energy sustainability, climate adaptation, water availability, and ecosystem priorities.

Ensuring Scientific and Scholarly Integrity

High quality science and scholarship play an important role in advancing Interior's mission. The USGS established the Office of Science Quality and Integrity in 2011, charged with the oversight for implementation of this and other critical policies to ensure the highest quality objective science. Interior released a new Scientific and Scholarly Integrity Policy in February 2011 that set forth clear expectations for all employees to uphold the principles of scientific integrity and establishes a process for impartial review of alleged breaches of those principles. The policy, based on the principles found in Secretarial Order 3305, builds on the previous USGS Scientific Integrity Policy. The policy applies to all departmental employees when they engage in, supervise, or manage scientific or scholarly activities; analyze and publicly communicate scientific or scholarly information; or use this information or analyses to make policy, management, or regulatory decisions. Additionally, the policy includes provisions for

contractors, partners, grantees, lessees, volunteers and others who conduct these activities on behalf of Interior.

The President's Management Agenda

The Department of the Interior supports the President's Management Agenda to cut waste and implement a government that is more responsive and open. The USGS budget supports the Interior's plan to build upon the Accountable Government Initiative through a set of integrated enterprise reforms designed to support collaborative, evidence-based resource management decisions; efficient Information Technology (IT) Transformation; optimized programs, business processes, and facilities; and a network of innovative cost controlling measures that leverage strategic workforce alignment to realize an effective 21st Century Interior organization.

Information Technology Transformation

The 2015 President's budget request includes $832,000 for the USGS's participation in the Department's IT Transformation efforts through the Department's Working Capital Fund. These funds will support IT Transformation project-level planning and coordination, and the implementation of enterprise IT services.

Real Property

In support of the Freeze the Footprint Program, the Administration issued policy-restricting agencies from increasing the size of their real estate inventory for space predominately used for offices and warehouses compared to its 2012 baseline. This policy, in conjunction with Interior's goals for real property cost savings, drove the USGS to develop a Real Property Strategic Plan and implement real property cost savings projects. Through these cost savings actions such as consolidations, colocations, and disposals, the USGS plans to reduce its inventory of office and warehouse space by over five percent by the end of 2015 compared to the 2012 baseline.

Strategic Objective Performance Summary

DOI Strategic Plan

In 2014, Interior will publish the 2014–2018 DOI Strategic Plan (Plan), in compliance with the principles of the Government Performance and Results Act (GPRA) Modernization Act of 2010. The Plan provides a collection of mission objectives, goals, strategies, and corresponding metrics that enable an integrated and focused approach for tracking performance across a wide range of Interior programs. The Plan for 2014–2018 is the foundational structure for the description of program performance measurement and planning for the 2015 President's budget; further details for achieving the Strategic Plan's goals are presented in the Interior Annual Performance Plan and Report (APP&R). USGS science strategy plans are fully consistent with the goals, outcomes, and measures described in the Plan and related implementation information in the APP&R.

USGS Strategic Planning

In 2007, the USGS published a Bureau Science Strategy, "Facing Tomorrow's Challenges—U.S. Geological Survey Science in the Decade 2007–2017." It provided a view of the future, establishing science goals that reflected the USGS's fundamental mission in areas of societal impact such as energy and minerals, climate and land use change, ecosystems, natural hazards, environmental health, and water. Intended to inform long-term program planning, the strategy emphasizes how USGS science can make substantial contributions to the well-being of the Nation and the world.

In 2010, the USGS realigned the management and budget structure, changing it from a structure associated with scientific disciplines—Geography, Geology, Biology and Hydrology—to an issue-based organization along the lines of the Science Strategy.

In 2013, seven Science Strategy Planning Teams (SSPTs) completed a10-year science strategy for each USGS mission area (*http://www.usgs.gov/start_with_science/*). Although the existing Bureau Science Strategy was a starting point for this exercise, the SSPTs went well beyond the scope of the existing document—balancing foundational science with new opportunities for research directions and incorporating cooperation and collaboration in new ways.

Each science strategy reinforces others because scientific knowledge inherently has significance to multiple issues. Leadership of the USGS and Interior use the science vision and priorities developed in these strategies for program guidance, implementation planning, accountability reporting, and resource allocation. These strategies guide science and technology investments, and workforce and human capital strategies. They inform partners regarding opportunities for communication, collaboration, and coordination.

USGS Contribution to Carrying out the DOI Strategic Plan

The USGS science portfolio contributes to Department of the Interior's Strategic Plan Mission Area 6: Building a Landscape-Level Understanding of Our Resources. To successfully carry out its mission, Interior must make decisions at the landscape scale. To effectively make these decisions, Interior must understand the resource at a landscape-level. The USGS conducts science to build this understanding and to inform decisions in land and resource planning, policy, mitigation, and management. USGS science outcomes result in data, research results, models, and tools used by resource managers and their stakeholders in landscape-level decisions.

Goal #1: Provide Shared Landscape-Level Management and Planning Tools (National Geospatial Program)

Mapping and imagery tools facilitate sound planning and management. With responsibilities for managing the Geospatial Platform, the USGS is developing these tools that can transform vast amounts of data on our resources into useful information, predictions and alternatives to inform decisions on powering our future, ensuring healthy landscapes, and ensuring sustainability water supplies. Science

underpins these data and tools and the Geospatial Platform makes them available to Interior managers, our partners, citizen scientists, and the public.

Implementation Strategy:

Landscape-level approaches to management hold the promise of a broader-based and more consistent consideration of both development and conservation, as opposed to a piecemeal approach. Over the last few decades, ecologists and conservationists have increasingly worked at larger geographic scales to improve their ability to characterize and combat complex threats and stressors such as habitat fragmentation and human population growth. When conservation is planned for and carried out at these larger scales, it is often easier to detect ecological patterns and population dynamics than with conservation undertaken within smaller units of habitat, improving the ability of conservationists to address limiting factors and achieve long-term benefits to species. The rigorous science underlying our landscape-scale databases, tools, and methodologies provides the foundation for a new generation of citizen scientists, professional experts, and organizations to better understand and care for our landscapes. By improving coordination with partner agencies, a landscape-level understanding of resources will be available for these needs.

- For the State of Alaska, continue the increased rate of acquisition of modern elevation data, develop more efficient means of updating hydrography data, and increase the rate of topographic map production.
- Enhance the National Hydrography Dataset by adding water-use information, including places where water is withdrawn, diverted, transferred, or returned to the network, in support of WaterSMART and other Federal and State agency water monitoring programs.
- Continue the three-year cycle of replacing topographic maps for the conterminous United States. Use the new enhanced elevation data to improve the quality of the topographic maps.
- Partner with Federal, State, tribal, and local agencies in the Columbia River Basin and Puget Sound priority ecosystem areas to develop detailed elevation, hydrography, and other geospatial data needed to support scientific activities, and better plan mitigation and restoration efforts.

GOAL #2: Provide Science to Understand, Model, and Predict Ecosystem, Climate, and Land Use changes at targeted and landscape-levels (biota, land cover, and Earth and ocean systems) (Ecosystems, Climate and Land Use Change)

The USGS will support scientific research to assess, understand, model, and forecast the impacts of climate change and other environmental drivers on our ecosystems, natural resources, and communities. The USGS will develop and construct strategies for adapting to climate change based on scientific analysis. The USGS will assist Federal, State, local, and tribal entities by monitoring water quality and quantity; analyzing energy and mineral resources' potential and environmental effects of their extraction and use; and analyzing and monitoring changes to the land and ocean environments.

Implementation Strategy:

Data from Landsat and other land-observing systems operated by the USGS are vital for scientists to understand changes occurring on the Earth's land surface, and to model their impacts for land and resource managers. Socioeconomic data shows a significant return on Landsat investments, with productivity enhancements and cost savings in the public and private sectors. For example, a study demonstrates the potential for approximately $100 million annual savings by using Landsat-derived applications for better water management for irrigated agriculture in the Western United States. One such product is the National Land Cover Database (NLCD), produced by the USGS in cooperation with a consortium of Federal partners. The NLCD supports thousands of science applications in the private, public, and academic sectors, and offers the only national database portraying land cover change spatially as a comprehensive "wall-to-wall" 30-meter cell database. It also provides a critical data layer in national assessments of biological carbon sequestration, water quality monitoring, wildfire monitoring and modeling, and biodiversity conservation efforts.

Improvements reflect critical climate change research developed for resource managers and policymakers. The CSCs support multiple resource management interests, including the Department of the Interior's Landscape Conservation Cooperatives (LCCs) and other resource management interests as they develop climate adaptation plans. For example, the Alaska CSC is developing, in coordination with the four Alaska LCCs, an integrated model that projects the effects of climate change on vegetation, wildfire regimes, permafrost and hydrology. Once completed, it will allow managers to integrate projected climate-change impacts in their long-term management strategies for fish and wildlife in arctic ecosystems.

- Support the Sustaining Environmental Capital initiative for piloting regional and sectorial assessments of ecosystem services including gap assessments, tests of alternative methodologies, and codification of standards and practices for natural resource decisionmaking.
- Conduct research on existing high-priority invasive species and provide information to forecast impacts of the next generation of invaders.
- Leverage new computing technologies to increase the usability of Landsat data for a wider array of users, including developing Landsat-based science products (climate data records and essential climate variables) to be updated every eight days for the United States. These Landsat science products include geospatial datasets on surface temperature, fire disturbance, snow covered area, and green biomass, and will support both natural resource managers and the climate monitoring community.
- Collaborate with National Aeronautics and Space Administration (NASA) on developing a sustained land imaging architecture for the Landsat program. NASA and the USGS will spend 2014 collectively working on an architecture study with the objective of designing a sustained land imaging program to ensure continuity of data collection, consistent with the existing 41-year Landsat dataset.

GOAL #3: Provide Scientific Data to Protect, Instruct, and Inform Communities (Natural Hazards and Environmental Health)

The USGS will support scientific research to improve the resilience of communities to natural hazards and wildlife diseases in order to preserve the quality of life and reduce the likelihood of fatalities and economic losses. The USGS will lead the scientific research on the environment and natural hazards and provide information to partners and stakeholders for use in making decisions that will protect lives.

Implementation Strategy:

The USGS's monitoring and assessments provide information and the scientific understanding that will help protect communities by significantly reducing the vulnerability of millions of people to natural hazards. For example, the USGS, working with many partners, collects accurate and timely data from modern earth observation networks and surveys, analyzes those data to assess areas that are at risk due to natural hazards, and conducts focused research to improve hazard predictions.

Human health is often related to the health of the environment and wildlife. The emergence of diseases from exposure to environmental contaminants and diseases transferred between animals and humans is a growing concern. The USGS is taking a leadership role in providing the natural science information needed by health researchers, policy makers, and the public to safeguard public health by monitoring the quality of the environment and wildlife sources which carry disease causing organisms, by identifying emerging environmental quality concerns and emerging threats from disease transmitted from animals to humans, and by providing critical knowledge that helps guide actions to manage, mitigate, and prevent adverse impacts on the environment, wildlife, and human health.

- Installed NetQuakes (low-cost strong motion seismometers) through volunteers who host the instruments. The U.S. Department of Veterans Affairs (VA) provided additional funding to install seismic sensors in VA hospitals, which allowed the USGS to instrument many more structures than planned. These efforts expand critical natural hazard knowledge and tools being developed and provided to land managers and policymakers to inform decisionmaking. In light of budgets decreased by sequestration, the USGS was able to continue to increase optimal monitoring because of volunteers, lower cost instruments and funding from other sources.
- Operate an expanded network of seismic stations in the Eastern United States, as portable stations installed with National Science Foundation funding are converted to permanent. This will improve the timeliness and accuracy of earthquake information products in the region, and provide critical data for research purposes.
- Expand monitoring of locations in areas of potential injection-induced earthquakes and, in coordination with EPA and DOE, further research and modeling of the connections between injection parameters and induced seismicity.
- Improve the Prompt Assessment of Global Events for Response (PAGER) earthquake impact assessment product, through the development of global, country-specific building vulnerability and risk indices. The goal is to identify a priori which structures are most vulnerable to collapse for any city, state, region or country.

- Complete the first comprehensive characterization of complex chemical mixtures in the Nation's streams.
- Expand baseline data for an assessment of environmental effects of uranium extraction in the Grand Canyon. This study will provide information essential to decisions related to the Secretary's moratorium on uranium mining in the Grand Canyon.
- Begin Phase II of agricultural animal feeding operations to determine fate and transport of contaminants associated with agricultural feeding operations.
- Establish a National Science Strategy for Endocrine Disrupting Chemicals (EDC), which will coordinate studies that evaluate the impacts of endocrine disruptors on aquatic and terrestrial ecosystems.
- Expand, with guidance from the National EDC Science Strategy, work on endocrine disrupting chemicals in the Chesapeake Bay Watershed.

GOAL #4: Provide Water and Land Data to Customers (Water Resources, National Cooperative Geologic Mapping Program, Energy and Minerals)

The USGS will lead the effort to provide water and land data to customers for their various uses. The USGS will gather and present data at targeted and landscape-levels to advance and refine our understanding of the earth and its geologic and ecologic systems. Three-dimensional models of ground water aquifers and energy and mineral deposits in the subsurface will be generated to help identify prospective areas for exploration and utilization. The USGS will produce vegetation maps and data to support and inform risk management of wildland fires, wildlife, and other natural resources. The USGS will deliver high-resolution geospatial databases and topographic map images to support public purposes and enhance resource management.

Implementation Strategy:

The Nation faces an increasing set of water resource challenges. The USGS will continue to monitor and conduct research to generate a more precise estimate of water availability and use for meeting current and future human, environmental, and wildlife requirements. These research and monitoring activities will help identify water resources for use by humans and the environment while also developing tools to forecast likely outcomes for landscape-level planning needs including water use and quality, and aquatic ecosystem health affected by changes in land use and land cover, natural and engineered infrastructure, water use, and climate. State and local governments rely heavily on the monitoring data that is provided by USGS monitoring systems that operate across the Nation.

As Interior's science arm, USGS produces accurate geologic maps and three-dimensional geologic frameworks that provide indispensable data for sustaining and improving the quality of life and economic vitality of the Nation. Geologic maps and research are foundational for exploring, developing, and preserving mineral, energy, and water resources; evaluating and planning for land management and environmental protection; supporting Interior's land management decisions, reducing losses from natural hazards, including earthquakes, volcanoes, landslides, and other ground failures; mitigating effects of

coastal and stream erosion; placement of critical infrastructure and facilities; and conducting basic earth science research. The geologic maps and interpretive products produced through the USGS and its state partners are served through the National Geologic Map Database, which is an authoritative and landscape-level data source for the general public, scientists, and decision makers.

The Nation faces increasing demands for domestic sources of energy and mineral resources. Interior's energy and mineral resources research, assessments, and information will improve our understanding of resource occurrence, distribution, quality, and supply and foster multidisciplinary analyses of the broad economic, environmental, and societal consequences of resource extraction and use. The outcomes of these activities will inform decision making with respect to such issues as natural resource protection, environmental health, economic vitality, and responsible resource management on Interior and other lands.

- Maintain monitoring and assessments, particularly those that address WaterSMART, the National Water Quality Assessment Program and tribal issues.
- Continue to assess the groundwater availability of the United States.
- Provide critical streamflow information at critical locations. This will support the Nation's economic well-being, the protection of life and property, and the management of the Nation's water resources by providing additional stability to the national streamgage network.
- Provide guidance and education for the National Cooperative Geologic Mapping Program 09 (NCGMP09) geologic map data schema and encourage State geological surveys to use this data standard. The concurrent use of NCGMP09 will provide a uniform mapping schema that will enable cross-border geospatial data compilations for regional research and the development of landscape scale studies.
- Collect performance metrics on the progress of geologic mapping across the Nation. The current projection shows a continued increasing trend (about two percent per year) on the amount of geologic mapping coverage and is currently geologically mapped at approximately 50 percent.
- Monitor implementation of the new National Geologic Map Database Web site interface to determine the user access of geologic maps available from the USGS and its partners. The Web site doubled in activity with the implementation of the new interface in 2013.
- Host the second annual "Best Student Geologic Map Competition" to create more visibility for geologic mapping and the program. The competition, co-hosted with the Geological Society of America brings together student geologic mappers who have submitted their geologic maps into the competition and those interested in geologic mapping. This event provides students an international forum to share their research, mapping techniques, and their enthusiasm for Earth science.
- Continue the collaborative efforts to develop a methodology and conduct a national assessment of domestic uranium resources. This effort will also continue to develop a complementary assessment methodology for potential environmental impacts associated with uranium occurrence and development. A pilot resource assessment will be conducted in 2014 and externally peer

reviewed in 2015. Continue support for collection, analysis, and dissemination of minerals information and materials flow studies.

- Continue research on mineral environmental health, domestic mineral and environmental assessments.
- Continue research to better understand the genesis and distribution of the Nation's critical mineral resources, particularly in Alaska and in the midcontinent and southeast regions of the United States.

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Program Changes

Program Changes – Priority Increases			
Component	**Subactivity/Program**	**2015 Program Change Amount ($000)**	**FTE Changes**
Meeting the Challenge: Climate Change Science for a Changing World		**18,150**	**25**
	National Climate Change and Wildlife Science Center/ DOI Climate Science Centers (CSCs)	[11,550]	[9]
	Climate Research & Development	[4,600]	[11]
	Carbon Sequestration	[2,000]	[5]
Ecosystem Priorities		**12,400**	**29**
	Environments Program	[3,500]	[8]
	Invasive Species	[4,500]	[12]
	Land Change Science	[500]	[2]
	Contaminant Biology	[200]	[0]
	National Water Quality Assessment	[1,700]	[5]
	Toxic Substances Hydrology	[200]	[1]
	Hydrologic Research & Development	[200]	[1]
	National Geospatial Program	[800]	[0]
	Science Synthesis, Analysis and Research Program	[800]	[0]
Hydraulic Fracturing		**8,336**	**20**
	Fisheries Program	[2,200]	[10]
	Energy Resources	[950]	[1]
	Contaminant Biology	[1,400]	[5]
	Earthquake Hazards	[700]	[2]
	Hydrologic Research & Development	[901]	[2]
	National Cooperative Geologic Mapping Program	[2,000]	[0]
	Science Synthesis, Analysis and Research Program	[185]	[0]
WaterSMART		**6,400**	**11**
	Groundwater Resources	[2,400]	[9]
	Hydrologic Networks & Analysis	[2,000]	[1]
	Cooperative Water Program	[2,000]	[1]
Data Innovation and Mapping		**5,236**	**0**
	National Geospatial Program	[5,236]	[0]
Environmental Impacts of Uranium Mining		**3,173**	**12**
	Contaminant Biology	[673]	[3]
	Toxic Substances Hydrology	[2,500]	[9]
Earth Scientists for Tomorrow		**2,700**	**8**
	Cooperative Research Units	[1,000]	[6]
	Administration and Management	[1,700]	[2]
Grand Total		**56,395**	**105**

Program Changes - USGS Increases			
Component	**Subactivity**	**2015 Program Change Amount ($000)**	**FTE Changes**
Pollinators		**300**	**1**
	Status and Trends	[300]	[1]
Wildlife Health		**200**	**1**
	Wildlife Program	[200]	[1]
Energy Future and Wildlife Sustainability		**1,000**	**1**
	Wildlife Program	[1,000]	[1]
Wildfire Restoration Ecology		**500**	**2**
	Environments Program	[500]	[2]
OCS Ecosystems Decisions		**300**	**2**
	Environments Program	[300]	[2]
Landsat Science Products for Climate and Natural Resources Assessments		**1,500**	**3**
	Land Remote Sensing	[1,000]	[0]
	Land Change Science	[500]	[3]
Alternative Energy Permitting on Federal Lands		**1,300**	**2**
	Energy Resources	[1,300]	[2]
Emerging Contaminants & Chemical Mixtures		**1,450**	**2**
	Toxic Substance Hydrology	[1,450]	[2]
Streamgages		**1,200**	**0**
	National Streamflow Information Program	[1,200]	[0]
Streamgage R&D		**700**	**1**
	Hydrologic Research & Development	[700]	[1]
National Hydrologic Modeling/Groundwater Sustainability		**750**	**3**
	Hydrologic Networks & Analysis	[750]	[3]
Tribes		**1,000**	**7**
	Cooperative Water Program	[1,000]	[7]
Big Earth Data Initiative		**2,000**	**0**
	Science Synthesis, Analysis and Research Program	[2,000]	[0]
National Map Modernization		**1,908**	**9**
	National Geospatial Program	[1,908]	[9]
Tribal Science Coordination		**300**	**0**
	Administration and Management	[300]	[0]
DOI Science Coordination		**200**	**1**
	Administration and Management	[200]	[1]
Reducing the Facilities Footprint - Cost Savings and Innovation Plan (CSIP)		**5,365**	**0**
	Rental Payments and Operations & Maintenance	[5,365]	[0]
Grand Total		**19,973**	**35**

Program Changes - USGS Decreases			
Component	**Subactivity**	**2015 Program Change Amount ($000)**	**FTE Changes**
Fisheries Program Research		**-1,000**	**-8**
	Fisheries Program	-[1,000]	-[8]
Wildlife Program Research		**-1,200**	**-7**
	Wildlife Program	-[1,200]	-[7]
Environments Program Research		**-3,220**	**-18**
	Environments Program	-[3,220]	-[18]
National Civil Applications Program/Civil Applications Committee		**-2,547**	**-12**
	Land Remote Sensing	-[2,547]	-[12]
Land Change Science Research		**-1,000**	**-7**
	Land Change Science	-[1,000]	-[7]
Energy Research		**-1,000**	**-2**
	Energy Resources	-[1,000]	-[2]
Oil, Oil Shale, and Gas Assessments		**-500**	**-1**
	Energy Resources	-[500]	-[1]
Contaminants in Wastewater Projects		**-369**	**-1**
	Toxic Substances Hydrology	-[369]	-[1]
Eliminate Geodetic Monitoring and Active-Source Seismic Profiling		**-700**	**-2**
	Earthquake Hazards	-[700]	-[2]
Coastal Vulnerability Studies		**-1,000**	**-1**
	Coastal & Marine Geology	-[1,000]	-[1]
Water Quality Monitoring		**-2,000**	**-8**
	National Water Quality Assessment	-[2,000]	-[8]
HR&D Monitoring and Assessments		**-1,500**	**-7**
	Hydrologic Research & Development	-[1,500]	-[7]
Watershed Support, Information Delivery, & Technical Support		**-1,500**	**-7**
	Hydrologic Networks & Analysis	-[1,500]	-[7]
Monitoring and Assessments		**-3,264**	**-9**
	Cooperative Water Program	-[3,264]	-[9]
Funding to State Institutes		**-3,000**	**0**
	Water Resources Research Act Program	-[3,000]	[0]
Bio-Science Data Synthesis		**-3,000**	**-4**
	Science Synthesis, Analysis and Research Program	-[3,000]	-[4]
Glacial Aquifers Project		**-2,000**	**0**
	National Cooperative Geologic Mapping Program	-[2,000]	[0]
Land Cover Data		**-422**	**-1**
	National Geospatial Program	-[422]	-[1]
Nation's 133 Largest Urban Areas		**-4,082**	**-25**
	National Geospatial Program	-[4,082]	-[25]
NGP Program Coordination and Partnership Development		**-822**	**-4**
	National Geospatial Program	-[822]	-[4]
The National Atlas		**-2,674**	**-18**
	National Geospatial Program	-[2,674]	-[18]
Reduction to Administrative Services		**-4,500**	**-16**
	Administration and Management	-[2,200]	-[14]
	Information Services	-[2,300]	-[2]
Grand Total		**-41,300**	**-158**

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Priority Increases

Meeting the Challenge: Climate Change Science for a Changing World

Meeting the Challenge: Climate Change Science for a Changing World						
		2013 Actual	2014 Enacted	Program Changes	2015 Request *	Change from 2014 Enacted (+/-)
National Climate Change and Wildlife Science Center/DOI Climate Science Centers (CSCs)		23,735	23,735	11,550	35,285	+11,550
	FTE	40	40	9	49	+9
Climate Research & Development		20,495	20,495	4,600	25,095	+4,600
	FTE	123	123	11	134	+11
Biological Carbon Sequestration		4,180	5,180	2,000	7,180	+2,000
	FTE	8	12	5	17	+5
Total Requirements ($000)		**48,410**	**49,410**	**18,150**	**67,560**	**+18,150**
	Total FTE	**171**	**175**	**25**	**200**	**+25**

* 2015 Request column does not include fixed costs.

Justification of 2015 Program Changes

The 2015 budget request for the U.S. Geological Survey's Meeting the Challenge: Climate Change Science for a Changing World initiative is $67,560,000 and 200 FTE, a program increase of +$18,150,000 and +25 FTE above the 2014 Enacted level.

Overview

Climate change requires that the Nation prepare for an increasingly wide range of temperature and precipitation patterns, including longer and more intense droughts, heat waves, and other climate-related environmental change. The USGS has conducted climate change research for more than 100 years, in an effort to understand the impact of climate change on humans, wildlife, and the environment. The Climate and Land Use Change (CLU) Mission Area conducts research and assessments to inform resource managers' strategies to mitigate and adapt to climate change, through the National Climate Change and Wildlife Science Center (NCCWSC)/Department of the Interior Climate Science Centers (CSC) Program, the Climate Research and Development (R&D) Program, and the biological carbon sequestration project based on Landsat satellite data and Landsat-based essential climate variables (ECVs) provided by the Land Remote Sensing Program. Continued research that leverages all of these programs' strengths is needed to better understand climate change impacts on natural resources and the infrastructure of the Nation.

Program Performance

Science for Adapting to a Changing Climate +11,550,000/+13 FTE

National Climate Change and Wildlife Science Center/Department of the Interior
Climate Science Centers (+8,550,000/+6 FTE)

Established in 2008, the NCCWSC has created eight regional CSCs to provide resource management agencies with science and technical support on the impacts of climate change on fish, wildlife, and ecological processes. In 2015, the NCCWSC/CSC Program requests an increase of $8.6 million to strengthen this work, focusing on interagency and regional coordination of climate science and adaptation planning activities; developing actionable science focused on decisionmakers' needs, including providing science to better integrate climate mitigation and adaptation planning; and addressing tribal needs for climate science.

In early 2013, Interior released a policy that requires Interior bureaus and offices to incorporate climate adaptation into policies, programs, planning, and operations. Identifying which species, ecosystems, and regions are likely to experience negative effects from climate change is a crucial initial step in building a climate adaptation program. Many Federal, State, tribal and other entities are conducting vulnerability assessments. These entities need to be able to easily access the findings of completed or ongoing assessments learn from existing methods and data to develop new studies, and combine results to provide larger and more meaningful conclusions. In 2015, the NCCWSC would work with an existing interagency/State coordination group and tribes to continue development of a public cross-agency database and field guide to vulnerability assessments. This project would support Interior and other agencies in establishing standards and best practices, tracking progress for such assessments, and strategically prioritizing adaptive management actions.

Assuring that Federal, State, and other scientific activities are efficiently and effectively devoted to high priority needs requires an increased level of coordination. In 2015, the NCCWSC would develop and implement the technical means to track relevant climate change adaptation-science across Federal agencies and ensure the availability of this information in a Web accessible format at the regional and national scale. Additionally, the CSCs would continue to work with regional partners to identify common priorities and develop multiagency strategies that ensure coordinated implementation of public science investments to target the most critical management needs. This cross-agency dialogue convened by the CSCs represents a critical component of an effective and efficient Federal response to the climate science needs of managers. Investment in better coordination allows the NCCWSC and CSCs to better leverage the capacity and expertise of existing institutions, eliminate redundancy, make maximum use of existing data, and better support the needs of decisionmakers.

Ensuring that scientific understanding translates into practical application-ready solutions is a major challenge for the scientific community. The NCCWSC and the CSCs are implementing multiple approaches to ensure that managers and scientists "co-develop" actionable scientific products. In 2015, all CSCs would significantly expand their activities that support adaptation planning, with a focus on meeting the needs of specific decisions and planning activities, and on delivering application-ready

scientific information. Building on existing CSC stakeholder interactions, the CSCs would work with regional managers to identify high priority policy management decisions that could be informed by research results, then ensure close working relationships between scientists, managers and decisionmakers to assure that science projects provide decision ready outcomes. This ongoing collaboration between research scientists and land managers is essential to the successful production of actionable science. The NCCWSC would work with the USGS biological carbon sequestration project to identify options for building climate mitigation into climate adaptation planning, in particular by developing decision tools to help natural resource managers account for the carbon impacts of routine management practices as well as future climate adaptations. The CSCs would pilot this effort through regional projects focused on migratory birds and on the impacts of extended drought on ecosystems.

Native American communities are increasingly engaging with the USGS and other partners to develop climate adaptation programs, and their needs for scientific and planning information are likewise increasing. In 2013, the NCCWSC/CSC Program established a Federal Advisory Committee: the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS). In early 2014, the ACCNRS recommended that the USGS convene tribal and indigenous partners from across the CSC network to identify common and high priority tribal needs. This recommendation would complement work at each of the CSCs, where scientists work with tribes to identify high priority tribal resource management concerns and build a science portfolio that provides information directly responsive to these needs. In 2015, the NCCWSC and the CSCs would help identify and implement best practices for the integration of traditional ecological knowledge into CSC science products. These efforts would be guided and supported by participation of tribal interests on CSC stakeholder committees and on the ACCCNRS as well as be coordinated with the Bureau of Indian Affairs climate programs, tribal governments, consortia, and organizations, and other Federal climate efforts in Indian Country. Finally, in 2015 the CSCs would build on existing training and educational efforts, working with tribes in the development of climate adaptation strategies. The CSCs would expand research on key climate concerns, such as identifying those “First Foods” and similar culturally valued interests (plants, animals) whose existence or access is threatened by climate change.

Climate Research and Development (+2,600,000/+7 FTE)

For more than 50 years, the Climate Research and Development (R&D) Program has supported fundamental multidisciplinary research needed to understand patterns of climate and land use change and their impacts on the Earth system. In 2015, the Climate R&D Program requests an increase of $2.6 million to focus efforts on emerging science needs. This research would improve understanding of regional responses to climate and land use stressors and forecasting of impacts of different climate and land use scenarios.

An important emerging science need is the identification and documentation of long-term patterns of drought and storms. Recent droughts and model projections of increased aridity in parts of the United States and elsewhere have raised concerns about the ability of society to respond to and mitigate impacts of altered water availability. Because instrumental monitoring of climate variables such as temperature and precipitation spans only the last century or so, it is critical to integrate them with fossil and chemical indicators of past climate to understand the magnitude, frequency, spatial impacts, and drivers of droughts

and megadroughts (events that lasted decades). In 2015, the Climate R&D Program plans to initiate a research effort to document historical baseline levels of variability in water resources across the United States, providing context and setting expectations for modern-day patterns of droughts, storms, and other hydrologic events that affect coasts, urban areas, agriculture, and other sectors in our Nation.

Because of the high concentration of the U.S. population along the Nation's coastline, rising sea level has significant impacts on society, infrastructure, and coastal habitats that serve as buffers from storm surges and severe weather events. An increasing science need is to improve the ability to accurately forecast rates and magnitudes of future sea level rise. In 2015, the Climate R&D Program would conduct research to develop consistent methods to measure the amount of water contained in alpine glaciers. This research would improve understanding of the potential contributions of melting glaciers and ice sheets to sea level. In addition, the Climate R&D Program would expand research on geologic records of past high sea levels.

Another emerging science need is the response of coastal habitats to combined effects of sea level rise and changing land use. Both stressors affect the distribution of plant communities and the ecosystem services that they provide. In 2015, the Climate R&D Program would expand efforts to integrate ecological research on existing plant communities with reconstructions of past vegetation and aquatic communities to improve understanding of how coastal habitats respond to specific changes. By designing projects in consultation with resource managers within national parks and U.S. Fish and Wildlife (FWS) Refuges, the results should facilitate development of sustainable resource management strategies for the Nation's coastlines.

Effective application of climate research to address resource management needs requires ongoing communication between USGS scientists and resource managers as well as an understanding of scientific capabilities and limitations. This requires Climate R&D Program scientists to work with stakeholders on public lands to identify their most pressing science needs and coordinate with researchers to develop projects to address those needs. In 2015, the Climate R&D Program and the NCCWSC propose cost-sharing of staff, with expertise in both natural resource management and research, to work with stakeholders and researchers to provide translational expertise and design research efforts to provide data on ecosystem response to climate and land use changes over appropriate temporal and regional scales that would facilitate development of sustainable management plans.

Grand Challenges +$7,000,000/+12 FTE

The Administration's grand challenges are ambitious but achievable goals that harness science, technology, and innovation to solve important national or global problems and that have the potential to capture the public's imagination. The three USGS proposed grand challenges focus on climate change and encourage collaboration between Federal, State, local and tribal governments, academia, non-governmental organizations, and the private sector.

Drought Impacts & Adaptive Management **(+3,000,000/+3 FTE*)***

National Climate Change and Wildlife Science Center/Department of the Interior
Climate Science Centers (+3,000,000/+3 FTE)

Given the persistent drought in the Central and Western United States, the NCCWSC proposes a grand challenge to harness the natural and social sciences for adaptive management of the complex consequences of severe and prolonged drought. Responding to drought patterns and managing the implications of limited water resources in the Central and Western United States are primary drivers for many land and water management agencies throughout the region. The grand challenge would be carried out by adapting the Natural Hazards Mission Area's approach for developing region-specific disaster scenarios (Science Applications for Risk Reduction), and updating the method with scenario modeling and visualization tools in development by the CSCs.

In 2015, the NCCWSC and the North Central and South Central CSCs would work with Actionable Science Working Groups for both CSCs and with the Water Resources Mission Area, regional stakeholder networks and multidisciplinary science groups to develop a science-based, shared understanding of future changes in water supply and consumptive water use; and to develop common, plausible scenarios for regional drought impacts across the midcontinent. The NCWSC/CSC Program would develop models on likely socio-ecological impacts from drought and create visualization tools or processes to address competing concerns and inform resource managers' decisionmaking. This effort would build on existing socio-ecological modeling capabilities in the Land Change Science (LCS) Program to incorporate management goals identified by the working groups, to enable resource managers to pose "what if" questions about potential responses to drought impacts, and to create a tool or process to address competing concerns and inform resource managers' decisionmaking. The North Central CSC's visualization tools would allow the Actionable Science Working Groups to evaluate potential impacts of decision regarding drought. Finally, the NCWSC/CSC Program would develop an online information management system for data, models, and tools that will allow managers to use the integrated modeling of drought to explore impacts of numerous decisions.

In summary, this "grand challenge" would provide actionable information on likely ecological impacts from drought, create a tool or process to address competing concerns, and inform resource managers' decisionmaking. By focusing on the ecological impacts of drought, this "grand challenge" complements ongoing activities focused on water availability/supply and the agricultural and municipal effects of drought such as those under the National Integrated Drought Information Systems, U.S. Bureau of Reclamation basin studies, and other partners. The USGS will develop an actionable science working group, consisting of scientists and managers from the Central United States, to identify science needs for decisions on drought. This effort will provide managers in the Central United States with a climate drought toolkit for adaptation planning. The toolkit will contain common plausible scenarios for projecting drought impacts, social-ecological models that can to be used to forecast the potential implications of drought, better access to climate and drought related data, and a tool that will allow managers to visualize the potential impacts of decisions.

Climate and Land Cover Change Effects **(+2,000,000/+4 FTE)**

Climate Research and Development (+2,000,000/+4 FTE)

Land use and land cover changes cause the boundaries between wet and dry regions to shift, altering regional climate patterns and vulnerability to droughts and floods. As regional resource managers plan future alterations or restorations of the landscape, those plans could be better supported by science that integrates long historical records of land change with modern Landsat satellite-based records of land change, and integrates these records into climate modeling efforts. For example, removal and drainage of hydrologic features early in the 20th century has had a significant impact on the timing and quantities of regional precipitation. Scientists and resource managers would benefit from a better representation of historical and modern-day water bodies, wetlands, and other hydrologic features in models. Auxiliary changes to such features (whether through artificial drainage or restoration of previous hydrology) would further affect regional climate, and the capability to incorporate such feedbacks into regional-scale climate and ecosystem models would improve the capability of policymakers and planners to forecast potential impacts of different land use scenarios. The Climate R&D Program plans to focus this "grand challenge" in two areas: (1) the Florida peninsula, including the Everglades and (2) the Upper Colorado Basin.

Hydrology is the primary driver of vegetation across much of the Florida peninsula, and most restoration efforts focus on achieving 'natural' quantity and quality of water. Previous regional climate simulations indicated that 20th century land-cover changes could have reduced regional precipitation by about 10 percent, consistent with historical evidence. These results suggest that restoration of more natural land cover and hydrology would have significant impacts on regional climate, and management actions should anticipate such changes in long-term ecosystem management planning. In 2015, the Climate R&D Program would conduct research to improve the resolution of land cover data for both pre-drainage and modern datasets. Land cover classes would be refined, and a more detailed analysis of historic and modern land cover would be conducted to derive datasets suitable for coupling regional climate, hydrologic, and ecologic models. These data would be used in an expanded set of sensitivity experiments, and the regional climate model outputs would be coupled with hydrologic and ecologic models to improve capabilities to model ecosystem responses to different climate and management scenarios. Coupling of the regional climate model outputs with hydrologic and ecologic models used by resource managers would allow them to run different management scenarios and see whether there were unanticipated feedbacks to the climate system (such as increased precipitation resulting from restoration of natural Everglades hydrology). An understanding of the possible feedbacks minimizes the likelihood of surprises and increases the chance of sustainable restoration outcomes.

Water supply, demand, and drought are important issues in the Colorado River Basin, and the relative controls of climate variability vs. human modification of the landscape on water availability are poorly known. Changes in fire frequency, arroyo cutting, and hydrology have been observed since the mid-19th century, and regional climate simulations that compare outcomes using pre-settlement and present-day land cover would clarify how such changes have influenced climate and the hydrologic system. In 2015, Climate R&D Program research would develop pre-settlement and modern land cover datasets in a consistent format for input to regional climate sensitivity experiments. Pre-settlement datasets will be

compiled from a combination of archival sources, such as Land Office Surveys and other historic datasets, and paleoecological evidence. Present-day datasets will be compiled from contemporary Landsat data with 30-meter resolution, as well as other remote sensing technology. Land cover types and other aspects of both datasets will be determined in the initial phases of the project. The datasets will be used in a regional climate model simulation to conduct paired pre-settlement and present-day simulations. Ultimately, researchers would work with resource managers to couple model outputs with hydrologic and ecological models to support management needs. The Integration of regional climate models with different ecosystem models allows identification of climate feedbacks from different management/land cover scenarios. This improves the likelihood of successful ecosystem management.

Carbon Inventory and Decision Support Tools **(+2,000,000/+5 FTE)**

Carbon Sequestration (+2,000,000/+5 FTE)

Biological carbon sequestration refers to both natural and deliberate processes by which carbon dioxide (CO_2) is removed from the atmosphere and stored as carbon in vegetation, soils and sediments. The biological carbon sequestration national assessment will be completed in 2015 for all 50 States. In 2015, the biological carbon sequestration project proposes a grand challenge leveraging this initial assessment to implement a carbon inventory and tracking system for carbon stocks and flows on all Interior lands, complete with online tools to support regional natural resource decisionmaking.

Interior can lead the Federal government in establishing a national carbon inventory and tracking system. Management of carbon stored in biological reservoirs has importance both for mitigation of climate change and for adaptation to such changes. Even though the USGS has developed methods for evaluating biological carbon storage at a regional scale, these methods were developed for a broad national assessment and need refinement to be applicable to a specific site or decision. The development of an approach that identifies the scientific basis for carbon management decisions (such as ecosystem restoration) and a process to incorporate science information directly in management planning will be critical to ensure effective use of scientific results. While management activities have implications for carbon management, informed decisions are often hampered by the lack of tools for understanding or incorporating science into decisionmaking. The USGS will work directly with decisionmakers to understand their needs and timelines, and develop and apply refined geospatial models and estimation techniques for biological carbon sequestration, as well as decision-support tools supporting carbon management objectives and the tradeoffs involved with other ecosystem services.

Ongoing use and relevance of the national biological carbon sequestration assessment results require that a continuing carbon monitoring effort, which will document the impact of management actions, as well as climate change, land use change, wildfire, and other environmental perturbations on carbon stocks, carbon sequestration and other ecosystem services. In 2015, the biological carbon sequestration project would develop methodologies for updating critical input data, streamline biogeochemical models for calculating carbon stocks and sequestration, and engage an interdisciplinary team of scientists for evaluating and documenting results.

Finally, the biological carbon sequestration project in 2015, would conduct research and development for reducing carbon stock and sequestration uncertainties. Further research into quantifying and reducing uncertainties in estimating carbon stocks and sequestration is needed to incorporate information on carbon stocks and sequestration into land management decisions. Inherent uncertainties in modeling, as well as in the quality of input data on fires, land use/land cover change, and aquatic measures would be investigated, along with incorporating the Land Remote Sensing Program's new Landsat-based essential climate variables (ECVs) such as burned area extent, surface water extent, and snow covered area. The ECVs help to provide an authoritative basis for regional- to continental-scale identification of historical change, monitoring of current conditions, and predicting future scenarios. The biological carbon sequestration project would also need to adapt the national assessment methodology to the same resolution as the Landsat satellites (30 meter (m) scale) so it can be used by land managers at a local scale. Beginning in 2015, the USGS would hold a set of workshops with management agencies (Federal agencies, States, tribes, and non-governmental organizations) to identify requirements and appropriate data inputs (such as possible management actions). Pilot projects with Interior land management agencies will be initiated. For example, in 2014, the U.S. Fish and Wildlife Service (FWS) is beginning work with the USGS to incorporate biological carbon sequestration into Refuge management. FWS pilot sites include the Great Dismal Swamp, Alligator River, and Pocosin Lakes National Wildlife Refuges. This work will be the basis for a refined approach in 2015.

Ecosystem Priorities – Landscape Priorities, Invasive Species and Restoration

Ecosystem Priorities		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Landscape Priorities						
California Bay Delta		6,884	6,884	1,500	8,384	+1,500
	FTE	12	12	3	15	+3
Chesapeake Bay		7,058	8,057	1,500	9,557	+1,500
	FTE	29	29	5	34	+5
Columbia River		3,408	3,408	850	4,258	+850
	FTE	48	48	2	50	+2
Puget Sound		5,704	5,704	1,050	6,754	+1,050
	FTE	26	26	2	28	+2
Upper Mississippi River		4,608	4,608	200	4,808	+200
	FTE	23	23	2	25	+2
Invasives Species						
Brown Tree Snakes – Detection and Control		0	0	500	500	+500
	FTE	0	0	0	0	0
Everglades		6,525	6,525	1,000	7,525	+1,000
	FTE	30	30	2	32	+2
Great Lakes Asian Carp		2,478	3,464	1,000	4,464	+1,000
	FTE	6	6	4	10	+4
Upper Mississippi River Asian Carp		0	0	1,000	1,000	+1,000
	FTE	0	0	2	2	+2
New and Emerging Invasives of National Concern		0	0	1,000	1,000	+1,000
	FTE	0	0	4	4	+4
Ecosystem Services						
National Ecosystems Services Framework		0	0	1,000	1,000	+1,000
	FTE	0	0	1	1	+1
Sustaining Environmental Capital		0	0	1,000	1,000	+1,000
	FTE	0	0	2	2	+2
Eco INFORMA		0	0	800	800	+800
	FTE	0	0	0	0	0
Total Requirements ($000)		**36,665**	**38,650**	**12,400**	**51,050**	**+12,400**
	Total FTE	**174**	**174**	**29**	**203**	**+29**

Justification of 2015 Program Changes (+$12,400,000/+29 FTE)

The 2015 budget request for Ecosystem Priorities is $51,207,000 and 203 FTE, a program increase of +$12,400,000 and +29 FTE above the 2014 Enacted level.

Overview – Landscape Priorities

Knowledge of ecosystems is critical to the well-being of the Nation because ecosystems supply the natural resources and other goods and services that humans require. The scope of science needed to improve conservation and restoration of ecosystems is complex. In many ecosystems, regional environmental resource issues challenge decisionmakers and place them at a critical juncture to balance human needs with ecosystem health. The multidisciplinary approach applied by the USGS is necessary to develop an understanding of both individual ecosystem processes as well as holistic ecosystem level evaluations of responses to actual and proposed restoration alternatives and plans. Science enables

resource managers to make informed decisions, to help resolve and prevent resource management conflicts, and to support Interior's public trust stewardship responsibilities for the Nation's lands and waters.

Increases in 2015, support research and development efforts focused in the California Bay-Delta, the Chesapeake Bay, the Columbia River, Puget Sound and Upper Mississippi River. These multi-disciplinary projects are designed to serve local ecosystem management needs and provide knowledge and approaches transferable to similar ecosystems across the Nation.

Program Performance

California Bay-Delta **(+$1,500,000/+3 FTE)**

Environments	(+$500,000/+2 FTE)
National Water Quality Assessment	(+$1,000,000/+1 FTE)

The California Bay-Delta Ecosystem (Delta) is recognized as one of the world's threatened treasures of biodiversity, supporting unique native species and their critical tidal and wetland habitats. Like other urban estuaries, this system has a history of anthropogenic changes involving multiple stressors including altered hydrodynamics, environmental contaminants, and invasive species that have degraded the ecosystem. The native fish fauna has been much reduced and key species are now protected by the Endangered Species Act. Among these species, the threatened Delta smelt most prominently influences human decisions about the movement of water through the system. The recovery of this species requires an improved understanding of the changes that influence all stressors and parts of the system, including watersheds, rivers, deltas, bays, and the ocean. This initiative builds on ongoing monitoring and research by the USGS to understand how flow conditions, water quality, and fish behavior affect fish survival. The USGS would use additional resources to increase capacity to further understand biological elements of the Sacramento – San Joaquin – San Francisco system, specifically the role of invertebrates, fish, and birds and other organisms and how these organisms respond to managed and natural flow changes and agency habitat-restoration efforts. USGS biological scientists would build on existing datasets, some of which are multi-decadal time series, and evaluate existing and new biological observations in light of physical changes to the system, especially drought conditions, changing salinities, and potential pollutant increases. Increased understanding of the flows in the system is possible using the existing USGS CASCaDE I model software and the CASCaDE II model that is under development. This funding would also support expedited development of the CASCaDE II model toward a version that is well-suited to evaluating multiple scenarios under a range of flow (e.g., drought) conditions in an operational mode. This model would permit assessment of the effects of flow regime and in-Delta management responses on water levels, velocities, and distributions of critical water quality and habitat parameters such as salinity and temperature throughout the Delta, physical conditions that can have profound effects on vegetation and wildlife. The USGS would advance the capability to collect, store, and access, visualize, and share data and information about the Delta system, the vulnerabilities of Delta ecosystem components to change, and the potential responses to these vulnerabilities.

Chesapeake Bay **(+$1,500,000/+5 FTE)**

Environments	(+$300,000/+1 FTE)
Land Change Science	(+$500,000/+2 FTE)
Contaminant Biology	(+$100,000/ 0 FTE)
Toxic Substances Hydrology	(+$100,000/ 0 FTE)
National Water Quality Assessment	(+$500,000/+2 FTE)

The USGS provides science to restore the Nation's largest estuary and carry out the President's Chesapeake Bay Executive Order (EO) strategy and associated action plan. The Interior, through the USGS, the U.S. Fish and Wildlife Service (FWS), and the National Park Service (NPS), is providing leadership, expertise, and resources to meet the major goals of the Chesapeake Bay Program (CBP) partnership and the associated EO to restore water quality, recover habitat, sustain fish and wildlife, and conserve lands and increase public access. The USGS has lead responsibility under the EO (in collaboration with the National Oceanic and Atmospheric Administration's (NOAA)) to strengthen science to support all of these goals.

In 2014, the USGS had $8.1 million among multiple programs to conduct Chesapeake activities. In 2015, the requested $1.5 million increase would enhance activities to (1) restore brook trout and their habitats; (2) help identify contaminants affecting fish health; (3) forecast the effects of land change and sea-level rise on black ducks and their habitats; (4) forecast effects of land and climate change on habitat conditions; (5) explain water-quality change; and (6) use remote sensing to assess effectiveness of conservation practices. Planned activities led by the programs listed below include —

- Expand science to help restore brook trout and their habitats. The USGS worked with the FWS and partners to identify five research priorities to support brook trout conservation and restoration, which is an EO priority. Refining and developing patch-prioritization tools and assessing effects of shale-gas drilling would begin in 2015 (Environments Program in collaboration with Fisheries Program).
- Enhance science on multiple factors affecting fish health in the Bay watershed and the associated effects and sources of toxic contaminants and endocrine-disrupting compounds. The USGS activities are needed to address recommendations in the recent EO on the extent and severity of toxic substances and their biologic effects in the bay and its watershed (Environments, Toxic Substances Hydrology and Contaminant Biology Programs).
- Assess the combined effects of land change and sea-level rise on black duck habitats. Additional funding would be used to enhance science to improve energetics models for wintering black ducks within the Bay refuge system, begin new effort to couple the energetics models with new models of sea-level rise and land use change to predict future impacts on coastal wetland, and help identify the best areas for restoration of black duck habitats (Environments Program).
- Forecast the combined effects of land and climate change on habitat conditions. To support the brook trout, black duck, and water-quality studies, the USGS would enhance efforts to identify potential effects of land use and climate change by: (1) considering the potential effects of

hydraulic fracturing and land change on stream quality; and (2) assessing potential changes in land cover on black duck habitats. (Land Change Science Program and Environments Program).

- Further investigate the factors affecting water quality to enhance progress toward the Bay total maximum daily load (TMDL). The USGS would enhance the use of models, land use information, and other data to explain changes in nutrients and sediment at key areas in the Bay watershed. The USGS has been asked by U.S. Environmental Protection Agency (EPA) and six States to better assess trends and explain the effects of water quality management practices as the Bay TMDL is implemented. The USGS would also work with the U.S. Department of Agriculture (USDA) to evaluate the effect of agricultural practices to improve water quality. (National Water Quality Assessment (NAWQA), Environments, and Land Change Science Programs).
- Increase research on the effectiveness of winter cover crops in reducing both soil erosion and nitrogen runoff from agricultural fields into the Chesapeake Bay. This research would support water-quality studies and conducted in collaboration with the USDA Agricultural Resource Service, the Maryland Department of Agriculture, and local soil conservation districts. Project scientists would use satellite-based remote sensing data products with site specific, privacy-protected conservation program farm data records to measure cover crop success in preventing sediment and nutrients from reaching the Bay. (Land Change Science Program).

Columbia River (Salmon) **(+$850,000/+2 FTE)**

Environments	(+$300,000/+1 FTE)
Contaminant Biology	(+$100,000/0 FTE)
Toxic Substances Hydrology	(+$100,000/+1 FTE)
National Geospatial Program	(+$350,000/0 FTE)

The Columbia River is the largest river in the Pacific Northwest, and plays an important role in the region's culture and economy through tribal fisheries, irrigation, power production, and recreation, among other goods and services. This system has been affected by a number of anthropogenic changes, including altered flows, environmental contaminants, and invasive species that have degraded the ecosystem. Managers and policymakers require scientific information to prevent the decline of critical species such as salmon, which are a valued tribal trust species; to manage ecological flows in this engineered river system; and to reduce risks from habitat degradation, changes in species composition, and climate change. With the proposed increase, the USGS would enhance documentation of the life history, habitat requirement, and population status and trends of forage fish, critical as a food source to other species, supporting fish, bird and mammals. The USGS would address invasive species, related climate impacts, chemical and physical habitat degradation, and effects on economic and trust species. USGS scientists would conduct research on the effect of altered flow regimes due to climate change and dam operations on habitats. A new Columbia River Treaty with Canada, which would take effect in 2025, could potentially affect flow regimes. USGS researchers would characterize ecological tradeoffs related to alternative flow regimes, as they affect physical habitat features, food webs, and ecological interactions influencing the sustainability of salmon, sturgeon, and other key species populations. The research results would help decision makers address flow regimes as required by the treaty. The USGS

would combine data acquisition efforts with the Science Application for Risk Reduction (SAFRR) project to better leverage multiple science uses for high-resolution lidar data over ecosystem and natural hazard projects in the Columbia River area. The SAFRR develops natural hazard disaster scenarios as a strategy to increase community resilience or a community's ability to cope with the effects of a disaster.

Puget Sound **(+$1,050,000/+2 FTE)**

Environments	(+$400,000/+1 FTE)
Hydrologic Research and Development	(+$200,000/+1 FTE)
National Geospatial Program	(+$450,000/0 FTE)

Puget Sound, the second largest estuary in the United States, provides diverse benefits to a growing regional human population. It provides a home, recreation, and economic opportunity to millions of people. The Sound is a natural resource treasure, supporting hundreds of species of fish, sea birds, and marine mammals, many of which are of enormous economic and cultural importance to the region. Human development and land use changes will likely affect the future sustainability of the Sound, particularly watershed and shoreline alterations that are likely to reduce critical habitat for species and reduce water quality. More than 20 Native American tribes are protected in perpetuity in their uses of salmon. However, salmon are in decline due to reductions in habitat quantity and quality. The USGS is providing critical science to a major ecosystem restoration effort involving tribal, local, State, and Federal entities. The proposed increase in 2015 would support managers and decisionmakers by developing process-based monitoring and models at the ecosystem scale to identify and address risks to salmon. These models, based on current and historic monitoring, help decisionmakers identify the key species and processes in the ecosystem for appropriate protections, controls, and monitoring. In addition, the USGS would investigate the status of forage fish populations—some of which are in decline—and identify linkages between population dynamics, bioenergetics, predation, habitat alterations, disease, and food availability. In support of the restoration, this work would result in new molecular tools and sampling methods. The USGS would combine data acquisition efforts with the SAFRR project to better leverage multiple science uses for high-resolution lidar data over ecosystem and natural hazard project in the Puget Sound area. Finally, the recent removal of two major dams on the Elwha River is one of the largest river restoration projects in history, requiring active management of former submerged reservoir lands; use of hatcheries to supplement wild fish populations; and monitoring of specific aquatic, terrestrial, and near-shore marine responses of the ecosystem. USGS science would provide managers with information on ecosystem responses to specific post-removal restoration actions to ensure that restoration is effective.

Upper Mississippi River **(+$200,000/+2 FTE)**

National Water Quality Assessment

This initiative builds on ongoing USGS activities in the Upper Mississippi River Basin (Basin). With this increase, the USGS will be able to perform more data collection and interpretative studies on water quality in the Upper Mississippi Region. The Basin contains a wide diversity of landscape types that include major agricultural operations headwaters with major urban landscapes. Both landscape types can have negative impacts on aquatic ecosystem health of the Mississippi River and connecting rivers downstream resulting in maintaining or expanding hypoxia conditions in the Gulf of Mexico. Existing

USGS programs in this region are developing a better understanding of water resources through critical streamflow measurement stations that characterize water quality. The USGS has been collecting samples of contaminants of emerging concern and learning about the potential effects of these contaminants on aquatic organisms living in the streams and rivers. Data collections and interpretive studies addressing water quality concerns are shared with State and local partners in this five State region (Minnesota, Wisconsin, Illinois, Iowa and Missouri).

Overview – Invasive Species

Nonindigenous invasive plants and animals cause significant economic losses and diminishing opportunities for beneficial uses of forests, croplands, rangelands, and aquatic resources. Costly effects include clogging of water facilities and waterways, wildlife and human disease transmission, threats to commercial, native, and farmed fisheries and increased fire vulnerability and adverse effects for ranchers and farmers. Across the Nation, the USGS partners with States, tribes, other Federal agencies, businesses, agriculture, natural resource managers, and the private sector to help solve problems posed by all significant groups of invasive organisms in terrestrial and aquatic ecosystems.

Increases in 2015, support research and development efforts focused on the brown tree snakes in Guam, invasive plants and animals in the Everglades, Asian carp in the Great Lakes and Upper Mississippi, and new and emerging invasive species of national concern.

Program Performance

Brown Tree Snakes – Detection and Control

Invasive Species (+$500,000/0 FTE)

Shortly after World War II, the brown tree snake (BTS) was transported from its native range in the South Pacific to Guam accidentally. Because of abundant prey on Guam and the absence of natural predators and other population controls, BTS populations reached extraordinarily high numbers. Snakes have caused the extinction of most of the native forest vertebrate species; thousands of power outages affecting private, commercial, and military activities; and widespread loss of domestic birds and pets. The highest priority needs for control and management of BTS are the development of landscape-scale methods to suppress or eradicate snakes on Guam, and to detect and eradicate incipient populations of snakes accidentally transported to other islands such as Hawaii and the Northern Mariana Islands. The military expansion on Guam will raise the profile of these issues because military construction will result in mitigation actions that include snake suppression in areas of high ecological value, and because increased military cargo transport and off-Guam training exercises will increase the odds of transporting snakes to other islands, such as Hawaii. With the increased funding, the USGS would focus on high-priority research to validate the efficacy of aerially-delivered toxicants for snake control at landscape-scales; predict the results of snake suppression on Guam and the increase of potentially problematic species (such as non-native rats); increase the number of trained snake rapid responders in Hawaii and other islands at risk of receiving BTS transported from Guam; and conduct a thorough assessment of the possibility that

scattered reports of snakes sighted in the U.S. Commonwealth of the Northern Mariana Islands represent an established population.

Everglades **(+$1,000,000/+2 FTE)**

Invasive Species (+$1,000,000/+2 FTE)

The USGS conducts research to fill key science information gaps and to assist in the sustainable use, protection, and restoration of the South Florida ecosystem through partnering with the Comprehensive Everglades Restoration Plan (CERP) and the South Florida Ecosystem Restoration Task Force (SFERTF). South Florida is particularly vulnerable to the introduction and spread of invasive plants and animals and is highly colonized by a wide variety of exotic species such as water hyacinth, melaleuca, old world climbing fern, and the Burmese python. The SFERTF recognizes the challenges that invasive species pose to the success of overarching ecosystem restoration efforts. Funding will support high priority research needs identified by the interagency invasive species working group of the SFERTF including quantifying ecosystem effects of invasive species to assist partnering agencies in deciding where best to allocate management and control efforts; filling key biological and ecological information gaps of invasive species to better inform early detection efforts of partnering agencies; and to improve methods to better detect and control species such as Burmese pythons for which ecosystem effects have been documented. The results and methodologies would be provided to resource and land managers for use in controlling the spread of invasive species.

Great Lakes – Asian Carp **(+$1,000,000/+4 FTE)**

Invasive Species (+$1,000,000/+4 FTE)

In 2009, the Administration established the Asian Carp Regional Coordinating Committee (ACRCC), a group of Federal, State, and local agencies and other private stakeholder entities, to protect and maintain the integrity and safety of the Great Lakes ecosystem from an Asian carp invasion. As a charter member of this group, the USGS has been conducting research to provide critical information to the ACRCC since 2010. Funding would augment ongoing research described in the ACRCC's annual Asian Carp Control Strategy Framework. This research focuses on providing scientific information and methodologies to better prevent, detect, and control Asian carp. Specific research activities include developing methods for the oral delivery of registered fish toxicants; identifying and developing attractant pheromones and food lures to aid in targeted removal of Asian carp from infested waters; and testing seismic technology as a means to affect the distribution of Asian carp and to restrict their passage through lock and dam structures. The proposed increase would allow the USGS to broaden research capacity and accelerate from "proof of concept" stage to transferring technology to resource managers for field use, and address research needs identified for managing grass carp.

Upper Mississippi River – Asian Carp (+$1,000,000/+2 FTE)

Invasive Species (+$1,000,000/+2 FTE)

Funding would support new research addressing needs identified for the Upper Mississippi River System (UMRS) in the 2007 "Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States," in the "2011 Asian Carp Action Plan," developed by the Minnesota-Wisconsin Asian Carp Task Force, and the ACRCC's annual Asian Carp Control Strategy Framework. The increase would allow the USGS to increase research capacity, augment ongoing efforts initiated in 2013, and target high priority research gaps identified in these collaborative planning efforts, including improving methods to detect Asian carp at low population levels, identifying habitats and locations most vulnerable to colonization by these invasive fishes, and improving methods for containment and control of Asian carp in UMRS habitats.

New and Emerging Invasive Species of National Concern

Invasive Species (+$1,000,000/+4 FTE)

The introduction, establishment, and spread of invasive species will be important drivers of biodiversity loss over the next century and will pose substantial risks to native species, valued ecosystem services, and human and wildlife health. Ongoing global changes such as more-frequent transcontinental and transoceanic trade and tourism, land and water use changes, and climate change are facilitating ever-faster rates of establishment and spread of harmful, invasive plant and animal species around the world. Challenges for scientists will be to determine which newly established nonnative species might cause significant impacts and become high priority invaders, and accurately estimate their potential spread throughout the country. While many invaders come without noticeable impact, causing little or no observed change in the invaded ecosystem, a small percentage of species that become established alter ecosystem structure and function in detectible and deleterious ways. The USGS has gained an understanding of the qualities and characteristics to help identify the next generation of invaders—hopefully in time to take action to prevent large-scale landscape changes like those caused by invasive cheatgrass, which have changed fire dynamics in ecosystems in the Western United States. USGS research on current high priority invasive species such as tamarisk in the Southwest, nutria in the Gulf of Mexico, Burmese pythons in the Everglades, and Asian carp in the Mississippi River Basin provides information to identify the next generation of invaders and to forecast their impacts. Assessing the factors influencing known invasions improves the national ability to predict invasions and to take preventative measures early enough to better address new invasive species.

This increase would allow investigation of the relationship between landscape-scale alterations such as dams and canals, drought, climate change, hurricanes and invasive species, and enhance the ability to improve predictive tools. The USGS would develop models, decision tools, and other approaches to predict geographic distribution of invasive species based on parameters such as temperature, precipitation, elevation, and vegetation. These models would provide screening tools to focus early detection efforts by predicting potential range and resulting distribution. The USGS would also enhance efforts focused on the development, evaluation, and improvement of capabilities for early detection and control of existing

and emerging high profile invasive species. The USGS would utilize advanced molecular detection tools (such as eDNA) to detect invasive species at very low densities in the field. These USGS research endeavors would provide information for assessments of risk and predictions; determine effects of invasive species; develop tools and innovative methods for control and management; and deliver information management tools to more effectively integrate and utilize available data on invasive species. The end result is a greatly enhanced capability for early detection and control of currently established and emerging invasive species and to ensure that the Nation is better prepared for the next—yet unknown—generation of invasive species.

Overview – Ecosystem Services

Agencies have multiple sources of information from monitoring and assessment programs, but need a formal mechanism or capability to routinely integrate these sources of information into assessment products for land and resource management of environmental benefits. Land and resource management agencies are increasingly being called upon to understand the effects of their actions in an economic context, and the tools must be well developed to achieve a comprehensive understanding of the effects of their actions on the value of the environment. A better understanding is needed of the environment's ability to sustain the multiple requirements for resource development, extraction and use, and to assess the value of the tradeoffs that inevitably occur as decisions are made.

Program Performance

National Ecosystem Services Framework (+$1,000,000/+1 FTE)

Environments (+$1,000,000/+1 FTE)

As part of a multiagency assessment of biodiversity and ecosystem services trends, USGS would evaluate data, information, methods, and tools that could contribute to the identification, assessment, valuation and use of ecosystem services for particular policy and management scenarios. The 2015 increase will enable the USGS to assess gaps in information; develop and test protocols for integrating interagency information in assessment; develop interagency practices for implementation of this information in natural resource decision-making, and work in an interagency context to develop assessments. This activity contributes to the goals of the Committee on Environment, Natural Resources and Sustainability's Subcommittee on Ecological Systems and other cross-government efforts to develop policy-relevant information on ecosystem services for Federal decision-making.

Sustaining Environmental Capital (+$1,000,000/+2 FTE)

Environments (+$1,000,000/+2 FTE)

The USGS, working with management agencies on current management decisions, will develop, integrate and enhance tools to value environmental benefits and predict changes that result from management options. The increase will enable the USGS ultimately to build standard methods and a national capability

to value ecosystem services. The increase will enable the USGS to assess trends in ecosystem services, and provide ecosystem service information to a broad network of resource managers for decision-making. The USGS would determine the conditions under which these methods can be used as standard methods, and the applicability of these methods to various geographic areas.

EcoINFORMA **(+$800,000/0 FTE)**

Science Synthesis, Analysis, and Research (+$800,000/0 FTE)

The President's Council on Science and Technology Advisors (PCAST) report, "Sustaining Environmental Capital: Protecting Society and the Economy" recommended a series of Federal actions including the Econinformatics-based Open Resources and Machine Accessibility (EcoINFORMA) initiative to enable integration and use of current knowledge to inform decisions. EcoINFORMA improves and expands Federal and non-Federal biodiversity, ecosystem, and ecosystem-service information access, data exploration, availability, and interoperability for decisionmakers. EcoINFORMA facilitates cost savings by providing ready access to data, improved applications and availability, and useful tools to resource managers and decisionmakers. Integration of essential partner data in EcoINFORMA (e.g., NPS, BLM, EPA, VegBank, etc.), will substantially expand the amount of data available in EcoINFORMA to inform climate change and provide landscape understanding.

In 2013, the USGS implemented recommendations in the PCAST report, including the development of the EcoINFORMA Implementation Blueprint. The Blueprint calls for implementation of resource hubs supported by existing communities of practice that improve data standards, interoperability, and ecosystems data reuse. In 2013, two hubs were established and a third hub was proposed: (1) the biodiversity resources hub that leverages the USGS BISON program (Biodiversity Information Serving Our Nation); (2) the ecosystem hub that powers the Environmental Protection Agency's EnviroAtlas; and (3) the Multi-Resolution Land Characteristics Consortium that support the land cover dynamics resource hub.

In 2014, the USGS continues to implement the EcoINFORMA Implementation Blueprint by initiating Ecosystems.data.gov as the public presence for EcoINFORMA. To advance the EcoINFORMA biodiversity hub, the USGS is expanding the data fields, providing greater discoverability and documentation of the data; integrating the ability to overlay base layers to better understand occurrence data (e.g., why species may be present or absent in a particular location); and to develop application programming interfaces (APIs) that allow direct access to BISON data regardless of a user's technical knowledge.

In 2015, the USGS requests an additional $0.8 million to continue implementing the PCAST report recommendations. The USGS would advance implementation of the EcoINFORMA biodiversity hub and support priorities such as: Ecosystems.data.gov; building communities to support the EcoINFORMA hubs; and developing standards and policy to allow interoperability among hubs. For example, the USGS would partner with BioEco (a working group on biodiversity and ecosystem) informatics to formalize rules for provision of data among Federal agencies, allowing more data to be added to the EcoINFORMA hubs.

Hydraulic Fracturing

Hydraulic Fracturing		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Fisheries Program		108	108	2,200	2,308	+2,200
	FTE	1	1	10	11	+10
Energy Resources		5,850	5,850	950	6,800	+950
	FTE	29	29	1	30	+1
Contaminant Biology		145	145	1,400	1,545	+1,400
	FTE	1	1	5	6	+5
Toxic Substances Hydrology		450	541	0	541	0
	FTE	2	3	0	3	0
Earthquake Hazards		800	1,800	700	2,500	+700
	FTE	2	4	2	6	+2
Groundwater Resources		520	520	0	520	0
	FTE	1	1	0	1	0
Hydrologic Research & Development		1,300	1,300	901	2,201	+901
	FTE	1	1	2	3	+2
Science Synthesis, Analysis and Research Program		0	0	185	185	+185
	FTE	0	0	0	0	0
National Cooperative Geologic Mapping Program		0	0	2,000	2,000	+2,000
	FTE	0	0	0	0	0
Total Requirements ($000)		**9,173**	**10,264**	**8,336**	**18,600**	**+8,336**
	Total FTE	**37**	**40**	**20**	**60**	**20**

Justification of 2015 Program Changes

The 2015 budget request for hydraulic fracturing research is $18,600,000 and 60 FTE, a program increase of +$8,336,000 and +20 FTE above the 2014 Enacted level.

Overview

In 2012, the President issued an Executive Order (EO), “Supporting Safe and Responsible Development of Unconventional Domestic Natural Gas Resources,” as a component of the energy strategy. The goal of the EO is to ensure coordination among Federal agencies regarding natural gas development activities. In support of this effort, the Interior, Department of Energy (DOE), and the Environmental Protection Agency (EPA) signed a Memorandum of Agreement (MOA) formalizing a Multiagency Collaboration on Unconventional Oil and Gas (UOG) Research. This collaboration is aimed at improving the ability to understand and address potential environmental, human health, and safety impacts of hydraulic fracturing and associated operational activities. The three agencies are working together to engage other organizations involved in research on hydraulic fracturing in the pursuit of collaborative research opportunities. Through the MOA, the USGS is applying and building its research strengths with focused studies on resource characterization and assessments, water quality and availability, ecological effects, effects on people, and induced seismicity. The interagency collaboration is intended to build on the core capabilities of each agency in synergistic ways that lead to complementary work. To accomplish this, Interior, the DOE, and the EPA are developing a multi-year National Research Strategy designed to address the highest priority research questions, new and innovative technological opportunities, and

community concerns associated with safely and prudently developing resources through hydraulic fracturing. These topics include scale and nature of U.S. unconventional oil and gas resources; water quality; water availability; air quality and greenhouse gas emissions; effects on human health; ecological effects; and induced seismicity. In addition, the National Research Strategy identifies a set of six multidisciplinary, collaborative "Flagship Projects" to provide examples of potential research and deliverables for the multiagency collaboration outlined in the MOA. While the National Research Strategy identifies the highest priority projects for research, all of the research efforts depend on available funding at the EPA, the DOE, and Interior.

The development of oil and gas resources through hydraulic fracturing is playing an important and rapidly growing role in the domestic energy portfolio of the United States. Shale and other unconventional oil and gas formations are found throughout the United States beneath Federal, State, tribal and private lands. The development and extraction of unconventional oil and gas resources are accomplished through hydraulic fracturing, a technique that entails horizontal drilling, perforation of steel casing and cement grout using explosive charges, and expansion of fractures using fluids and propellants under high pressure.

While there are economic benefits associated with oil and gas production and industry has developed best management practices for well site activities, concerns remain about potential environmental, health, and safety impacts of hydraulic fracturing. A comprehensive understanding of these potential impacts will require a significant research effort, including baseline data collection across various geologic settings. Potential effects of hydraulic fracturing may include: (1) impacts to water resources, including the contamination of aquifers and surface waters from drilling and hydraulic fracturing chemicals; the cross-contamination of aquifers through faulty well construction and casing installation; the release of methane and other greenhouse gases into aquifers and the atmosphere; contamination from radioactive elements and other toxic chemicals in waters recovered during gas production; and the reduced availability of water, particularly in water-scarce areas; (2) landscape changes including soil erosion and habitat fragmentation; (3) generation of airborne pollutants; and (4) unintended seismic events from the subsurface injection disposal of recovered hydraulic fracturing and rock formation fluids. Singly or in combination, these potential effects might result in harmful impacts on human health or on terrestrial and aquatic wildlife and ecosystems.

Program Performance

Hydraulic Fracturing	**(+$8,336,000/+20 FTE)**
Fisheries	(+$2,200,000/+10 FTE)
Energy Resources Program	(+$950,000/+1 FTE)
Contaminants Biology	(+$1,400,000/+5 FTE)
Earthquake Hazards Program	(+$700,000/+2 FTE)
Hydrologic Research and Development	(+$901,000/+2 FTE)
Science Synthesis, Analysis, and Research	(+$185,000/0 FTE)
National Cooperative Geological Mapping Program	(+$2,000,000/0 FTE)

The 2015 President's budget request supports this collaborative interagency research and development effort by the USGS, the DOE, and the EPA to conduct a national science, research, and development program aimed at understanding and reducing the potential environmental, health, and safety impacts of hydraulically fractured oil and gas resources and to address the most urgent questions and decision-support needs surrounding hydraulic fracturing. Through this effort, the three agencies are building upon current work and collaboratively identifying and coordinating new priority research and development activities that support sound management and policy decisions by Federal, State, tribal, and local entities. The goal is to produce decision-ready information to ensure the prudent development of energy resources and the protection of human health and the environment.

In 2014, USGS research efforts are focused on a number of activities including resource characterization and assessments, water quality and availability, ecological impacts, effects on people, and induced seismicity. The USGS conducted research and assessments of undiscovered, technically recoverable unconventional oil and gas resources for high-priority shale and tight gas basins. It is important to understand where these resources are located, and what their potential volumes and physical character are, so as to understand where production might occur, and to understand potential environmental impacts should development commence.

Also in 2014, the USGS will continue or initiate selected monitoring and research efforts directed toward understanding potential effects of unconventional oil and gas production on water resources. Baseline monitoring of groundwater was conducted in a number of States, notably in Arkansas, where hydraulic fracturing is underway, and in New York, where baseline studies are underway before drilling takes place to look at ambient groundwater conditions. Surface water monitoring will continue to be conducted in Pennsylvania, Utah and New York, among other areas. The USGS will continue to conduct studies of produced waters to characterize the geochemical nature of these fluids, including the occurrence of naturally occurring radioactive materials contained within the waters, which provides important baseline information as well as information for the proper disposal methods. The USGS will continue to work collaboratively with the EPA and others to develop appropriate groundwater sampling protocols in regions subject to hydraulic fracturing. New laboratory methods for analysis of flowback and produced waters were developed collaboratively with the EPA. A USGS-wide effort to compile water quality data extending back more than 60 years is scheduled to be completed in 2014, potentially leading to a better understanding of water quality trends in relation to unconventional oil and gas development. A compilation of national water quality databases associated with unconventional oil and gas production is continuing in 2014. In addition, the USGS has expanded seismic networks into areas of suspected induced seismicity and continues to publish studies on the occurrence of, and potential for, earthquakes triggered by the injection disposal of hydraulic fracturing flowback fluids and produced formation fluids into deep rock formations. A number of reports on the impact of shale gas development activities on land use change were published in 2013. In 2014, the USGS will collect seasonal baseline and post-development data to monitor and model the effects of shale gas development on wildlife and aquatic species and ecosystem integrity.

Resource assessments provide critical evaluations of where future energy development might take place, or equally important, where it is unlikely to take place. The USGS is the sole provider of publicly available estimates of undiscovered, technically recoverable unconventional oil and gas resources of

onshore lands and offshore State waters. In 2015, a portion of the requested new funding would allow the USGS to begin an assessment of the size and location of hydraulically fractured oil and gas resources in a new basin such as assessments underway in the Barnett Shale and Green River Shale. Geologic mapping conducted by the USGS would support research on the geological parameters of unconventional oil and gas basins under current or near-term development.

The development and extraction of shale gas and other unconventional oil and gas resources require large quantities of water for hydraulic fracturing and produce large volumes of fluids during flowback and production. In 2015, a portion of the requested funding increase would be used for water availability studies to: (1) assess the water needs associated with unconventional oil and gas development; (2) evaluate the volumes of water resources needed for use in tight oil development; and (3) characterize flowback fluids and brines from hydraulically fractured wells, which would be important to identify and track potential contamination. The USGS would also conduct studies that address the identification of alternative sources of water used for hydraulic fracturing to replace the use of scarce fresh water sources. In addition, the USGS would address water availability through the development of groundwater flow and transport models in selected case study areas. These models would be used to understand the effects of withdrawals whether water would be used for hydraulic fracturing operations or produced waters, on basinwide water availability.

In 2015, the USGS would use a portion of the requested funding to expand baseline surface water and groundwater quality monitoring. The USGS would support the continued development of analytical methods for the detection of contaminants associated with produced and flowback waters in the environment, including an enhancement of methods for sampling and measuring methane. This would include enhanced methods for monitoring and characterization of “stray gas.” The USGS would support research on the development of geochemical methods and groundwater flow models used to determine if hydrofracture fluids and other drilling materials are contaminating water supplies. These tools and monitoring data would enable assessments and prioritization of key human and ecological exposure pathways associated with natural or anthropogenic contaminants created and mobilized throughout the life cycle of hydraulic fracturing activities.

Additionally, the USGS would develop new methods to detect and understand the mobilization and occurrence of naturally-occurring contaminants resulting from hydraulic fracturing. The USGS will work with EPA and other partners at prospective sites as part of the EPA Drinking Water Program to assess potential groundwater and surface water contaminants associated with hydraulic fracturing operations. A new research project on environmental contaminants potentially associated with hydraulic fracturing has begun in 2014, and will continue in 2015. Specifically, the USGS will investigate the role of bacteria in natural attenuation of organic compounds in wastewaters from unconventional oil and gas (hydraulic fracturing flowback and produced waters) as well as the potential for adverse impacts on microbial communities. In addition, the USGS will assess soils and streambed sediments for contamination where UOG wastewaters are land applied and will begin working on new analytical methods to detect a range of chemicals known, or suspected to be, associated with these wastewaters.

In 2015, the USGS would support research that assesses potential ecological impacts associated with unconventional oil and gas development. The ecological effects research will continue to implement the

Flagship project outlined in the Federal Multiagency Collaboration on Unconventional Oil and Gas Research strategy. This flagship focuses on the assessment of potential ecological impacts of wastewater and water withdrawal associated with unconventional oil and gas development. This research includes acute and chronic toxicity impacts, toxicity mechanisms and pathways and the cumulative impacts and risks at the landscape scale. Coordinated efforts are being made with the DOE and the EPA to collect both ecological and human health data at selected monitoring sites when possible.

The USGS continues its research and assessments studies of injection-induced earthquakes and the risks are primarily associated with wastewater disposal using deep well injection. The work combines analysis of earthquake sources with related geologic data to determine those factors that affect induced seismicity from subsurface disposal of fluids. This information could be used to guide changes to disposal operations, such as by adding new wells or changing injection parameters. Cataloging the presence or absence of earthquakes induced by injection activities is already yielding critical information on the regions and conditions that are favorable for induced seismicity. This information is being combined with probabilistic seismic hazard analysis to assess the hazard and risk of damaging earthquakes.

In 2013 and 2014, the USGS has responded to significant increases in earthquake rates in Oklahoma, Kansas, and Texas, accompanied by moderate-magnitude, lightly damaging earthquakes. In the 2014 enacted appropriation, Congress included an additional $1.0 million for earthquake assessments. This funding is being used to develop methods to forecast whether or not a particular type of injection operation in a specified geologic setting would be likely to induce or trigger earthquakes, to perform comprehensive studies at two carefully selected field sites, and to establish procedures to adapt the USGS National Seismic Hazard Maps to take account of the additional hazard due to earthquakes associated with the production of oil and gas. In 2015, the proposed expansion of work on induced seismicity will allow the USGS to expand the number of sites that are monitored and assessed in detail. Because the phenomenon of earthquake triggering by fluid injection is relevant to several energy-sector technologies of national interest, such as enhanced geothermal and carbon sequestration, expanded USGS efforts could include targeted research at one or more injection sites in those technology areas.

The USGS would emphasize products that contain decision-ready information. Deliverables would include new assessments of undiscovered technically recoverable unconventional oil and gas resources to inform the public about the magnitude and location of potential future production and its associated impacts. These and other assessments would form a foundation for planning where and what kind of additional studies are needed, such as those involving water quality and quantity, potential ecological impacts, and induced seismicity. Three-dimensional geologic mapping and a better understanding of rock structures form the basis to characterize the hydro-geologic framework used to understand impacts. Results of water budget analyses and water requirements for unconventional oil and gas development would help water managers better utilize existing water resources and protect scarce potable resources. Maps and databases showing the occurrence and distribution of naturally occurring radioactive elements would be used to inform water disposal management in a way that reduces or eliminates the potential for buildup of radiation to dangerous levels. Data and reports that characterize baseline surface water and groundwater quantity and quality of selected sites would be produced. These assessments would provide the information needed to determine pathways of human and ecological exposures to natural and anthropogenic contaminants associated with hydraulic fracturing activities.

The USGS plans to release reports describing the factors controlling the occurrence of earthquakes due to fluid injection activities to inform both Federal and State agencies that permit the injections and the industry operators who wish to minimize the risk of damaging earthquakes. The USGS would produce updated probabilistic seismic hazard maps that incorporate the contribution from injection induced seismicity, so that building codes (which reflect long-term hazard) can appropriately account for the local or regional effects of induced earthquakes. Finally, the USGS would plan to release reports and other publications that outline effects of hydraulic fracturing and associated activities on terrestrial and aquatic species and create decision support systems that would help avoid or minimize ecological impacts associated with hydraulic fracturing.

Water Challenges: WaterSMART

WaterSMART		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Fisheries Program		466	466	0	466	0
	FTE	0	0	0	0	0
Land Change Science		514	514	0	514	0
	FTE	0	0	0	0	0
Groundwater Resources		2,645	2,645	2,400	5,045	+2.400
	FTE	0	0	9	9	+9
Hydrologic Networks & Analysis		4,427	4,427	2,000	6,427	+2,000
	FTE	3	3	1	4	+1
Cooperative Water Program		0	0	2,000	2,000	+2,000
	FTE	0	0	1	1	+1
Total Requirements ($000)		**8,052**	**8,052**	**6,400**	**14,452**	**+6,400**
	Total FTE	**3**	**3**	**11**	**14**	**+11**

Justification of 2015 Program Changes

The 2015 budget request for the USGS's WaterSMART Availability and Use Assessment initiative is $14,452,000 and 14 FTE, a program increase of +$6,400,000 and +11 FTE above the 2014 Enacted level.

Overview

As competition for water resources grows for irrigation of crops, for serving cities and communities, for energy production, and for the environment, the need for information and tools to aid water and natural resource managers grows. WaterSMART is a Department of the Interior initiative that leverages and directs existing expertise and resources within the USGS and the Bureau of Reclamation toward addressing complex, national- and regional-scale water challenges. Primary focuses of the WaterSMART initiative include developing a national water census, better understanding water budgets, and supporting ecologically-sound water management. Leveraging expertise across multiple disciplines enables a broader focus to address these challenging issues in a time of growing competition for water resources. The USGS possesses both the skills and foundational resources to unlock this knowledge and provide water resource, ecosystem, and land use managers the decision support tools to make decisions that are more informed. The goal of this initiative is to improve the understanding of groundwater and human water use and the ways in which they influence water availability. USGS expertise in understanding the hydrologic cycle effects on water, human water use, and the ways in which water quality and quantity affect the natural environment is critical to addressing this issue. The Nation will be well served through this effort, by gaining the ability to balance water resource sustainability through consideration of water quantity, quality, and uses, including ecological uses.

Program Performance

National Groundwater Monitoring Network (+$2,400,000/+9 FTE)

Groundwater Resources (+$2,400,000/+9 FTE)

Current USGS water-level networks do not provide adequate spatial or temporal monitoring for all the Nation's major aquifers, which is critical information for determining availability. To address this national need, a framework was developed for a National Groundwater Monitoring Network (NGWMN) in response to the SECURE Water Act (P.L. 111-11) Section 9507(b) to provide a systematic groundwater monitoring program for each aquifer system in the United States. To date, the Advisory Committee on Water Information (ACWI) Subcommittee on Groundwater (SOGW), through a successful pilot program and a pilot information portal developed by the USGS Groundwater Resources Program, demonstrated that a collaborative NGWMN can be successfully implemented by taking advantage of existing monitoring done by Federal, State, tribal and local agencies *(http://acwi.gov/sogw/*). The DOI, in consultation with the ACWI, identified the USGS as the Federal agency needed to manage this collaborative NGWMN. In 2015, the USGS will begin implementation of the NGWMN as outlined in the SOGW report, "A National Framework for Ground-Water Monitoring in the United States" (*http://acwi.gov/sogw/ngwmn_framework_report_july2013.pdf*), which calls for selecting a NGWMN advisory group, soliciting additional Federal, State and local data providers, and funding operation of data portal and collection at NGWMN backbone sites managed by Federal and non-Federal NGWMN partners.

Water Use Research (+$2,000,000/+10 FTE)

Cooperative Water Program (+$2,000,000/+1 FTE)

Water use information that identifies the impacts of human water withdrawals and return-flows is critical for WaterSMART's water budget analysis. This information, which is mostly collected at State, tribal, regional, and local governmental levels, must be obtained on a site-specific scale in order to be fully useful in WaterSMART analyses. Directed work is required to develop better methods of sampling, estimating, aggregating, and presenting water use data. This includes research into new methods that use remote sensing and spatial datasets in water use estimation. The research and networks and analysis functions of the USGS would work together to advance the development of those methods for use within the WaterSMART initiative. In addition, the Cooperative Water Program would work directly with State, tribal, regional, and local cooperators to make maximum use of their water use datasets in the water availability and use assessment. The USGS would integrate this information with decision-support tools that facilitate use of that information in a manner that is relevant to water resource management decisionmaking.

Cooperative Water Program monitoring, assessments, and research will continue and expand related to WaterSMART and its efforts on water use. Additional focus will be placed on tracking site-specific, public-supply and other water use information; developing consumptive use measurements and methodology (particularly associated with irrigated agriculture); assessing watershed water budgets

(including developing estimates for streamflow at ungaged sites for more accurate water budgets); developing water use/budget models to track long-term patterns in groundwater and surface water flow; and advancing evapotranspiration measurements and assessment techniques.

As with all Cooperative Water Program efforts, appropriated funds could be leveraged by non-Federal partners who are interested in and willing to further these objectives.

State Water Use Grants **(+$2,000,000/+1 FTE)**

Hydrologic Networks and Analyses (+$2,000,000/+1 FTE)

Water managers across the United States require more complete, timely, and accurate water availability information to support decision making. Data concerning water withdrawals and consumptive use needs improvement, as decisionmakers require accurate water use data to establish local and regional water budgets. State water resource agencies are vital entities and primarily responsible for collecting data on water supplies, water allocations and water rights. Water budgets, which account for the water inputs, outputs and changes in storage within a watershed, have been widely referred to as the foundation for effective water resources management. This initiative will provide financial resources, through grants to State water resource agencies, to improve the availability and quality of water use data that they collect and will integrate that data with the USGS Water Census.

Currently, the only Federal agency that explicitly collects water use data as a part of its mission is the USGS, through its National Water Use Information Program (NWUIP). The NWUIP works with State, local, and Federal partners to consolidate dozens of disparate data sets in order to create comprehensive reports of water use in the United States every five years. Because of the large differences in methodology and quality control in State programs to collect water use data, these reports require significant effort to standardize (to the extent possible) such data between States. The NWUIP products largely form the basis of the water use portion of the Water Census as created by the SECURE Water Act. Recognizing the limitations of current water use data, the Act authorized a grants program to support State data collection to improve water use data sets and share them with NWUIP.

The initiative will provide the budget resources to implement this part of the Act. Funding provided to States through these grants would be targeted at improvements to water use data collection and integration that will be of the greatest benefit to a national assessment of water availability and use. The USGS will work with State stakeholders to develop and implement this grants program in a fashion easily accomplished through existing grant mechanisms and in a way that is most beneficial to the common goal of understanding water availability at the State and national scales.

Data Innovation and Mapping

Data Innovation and Mapping						
		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
National Geospatial Program		13,621	14,376	5,236	19,612	+5,236
	FTE	59	59	0	59	0
Total Requirements ($000)		**13,621**	**14,376**	**5,236**	**19,612**	**+5,236**
	Total FTE	**59**	**59**	**0**	**59**	**0**

Justification of 2015 Program Changes

The 2015 budget request for the Data Innovation and Mapping initiative is $19,612,000 and 59 FTE, a program increase of +$5,236,000 and 0 FTE above the 2014 Enacted level.

Overview

The 3D Elevation Program (3DEP) initiative responds to growing needs for high-quality and high resolution topographic data to capture change in the Nation's natural and constructed features. New and accurate data is constantly in demand to improve aviation safety; understand and mitigate the negative effects of coastal erosion and storm surges; provide infrastructure for Arctic shipping and resource extraction; and protect biodiversity and habitats. The 3DEP initiative will systematically collect enhanced elevation data using lidar (light detection and ranging) and other technologies over the United States. A 2012 study funded by the USGS and partners identified 602 mission-critical activities of 34 Federal agencies; the 50 States; and selected local and tribal government, private, and other organizations. A fully funded and implemented multiagency 3DEP will acquire national coverage during an eight-year period, and would provide more than $690 million annually in new benefits to the public and private sectors and citizens. The National Geospatial Advisory Committee, the National States Geographic Information Council, the Association of State Floodplain Managers, the Association of American State Geologists, and the Management Association for Private Photogrammetric Surveyors endorsed the 3DEP plan. Interior, staffed by the National Geospatial Program, is organizing an interagency 3DEP Executive Forum to identify interagency funding strategies and coordinate Federal activities.

The NGP is working with the State of Alaska and Federal partners to replace the more than half-century-old topographic maps for Alaska. The NGP and its partners have developed a five-year plan (2013-2018) to acquire data to remap the State, with an emphasis on replacing lower-quality elevation data for the State using newer interferometric synthetic aperture radar (ifsar) technology. Unlike conventional technology, ifsar allows elevation data to be collected in challenging conditions including cloud cover, which is common in Alaska. The Alaska Mapping initiative is a combined Federal, State, local, and tribal program to support and improve maps and digital map data for Alaska, bringing Alaska topographic maps and digital map data quality in line with the rest of the United States.

The USGS is currently inventorying lidar data that is now publicly available, developing a process for unified Federal and State partner data acquisition, refining data specifications, organizing executive- and operational-level governance, and publishing the 3DEP implementation plan.

The Alaska Mapping initiative is improving the currency and accuracy of topographic data including elevation and hydrography and other datasets. New 1:25,000-scale maps are being produced to replace the 1:63,000-scale maps which were as much as 50 years old. The USGS has generated the first 400 of 11,273 new US Topo maps for Alaska, and in 2014, the USGS will generate 718 more. In 2014, the USGS will increase ifsar acquisition by over 5,000 square miles.

Program Performance

3D Elevation Program

National Geospatial Program (+$5,000,000/0 FTE)

The USGS plans to finalize the 3DEP implementation plan by January 2015. The proposed funding would increase data acquisition by 15,000 square miles (approximately a tenth of the area of California) and would support development efforts to process and serve lidar and derived elevation data. The percentage of the Nation (excluding Alaska) published as enhanced elevation data would increase to seven percent, an increase of two percent to the 2014 coverage. (See “Alaska Mapping” for a discussion of coverage for that State.)

Alaska Mapping

National Geospatial Program (+$236,000/0 FTE)

In 2015, the proposed increase would boost ifsar acquisition by approximately 10,000 square miles annually. The percentage of Alaska published as high resolution elevation data would be 48 percent, an increase of five percent to 2014 coverage. Map production will increase 50 percent from 2014 levels to approximately 1,100 maps.

Environmental Impacts of Uranium Mining

Environmental Impacts of Uranium Mining		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Contaminant Biology		50	50	673	723	+673
	FTE	0	0	3	3	+3
Toxic Substance Hydrology		100	100	2,500	2,600	+2,500
	FTE	0	0	9	9	+9
Total Requirements ($000)		**150**	**150**	**3,173**	**3,323**	**+3,173**
	Total FTE	**0**	**0**	**12**	**12**	**+12**

Justification of 2015 Program Changes

The 2015 budget request for the Environmental Impacts of Uranium Mining is $3,323,000 and 12 FTE, a program increase of $3,173,000 and 12 FTE above the 2014 Enacted level.

Overview

In January 2012, the Secretary of the Interior withdrew over one million acres of public lands in the Grand Canyon region from mining for 20 years under the Mining Law of 1872. However, even under the withdrawal, some mining will occur on valid existing claims. For example, the Canyon Mine (on U.S. Forest Service (USFS) lands south of the Grand Canyon) and the EZ Mine (on Bureau of Land Management (BLM) property north of the Grand Canyon) are expected to begin ore extraction in 2014 and 2016, respectively. A key factor in the Secretary's decision was a lack of scientific information. The USGS developed a 15-year science plan in collaboration with the BLM, National Park Service, U.S. Fish and Wildlife Service, and the USFS. The studies would provide critical information for future decisions on withdrawal of lands and help inform the development, mitigation, reclamation, and ecological restoration of mines on valid existing claims, as applicable.

Program Performance

Northern Arizona Uranium Mining Science +$3,173,000/+12 FTE

Toxic Substances Hydrology Program (+$2,500,000/+9 FTE)

The proposed increase would begin the implementation of the integrated 15-year science plan by collecting new baseline data, expanding smaller scale studies begun in previous years, and lay the foundation for future modeling and monitoring efforts. Work in 2015, would characterize the baseline conditions of soil, groundwater, and surface water at the Canyon and EZ Mine sites before ore extraction begins. This would be done in cooperation with agency partners and private mining companies, and would complement USGS work on Trust resources (animal and plant species) started at Canyon Mine in 2013. This baseline work is crucial for comparison after extraction occurs and enables understanding of

the extent of naturally occurring versus mine- related uranium and associated contaminants in soil, water, and biota.

In addition, work would begin to determine potential pathways of uranium exposure, such as movement through groundwater-flow paths, surface water, and wind dispersion. This includes continued and expanded monitoring of water quality and uranium levels in the Colorado River in the Grand Canyon, Kanab and Havasu Creeks, and other regional rivers, streams, intermittent washes, and springs. USGS researchers would analyze data continually in preparation for presenting an interim report at the end of the third year of the study that describes spatial and temporal patterns of uranium in soil and water samples, and includes regional exposure models that would shape subsequent research and monitoring components.

Contaminant Biology Program (+$673,000/+3 FTE)

The proposed increase would support characterization of baseline radiation and chemical concentrations in sentinel species (e.g., birds, mammals and reptiles) from samples obtained at targeted mine sites before ore extraction began. Biological surveys and samples were collected at the Kanab North Uranium Mine, Arizona Strip. Pre-mining species inventories (currently at 200 species) and sampling of those species was done in 2014. These foundational activities are necessary for measuring the environmental effects of mining uranium, and its associated release of radiation, beyond what is naturally occurring in this area of the country to determine whether those increases pose a risk to biota. In 2015, USGS would complete the uranium baseline assessment, analyzing the pre-mining background levels of uranium in dust water, and biota, and begin modeling the ‘natural’ transport and occurrence of uranium and radiation in native animals and plants. Post mining samples that parallel those collected pre-mining will be collected during uranium extraction at active mines. Results will be used to develop a modeling tool to assess ecosystem health before, during, and eventually after uranium extraction. The knowledge gained from these studies will be used for developing prevention and mitigation strategies to ensure that the health and sustainability of natural resources are balanced with economic development. This study will provide science needed by the Secretary of the Interior for making sound decisions regarding extraction activities on Federal lands.

Earth Scientists for Tomorrow

Justification of 2015 Program Changes

Earth Scientists for Tomorrow		2013 Actual	2014 Enacted	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Cooperative Research Units		0	0	1,000	1,000	+1,000
	FTE	0	0	6	6	+6
Administration and Management		1,602	1,602	1,700	3,302	+1,700
	FTE	0	0	2	2	+2
Total Requirements ($000)		**1,602**	**1,602**	**2,700**	**4,302**	**+2,700**
	Total FTE	**0**	**0**	**8**	**8**	**+8**

Justification of 2015 Program Changes

The 2015 budget request for the USGS's Earth Scientists for Tomorrow initiative is $4,302,000 and 8 FTE, a program increase of $2,700,000 and 8 FTE above the 2014 Enacted level.

Overview

The USGS has a proud history of mentoring and engaging the youth of our country. The USGS provides a broad array of research and learning experiences for young people in the Earth and biological sciences aimed at inspiring the pursuit of scientific careers and increasing science literacy. USGS engagement with youth covers a broad age range. Typically, outreach activities and science camps are aimed at elementary and secondary school students, while internship programs employ students in high school, undergraduate, and graduate school. The USGS engages and hires post graduate students that include 26-30 year old young scientists. A number of the youth employed by the USGS stay onboard while finishing their degrees.

The USGS's Youth Stewardship of Natural and Cultural Resources High Priority Performance Goal (HPPG) is an investment in the Nation's youth to develop the next generation of young scientists and Earth stewards, and provide opportunities to pass on institutional knowledge. Youth employment has proven to be an effective and economical means of helping accomplish the critical USGS science mission, and develop and mentor a cadre of young scientists through real-time work experiences. The USGS has expanded programs engaging youth in science, technology, engineering, and mathematics (STEM). In 2013 and 2014, USGS expanded education and internship programs for students underrepresented in STEM, tribal colleges, and veterans, as well as expanding partnerships in support of the 21st Century Conservation Service Corps (21CSC) in 2015. These examples highlight the USGS's unique role of working with a wide array of cooperators to bring world class Earth science to decisionmakers, communities, and schools.

As the Federal workforce faces the retirement eligibility of 53 percent of permanent full-time employees in 2014 (per OPM estimates), the USGS considers the development of a science workforce of tomorrow a

vital tool in succession planning, passing on institutional knowledge, and recruiting youth into federal services careers in earth sciences.

Program Performance

Cooperative Research Units Scientists for Tomorrow **(+$1,000,000/+6 FTE)**

Cooperative Research Units (+$1,000,000/+6 FTE)

The Cooperative Research Units (CRU) Program will use its existing cooperative network to work with Interior partners to improve and increase youth involvement in Interior science and resources management. The proposed increase would enhance opportunities to provide advanced scientific training and professional mentorship leading to Masters and PhD degrees to students underrepresented in the Nation's conservation workforce. Funding will focus on the training of students on contemporary research topics including the application of science and analytical tools for decisionmaking, energy development, fire ecology, ecosystem sustainability, threatened and endangered species, invasive species, and water quality and use. Funding also will assist in the career development of undergraduate students by providing additional experiential learning opportunities on research projects addressing priority information needs of State and Federal agencies. Student support includes safety training and equipment in addition to financial and research support. Implementation will be through enhancement of existing partnerships with universities and nongovernmental organizations (NGOs) serving Native American and Hispanic communities and other underrepresented groups. The Interior and other program partners will be fully engaged in this initiative, leveraging funding provided. The CRU has a record of accomplishment of approximately fivefold leveraging of each dollar appropriated to the program.

Youth and Education in Science **(+$1,000,000/+1 FTE)**

Administration and Management (+1,000,000/+1 FTE)

The program increases in 2015, would provide the USGS the opportunity to expand USGS education and internship programs for students underrepresented in STEM, tribal colleges, and veterans; and expand partnerships in support of the 21CSC, in line with the Youth Stewardship of Natural and Cultural Resources APG. The USGS would receive an increase of $1.0 million to establish the science component of the 21CSC. This science component, the 21st Century Conservation and Natural Resources Science Corps (Science Corps), would put young Americans to work for USGS science programs, providing science for decisionmaking in support of protecting, restoring, and enhancing public and tribal lands and waters. The USGS would engage other Interior bureaus, tribes, learning institutions and governmental and non-governmental organizations, to create partnerships and projects with the goal of developing the USGS's next generation of scientists. The USGS provides critical early science experiences through its education programs, resources for teachers, and research opportunities for students to work with USGS scientists.

Career pathways in conservation and natural resources science would be provided to 50 students from underrepresented groups, by coupling Science Corps internships with cooperative training programs at

two- and four-year colleges. This would help build upon and expand current hydrologic, biologic, and physical science technician programs with Gateway (Phoenix, AZ), Vermillion (Ely, MN), South Dakota, and Northern Virginia Community Colleges, and would be expanded to new minority-serving institutions and tribal colleges. The Science Corps would also provide internships, mentoring, and training in life skills, such as how to effectively apply to college, to approximately 50 urban high school youth by working with city governments, city schools, and inner city summer programs.

The development of a new general Science Corps program of approximately 100 undergraduate students would work with Interior bureaus and other partners, such as the National Science Foundation, University of Texas, and Environmental Stewards to create recruitment, hiring, and project placement processes that can be readily used by others. The students would work with USGS scientists and others on projects that support USGS mission goals. In addition, an effective, low cost evaluation methodology would be developed and implemented to ensure USGS youth programs are meeting goals, are based on best practices, and provide an evidence-based improvement process.

Mendenhall Research Fellowship Program **(+$500,000/+1 FTE)**

Administration and Management (+$500,000/+1 FTE)

The Mendenhall Research Fellowship Program is the flagship postdoctoral research program for the USGS. Established in 2001, this program has grown into one of the most prestigious and coveted postdoc programs in science. Through the Mendenhall Program, the USGS obtains the some of the best available new PhD talent to address the needs of its science mission. The increased funding will allow the USGS to increase the number of postdocs by a minimum of four, if only this funding is used, or perhaps as many as 8-10 if combined with a matching process with the science mission areas.

Outreach to Underserved Communities **(+$200,000/0 FTE)**

Administration and Management (+$200,000/0 FTE)

The USGS culture strongly supports mentoring students, promoting interest in science to a broad range of young people through varied experiences, and instilling a sense of stewardship for the Earth. These efforts are aligned with the performance of the Youth Stewardship of Natural and Cultural Resources APG, and reach out to underserved communities by creating meaningful educational experiences for youth and USGS employees. An increase of $0.2 million would continue and help grow the high quality and diverse programs highlighted below:

The USGS and the Denver Mayor’s Office initiated a collaborative employment partnership in 2011 aimed at promising inner-city, at-risk youth. Students were given exposure to diverse science activities and were provided life skills training, meaningful work assignments, a mentor and group counseling sessions. The initial 2011 cohort had fourteen students from either high school or beginning college. In 2012, the Partnership expanded to the Albuquerque Mayor’s Office, with a cohort of twenty-one students. The Partnership was suspended in 2013 due to Sequestration; it was restarted in 2014, but only in Denver. The proposed funding would allow the partnership to expand to Albuquerque and Flagstaff in 2015.

The USGS led and funded the development and delivery of the Native Youth in Science – Preserving Our Homelands summer science camp. The Woods Hole Coastal and Marine Science Center collaborated with the Mashpee Wampanoag Departments of Education and Natural Resources, the Bureau of Indian Affairs, and the Waquoit Bay Estuarine Research Reserve to organize a four-week summer science and Wampanoag cultural program for sixth-to-eighth graders from the Mashpee Wampanoag Tribe. To demonstrate how science topics learned in school relate to Wampanoag culture and the environmental health of local lands, lessons focused on addressing tribally important sites and topics through the perspectives of environmental science and Wampanoag culture. The proposed funding would allow outreach to additional tribes who have expressed interest in working with the USGS to bring the program to their communities.

GeoFORCE is a program of the Jackson School of Geosciences, University of Texas at Austin, designed to encourage students from minority serving high schools in rural South Texas and inner city Houston to take on the challenge of a rigorous math and science curriculum, to pursue higher education in these fields, and to enter the high tech workforce. Each summer GeoFORCE takes over 600 high school students on spectacular geologic field trips in Texas and throughout the United States. With a high school graduation rate of 100 percent and a college matriculation rate of over 95 percent, GeoFORCE has 439 college students currently enrolled in over 70 colleges and universities throughout Texas and across the United States. Nearly two-thirds of GeoFORCE college students are majoring in STEM fields. Over eighty percent of GeoFORCE students are from underrepresented groups. For the ninth year in a row, the USGS has provided financial support, mentoring, tours of USGS laboratories, and STEM related internship opportunities. Students can move on from GeoFORCE to the EdMAP program, a component of the National Cooperative Geologic Mapping Program (NCGMP), which trains the next generation of geologic mappers.

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Other Program Changes

This section addresses other program increases and decreases within each of the USGS Mission Areas.

Program Increases

Ecosystems

Status and Trends Program Change Items

Pollinators

Status and Trends (+$300,000/+1 FTE)

Insect pollination is a vital ecosystem service. Our Nation's agricultural systems rely on pollination for food production, and wild settings require pollination for promoting diversity among the trees, shrubs, and wildflowers that collectively make up the landscape. Honey bees, the Nation's most prominent and wide-spread pollinating species, have recently suffered from Colony Collapse Disorder (CCD), resulting in widespread loss of US honey bee colonies and heightened societal concern over honey bee health and pollination services. Continued declines in managed bee colonies are placing considerable pressure on agricultural productivity, global food supplies, and commercial beekeepers. Additionally, recent research indicates that diseases are being passed from honey bees to native bees, providing evidence of the complex interconnected nature of pollination systems.

The USGS has unique scientific capabilities to contribute to pollination research through our portfolio of interdisciplinary research on biological, hydrological, geological, and spatial sciences. The research is predominantly applied in nature, focusing on free-ranging animals and populations within the context of their habitats, and ultimately designed to inform management decisions for species of interest. The science links habitat and environmental factors to the condition of wildlife populations, determining not only which different land use conditions cause a population level response, but also why.

While the precise cause of CCD remains unclear to scientists and beekeepers, habitat loss and poor nutrition are proposed as important factors of honey bee declines. It is generally accepted that increases in forage plant abundance and diversity will do much to promote overall bee health and pollination service. Therefore a landscape scale research initiative is needed to understand how bee health is influenced by changing habitat conditions and resource availability throughout the country.

Working with U.S. Department of Agriculture (USDA) and other Federal agencies, the USGS would conduct focused assessments and research on the status and health of honey bees and other insect pollinators that contribute to the human food supply and the sustainability of wild lands, emphasizing options for monitoring and management actions by the public and private sectors to mitigate demonstrated or potential adverse impacts. Studies would include a range of objectives, such as foraging habitat quality, limiting nutritional factors, effects of pesticides, impacts and transmission of disease, and the ecological and economic value of pollination to the Nation. Efforts will be integrated with PCAST Assessment activities.

Wildlife

Wildlife Health

Wildlife Program (+$200,000/+1 FTE)

Emerging and resurging wildlife diseases such as West Nile virus, chronic wasting disease, white-nose syndrome, chytridiomycosis, and avian influenzas are having profound impacts on wildlife populations and also threatening human and domestic animal health. Consequently, there is increased need for sharing wildlife mortality information to improve situational awareness of these disease events and allow for more effective planning and response. The USGS plans to continue the development of an online national wildlife mortality event reporting system that will facilitate the sharing of disease event information, such as outbreak onset and ending date, location, species involved, numbers involved, diagnoses, laboratory, and contact names. The system will be Web-enabled allowing users to upload event information online as well as search, sort, and retrieve relevant information for downloading. The system will be populated initially with 30 years of data from the National Wildlife Health Center, allowing wildlife managers to understand the historical context of disease detection and therefore the significance of a disease event. The system will allow for tracking of diseases that spread over large geographical areas, enhance detection of novel or new diseases or known diseases in new geographic areas or species, allow for the generation of hypotheses regarding causes, relatedness and significance of disease events, and improve disease response planning and preparedness.

Energy Future and Wildlife Sustainability

Wildlife Program (+$1,000,000/+1 FTE)

Traditional and alternative energy innovation, development, production, and delivery will remain a national focus for decades. USGS ecosystems science is a key linkage between energy development and sustainability of the Nation's ecosystems, and is at the forefront of providing information for management decisions, particularly for renewable energy. The USGS is a leader in supplying science needed to solve the challenges of making progress in energy availability while maintaining functioning natural systems. New research would build on the past three years of focused work on impacts to bald and golden eagles, bats, condors, and desert wildlife from wind and solar energy development to meet new priorities. The USGS will collect critical biological data, particularly on demographics and habitat; focus on strengthening and developing advanced technologies, such as algorithms and advanced computing infrastructure to mine bird and bat information from existing weather data; and thermal imaging and infrared videography to allow observations of birds and bats at night. Offshore energy development and new solar technologies are emerging and the USGS is working with management bureaus to identify the highest priority research for seabirds, desert species, and Interior's trust marine mammals. Large tracts of the Arctic are now leased for oil and gas development and exploratory drilling, resulting in significant overlap between the leased areas and those used by the Pacific walrus. Research would add new knowledge on potential impacts of seismic activities and ship traffic for this declining species.

Environments

Outer Continental Shelf (OCS) Ecosystems Decisions

Environments Program (+$300,000/+2 FTE)

The coastal and offshore environment is increasingly being seen as an opportunity for renewable resource development, substantially ramping up the need for biological science to support decision needs of Interior bureaus. USGS Ecosystems research has a unique role in marine waters to support, in particular, Bureau of Ocean Energy Management's (BOEM) mission-critical research priorities focused on Interior trust resources (sea birds, marine mammals, aquatic ecosystems) and potential impacts of energy development on wildlife, their habitats, and the coastal ecosystem resilience. Continued long-term research, supported by short-term focused research, is needed across multiple disciplines. This includes investigations as diverse as predicting the response of polar bears and walrus to sea ice declines, mapping of seabird abundance and distribution, understanding benthic resources and microbial ecology, determining acoustic effects on marine animals, and charting deep sea coral distributions and function. This increase would provide the USGS with resources to develop a comprehensive geographic dataset on the pelagic distribution and movements of seabirds in the U.S. Pacific Ocean using methodology developed for the Atlantic, to design long-term research and monitoring strategies to understand ecosystem changes in relation to wildlife resources, and to expand investigations on offshore wind energy and wildlife on the Atlantic coast. Research will be coordinated closely with BOEM to identify the most effective science projects. This will result in improved study planning and implementation mechanisms to enhance the Outer Continental Shelf (OCS) program results overall.

Wildfire Restoration Ecology

Environments Program (+$500,000/+2 FTE)

Land management organizations make significant investments in restoration activities both before and after wildfires. The objectives of these activities are myriad and diverse and include reducing the risk of future wildfires; maximizing safety and suppression opportunities for wildfire responders; restoring and maintaining resilient landscapes, wildlife habitat, and native vegetation communities; limiting the spread of invasive species; and stabilizing hill slopes, restoring watersheds, and ensuring water quality and supply. Although many of these activities effectively meet their objectives, many (particularly on arid landscapes) fail to meet their stated objectives. Further, there is little information about how these combined activities contribute to resilient landscapes into the future. Despite the size of the investments, there is a lack of comprehensive, integrated, and accessible scientific information that evaluates the short- and long-term effectiveness of these activities (particularly on arid landscapes). Further, national capacity is needed for providing science information that may be used to support adaptive management approaches to managing hazardous fuels and establishing and promoting resilient landscapes.

This new effort consists of two main components. The first component will initially develop an integrated and accessible database of scientific information on fuel treatment, post-fire rehabilitation, and ecological restoration activities. Following this initial development, work will focus on new science

required to support effective establishment and maintenance of resilient landscapes. The second component will use the products of the first component to develop a national, multi-scale database that characterizes the effects of fuel treatment and ecological restoration activities on wildland fire risk and resilient landscapes. This database will draw heavily from land cover change products from Landsat, broad scale monitoring programs like the Bureau of Land Management (BLM) Assessment, Inventory, and Monitoring program, and integrated fire behavior and effects models used by wildland fire managers. Deliverables of this system will include metrics that define changed fire behavior and landscape condition. This system will support the performance monitoring metrics that are being developed in current revisions of the Interior fuels management programs.

Climate and Land Use Change

Landsat Science Products for Climate and Natural Resource Assessments (+$1,500,000/+3 FTE)

The Interior bureaus rely on Landsat as a data source on wildfires, consumptive water use, land cover change, rangeland status, wildlife habitat, and other Interior responsibilities. The 2015 increase would take advantage of new Landsat capabilities to support departmental and bureau priorities including climate, wildland fire, and WaterSMART. Landsat 8 (launched in February 2013) is a $1.0 billion Federal investment and has improved data quality, particularly for snow- and ice-covered land surfaces, and has a thermal sensor that provides new capabilities for water resources monitoring and management.

Land Remote Sensing (+$1,000,000/0 FTE)

In 2015, the Land Remote Sensing (LRS) Program proposes funding (along with the Land Change Science (LCS) Program) to accelerate the development of Landsat science and applications supporting natural resource management. The LRS Program has identified a set of Landsat-based science products that will improve applications used by natural resource managers, and will contribute to the international and interagency climate monitoring community's initiative to develop consistent Essential Climate Variables (ECVs) and related Climate Data Records (CDRs). The CDRs are long-term time-series measurements such as surface temperature that support a variety of ECVs, including measures of fire disturbance, snow cover, glaciers and ice caps, permafrost, surface water extent, land cover, and biomass. The CDRs and ECVs will provide an authoritative basis for regional- to continental-scale identification of historical change, monitoring of current conditions, and predicting future scenarios. This funding would provide the opportunity to create a standing process to detect land change as it is occurring, develop national-scale ECVs documenting land and water conditions, develop algorithms to automate the products, and provide updated interpretive products in near real time. The output will be a baseline set of science products that support a wide variety of further products. This effort leverages preparatory work started in 2012 and continuing through 2014.

Land Change Science (+$500,000/+3 FTE)

In 2015, the LCS Program proposes funding (along with the LRS Program) to accelerate the development of Landsat science and applications supporting natural resource management. Water availability information is a critical input to landscape science and decisionmaking. The LCS Program has developed a proof-of-concept geospatial analysis product that integrates the principal water balance components at a sub-basin scale. The product would combine long-term Landsat data with water use information dating back to the 1980s, taking advantage of the recent gridded USGS streamflow data, Landsat-based evapotranspiration estimates, and precipitation from the Parameter-elevation Regressions on Independent Slopes Model. The resultant products will not only provide water budget information but will also provide estimates of the relative impact of climate versus land use/land cover change on water budgets. Preliminary studies will focus on watersheds in California, the Great Plains, and the Southeastern United States. This work will leverage the WaterSMART National Water Census sub-basin-scale estimates of streamflow, which are in development through 2014, and scheduled for full implementation in 2015. In turn, the resultant online tool will directly support National Water Census goals by advancing the ability to produce landscape-scale water budgets—the building blocks of water availability.

Energy, Minerals, and Environmental Health

Alternative Energy Permitting on Federal Lands +$1,300,000/+2 FTE

Energy Resources Program (+$1,300,000/+2 FTE)

This proposed increase allows the Energy Resources Program (ERP) to provide science support to the agencies responsible for energy resource management on Federal Lands in several ways. There is substantial potential for unconventional geothermal resources (Enhanced Geothermal Systems) on Federal lands, but these resources have not been thoroughly evaluated. The USGS would use core capabilities in geothermal research to evaluate the geology and subsurface characteristics to identify likely areas of potential exploration and development of geothermal resources. The Bureau of Land Management (BLM) and other bureaus could use this information for land use planning and potentially a targeted environmental impact statement for high potential use areas. The proposed funding increase would allow a focused effort in targeted areas to survey and subsequently track the impacts of geothermal development over time, which have been poorly characterized to date. This effort would focus on key areas where there are, or may be, issues related to ongoing geothermal production. The increase would also allow for additional support for researching induced seismicity related to geothermal development on Federal lands, and help to determine the risks and potential mitigation plans should development be proposed.

Emerging Contaminants and Chemical Mixtures (+$1,450,000/+2 FTE)

Toxics Substances Hydrology Program (+$1,450,000/+2 FTE)

The proposed increase would support a national assessment of contaminant mixtures at stream locations affected by combinations of contaminant sources, including wastewater treatment plant discharges, industrial discharges, landfill leachate, crop agriculture, and animal agriculture. Samples of stream waters

and sediments would be analyzed using USGS analytical capabilities for approximately 800 common and emerging chemical contaminants. In addition, the USGS would employ extensive forensic analyses to identify unknown contaminants in these environmental samples. This project would be coordinated with the EPA and their capability to conduct *in vitro* bioassays of environmental samples. The information produced by these activities would provide a basis for toxicity testing for chemical mixtures and low-level exposures; help improve understanding groups of contaminant effects on organism health; and identify unidentified contaminants of emerging concern based their actual presence and their levels in the environment. A pilot project, currently ongoing in 2014, is testing chemical mixtures and forensic methods in stream waters at a limited number of stream sites; scientists from the EPA National Exposure Research Lab, National Risk Management Research Lab, and National Health and Environmental Effects Research Laboratory are testing the same water samples for biological activity using bioassays. The expanded effort would enable testing at additional sites for other contaminant source types and combinations, and would enable testing of contaminants in both stream water and sediments, providing a better estimate of total contaminant mass and exposure potential.

Water Resources

Streamgages and Streamgage R&D (+$1,900,000/+1 FTE)

The USGS streamgage network provides streamflow information and understanding for national, State, tribal, and local economic well-being, the protection of life and property, and efficient and effective water resource management. Research and development into complimentary methods of streamflow data collection is important to measure areas in which it is not practical or feasible to place a gage.

National Streamflow Information Program (+$1,200,000/0 FTE)

The increase proposed for the National Streamflow Information Program (NSIP) would enhance the stability of the national backbone of streamgages by retaining streamgages that would otherwise be discontinued. It is expected that the NSIP would be able to fully fund about 50 streamgages. With the proposed increase, the program would help support a highly reliable system for real-time and historic streamflow information delivery to customers that includes data processing, quality assurance, storage, and easy data access. These funds would help ensure that the National Water Information System (NWIS) database, critical to the success of the NSIP, is operated and maintained at peak efficiency and effectiveness. Additional efforts are needed to provide real-time data users information on the range of uncertainty of the streamflow information they use to make decisions on a regular basis. Proposed funding would support software upgrades for time series information. The proposed 2015 budget increase would allow continuation of efforts to characterize streamflow at ungaged locations started in 2014.

Hydrologic Research and Development (+$700,000/+1 FTE)

The USGS would continue to develop and improve hydro-acoustic measurement and monitoring techniques. These techniques have greatly improved the efficiency of the USGS streamgage network and offer additional opportunities to more efficiently collect and share streamflow information in the near

term. The USGS would also expand research and development on the next generation of streamflow and bathymetric measurement techniques, which could achieve cost efficiencies in existing monitoring networks and improve capabilities for measuring discharge and depth profiles at ungaged sites. High-speed infrared video and particle image velocimetry have demonstrated potential for generating accurate, spatially detailed measurements of water-surface velocities and channel bathymetry. Laboratory experiments and field tests of these techniques using data collected from aircraft and unmanned aerial vehicles (UAV's) will enhance current capabilities for measuring discharge in ungaged streams, and could produce methods that might eventually be applied to remote sensing data from satellite platforms that currently are in development and scheduled to become operational in a few years. This capability has applications that potentially could reduce loss of life and property damage during floods; other applications include hydrographic charting for navigation, ecological monitoring and restoration, water resource management, and contaminant transport.

National Hydrologic Modeling/Groundwater Sustainability (+$750,000/+3 FTE)

Hydrologic Networks and Analysis (+$750,000/+3 FTE)

National Hydrologic Modeling Framework –Multiple agencies are very concerned that U.S. modeling capacity is inadequate to meet the needs of water managers in a rapidly changing world. Existing hydrologic modeling challenges include difficulty incorporating climate change information, lack of interoperability and integration among models, difficulty incorporating new and improved datasets, and an inability to model certain critical hydrologic processes adequately. It is essential that water management decisions be made using the best available data and modeling tools, suggesting the need for a National Hydrologic Modeling Framework or community modeling system like that currently used by the international climate modeling community. Through a series of workshops and working groups, this initiative will assess the feasibility of a new framework or modeling community.

Targeted investments in Federal science and technology as well as identification of cost-effective policy options could enhance groundwater sustainability in regions where overdraft is already occurring or expected in the near future. Through a series of workshops and working groups, the USGS will identify and describe specific investments and strategies that will provide a path forward for significantly improving management of the Nation's important groundwater resources based on changes in existing Federal programs, partnerships, regulations, grants and management strategies.

Tribes (+$1,000,000/+7 FTE)

Cooperative Water Program (+$1,000,000/+7 FTE)

Cooperative Water Program monitoring, assessments, and research would continue and expand work related to water availability issues on tribal lands in order to address such topics as water rights, water use, hydrologic conditions, and water-quality issues. The CWP would continue development of quantitative models of water budgets, including groundwater and surface-water interactions, that provide information on how human and natural factors, such as groundwater pumping and climate change, affect streamflows so that tribal river managers can develop effective strategies to maintain water supplies and

restore critical habitats and healthy ecosystems. Funding for tribal cooperators, including an increase in the 2014 budget, will be allocated in coordination with the Secretary's Indian Water Rights Office and other bureaus (including Indian Affairs and Reclamation) that support the Federal trust responsibility for water in Indian Country.

Core Science Systems

Big Earth Data

Science Synthesis, Analysis, and Research (+$2,000,000/0 FTE)

The USGS and other Interior bureaus are home to high value Earth observations, satellite and other remote sensing technologies, that are critical to providing reliable scientific information to the Nation to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. USGS datasets are regularly recognized as a high priority from a Federal science perspective. These data are regularly used for science and decisionmaking, and this additional funding to enable data innovation would dramatically expand the utility of this information and the array of users that can tap into the resource.

In coordination with the National Science and Technology Council (NSTC)/ U.S. Group on Earth Observations (USGEO) led by the President's Office of Science and Technology Policy, the USGS will coordinate with Interior bureaus, other Federal agencies, Tribes, and States to develop a cohesive strategy that contributes to and follows guidelines for government wide interoperability improvements that focus on web service access layer development to deliver underlying Earth observations. For example, investments under this initiative would enable access and integration of data from State Wildlife Management Plans, the U.S. Fish and Wildlife Service Wetland Inventory and USGS habitat and water quality databases to inform management strategies needed to restore the Gulf Coast Ecosystem.

In 2014, the USGS is leading the USGEO Subcommittee of the NSTC Data Management Working Group, to further develop the implementation plan for the Big Earth Data Initiative (BEDI). This plan outlines an approach for collecting and managing high value Earth observations. Interior bureaus included in this plan are the USGS, the U.S. Fish and Wildlife Service, the National Park Service, and the Bureau of Land Management. Work is underway to define characteristics of discoverability, accessibility, and usability and apply them to Interior observational data products such as LANDSAT and USGS Water Data for the Nation, with the expectation of understanding the treatments needed. As defined in the Big Earth Data Strategy, treatments include policies, standards, services, and tools applied in the context of the data lifecycle to improve capabilities.

In 2015, an increase of $2.0 million is proposed to support BEDI and Interior-wide coordination efforts. The USGS will continue to lead the USGEO to advance the proposals of the Big Earth Data Strategy. To advance the strategy's proposals, the USGS would continue implementing the USGS Science Data Catalog to provide a portal for organized access to USGS science data, making data easier to find using common search engines (e.g., Google, etc.); improve discoverability, accessibility, and usability; develop

and apply USGS science data-management policies that address data release and approval, metadata, and data lifecycle; develop and execute tools to make it easier for scientists to document data; make available managed collections of Earth science data to Data.gov, the Geospatial Platform, and specialized collaborative portals (e.g., Ecosystems.data.gov); integrate individual datasets into larger portal platforms (e.g., Biodiversity Information Serving Our Nation, etc.), creating efficiencies by reducing the number of smaller data systems; support the development of Web services (Application Programming Interfaces) to improve the accessibility and usability of high-priority Big Earth Data systems and data supporting the Climate Data Initiative; begin defined Big Earth Data treatments for high-priority Big Earth Data systems defined in the USGS implementation strategy; and, establish processes to sustain the viability of the USGS's Earth science data by characterizing the Nation's natural systems in new ways that spurs economic development and informs landscape conservation decisionmaking.

National Map Modernization

National Geospatial Program (+$1,908,000/+9 FTE)

Funding for National Map modernization will support geospatial data acquisition for lidar and ifsar elevation data, revised and more detailed hydrography data for the Nation's surface water, and the integration of transportation, boundaries, structures, and geographic place names data into the online geospatial data access portals, including the National Map Viewer and Download Portal, and the Geospatial Platform. These data and their access are required to support Presidential and Secretarial priorities for Building a Landscape Level Understanding of Our Resources. The proposed funding allows the National Geospatial Program to address landscape level understanding by increasing the ability to accurately visualize the natural and built environment within a set of tools that support modeling and applications. These additional funds would also boost the NGP's research and development component to provide a systematic application of knowledge and understanding to develop and improve prototypes and new processes to better use NGP map data, products, and services.

Science Support

Administration and Management (+$500,000/+1 FTE)

The Science Support program funds the bureau and region leadership and management that provide guidance, direction, and oversight of all USGS science activities and resource management and business and information systems, which provide the framework for science activities.

DOI Science Coordination (+$200,000/+1 FTE)

As the primary science bureau for Interior, the Director serves as the Secretary's Science Advisor and the Deputy Director serves as Interior's Science Integrity Officer. Starting in 2013, the USGS worked with other Interior bureau's science integrity officers to facilitate a revision of Interior's science integrity policy (to be released in 2014) and the development of training on scientific integrity that will be available to all Interior employees. The USGS has also worked with other Interior bureau's science advisors to initiate better collaboration on science issues and activities common to Interior. Together,

these activities strengthen the research and application of science across Interior. In 2015, the USGS will provide a science position dedicated to science collaboration, internal to the USGS and external with other Interior bureaus, and assisting in the fulfilling the requirements of the science integrity process.

Tribal Science Coordination (+$300,000/0 FTE)

The USGS would make existing partnerships more robust and strengthen the ability to hire interns for the Students in Support of Native American Relations (SISNAR) program, which brings interns to work on USGS research studies, including climate studies, on tribal lands. The USGS would also increase tribal capacity building through the Technical training in Support of Native American Relations (TESNAR) program, which provides training to tribal employees on a variety of scientific data collection and analysis topics, including those associated with climate change impacts, mitigation and adaptation. This funding would also allow the USGS to increase its support for tribal colleges and universities (TCUs) by allowing increased collaboration with TCU staff working on curriculum development for science programs.

Facilities

Reduce Facilities Footprint – Cost Savings and Innovation Plan (CSIP)

Rental Payments and Operations and Maintenance (+$5,365,000/0 FTE)

The USGS produces space cost savings when locations are able to consolidate space or relocate to space with lower costs. With the proposed increase, Facilities, Rental Payments and Operations and Maintenance would have the ability to invest in Cost Savings and Innovation Plan (CSIP) projects, that allow the USGS to consolidate space, reduce the occupancy footprint, improve utilization and create real property cost savings and other efficiencies.

Because the USGS relies on the General Services Administration (GSA) owned and leased buildings for about 67 percent of the space it occupies, the USGS has no ability to reduce fixed rental rates at these sites and can only offset the higher facility costs by vacating space. Therefore, primary emphasis is placed on improving space utilization, consolidating operations within, and relinquishing space to GSA provided offices, laboratories, data centers, and warehouses.

In 2013 and 2014, the USGS made significant progress in CSIP consolidation projects, reducing the bureau's footprint by more than 400,000 square feet (SF) which represents approximately 10 percent of the USGS's GSA provided space holdings.

The proposed increase would fund the library consolidation projects at the Denver Federal Center and Menlo Park Campus reducing the library space by 29,400 SF; a 48 percent reduction. Completing the Menlo Park library project will also speed up the overall consolidation plan at the Menlo Park Campus, which will ultimately allow the USGS to release the remainder of Building 3; an additional reduction of 50,100 SF. The increase would also fund a co-location project with the Bureau of Reclamation in Boulder City, NV, significantly reducing the rent costs as well as lessening Interior's overall footprint. Ultimately, these projects will yield a $1.4 million annual rent savings with a 40,750 SF footprint

reduction. The USGS has also identified six additional CSIP projects located in Menlo Park, CA; Denver, CO; and Seattle and Spokane, WA. Once these projects are completed, they will yield a footprint reduction of over 70,000 SF and annual savings of $2.4 million. The USGS is beginning to accumulate a backlog of viable short payback CSIP projects.

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Program Decreases

In order to support national priorities in a constrained budget environment, difficult choices must be made to reduce other programmatic efforts. In making these tough choices, the USGS, wherever possible, made reductions to programs where activities were nearing completion, near the end of their life cycle, or of a lower priority. The following are descriptions of those activities and programs where reductions in funding were taken.

Ecosystems

Fisheries Program Research

Fisheries Program (-$1,000,000/-8 FTE)

This funding reduction within the Fisheries Program of the Ecosystem Mission Area will reduce the collection, analysis, and dissemination of fisheries research across four areas: (1) aquaculture and hatchery support; (2) contaminant research; (3) marine ecosystems and ecology; and (4) place-based research in support of individual States.

Wildlife Program Research

Wildlife Program (-$1,200,000/-7 FTE)

The USGS would reduce research involving captive wildlife and reduce the scope of long-term monitoring activities funded under the Wildlife Program, while retaining investments in the design of monitoring and surveys. The Wildlife Program will refocus efforts to a limited number of species and populations designated as priorities for Interior management bureaus, and reduce the overall breadth of the USGS portfolio by minimizing efforts on all but the most urgent research needs.

Environments Program Research

Environments Program (-$3,220,000/-18 FTE)

The USGS would reduce the collection, analysis, and dissemination of environmental information and products across three areas: (1) landscape level science support to States; (2) biogeochemical and hydrological cycles; and (3) contaminants, toxicology, and disease research.

Climate and Land Use Change

National Civil Applications Program (-$2,547,000/-12 FTE)

Land Remote Sensing Program (-$2,547,000/-12 FTE)

The National Civil Applications Program (NCAP) uses data from classified systems and commercial satellites to investigate climate change and other Earth dynamics, ecosystems, natural hazards, and manmade disasters (such as wildland fires), and improve land and resources management. In 2014 and 2015, the Land Remote Sensing Program will begin to decrease lower-priority, outdated, or duplicative functions of the NCAP. The USGS will maintain its civil science leadership of the Civil Applications Committee and assess ways to use classified assets for hazards, environmental, and natural resources applications strategically. The USGS would continue to scale back operations at the Advanced System Center (ASC) Sensitive Compartmented Information Facility (SCIF) in Reston and would discontinue funding research at the Special Applications Science Center (SASC) SCIF located in Denver. In addition, the ASC SCIF in Reston would release additional space in their building and vacant positions would not be filled. In addition, NCAP funding provided to the Eastern Geographic Science Center for the use of classified data at the ASC would be reduced. The acquisition, archive, and dissemination of classified remotely sensed data to support science programs of the USGS, Interior, and other Federal civil agencies would be continued.

Land Change Science (-$1,000,000/-7 FTE)

The Land Change Science (LCS) Program conducts research on land cover to provide a historical record of resource use; information on the availability and quality of natural resources; assessment of the impacts of land cover change; and tool development for decisionmakers to use for resource allocation. In 2015, the LCS Program is proposing a $1.0 million reduction. This reduction permits program prioritization of Landsat information products and research on the Chesapeake Bay but the reduction would result in the elimination of projects whose objectives are to use remotely sensed imagery to assess vegetation, ecosystems function, flood inundation, and historical land cover change.

Energy, Minerals, and Environmental Health

Energy Research (-$1,000,000/-2 FTE)

Energy Resources Program (-$1,000,000/-2 FTE)

This proposed reduction would reduce methanogensis (formation of methane) research and other environmental studies related to energy resources. At this level, contributions to the Energy Resources Program publications would only fund assessment fact sheets.

Activities related to Oil, Oil Shale and Gas Assessments (-$500,000/-1 FTE)

Energy Resources Program (-$500,000/-1 FTE)

This proposed reduction would reduce basic oil and gas resource research and assessment activities in the Energy Resources Program including research on domestic oil shale resources, and oil and gas activities in the U.S. Gulf Coast.

Discontinue Research on Contaminants in Wastewater Projects (-$369,000/-1 FTE)

Toxics Substances Hydrology (-$369,000/-1 FTE)

The proposed reduction would eliminate projects which enable scientists and decisionmakers to design monitoring strategies, predict how wastewater contaminants move in groundwater and surface water, and estimate how quickly contaminants in wastewater effluents released to the environment degrade to less toxic compounds at these targeted sites and other similar sites nationwide. Journal articles originally scheduled for publication this year would be delayed. These products are designed to inform wastewater managers working in municipal as well as military sectors about the balance between natural attenuation versus the longevity of wastewater contaminants released to surface water and groundwater in the years after cessation of these releases.

Natural Hazards

Eliminate Precision Geodetic Monitoring and Active-Source Profiling (-$700,000/-2 FTE)

Earthquake Hazards Program (-$700,000/-2 FTE)

Between the occurrences of large earthquakes, precision geodetic monitoring is used to track non-seismic fault movement. Data from this monitoring helps assess the buildup of energy along a fault, and can affect assessments of earthquake probabilities and large-earthquake recurrence times. Without these technologies, users will rely on less precise data, such as GPS, for fault-specific assessments. Fault slip and earthquake potential are also assessed through geophysical profiling, especially seismic profiling such as is used in the oil and gas industry. Such capabilities can also be used to determine site-specific earthquake risk. Without these data, USGS researchers will rely on geologic studies alone, significantly diminishing the understanding of individual fault geometry and slip history.

Coastal Vulnerability Studies (-$1,000,000/-1 FTE)

Coastal and Marine Geology Program (-$1,000,000/-1 FTE)

The Coastal and Marine Geology Program would reduce regional ecosystem and coastal change studies focused on estuarine and wetland vulnerability to coastal hazards (except within the areas impacted by

Hurricane Sandy), tsunami risk to coastal communities, ecological impacts of sea-level rise, and studies of coral reef health and resilience in Hawaii and Florida.

Water Resources

Water Quality Monitoring (-$2,000,000/-8 FTE)

National Water Quality Assessment Program (-$2,000,000/-8 FTE)

In order to fund work that is of a higher priority, the National Water Quality Assessment Program had to make some strategic reductions. The NAWQA program would reduce groundwater quality monitoring at about 150 of 750 wells in large aquifers across the Nation. The reduction would also decrease development of groundwater-quality models used by water-supply managers to assess the amount and quality of drinking water that is available and to forecast changes in water quality resulting from alternative management actions.

Monitoring and Assessments (-$1,500,000/-7 FTE)

Hydrologic Research and Development (-$1,500,000/-7 FTE)

As resources are refocused on high-priority research areas such as the Puget Sound Ecosystem, Hydraulic Fracturing, and Streamgaging R&D, there would be a $1.5 million decrease in base funding for Hydrologic Research and Development, resulting in reduced effort on long-term monitoring and assessments at research sites. This would slow progress on data collection and publication of information products in specific areas related to water availability, contaminants, ecosystem restoration, and others.

Watershed Support, Information Delivery, and Technical Support (-$1,500,000/-7 FTE)

Hydrologic Networks and Analysis (-$1,500,000/-7 FTE)

The Water Mission Area made strategic budget decisions that meant moving funds from lower priority projects to Administration and USGS priorities. The Hydrologic Networks and Analysis program would reduce watershed modeling within the Hydrologic Analysis component of the program and reduce its support for Information Delivery and Technical Support.

Monitoring and Assessments (-$3,264,000/-9 FTE)

Cooperative Water Program (-$3,264,000/-9 FTE)

Reductions redirect funding to other priorities under the Cooperative Water Program. Funding for a number of monitoring and assessment activities would be redirected to priority areas such as national water quality assessment, streamflow studies, and tribal water needs as discussed in the program increases section.

Water Resource Research Act Program **(-$3,000,000/0 FTE)**

Water Resources Research Act Program (-$3,000,000/0 FTE)

The proposed budget reduction would reduce funding of the annual base grants to the Institutes by approximately one-half of what was allocated to each Institute in 2014. The competitively awarded portion of the program would continue. The USGS is working with the Institutes in 2014 and will continue in 2015, to develop more rigorous oversight of the program and ensure that Federal investments at each of the Institutes effectively and consistently maximize national science goals and leverage all available resources, particularly in the areas of water availability, quality, and climate change.

Core Science Systems

Bio-Science Data Synthesis

Science Synthesis, Analysis, and Research **(-$3,000,000/-4 FTE)**

The USGS proposes to redirect funds from lower priority bio-scientific data and information such as vegetation characterization and oceans to advance implementation of higher priority data synthesis and analysis activities such as the Big Earth Data Initiative and EcoINFORMA.

Glacial Aquifers Project

National Cooperative Geologic Mapping Program **(-$2,000,000/0 FTE)**

The USGS would redirect funds to higher priority hydraulic fracturing research. The proposed reduction would discontinue mapping in support of the glacial aquifer project, which provides information about aquifer characterization in glaciated areas of the Northeast. Geologic mapping of glacial aquifers in the northern United States will be curtailed in order to redirect some expertise toward hydraulic fracturing research. This would end some collaborative work being conducted jointly with the States of Massachusetts, Michigan and New York.

Land Cover Data

National Geospatial Program **(-$422,000/-1 FTE)**

This reduction eliminates the support of USGS land cover data in the National Geospatial Program's (NGP's) maps, products, and services. NGP funding will be focused on higher priorities necessary to modernize the National Map.

Urban Area Imagery

National Geospatial Program **(-$4,082,000/-25 FTE)**

This reduction eliminates the USGS's participation to cooperatively acquire high-resolution imagery with the National Geospatial-Intelligence Agency's (NGA's) 133 urban areas program in support of homeland security and other national needs. The program has become a lower priority for the USGS and the NGA as other resources and technologies have become a higher priority.

NGP Program Coordination and Partnership Development

National Geospatial Program **(-$822,000/-4 FTE)**

The USGS would redirect funds to higher priority work. This component oversees external coordination and communications with partners, and NGP's geospatial liaison network. This program advances effectiveness in working with external organizations and partnership development, but would retain core data program investments.

The National Atlas of the United States of America®

National Geospatial Program **(-$2,674,000/-18 FTE)**

This reduction eliminates some lower priority activities of The National Atlas of the United States of America®. The National Atlas effort develops, integrates, and disseminates small-scale (national-, multi-State, and regional) base maps, geospatial data for download, thematic maps, articles, and interactive map viewer products and Web services. It is the only integrated and comprehensive national source for much of these small-scale base data. Some of these datasets will still be available through the National Map viewer or other accesses such as the National Cooperative Geologic Mapping Program's Tapestry of Time and Terrain, a union of two maps of the United States that depicts the geology and topography.

Science Support

To prioritize on-the-ground science activities funding would be redirected from Administration services to science.

Administrative Services **(-$4,500,000/-16 FTE)**

The Science Support Activity funds the bureau and regional leadership and management that provide guidance, direction and oversight of all USGS science activities and resource management, and business and information systems, which provide the framework for science activities.

Administration and Management (-$2,200,000/-14 FTE)

The Administration and Management subactivity includes science quality and integrity, communications, and bureau management activities, such as leadership and budget formulation and analysis. The proposed reduction could affect such Administrative services as acquisition and grant services, human capital, communications, financial and budget management, vehicle management, safety training, and hazardous waste management.

Information Services (-$2,300,000/-2 FTE)

Information Services facilitates science through technologies that enable collaboration and knowledge and information sharing between scientists across the landscape in addition to providing the communications and data management backbone. The proposed reduction could impact functions such as cyber security, records management (including the Data Rescue Program), maintenance and technology refresh for computing infrastructure hardware, and system software contracts and services.

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Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Appropriation: Surveys, Investigations, and Research						
Ecosystems						
Status and Trends	**20,473**	**20,473**	**144**	**0**	**300**	**20,917**
Program Amount	20,473	20,473	0	0	0	20,917
Fixed Costs	0	0	144	0	0	0
Pollinators	0	0	0	0	300	0
Fisheries Program	**20,886**	**20,886**	**171**	**0**	**1,200**	**22,257**
Program Amount	20,886	20,886	0	0	0	22,257
Fixed Costs	0	0	171	0	0	0
Fisheries Program Research	0	0	0	0	(1,000)	0
Hydraulic Fracturing	0	0	0	0	2,200	0
Wildlife Program	**44,252**	**44,757**	**366**	**0**	**0**	**45,123**
Program Amount	44,252	44,757	0	0	0	45,123
Fixed Costs	0	0	366	0	0	0
Energy Future and Wildlife Sustainability	0	0	0	0	1,000	0
Wildlife Health	0	0	0	0	200	0
Wildlife Program Research	0	0	0	0	(1,200)	0
Environments Program	**34,024**	**36,244**	**214**	**0**	**1,080**	**37,538**
Program Amount	34,024	36,244	0	0	0	37,538
Fixed Costs	0	0	214	0	0	0
Ecosystem Priorities: California Bay Delta	0	0	0	0	500	0
Ecosystem Priorities: Chesapeake Bay	0	0	0	0	300	0
Ecosystem Priorities: Columbia River	0	0	0	0	300	0
Ecosystem Priorities: National Ecosystems Services Framework	0	0	0	0	1,000	0
Ecosystem Priorities: Puget Sound	0	0	0	0	400	0
Sustaining Environmental Capital	0	0	0	0	1,000	0
Environments Program Research	0	0	0	0	(3,220)	0
OCS Ecosystems Decisions	0	0	0	0	300	0
Wildfire Restoration Ecology	0	0	0	0	500	0
Invasive Species	**12,080**	**13,080**	**59**	**0**	**4,500**	**17,639**
Program Amount	12,080	13,080	0	0	0	17,639
Fixed Costs	0	0	59	0	0	0
Brown Tree Snakes: Detection and Control	0	0	0	0	500	0
Ecosystem Priorities: Everglades	0	0	0	0	1,000	0
Ecosystem Priorities: Great Lakes Asian Carp Control	0	0	0	0	1,000	0
Ecosystem Priorities: Ecosystem Priorities: Upper Mississippi River Asian Carp Control	0	0	0	0	1,000	0
New and Emerging Invasives of National Concern	0	0	0	0	1,000	0
Cooperative Research Units	**17,371**	**17,371**	**180**	**0**	**1,000**	**18,551**
Program Amount	17,371	17,371	0	0	0	18,551
Fixed Costs	0	0	180	0	0	0
CRU Scientists for Tomorrow	0	0	0	0	1,000	0
Activity Total, Ecosystems	**149,086**	**152,811**	**1,134**	**0**	**8,080**	**162,025**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Climate and Land Use Change						
Climate Variability						
National Climate Change and Wildlife Science Center/DOI Climate Science Centers (CSCs)	**23,735**	**23,735**	**50**	**0**	**11,550**	**35,335**
Program Amount	23,735	23,735	0	0	0	35,335
Fixed Costs	0	0	50	0	0	0
Climate Adaptation and Resiliency - Vulnerability Assessment Database & Field Guide	0	0	0	0	800	0
Grand Challenge: Drought Impacts & Adaptive Management	0	0	0	0	3,000	0
Interagency Coordination	0	0	0	0	2,250	0
Translational Science Grants	0	0	0	0	3,000	0
Tribal Climate Science Partnerships	0	0	0	0	2,500	0
Climate Research & Development	**20,495**	**20,495**	**154**	**0**	**4,600**	**25,249**
Program Amount	20,495	20,495	0	0	0	25,249
Fixed Costs	0	0	154	0	0	0
Emerging Science Needs	0	0	0	0	2,600	0
Grand Challenge: Climate & Land Cover Change Effects	0	0	0	0	2,000	0
Carbon Sequestration	**8,359**	**9,359**	**31**	**0**	**2,000**	**11,390**
Program Amount	8,359	9,359	0	0	0	11,390
Fixed Costs	0	0	31	0	0	0
Grand Challenge: Carbon Inventory & Decision Support Tools	0	0	0	0	2,000	0
Science Support for DOI Bureaus	**2,220**	**0**	**0**	**0**	**0**	**0**
Program Amount	2,220	0	0	0	0	0
Fixed Costs	0	0	0	0	0	0
Subtotal: Climate Variability	*54,809*	*53,589*	*235*	*0*	*18,150*	*71,974*
Land Use Change						
Land Remote Sensing	**67,894**	**67,894**	**192**	**0**	**(1,547)**	**66,539**
Program Amount	67,894	67,894	0	0	0	66,539
Fixed Costs	0	0	192	0	0	0
Landsat Science Products for Climate and Natural Resources Assessments	0	0	0	0	1,000	0
National Civil Applications Program/Civil Applications Committee	0	0	0	0	(2,547)	0
Land Change Science	**10,492**	**10,492**	**76**	**0**	**0**	**10,568**
Program Amount	10,492	10,492	0	0	0	10,568
Fixed Costs	0	0	76	0	0	0
Ecosystem Priorities: Chesapeake Bay	0	0	0	0	500	0
Landsat Science Products for Climate and Natural Resources Assessments	0	0	0	0	500	0
Land Change Science Research	0	0	0	0	(1,000)	0
Subtotal: Land Use Change	*78,386*	*78,386*	*268*	*0*	*(1,547)*	*77,107*
Activity Total, Climate and Land Use Change	**133,195**	**131,975**	**503**	**0**	**16,603**	**149,081**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Energy, Minerals, and Environmental Health						
Mineral and Energy Resources						
Mineral Resources	**45,931**	**45,931**	**414**	**0**	**0**	**46,345**
Program Amount	45,931	45,931	0	0	0	46,345
Fixed Costs	0	0	414	0	0	0
Energy Resources	**25,970**	**25,970**	**182**	**0**	**750**	**26,902**
Program Amount	25,970	25,970	0	0	0	26,902
Fixed Costs	0	0	182	0	0	0
Alternative Energy Permitting on Federal Lands	0	0	0	0	1,300	0
Energy Research	0	0	0	0	(1,000)	0
Hydraulic Fracturing	0	0	0	0	950	0
Oil, Oil Shale, and Gas Assessments	0	0	0	0	(500)	0
Subtotal: Mineral and Energy Resources	*71,901*	*71,901*	*596*	*0*	*750*	*73,247*
Environmental Health						
Contaminant Biology	**8,647**	**9,647**	**80**	**0**	**2,273**	**12,000**
Program Amount	8,647	9,647	0	0	0	12,000
Fixed Costs	0	0	80	0	0	0
Ecosystem Priorities: Chesapeake Bay	0	0	0	0	100	0
Ecosystem Priorities: Columbia River	0	0	0	0	100	0
Environmental Impacts of Uranium Mining	0	0	0	0	673	0
Hydraulic Fracturing	0	0	0	0	1,400	0
Toxic Substance Hydrology	**9,967**	**9,967**	**78**	**0**	**3,781**	**13,826**
Program Amount	9,967	9,967	0	0	0	13,826
Fixed Costs	0	0	78	0	0	0
Contaminants in Wastewater Projects	0	0	0	0	(369)	0
Ecosystem Priorities: Chesapeake Bay	0	0	0	0	100	0
Ecosystem Priorities: Columbia River	0	0	0	0	100	0
Emerging Contaminants & Chemical Mixtures	0	0	0	0	1,450	0
Environmental Impacts of Uranium Mining	0	0	0	0	2,500	0
Subtotal: Environmental Health	*18,614*	*19,614*	*158*	*0*	*6,054*	*25,826*
Activity Total, Energy, Minerals, and Environmental Health	**90,515**	**91,515**	**754**	**0**	**6,804**	**99,073**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Natural Hazards						
Earthquake Hazards	**50,753**	**53,803**	**314**	**0**	**0**	**54,117**
Program Amount	50,753	53,803	0	0	0	54,117
Fixed Costs	0	0	314	0	0	0
Eliminate Geodetic Monitoring and Active-Source Seismic Profiling	0	0	0	0	(700)	0
Hydraulic Fracturing - Induced Seismicity	0	0	0	0	700	0
Volcano Hazards	**22,721**	**23,121**	**187**	**0**	**0**	**23,308**
Program Amount	22,721	23,121	0	0	0	23,308
Fixed Costs	0	0	187	0	0	0
Landslide Hazards	**2,985**	**3,485**	**26**	**0**	**0**	**3,511**
Program Amount	2,985	3,485	0	0	0	3,511
Fixed Costs	0	0	26	0	0	0
Global Seismographic Network	**4,853**	**4,853**	**13**	**0**	**0**	**4,866**
Program Amount	4,853	4,853	0	0	0	4,866
Fixed Costs	0	0	13	0	0	0
Geomagnetism	**1,888**	**1,888**	**17**	**0**	**0**	**1,905**
Program Amount	1,888	1,888	0	0	0	1,905
Fixed Costs	0	0	17	0	0	0
Coastal & Marine Geology	**40,336**	**41,336**	**296**	**0**	**(1,000)**	**40,632**
Program Amount	40,336	41,336	0	0	0	40,632
Fixed Costs	0	0	296	0	0	0
Coastal Vulnerability Studies	0	0	0	0	(1,000)	0
Activity Total, Natural Hazards	**123,536**	**128,486**	**853**	**0**	**(1,000)**	**128,339**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Water Resources						
Groundwater Resources	**8,348**	**8,948**	**81**	**0**	**2,400**	**11,429**
Program Amount	8,348	8,948	0	0	0	11,429
Fixed Costs	0	0	81	0	0	0
WaterSMART: Groundwater Network	0	0	0	0	2,400	0
National Water Quality Assessment	**58,859**	**58,859**	**531**	**0**	**(300)**	**59,090**
Program Amount	58,859	58,859	0	0	0	59,090
Fixed Costs	0	0	531	0	0	0
Ecosystem Priorities: California Bay Delta	0	0	0	0	1,000	0
Ecosystem Priorities: Chesapeake Bay	0	0	0	0	500	0
Ecosystem Priorities: Upper Mississippi River	0	0	0	0	200	0
Water Quality Monitoring	0	0	0	0	(2,000)	0
National Streamflow Information Program	**27,701**	**33,701**	**159**	**0**	**1,200**	**35,060**
Program Amount	27,701	33,701	0	0	0	35,060
Fixed Costs	0	0	159	0	0	0
Streamgages	0	0	0	0	1,200	0
Hydrologic Research & Development	**10,915**	**10,915**	**107**	**0**	**301**	**11,323**
Program Amount	10,915	10,915	0	0	0	11,323
Fixed Costs	0	0	107	0	0	0
Ecosystem Priorities: Puget Sound	0	0	0	0	200	0
HR&D Monitoring and Assessments	0	0	0	0	(1,500)	0
Hydraulic Fracturing	0	0	0	0	901	0
Streamgage R&D	0	0	0	0	700	0
Hydrologic Networks & Analysis	**28,884**	**28,884**	**289**	**0**	**1,250**	**30,423**
Program Amount	28,884	28,884	0	0	0	30,423
Fixed Costs	0	0	289	0	0	0
National Hydrologic Modeling/Groundwater Sustainability	0	0	0	0	750	0
Watershed Support, Information Delivery, & Technical Support	0	0	0	0	(1,500)	0
WaterSMART: State Water Use Grants	0	0	0	0	2,000	0
Cooperative Water Program	**59,474**	**59,474**	**351**	**0**	**(264)**	**59,561**
Program Amount	59,474	59,474	0	0	0	59,561
Fixed Costs	0	0	351	0	0	0
Monitoring and Assessments	0	0	0	0	(3,264)	0
Tribes	0	0	0	0	1,000	0
WaterSMART: Water Use Research	0	0	0	0	2,000	0
Water Resources Research Act Program	**3,268**	**6,500**	**0**	**0**	**(3,000)**	**3,500**
Program Amount	3,268	6,500	0	0	0	3,500
Fixed Costs	0	0	0	0	0	0
Funding to State Institutes	0	0	0	0	(3,000)	0
Activity Total, Water Resources	**197,449**	**207,281**	**1,518**	**0**	**1,587**	**210,386**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Core Science Systems						
Science Synthesis, Analysis and Research Program	**23,914**	**24,314**	**140**	**0**	**(15)**	**24,439**
Program Amount	23,914	24,314	0	0	0	24,439
Fixed Costs	0	0	140	0	0	0
Big Earth Data Initiative	0	0	0	0	2,000	0
Bio-Science Data Synthesis	0	0	0	0	(3,000)	0
EcoINFORMA	0	0	0	0	800	0
Hydraulic Fracturing	0	0	0	0	185	0
National Cooperative Geologic Mapping Program	**24,397**	**24,397**	**136**	**0**	**0**	**24,533**
Program Amount	24,397	24,397	0	0	0	24,533
Fixed Costs	0	0	136	0	0	0
Glacial Aquifers Project	0	0	0	0	(2,000)	0
Hydraulic Fracturing	0	0	0	0	2,000	0
National Geospatial Program	**59,332**	**60,096**	**388**	**0**	**(56)**	**60,428**
Program Amount	59,332	60,096	0	0	0	60,428
Fixed Costs	0	0	388	0	0	0
3D Elevation Program	0	0	0	0	5,000	0
Alaska Mapping	0	0	0	0	236	0
Ecosystem Priorities: Columbia River	0	0	0	0	350	0
Ecosystem Priorities: Puget Sound	0	0	0	0	450	0
Land Cover Data	0	0	0	0	(422)	0
Nation's 133 Largest Urban Areas	0	0	0	0	(4,082)	0
The National Map Modernization	0	0	0	0	1,908	0
NGP Program Coordination and Partnership Development	0	0	0	0	(822)	0
The National Atlas	0	0	0	0	(2,674)	0
Activity Total, Core Science Systems	**107,643**	**108,807**	**664**	**0**	**(71)**	**109,400**

Budget at a Glance
(Dollars in Thousands)

	2013 Actual	2014 Enacted	Fixed Costs	Internal Transfers	Program Changes	2015 Request
Science Support						
Administration and Management	**86,985**	**86,985**	**(593)**	**0**	**0**	**86,392**
Program Amount	86,985	86,985	0	0	0	86,392
Fixed Costs	0	0	(593)	0	0	0
DOI Science Coordination	0	0	0	0	200	0
Youth & Education in Science	0	0	0	0	1,000	0
Mendenhall Program Postdocs	0	0	0	0	500	0
Outreach to Underserved Communities	0	0	0	0	200	0
Reduction to Administrative Services	0	0	0	0	(2,200)	0
Tribal Science Coordination	0	0	0	0	300	0
Information Services	**23,719**	**23,719**	**456**	**0**	**(2,300)**	**21,875**
Program Amount	23,719	23,719	0	0	0	21,875
Fixed Costs	0	0	456	0	0	0
Reduction to Administrative Services	0	0	0	0	(2,300)	0
Activity Total, Administration and Management	**110,704**	**110,704**	**(137)**	**0**	**(2,300)**	**108,267**
Facilities						
Rental Payments and Operations & Maintenance	**93,141**	**93,141**	**911**	**0**	**5,365**	**99,417**
Program Amount	93,141	93,141	0	0	0	99,417
Fixed Costs	0	0	911	0	0	0
Reducing the Facilities Footprint - Cost Savings and Innovation Plan (CSIP)	0	0	0	0	5,365	0
Deferred Maintenance and Capital Improvement	**6,899**	**7,280**	**0**	**0**	**0**	**7,280**
Program Amount	6,899	7,280	0	0	0	7,280
Fixed Costs	0	0	0	0	0	0
Activity Total, Facilities	**100,040**	**100,421**	**911**	**0**	**5,365**	**106,697**
Total, SIR	**1,012,168**	**1,032,000**	**6,200**	**0**	**35,068**	**1,073,268**

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Analysis by Account and Activity
(Dollars in Thousands)

Activity/Subactivity/Program Element	2013 Actual		2014 Enacted		Fixed Costs & Related Changes (+/-)		Program Changes (+/-)		2015 Request		Inc (+) Dec (-) from 2014	
	FTE	Amount	FTE	Amount	FTE	Amount	FTE	Amount	FTE	Amount	FTE	Amount
Appropriation: Surveys, Investegations, and Reseach												
Ecosystems	967	149,086	982	152,811	0	1,134	10	8,080	992	162,025	10	9,214
Climate and Land Use Change	415	133,195	407	131,975	0	503	11	16,603	418	149,081	11	17,106
Energy, Minerals, and Environmental Health	581	90,515	584	91,515	0	754	19	6,804	603	99,073	19	7,558
Natural Hazards	654	123,536	661	128,486	0	853	(1)	(1,000)	660	128,339	(1)	(147)
Water Resources	1,452	197,449	1,455	207,281	0	1,518	(1)	1,587	1,454	210,386	(1)	3,105
Core Science Systems	546	107,643	546	108,807	0	664	(43)	(71)	503	109,400	(43)	593
Science Support	527	110,704	527	110,704	0	(137)	(13)	(2,300)	514	108,267	(13)	(2,437)
Facilities	60	100,040	60	100,421	0	911	0	5,365	60	106,697	0	6,276
Total, USGS	**5,202**	**1,012,168**	**5,222**	**1,032,000**	**0**	**6,200**	**(18)**	**35,068**	**5,204**	**1,073,268**	**(18)**	**41,268**

United States Geological Survey

Federal Funds

General and special funds:

SURVEYS, INVESTIGATIONS, AND RESEARCH

For expenses necessary for the United States Geological Survey to perform surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States, its territories and possessions, and other areas as authorized by 43 U.S.C. 31, 1332, and 1340; classify lands as to their mineral and water resources; give engineering supervision to power permittees and Federal Energy Regulatory Commission licensees; administer the minerals exploration program (30 U.S.C. 641); conduct inquiries into the economic conditions affecting mining and materials processing industries (30 U.S.C. 3, 21a, and 1603; 50 U.S.C. 98g(1)) and related purposes as authorized by law; and to publish and disseminate data relative to the foregoing activities; [$1,032,000,000] *$1,073,268,000*, to remain available until September 30, [2015] *2016*; of which [$53,337,000] *$53,337,189* shall remain available until expended for satellite operations; and of which [$7,280,000] *$7,280,000* shall be available until expended for deferred maintenance and capital improvement projects that exceed $100,000 in cost: *Provided*, That none of the funds provided for the ecosystem research activity shall be used to conduct new surveys on private property, unless specifically authorized in writing by the property owner: *Provided further*, That no part of this appropriation shall be used to pay more than one-half the cost of topographic mapping or water resources data collection and investigations carried on in cooperation with States and municipalities.

Appropriation Language and Citations

For expenses necessary for the United States Geological Survey to perform surveys, investigations, and research covering topography, geology, hydrology, biology, and the mineral and water resources of the United States,

- **43 U.S.C. 31(a)** provides for establishment of the Office of the Director of the Geological Survey, under the Interior Department, and that this officer shall have direction of the Geological Survey, and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain.

A full listing of USGS appropriation language and citations is available at the USGS Office of Budget, Planning, and Integration Web site, under Resources and Tools.

Web site: *http://www.usgs.gov/budget/resources_tools.asp*

Expiring Authorization Citation	
Bureau/Office Name	USGS/Natural Hazards
Program Name	Earthquakes Hazards Program
Citation	P.L. 108-360; 42 U.S.C. Sec. 7701-7709
Title of Legislation	National Earthquake Hazards Reduction Program Reauthorization Act of 2004
Last Year of Authorization	2009
BY Budget Request ($000)	$54,117
Explanation of Authorization Requirement for BY	No individual programmatic authorization is necessary for the USGS to continue this effort
Program Description	Monitoring, research, assessment and characterization of earthquake hazards

Expiring Authorization Citation	
Bureau/Office Name	USGS/Core Science Systems
Program Name	Science Synthesis, Analysis, and Research
Citation	42 U.S.C. 15908 sec 351, P.L. 109-58
Title of Legislation	National Geologic and Geophysical Data Preservation Program Act of 2005
Last Year of Authorization	2010
BY Budget Request ($000)	$24,439
Explanation of Authorization Requirement for BY	No individual programmatic authorization is necessary for the USGS to continue this effort
Program Description	SEC. 351. Preservation of Geological and Geophysical Data Program.—The Secretary (Interior) shall carry out a National Geological and Geophysical Data Preservation Program in accordance with this section—(1) Establishment.—The Secretary shall establish, as a component of the Program, a data archive system to provide for the storage, preservation, and archiving of subsurface, surface, geological, geophysical, and engineering data and samples. The Secretary, in consultation with the Advisory Committee, shall develop guidelines relating to the data archive system, including the types of data and samples to be preserved.

Expiring Authorization Citation	
Bureau/Office Name	USGS/Water Resources Program
Program Name	Water Resources Research Act Program
Citation	42 U.S.C. 10301 - 10303, P.L. 109-471
Title of Legislation	Water Resources Research Act Amendments of 2006
Last Year of Authorization	2011
BY Budget Request ($000)	$3,500
Explanation of Authorization Requirement for BY	No individual programmatic authorization is necessary for the USGS to continue this effort
Program Description	Sec. 2 (a) Scope of Research; Other Activities; Cooperation and Coordination. –Section 104(b)(1) of the Water Resources Research Act of 1984 (42 U.S.C. 10303(b)(1) is amended to read as follows: “plan, conduct, or otherwise arrange for competent applied and peer reviewed research that fosters: improvements in water supply reliability; the exploration of new ideas that address water problems, or expand understanding of water and water related phenomena; the entry of new research scientists, engineers, and technicians into water resources fields; and the dissemination of research results to water managers and the public.

Expiring Authorization Citation	
Bureau/Office Name	USGS/Climate and Land Use Change/Climate Variability
Program Name	Carbon Sequestration Program (Biologic)
Citation	42 U.S.C. 17286, P.L. 110-140
Title of Legislation	Energy Independence and Security Act of 2007
Last Year of Authorization	2012
BY Budget Request ($000)	$7,180
Explanation of Authorization Requirement for BY	National assessments of biologic carbon sequestration
Program Description	Subtitle B-Carbon Capture and Sequestration Assessment and Framework. Sec 711-712: The Secretary (Interior) through the Director of the USGS should consult with the Secretary of DOE, EPA Administrator, and State Surveys to complete national assessment of capacity for carbon dioxide in accordance with the methodology created.

Expiring Authorization Citation	
Bureau/Office Name	USGS/Climate and Land Use Change/Climate Variability
Program Name	Carbon Sequestration Program (Geologic)
Citation	42 U.S.C. 17286, P.L. 110-140
Title of Legislation	Energy Independence and Security Act of 2007
Last Year of Authorization	2012
BY Budget Request ($000)	$4,180
Explanation of Authorization Requirement for BY	National assessments of geologic carbon sequestration
Program Description	Subtitle B-Carbon Capture and Sequestration Assessment and Framework. Sec 711-712: The Secretary (Interior) through the Director of the USGS should consult with the Secretary of DOE, EPA Administrator, and State Surveys to complete national assessment of capacity for carbon dioxide in accordance with the methodology created.

Administrative Provisions

From within the amount appropriated for activities of the United States Geological Survey such sums as are necessary shall be available for contracting for the furnishing of topographic maps and for the making of geophysical or other specialized surveys when it is administratively determined that such procedures are in the public interest; construction and maintenance of necessary buildings and appurtenant facilities; acquisition of lands for gauging stations and observation wells; expenses of the United States National Committee for Geological Sciences; and payment of compensation and expenses of persons employed by the Survey duly appointed to represent the United States in the negotiation and administration of interstate compacts: *Provided*, That activities funded by appropriations herein made may be accomplished through the use of contracts, grants, or cooperative agreements as defined in section 6302 of title 31, United States Code: *Provided further*, That the United States Geological Survey may enter into contracts or cooperative agreements directly with individuals or indirectly with institutions or nonprofit organizations, without regard to 41 U.S.C. 6101, for the temporary or intermittent services of students or recent graduates, who shall be considered employees for the purpose of chapters 57 and 81 of title 5, United States Code, relating to compensation for travel and work injuries, and chapter 171 of title 28, United States Code, relating to tort claims, but shall not be considered to be Federal employees for any other purposes.

Administrative Provisions Language and Citations

A full listing of USGS appropriation language and citations is available at the USGS Office of Budget, Planning, and Integration Web site, under Resources and Tools.

Web site: *http://www.usgs.gov/budget/resources_tools.asp*

Summary Of Requirements

($ in Thousands)

Activity/Subactivity/Program Element	2013 Actual		2014 Enacted		Fixed Costs & Related Changes		Program Changes		Internal Transfers		2015 Request		Change from 2014 Enacted	
	Total FTE	Amount	Total FTE	Amount	FTE Changes	Amount	FTE Changes	Amount	FTE Changes	Amount	Total FTE	Amount	FTE Changes	Amount
Appropriation: Surveys, Investigations, and Research														
Ecosystems														
Status and Trends	124	20,473	124	20,473	0	144	1	300	0	0	125	20,917	1	444
Fisheries Program	147	20,886	147	20,886	0	171	2	1,200	0	0	149	22,257	2	1,371
Wildlife Program	304	44,252	305	44,757	0	366	-5	0	0	0	300	45,123	-5	366
Environments Program	185	34,024	197	36,244	0	214	-6	1,080	0	0	191	37,538	-6	1,294
Invasive Species	51	12,080	53	13,080	0	59	12	4,500	0	0	65	17,639	12	4,559
Cooperative Research Units	156	17,371	156	17,371	0	180	6	1,000	0	0	162	18,551	6	1,180
Ecosystems Total	**967**	**149,086**	**982**	**152,811**	**0**	**1,134**	**10**	**8,080**	**0**	**0**	**992**	**162,025**	**10**	**9,214**
Climate and Land Use Change														
Climate Variability														
National Climate Change and Wildlife Science Center/DOI Climate Science Centers (CSCs)	40	23,735	40	23,735	0	50	9	11,550	0	0	49	35,335	9	11,600
Climate Research & Development	123	20,495	123	20,495	0	154	11	4,600	0	0	134	25,249	11	4,754
Carbon Sequestration	25	8,359	29	9,359	0	31	5	2,000	0	0	34	11,390	5	2,031
Science Support for DOI Bureaus	12	2,220	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	*200*	*54,809*	*192*	*53,589*	*0*	*235*	*25*	*18,150*	*0*	*0*	*217*	*71,974*	*25*	*18,385*
Land Use Change														
Land Remote Sensing	154	67,894	154	67,894	0	192	-12	-1,547	0	0	142	66,539	-12	-1,355
Land Change Science	61	10,492	61	10,492	0	76	-2	0	0	0	59	10,568	-2	76
Subtotal	*215*	*78,386*	*215*	*78,386*	*0*	*268*	*-14*	*-1,547*	*0*	*0*	*201*	*77,107*	*-14*	*-1,279*
Climate and Land Use Change Total	**415**	**133,195**	**407**	**131,975**	**0**	**503**	**11**	**16,603**	**0**	**0**	**418**	**149,081**	**11**	**17,106**
Energy, Minerals, and Environmental Health														
Mineral and Energy Resources														
Mineral Resources	319	45,931	319	45,931	0	414	0	0	0	0	319	46,345	0	414
Energy Resources	141	25,970	141	25,970	0	182	0	750	0	0	141	26,902	0	932
Subtotal	*460*	*71,901*	*460*	*71,901*	*0*	*596*	*0*	*750*	*0*	*0*	*460*	*73,247*	*0*	*1,346*
Environmental Health														
Contaminant Biology	61	8,647	64	9,647	0	80	8	2,273	0	0	72	12,000	8	2,353
Toxic Substance Hydrology	60	9,967	60	9,967	0	78	11	3,781	0	0	71	13,826	11	3,859
Subtotal	*121*	*18,614*	*124*	*19,614*	*0*	*158*	*19*	*6,054*	*0*	*0*	*143*	*25,826*	*19*	*6,212*
Energy, Minerals, and Environmental Health Total	**581**	**90,515**	**584**	**91,515**	**0**	**754**	**19**	**6,804**	**0**	**0**	**603**	**99,073**	**19**	**7,558**
Natural Hazards														
Earthquake Hazards	241	50,753	244	53,803	0	314	0	0	0	0	244	54,117	0	314
Volcano Hazards	144	22,721	145	23,121	0	187	0	0	0	0	145	23,308	0	187
Landslide Hazards	20	2,985	22	3,485	0	26	0	0	0	0	22	3,511	0	26
Global Seismographic Network	10	4,853	10	4,853	0	13	0	0	0	0	10	4,866	0	13
Geomagnetism	13	1,888	13	1,888	0	17	0	0	0	0	13	1,905	0	17
Coastal & Marine Geology	226	40,336	227	41,336	0	296	-1	-1,000	0	0	226	40,632	-1	-704
Natural Hazards Total	**654**	**123,536**	**661**	**128,486**	**0**	**853**	**-1**	**-1,000**	**0**	**0**	**660**	**128,339**	**-1**	**-147**

Summary Of Requirements
($ in Thousands)

Activity/Subactivity/Program Element	2013 Actual		2014 Enacted		Fixed Costs & Related Changes		Program Changes		Internal Transfers		2015 Request		Change from 2014 Enacted	
	Total FTE	Amount	Total FTE	Amount	FTE Changes	Amount	FTE Changes	Amount	FTE Changes	Amount	Total FTE	Amount	FTE Changes	Amount
Water Resources														
Groundwater Resources	77	8,348	80	8,948	0	81	9	2,400	0	0	89	11,429	9	2,481
National Water Quality Assessment	507	58,859	507	58,859	0	531	-3	-300	0	0	504	59,090	-3	231
National Streamflow Information Program	153	27,701	153	33,701	0	159	0	1,200	0	0	153	35,060	0	1,359
Hydrologic Research & Development	103	10,915	103	10,915	0	107	-3	301	0	0	100	11,323	-3	408
Hydrologic Networks & Analysis	276	28,884	276	28,884	0	289	-3	1,250	0	0	273	30,423	-3	1,539
Cooperative Water Program	334	59,474	334	59,474	0	351	-1	-264	0	0	333	59,561	-1	87
Water Resources Research Act Program	2	3,268	2	6,500	0	0	0	-3,000	0	0	2	3,500	0	-3,000
Water Resources Total	**1,452**	**197,449**	**1,455**	**207,281**	**0**	**1,518**	**-1**	**1,587**	**0**	**0**	**1,454**	**210,386**	**-1**	**3,105**
Core Science Systems														
Science Synthesis, Analysis and Research Program	115	23,914	115	24,314	0	140	-4	-15	0	0	111	24,439	-4	125
National Cooperative Geologic Mapping Program	112	24,397	112	24,397	0	136	0	0	0	0	112	24,533	0	136
National Geospatial Program	319	59,332	319	60,096	0	388	-39	-56	0	0	280	60,428	-39	332
Core Science Systems Total	**546**	**107,643**	**546**	**108,807**	**0**	**664**	**-43**	**-71**	**0**	**0**	**503**	**109,400**	**-43**	**593**
Science Support														
Administration and Management	454	86,985	454	86,985	0	-593	-11	0	0	0	443	86,392	-11	-593
Information Services	73	23,719	73	23,719	0	456	-2	-2,300	0	0	71	21,875	-2	-1,844
Administration and Enterprise Information Total	**527**	**110,704**	**527**	**110,704**	**0**	**-137**	**-13**	**-2,300**	**0**	**0**	**514**	**108,267**	**-13**	**-2,437**
Facilities														
Rental Payments and Operations & Maintenance	60	93,141	60	93,141	0	911	0	5,365	0	0	60	99,417	0	6,276
Deferred Maintenance and Capital Improvement	0	6,899	0	7,280	0	0	0	0	0	0	0	7,280	0	0
Facilities Total	**60**	**100,040**	**60**	**100,421**	**0**	**911**	**0**	**5,365**	**0**	**0**	**60**	**106,697**	**0**	**6,276**
Total, USGS	**5,202**	**1,012,168**	**5,222**	**1,032,000**	**0**	**6,200**	**-18**	**35,068**	**0**	**0**	**5,204**	**1,073,268**	**-18**	**41,268**

Justification of Fixed Costs and Internal Realignments

(Dollars In Thousands)

Fixed Cost Changes and Projections	2014 Total or Change	2014 to 2015 Change
Change in Number of Paid Days	0	0
This column reflects changes in pay associated with the change in the number of paid days between the 2014 and 2015. In years where there is no change in paid days, the salary impact will be zero.		
Pay Raise	+4,865	+5,816
The change reflects the salary impact of a programmed one percent pay raise increase as proposed in the Circular A-11.		
Employer Share of Federal Health Benefit Plans	+297	+399
The change reflects expected increases in employer's share of Federal Health Benefit Plans.		
Departmental Working Capital Fund	+435	-534
The change reflects expected changes in the charges for centrally billed Department services and other services through the Working Capital Fund. These charges are displayed in the Budget Justification for Department Management.		
Worker's Compensation Payments	-241	-343
The adjustment is for changes in the costs of compensating injured employees and dependents of employees who suffer accidental deaths while on duty. Costs for 2015 will reimburse the Department of Labor, Federal Employees Compensation Fund, pursuant to 5 U.S.C. 8147(b) as amended by Public Law 94-273.		
Unemployment Compensation Payments	+11	+9
The adjustment is for projected changes in the costs of unemployment compensation claims to be paid to the Department of Labor, Federal Employees Compensation Account, in the Unemployment Trust Fund, pursuant to Public Law 96-499.		
Rental Payments	-4,218	+853
The adjustment is for changes in the costs payable to General Services Administration (GSA) and others resulting from changes in rates for office and non-office space as estimated by GSA, as well as the rental costs of other currently occupied space. These costs include building security; in the case of GSA space, these are paid to Department of Homeland Security (DHS). Costs of mandatory office relocations, i.e. relocations in cases where due to external events there is no alternative but to vacate the currently occupied space, are also included.		
Fixed Cost Changes Total	**+1,149**	**+6,200**

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Activity: Ecosystems

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Status and Trends ($000)		20,473	20,473	144	0	300	20,917	+444
	FTE	124	124	0	0	1	125	+1
Fisheries Program (($000)		20,886	20,886	171	0	1,200	22,257	+1,371
	FTE	147	147	0	0	2	149	+2
Wildlife Program ($000)		44,252	44,757	366	0	0	45,123	+366
	FTE	304	305	0	0	-5	300	-5
Environments Program ($000)		34,024	36,244	214	0	1,080	37,538	+1,294
	FTE	185	197	0	0	-6	191	-6
Invasive Species ($000)		12,080	13,080	59	0	4,500	17,639	+4,559
	FTE	51	53	0	0	12	65	+12
Cooperative Research Units ($000)		17,371	17,371	180	0	1,000	18,551	+1,180
	FTE	156	156	0	0	6	162	+6
Total Requirements ($000)		**149,086**	**152,811**	**1,134**	**0**	**8,080**	**162,025**	**+9,214**
	Total FTE	**967**	**982**	**0**	**0**	**10**	**992**	**+10**

Summary of Program Changes

Request Component	($000)	FTE	Page
Status and Trends	**300**	**1**	
Pollinators	300	1	B-41
Fisheries Program	**1,200**	**2**	
Hydraulic Fracturing	2,200	10	B-24
Fisheries Program Research	-1,000	-8	B-53
Wildlife Program	**0**	**-5**	
Energy Future and Wildlife Sustainability	1,000	1	B-42
Wildlife Health	200	1	B-42
Wildlife Program Research	-1,200	-7	B-53
Environments Program	**1,080**	**-6**	
Ecosystem Priorities: California Bay Delta	500	2	B-14
Ecosystem Priorities: Chesapeake Bay	300	1	B-15
Ecosystem Priorities: Columbia River	300	1	B-16
Ecosystem Priorities: National Ecosystems Services Framework	1,000	1	B-21
Ecosystem Priorities: Puget Sound	400	1	B-17
Ecosystem Priorities: Sustaining Environmental Capital	1,000	2	B-21
OCS Ecosystems Decisions	300	2	B-43
Wildfire Restoration Ecology	500	2	B-43
Environments Program Research	-3,220	-18	B-53
Invasive Species	**4,500**	**12**	
Brown Tree Snakes: Detection and Control	500	0	B-18
Ecosystem Priorities: Everglades	1,000	2	B-19
Ecosystem Priorities: Great Lakes Asian Carp Control	1,000	4	B-19
Ecosystem Priorities: Upper Mississippi River Asian Carp	1,000	2	B-20
New and Emerging Invasives of National Concern	1,000	4	B-20
Cooperative Research Units	**1,000**	**6**	
CRU Scientists for Tomorrow	1,000	6	B-37
Total Program Change	**8,080**	**10**	

Justification of Program Changes

The 2015 Budget Request for Ecosystems is $162,025,000 and 992 FTE, a net program change of +$9,214,000 and +10 FTE from the 2014 Enacted Budget. For more information on the Ecosystems Mission Area changes, please see Section B, Program Changes as indicated in the table.

Activity Summary

The Ecosystems activity is comprised of six subactivities —

- Status and Trends *(http://www.usgs.gov/ecosystems/status_trends)*
- Fisheries Program (*http://www.usgs.gov/ecosystems/fisheries/index.html*)
- Wildlife Program *(http://www.usgs.gov/ecosystems/wildlife/index.html)*
- Environments Program *(http://www.usgs.gov/ecosystems/environments/index.html)*
- Invasive Species (*http://www.usgs.gov/ecosystems/invasive_species/index.html)*
- Cooperative Research Units *(http://www.coopunits.org/Headquarters/*)

Ecosystems Mission Area programs provide science support to the Department of the Interior (Interior) bureaus and other partners through research focused on answering management questions and real-world problems. This requires a combination of short- and long-term biological research, survey and monitoring, data analysis and applications, development of new tools and techniques, and decision support and adaptive management. Partnerships with other Federal, State, tribal and private research organizations leverage millions of dollars that result in ecosystem restoration and conservation efforts vital to community economies, public safety, and well-being by delivering key services to society. Among the many areas this science support are as commercially valuable fish and wildlife management, water filtration and pollution control, healthy soils, crop pollination, reducing the impact of severe weather events and other natural disasters. Ongoing efforts focus on critical issues such as ecosystem restoration, energy development, coastal resiliency, and fire ecology in places such as Chesapeake Bay, California Bay-Delta, Puget Sound, Gulf Coast, Sagebrush Biome, Everglades, Great Lakes, Alaska, Mississippi River Basin, and the Outer Continental Shelf.

> *"USGS science data is used in many of our science information syntheses and guides for land managers in the Great Basin. Three examples are: A Review of Fire Effects on Vegetation and Soils in the Great Basin: Response and Ecological Site Characteristics; Hydrologic Impacts of Rangeland Fire on Runoff and Erosion: A Literature Synthesis; and A Field Guide to Wind Erosion as it Relates to Landscape Assessment of Post-Fire Stabilization. I asked a fire ecologist at the Great Basin Consortium(GBC) conference today what additional tools we could produce that would help him in his job and he responded that these science syntheses sound like just what he needs right now and he looks forward to the publications."*
>
> *Eugénie MontBlanc*
> *Great Basin Fire Science*
> *Delivery Coordinator*
> *University of Nevada*
> *Reno, NV*

The mission area has been collaborating with USGS Regions and Science Centers to develop a five-year Ecosystems Action Plan. The Plan will define Ecosystems strategic actions and targeted lines of work across the landscape and will be completed in the summer of 2014.

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #2: Provide Science for to Understand, Model, and Predict Ecosystem and Land use Changes at Targeted and Landscape Levels (biota, land cover, and Earth and ocean systems)
Strategy #1: Identify and Predict Ecosystem Change

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
USGS Ecosystems.....	154,164	165,587	160,837	158,268	149,086	152,811	162,025		

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #1: Identify and Predict Ecosystem Change									
Percent of targeted species for which monitoring and decision support information on their status and trends are available (Status & Trends)	USGS	27.2%	27.2%	28.2%	28.5%	28.5%	28.5%	28.5%	29.0%
		178	178	185	187	187	187	187	190
		655	655	655	655	655	655	655	655
Percent of targeted fish and aquatic populations and their habitats for which information is available regarding limiting factors such as migratory barriers, habitat, and effects of disturbance (fire, flood, nutrient enhancement) (Fisheries)	USGS	41.2%	41.2%	42.0%	42.9%	42.9%	42.9%	43.7%	45.4%
		49	49	50	51	51	51	52	54
		119	119	119	119	119	119	119	119
Percent of targeted wildlife populations for which science information is provided for management decisionmaking to inform and improve conservation (Wildlife)	USGS	51.6%	54.4%	57.8%	61.2%	61.2%	61.2%	61.2%	62.3%
		182	192	204	216	216	216	216	220
		353	353	353	353	353	353	353	353
Percent of targeted ecosystems with information products forecasting ecosystem change (Environments)	USGS	11%	22%	22%	33%	33%	33%	44%	44%
		1	2	2	3	3	3	4	4
		9	9	9	9	9	9	9	9
Percent of critical science information products available for successful control and management of targeted groups of invasive species.	USGS	45%	45%	45%	45%	45%	45%	45%	48%
		27	27	27	27	27	27	27	29
		60	60	60	60	60	60	60	60

Supporting Performance Measures

Outputs, Supporting Performance Measures, and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Number of students complete degree requirements for MS, PhD, and post-doctoral program under the direction and mentorship of Unit Scientists (Cooperative Research Units)	USGS	110	89	84	83	83	83	75	75
Number of systematic analyses and investigations completed (Ecosystems)	USGS	1,267	1,169	1,273	1,444	1,031	1,262	1,250	1,288
Number of formal workshops or training provided to customers (Ecosystems)	USGS	112	113	142	129	95	75	65	68

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Activity: Ecosystems
Subactivity: Status and Trends

2013 Actual: $20.5 million (124 FTE)
2014 Enacted: $20.5 million (124 FTE)
2015 Request: $20.9 million (125 FTE)

Overview

The living resources of the United States, and the habitats on which they depend, are undergoing constant change due to human and natural influences. The Status and Trends Program monitors, evaluates, forecasts, and reports the status of the Nation's biological resources to advance science, inform policy, and facilitate resource management. Specific goals of the Program are to —

(1) Describe and track the abundance, distribution, productivity, and health of the Nation's plants, animals, and ecosystems.

(2) Develop and evaluate inventory and monitoring methods, designs, tools, models, and technologies to measure and track biological status and trends.

(3) Collaborate with partners to collect, manage, and share data and information to determine and understand biological status and trends.

(4) Describe and deliver information and synthesis products to meet the needs of stakeholders including natural resource managers, policy- and decisionmakers, researchers, and the public.

The Program targets research, monitoring, and assessment activities to support diverse resource management and policy decisions for a variety of stakeholders.

Program Performance

Monitoring and Research to Support Department of the Interior Lands and Species

The USGS is the principal science agency for the Department of the Interior (Interior), providing unbiased, independent data and information to Interior resource management bureaus such as the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), and Bureau of Ocean Energy Management (BOEM) on the current and future status of biological resources. This information is used to improve the effectiveness and efficiency of management and policy decisions through early detection and action. To address these issues in an

Wetlands in Rocky Mountain National Park

integrated manner, the USGS works with other Interior bureaus and external partners to provide scientific information critical to adaptive natural resource management.

Park Monitoring – A key task for DOI land management bureaus, as well as States and other entities, is to monitor their natural resources to detect changes that are in a healthy or unhealthy condition. This is not only an essential activity, but one that has multiple challenges. One of the key approaches used is to develop sensitive bio-indicators, based on ecological attributes of the natural communities that can be used to detect environmental changes before they become too severe. A problem that is all too common, however, is that some of the fluctuations in the bio-indicators relate to variations in natural conditions, not human-induced alterations. The Rocky Mountain National Park in Colorado, along with Acadia National Park in Maine, have been particularly interested in monitoring their wetland habitats, both because water supplies play such an important role in the landscape, and also because wetlands are easily impacted by common human activities that affect water movement and nutrient runoff. In 2013, the USGS, working with collaborators in the NPS, developed a new approach using causal network models that is more efficient and provide a clearer interpretation of synergies and co-dependencies in natural resource systems.

The USA National Phenology Network – The National Phenology Network (NPN), established in 2007 by the USGS in collaboration with other governmental and non-governmental organizations, is a national-scale science and monitoring initiative focused on phenology, which is the study of seasonal life-cycle events such as leafing, flowering, reproduction, and migration as a tool to understanding how plants, animals, and landscapes respond to environmental variation and change. Stakeholders include researchers, resource managers, educators, communication specialists, non-profit organizations, human health organizations, science networks, and the public who make decisions about resource management and adaptation to variable and changing climates and environments. Timely and widely-distributed phenological information is critical for the management of wildlife, invasive species, agricultural pests, understanding drought, wildfire risk, and managing risks to human health and welfare, including allergies, asthma, and vector-borne diseases. In 2013, data from the NPN were used to improve models that predict onset of seasonal activity of important tree species in the Eastern United States, which has implications for local activities and economies, such as maple syrup production, honey production, allergy seasons, bird migrations, cultural festivals, and harvesting of native herbs. Other models using data from the NPN indicate that 2012 was the earliest spring since 1900, and illustrated how such a “false spring” increased susceptibility of agricultural crops (such as apples and grapes in Michigan) to frost, and

An observer records phenology of trees as part of the USA National Phenology Network project Nature’s Notebook. Photo credit: Brian Powell

may have exacerbated impacts of summer drought on regional agricultural productivity. Activities in 2014 and beyond will be focused on understanding the sensitivity of native species to climate change and variation across national parks in California, and in national wildlife refuges across the Nation based on a pilot project near Albuquerque, NM. The NPN will distribute its first set of data products to support decisionmaking by resource management agencies, and will continue activities focused on engaging groups of people typically underrepresented in science (e.g., minorities, urban youth, and tribes) in support of the America's Great Outdoors initiative.

Wyoming Landscape Conservation Initiative – The Wyoming Landscape Conservation Initiative (WLCI) is a long-term, science-based program of assessing, conserving, and enhancing fish and wildlife habitats while facilitating responsible energy and other development in Wyoming. The success of the WLCI depends on local cooperation, involvement, and partnerships. Formal partners with the USGS include the BLM, FWS, Wyoming Game and Fish Commission, Wyoming Department of Agriculture, the U.S. Department of Agriculture (USDA), six county commissions, and nine conservation districts. The USGS provides practical scientific and technical assistance to WLCI partners to support management decisions and advance understanding of ecosystems in southwestern Wyoming. In 2013, several studies were conducted to evaluate wildlife responses to energy and other development. These activities entail in-depth research of species of conservation concern: the pygmy rabbit, greater sage-grouse, mule deer, a suite of three sagebrush-obligate songbird species, and native fish in southwestern Wyoming. The goals of these activities are to gain a better understanding of (1) how species respond to direct and indirect effects of energy development, particularly their distribution, habitat use, demographics, and population dynamics, and (2) the mechanisms that underlie species' responses.

In 2013, researchers found that mule deer migratory behavior was influenced by disturbance associated with coalbed-gas development and observed an increase in movement rates, increased detouring from established routes, and overall decreased use of habitat along migration routes with increasing density of well pads and roads. Altered habitat use and behavior by mule deer in response to unconventional oil and gas development is of particular interest in the Western United States, where mule deer populations are stable or declining in most States and there is extensive overlap between potential oil and gas development areas and mule deer distributions. The USGS conducted on-the-ground surveys of wildlife populations, assessing habitat use, animal movements, habitat characteristics, and other important factors. Early results from these studies, particularly regarding the effects of energy development on mule deer migration, are already being used to inform planning and land use decisions. In 2014 and beyond, research will focus studies on establishing thresholds of development that can affect wildlife habitat use and behavior so that these considerations can be used in planning decisions for resource development. Results from these wildlife studies will also be integrated with alternative development scenarios that will enhance understanding of potential effects of different patterns of development on wildlife. These, and many other, research and technical assistance efforts will be presented at a major 2015 WLCI Science Workshop that is currently being planned by the USGS and WLCI partner agencies.

Gulf of Mexico Restoration – Since implementation in 2003, Louisiana's Coastwide Reference Monitoring System (CRMS) has facilitated the creation of a comprehensive dataset that includes vegetation and hydrologic and soil metrics collected from 392 wetland monitoring sites to support assessment of the status and trends of Louisiana's wetlands, focusing on restoration efforts across the

coastal zone, including forested wetlands, floating marshes, and emergent marshes. In 2013, the USGS teamed with State and Federal natural resource agencies and universities to synthesize CRMS monitoring data to provide multi-scaled evaluations of Louisiana's coastal wetlands. Several indices focusing on vegetation, hydrology, and landscape change were developed to facilitate status assessments. For example, the newly-developed Submergence Vulnerability Index (SVI) assesses a site's vulnerability to submergence due to sea-level rise, which results from the feedback between flooding regime, surface elevation, and surface accretion processes. Interpretation of the SVI is based on the assumption that wetlands situated at lower elevations within the hydrologic frame are more vulnerable to future changes in sea level and submergence than wetlands situated at higher elevations. In 2014 and 2015, the SVI will be incorporated into monitoring restoration and land change trends at local, hydrologic basin, and coastwide scales to assess restoration program effectiveness and vulnerability to sea-level rise.

Great Lakes Deepwater Fishery **–** Great Lakes commercial and recreational fisheries are valued at over $7.0 billion. The USGS supports Great Lakes fisheries management by providing resource agencies, including the Great Lakes Fisheries Commission, States, tribes, Canadian Provinces, and innovative FWS science for the management, conservation, and restoration of this ecosystem. The USGS provides long-term, consistent, lakewide assessment of forage fish stocks, emphasizing deep water fishes. In 2013, the USGS conducted a lakewide assessment of forage fish stocks. In 2014 and 2015, funding from the Status and Trends and Fisheries Programs will continue the long-term assessment work on forage fish stocks critical to the scientific management of this world-class fishery.

Bird Banding Laboratory – Bird banding is a universal technique using leg bands and other types of markers to study the movements, survival, and behavior of birds. The USGS Bird Banding Laboratory (BBL) manages all banding and recovery information for migratory birds in the United States and Canada. Reports of birds wearing bands or markers are submitted to the BBL and these data are a critical source of information for Federal, State, and tribal agencies to develop bird conservation strategies and develop annual migratory bird hunting regulations. In 2013, the BBL processed approximately 1.5 million banding records and 100,000 reports of banded birds. It began implementation of a data management system to maintain re-sighting data collected by banders, a process that will be completed in 2014, and will substantially improve the ability to use banding data to monitor the demographic parameters of migratory bird populations. The BBL has initiated development of an electronic permitting process that, by 2015, will help the BBL expedite its critical regulatory role in processing bird-banding permits.

Color-marking birds individually allows the researcher to obtain a "visual recapture" without actually having to trap or handle the bird again.

Activity: Ecosystems
Subactivity: Fisheries Program

2013 Actual: $20.9 million (147 FTE)
2014 Enacted: $20.9 million (147 FTE)
2015 Request: $22.3 million (149 FTE)

Overview

Healthy watersheds and thriving fish populations are vital to the well-being of American society, providing clean water, food, and recreation. Unfortunately, in many places around the United States, fish and the habitats on which they depend on are in decline. According to the National Fish Habitat Action Plan, almost 40 percent of the Nation's freshwater fish species are considered at risk or vulnerable to extinction. Many saltwater fish are also in decline due to habitat degradation and overfishing. Revenue from recreational (46 million U.S. anglers fish in a given year) and commercial fisheries added more than $115.0 billion to our Nation's economy, but this economic engine is at risk as fisheries and habitats decline.

> *"The long-term USGS research program has provided a comprehensive evaluation of the status of Upper Klamath Lake sucker populations and has helped determine some of the factors preventing recovery of these species. The state-of-the-art population vital rate estimates produced by USGS have not only provided the best basis we have ever had to monitor status of these species, but also have been incorporated into the Recovery Plan for these species as the methods and criteria required to make down-listing and de-listing decisions in the future."*
>
> *Larry Dunsmoor*
> *Senior Aquatic Biologist*
> *Klamath Tribes*

The USGS Fisheries Program employs world-class scientists to work on cutting-edge research to protect, restore, and enhance our Nation's fisheries and their habitats. The quality, quantity, and breadth of USGS capacity, expertise, and geographic coverage are conducive to addressing local, regional, and national questions on aquatic species, communities, and habitats. The Fisheries Program brings the following expertise and capacity to accomplish Ecosystem Mission Area goals and conduct crosscutting research with other USGS Mission Areas, Interior bureaus, and other internal and external partners.

Fish and Aquatic Organism Health
The USGS investigates pathogens and other environmental factors that affect aquatic organism health to support the management, conservation, and restoration of aquatic species. In 2014, fish disease research includes both basic and applied science focused on understanding the factors that control the distribution and severity of infectious diseases affecting aquatic organisms and wild fish populations. (*http://www.usgs.gov/ecosystems/fisheries/health.html)*

Genetics, Genomics, and Molecular Biology
Research on genetics and genomics of fish and other aquatic organisms examines and characterizes variation, diversity, taxonomy, and response of individuals, stocks, strains, and populations to environmental change. Molecular tools include the construction of genomic libraries, cloning,

sequencing, phylogenetic analysis, recombinant DNA expression systems, standard and quantitative polymerase chain reaction assays, random-amplified polymorphic DNA fingerprinting, DNA probes, and DNA microarray. This capacity provides aquatic resource managers with a more accurate method to identify and discriminate among native, cultured, introduced, and invasive aquatic species, as well as develop science-based conservation and restoration strategies. In 2014, USGS research is focusing on developing new technologies to monitor and evaluate wild fish populations such a brook trout. (*http://www.usgs.gov/ecosystems/fisheries/genetics.html)*

Imperiled Aquatic Species

USGS scientists conduct studies on biology, life history, population ecology, and conservation strategies for at-risk species, and the impacts of environmental stressors on and habitat requirements of those species. These investigations lead to more effective and viable conservation actions that reduce the need for formal listing of aquatic species as threatened or endangered and support the goal of downlisting or delisting species. In 2014, USGS research will continue to focus on American eel in the eastern United States and native salmonids in the western United States.
(*http://www.usgs.gov/ecosystems/fisheries/imperiled.html)*

Restoration Science and Technology

USGS research and technology provides the scientific basis for the adaptive management of aquatic species and aquatic habitats in the United States. The USGS examines the physiology, life history, reproduction, and habitat needs of specific life stages of fish and other aquatic organisms to assist fishery managers to develop techniques to understand, conserve, and restore fish communities. In 2014, the USGS will continue to focus on restoration research before and after dam removal at Elwha and Glines Canyon Dams. (*http://www.usgs.gov/ecosystems/fisheries/restoration.html)*

Species Diversity and Life History

USGS scientists study the diversity of aquatic species and their varied life histories and species interactions that represent complex aquatic communities in unique aquatic habitats. They provide scientific syntheses and modeling to develop decision-support and adaptive management models that incorporate diversity, life history, and species interactions of fish and other aquatic organisms. Scientists forecast causes of change based on scientific information about diversity, life history, and species interactions that affect the condition and dynamics of aquatic communities. In 2014, USGS research will continue to focus on mussels and threatened native fish species.
(*http://www.usgs.gov/ecosystems/fisheries/diversity.html)*

Aquatic Community Ecology

USGS scientists quantify and describe functional relationships among aquatic species and habitats to describe aquatic community structure, function, adaptation, and sustainability. By conducting basic research, this science links biology, population genetic diversity, and organism health for fish, native mussels, and other aquatic organisms in relation to their habitat requirements. This science contributes to understanding ecological processes and patterns of diversity through coordination, development, and standardization of geospatial classification models and maps of national ecosystems. In 2014, USGS research will continue to focus on nutrient and sediment reduction provided by aquatic ecosystems.
(*http://www.usgs.gov/ecosystems/fisheries/ecology.html)*

Fish Passage and Dams
USGS research assesses and evaluates management efforts to improve fish passage for anadromous and other migratory fish. Research focuses on fish physiological and behavioral characteristics as well as hydrological conditions that affect successful navigation around barriers by fish and other at-risk aquatic species. In 2014, research will continue to focus on improving the efficiency and effectiveness of artificial passage structures to improve passage of American eel, shad species, and Pacific salmon. (*http://www.usgs.gov/ecosystems/fisheries/fish_passage.html)*

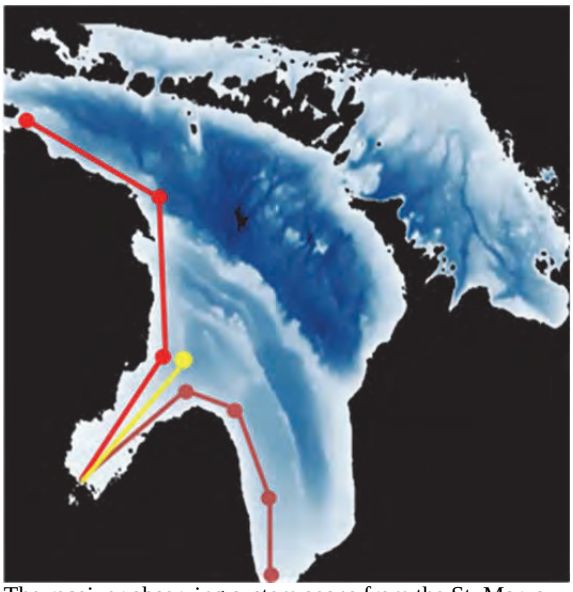
River Science
The USGS conducts research on structure and function of large river systems with the goal of sustaining and enhancing fisheries resources in concert with other human uses such as navigation, transportation, energy production, irrigation, and human water supply. The USGS studies the ecology and biodiversity of large rivers and gathers data on the effects of impoundment, urbanization, and changing land and water use on fish, other aquatic species, and their riverine habitats. In 2014, USGS research will provide modeling expertise, including aquatic habitat mapping and development of decision-support systems, to investigate population dynamics and biological requirements of at-risk species such as native fish, amphibians, and riparian vegetation. (*http://www.usgs.gov/ecosystems/fisheries/river_science.html)*

Program Performance

Removals of Elwha and Glines Canyon Dams – There are over 75,000 large dams in the United States and over two million smaller dams and water diversions. Many of these are near the end of their life expectancy and are being considered for removal for ecological, economic, and safety reasons. Improved science on where, when, and how to remove these dams is needed by natural resource managers and decisionmakers. For nearly 100 years, the Elwha and Glines Canyon dams in Washington have disrupted natural processes, trapped sediment in the reservoirs, and blocked fish migrations, all of which changed the ecology of the river downstream of the dams. All five Pacific salmon species and steelhead trout that were historically present in large numbers in the river are locally extirpated or persist in critically low numbers today. Upstream of the dams, more than 145 kilometers of pristine habitat, protected inside the Olympic National Park, awaits the return of salmon populations. As the dams were removed during this two to three year project, some of the 19.0 million cubic meters of entrapped sediment was carried downstream by the river in the largest controlled release of sediment into a river and marine waters in history. In 2012, the Elwha and Glines Canyon dams were removed and the USGS began intensive monitoring of the downstream sediment delivery. In addition, benchmark data on fish populations was collected in order to monitor post-dam removal population trends in 2013. Critical monitoring information was shared with a variety of stakeholders. Research in 2014 and beyond will focus on population response, interaction with resident fishes, sediment redistribution, ecosystem stabilization, and ecosystem effects of sediment release. Understanding the changes to the river and coastal habitats, the fate of sediments, and the salmon re-colonization of the Elwha River wilderness will provide useful information for society and resource managers as future dam removals are considered.

Ecological Flows (WaterSMART) – Developing Adaptive Management Decision Support Systems for Improved Aquatic Habitat Modeling and Water Management – The quality, quantity, and delivery time of water are critical drivers influencing ecosystem change. Developing tools and approaches for quantifying effects of flow alteration to inform water management includes (1) formal consideration of how different hydraulic models and data densities affect estimates of weighted usable area to address the question of how much study effort is enough; (2) use of landscape ecology concepts in habitat analysis supported by two-dimensional (2D) hydraulic models; (3) development of streamflow response and valuation models for riparian vegetation; and (4) development of decision-support-system (DSS) and Geographic Information System (GIS)-derived spatial visualization tools to model outputs more accessible to water managers and interested parties. In 2013, the USGS developed a desktop application to allow decisionmakers and scientists to easily view and change the inputs and parameters used in aquatic habitat modeling and visually inspect how changes to instream flow and modeling parameters will affect model output. The improved DSS is programmed to allow the framework to be quickly and easily applied to a new river system where data inputs are available. In 2014, and beyond, the USGS will continue research efforts in the Delaware, Colorado, and Apalachicola, Chattahoochee and Flint (ACF) river watersheds. Science and information needs on this topic are critical to states, river basin commissions, federal agencies, tribes, and local communities involved in water management and allocation decisions.

Fish Health – Viral Hemorrhagic Septicemia Virus – There is an increased understanding that disease is a natural component of aquatic ecosystems and that many environmental factors can modulate the impacts of disease in such systems. The USGS fish health research program continues to address pathways at individual, population, community, ecosystem, and other levels of biological organization and will continue to develop novel methods for prevention, mitigation, and control of diseases affecting aquatic species. Viral Hemorrhagic Septicemia Virus (VHSV) is considered to be one of the most important viral pathogens of fish worldwide with recent outbreaks resulting in massive fish kills throughout North America. In 2013, work continued on the predictive factors and genetic analysis of VHSV and the susceptibility of freshwater fishes in the Great Lakes ecosystem to the virus. In 2014, and beyond, VHSV research continues in the analysis of emerging strains from outbreaks in the Great Lakes, improvement of diagnostic tools for detection, virulence trials in marine and freshwater fish, and comparison of West Coast, Great Lakes, and European strains.



The receiver observing system spans from the St. Marys River outlet from Lake Superior to central Lake Erie and includes the largest fine-scale tracking array (25 km^2) in the world. Major movement paths of walleye tagged in the Tittabawassee River (Saginaw Bay) during spawning show that they migrate throughout Lake Huron (100s of miles) and crossing many jurisdictional boundaries.

Great Lakes Fisheries Science – Tracking Fish Movements for Better Fisheries Management – Over the last four years the USGS, in partnership with the Great Lakes

Fishery Commission, developed a world-class acoustic telemetry program centered at the Hammond Bay Biological Station. Acoustic telemetry technology allows the scientists to track the movements of fishes across the Great Lakes and to answer questions about fish behavior and population dynamics that were not previously possible. In 2013, studies focused on population dynamics of walleye and sturgeon, restoration of lake trout, and control of invasive sea lampreys. Data collected by the USGS (more than 57 million detections) are being used to better inform fishery managers and stakeholders and to improve the management of the $7.0 billion Great Lakes fishery industry. A significant step in building the acoustic telemetry research program involved spear-heading development of the Great Lakes Acoustic Telemetry Observation System (GLATOS), a network that provides acoustic telemetry researchers across the Great Lakes basin with a venue for sharing information and resources. In 2014, and beyond, the USGS will continue collaborations among fishery management agencies in the United States and Canada (e.g., the Ohio Department of Natural Resources [DNR], Michigan DNR, FWS, Ontario Ministry of Natural Resources [MNR], Department of Fisheries and Oceans [DFO] Canada), and researchers from academic institutions (e.g., Michigan State University, Grand Valley State University, University of Windsor, Carleton University) to better manage Great Lakes fisheries.

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Activity: Ecosystems
Subactivity: Wildlife Program

2013 Actual: $44.3 million (304 FTE)
2014 Enacted: $44.8 million (305 FTE)
2015 Request: $45.1 million (300 FTE)

Overview

Wildlife and the habitats upon which they depend are an enduring part of the United States' rich natural heritage. They boost the economy directly through hunting, bird watching and other recreational opportunities and contribute to food security, medical research, and genetic diversity while producing sustainable ecosystems that provide healthy soils, pollutant filtration, carbon storage, and storm mitigation. The Department of the Interior (Interior) has responsibility for the conservation and management of a number of wildlife species through the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), the Marine Mammal Protection Act (MMPA) and other statutory responsibilities. The USGS Wildlife Program conducts research on migratory birds, terrestrial and marine mammals, amphibians and reptiles, terrestrial plants, threatened and endangered species, wildlife disease, and on wildlife issues resulting from human activities such as energy development. Research spans all functional aspects of the ecosystems that these wildlife species need to survive. This contributes toward a more complete understanding of the Nation's ecosystems and landscapes, helping Federal, tribal, and State managers and policymakers make informed, cost-effective, and balanced decisions of economic, social, ecological, and cultural importance.

> *"The science support from USGS for sage grouse status and threats evaluation under the Endangered Species Act has been invaluable for three reasons: (1) it is clearly the best scientific information focused on the most important questions, (2) their work has been timely, prodigious, and complementary to the work of other scientists and managers, and (3) USGS scientists communicate that information with authority and in a manner that is accessible to all, so not only does the Service find it useful and reliable, but so do other stakeholders in sage grouse conservation. All this has greatly minimized potential disagreement over what is, 'best science'."*
>
> *Ted Koch*
> *Nevada State Supervisor*
> *U.S. Fish and Wildlife Service*
> *Reno, Nevada*

The Wildlife Program supports four key activities:

Conservation and Management of Wildlife and their Habitats
The USGS conducts basic and applied research on factors influencing the distribution, abundance, and condition of wildlife populations and their associated ecosystems. Many activities focus on the development of new information and tools for the management of wildlife on federally managed lands such as national parks, national wildlife refuges, and BLM-managed lands, and the results of USGS science are also transferrable to other public and private landscapes.

Tools and Techniques for Effective, Science-Based Management
The USGS develops tools and methods for wildlife management including modeling alternative scenarios for resource management, incorporation of new and specialized statistical formulas and programs, analysis of large scale genomic datasets, and identification and prediction of disease outbreaks and spread.

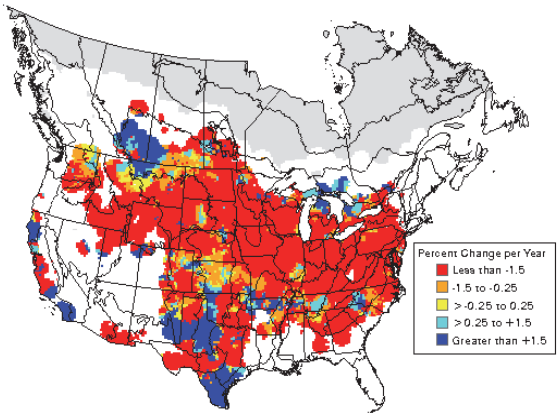
Factors Affecting Conservation of Species of Concern
The USGS provides scientific information in support of management decisions related to species protected under the ESA, MMPA, and similar State laws and regulations, as well as other species in decline such as amphibians. This information is used by resource managers in listing decisions and other management actions for wildlife species.

Emerging Wildlife Issues
Wildlife resources are being affected in unanticipated ways by multiple stressors such as fragmented habitat, invasive species, disease, and climate change. The USGS provides interdisciplinary science on a constantly changing array of issues to help managers, policymakers, and industry make decisions using landscape or regional approaches to evaluate potential impacts to species or habitats.

Program Performance

Conservation and Management of Wildlife and their Habitats
Priority Research for DOI Bureaus – USGS partnership programs, such as the Science Support Partnership (FWS) and the Natural Resources Preservation Program (NPS) support USGS researchers to work directly with FWS and NPS resource managers to develop joint studies that address critical science needs identified by the management agencies. More than 100 unique studies are conducted each year on topics requested by FWS and NPS managers. In 2013, a study was designed to help the NPS balance its need to allow visitors into Mammoth Cave National Park while effectively preventing the spread of White Nose Syndrome. Another ongoing study is in documenting the distribution and status of Golden Eagles in the Mojave Desert to assist the FWS in managing this species with effective conservation plans which mitigate the increasing threats to stable populations.

Another study requested by the FWS in 2013 was to assess the outcome of the largest estuarine restoration project in the Pacific Northwest. The Nisqually Wildlife Refuge has worked with the Nisqually Indian Tribe to restore more than 900 acres of estuarine habitat, an effort that is expected to benefit populations of fish and birds, including some 275 migratory bird species that use the refuge as well as species of federally listed fish. The study is ongoing in 2014, expected to complete in 2015, and will assess how effective the restoration has



Population Trends of the Grasshopper Sparrow based on Breeding Bird Survey Data, 1966 to 2011. Dark red areas indicate places where Grasshopper Sparrow populations are declining; blue indicates population increases. View color map at http://www.usgs.gov/budget/fiscal year.asp

been in providing food for wildlife and fish populations, allowing wildlife managers to learn from their actions and make improvements as needed.

Migratory Birds –The USGS works with the FWS, States, other American continent countries, tribal wildlife agencies, and private organizations to provide science needed for conservation and management of over 1,000 bird species. Activities include researching the ecology and movements of migrating birds to identify habitats requirements, development of geospatial, telemetry, and molecular tools to better describe long-distance movements, and population-related information. At the request of the BLM, the USGS is studying the Arizona Grasshopper Sparrow subspecies in southern Arizona and New Mexico. An important project for migratory bird management, scientists completed field work in 2013, with publications on the project expected in 2014. This sparrow is a grassland bird that has experienced decline across the majority of its range. The FWS considers it a Bird of Conservation Concern due to a combination of a small breeding population and continued habitat loss and modification. Information from this project on breeding ecology and distribution is required for successful management and conservation actions.

Tools and Techniques for Effective, Science-Based Management

Emerging Wildlife Disease – The USGS provides information, technical assistance, and research on State, national, and international wildlife health and disease issues such as White Nose Syndrome (WNS) in bats, highly pathogenic avian influenza, plague, and chronic wasting disease. USGS infrastructure and interagency partnerships like the Centers for Disease Control (CDC) provide a critical foundation and template for emergency disease response to future zoonotic diseases of wildlife. The USGS uses the latest tools of molecular biology and genetics to address the ecology of infectious diseases affecting both fish and wildlife. In 2013, as part of the USGS's work on the battle to understand and slow spread of white-nose syndrome in bats, the USGS published results of a study to understand electrolyte depletion in white-nose syndrome bats. On the coastal front, the USGS published results on investigations into pathogen exposure and blood chemistry in sea otters.

Factors Affecting Conservation of Species of Concern

Threatened, Endangered, and At-Risk Wildlife – The USGS investigates factors that contribute to the conservation and recovery of at-risk species. USGS science is designed to understand the status of declining, threatened, and endangered species and assist managers in their recovery. In 2013, USGS scientists and FWS colleagues published a population model for the federally endangered Indiana bat (*Myotis sodalis*) that predicted if the current rate of WNS disease spread and associated declines continue there would be a severe decline in the total number of individuals and regional extinctions.

The USGS partnered and leveraged funds from multiple partners to conduct research on the lesser prairie-chicken (*Tympanuchus pallidicinctus)*, a species proposed for Federal protection under the ESA. The distribution and range of the lesser prairie-chicken has been reduced by 90 percent since European settlement of the Great Plains of North America, and several questions have emerged about its status and management. The USGS and its partners published a series of scientific publications on its wintering ecology, an evaluation of recommended habitat management, and using climate change models, a prediction that in the year 2050 nest survival would not be high enough for the persistence of viable populations. In 2013, the USGS also completed and published a national research strategy for greater

framework for future research by characterizing a full range of science needs expressed by managers and researchers.

The distribution of mountain-dwelling species has changed in response to climate change. The USGS and its partners conducted a study on American pikas (*Ochotona princeps*) to determine if a change in distribution coincided with changes in actual numbers of animals. The study was conducted on mountain tops across multiple States in the Great Basin (i.e., Nevada, Oregon, California, Idaho, and Utah). Published results show that the change in distribution is linked with declines in numbers of pikas, but that certain environmental variables (e.g., maximum snowpack) were early warnings of population declines.

Pika collecting vegetation in preparation for overwintering in the Great Basin Desert, NV

USGS scientists published and presented papers at a scientific symposium in 2013 on how to improve the outcomes of imperiled species reintroductions. The USGS presented several examples of the benefits gained from the use of formal decision-analytic frameworks (e.g., adaptive management) to structure and implement reintroduction projects. Adopting these practices will require close collaboration among resource managers, decision analysts, population modelers, and field biologists.

Amphibian Research and Monitoring Initiative – Worldwide declines of amphibians prompted the development of the Amphibian Research and Monitoring Initiative (ARMI) to monitor the status of amphibians on Interior lands, determine causes for their decline, and work with partners to develop management options to reverse declines. In 2013, ARMI released a landmark publication confirming that U.S. amphibian populations are declining at precipitous rates. This synthesis of nine years of data produced the first-ever estimate of how fast frogs, toads, and salamanders in the United States are disappearing from their habitats. Since these declines are occurring on largely protected lands, ARMI has been working closely with agencies to develop and test hypotheses about the stressors contributing to these widespread changes and how they can be slowed.

Sierra Nevada Yellow-legged frog (*Rana sierrae)*, Yosemite National Park, CA

> *"This [publication] is the culmination of an incredible sampling effort and cutting-edge analysis pioneered by the USGS. Now, more than ever, we need to confront amphibian declines in the U.S. and take actions to conserve our incredible frog and salamander biodiversity."*
>
> *Dr. Brian Gratwicke, amphibian conservation biologist, Smithsonian Conservation Biology Institute.*

Emerging Wildlife Issues

Energy and Wildlife – Recent focus and incentives for renewable energy and advances in technology for extracting fossil fuels have increased energy production footprints on the U.S. landscape, resulting in greater interactions between energy production and wildlife. The USGS is on the forefront of science to support good management decisions that provide options for siting and operating energy development to meet wildlife and ecosystem sustainability goals. The USGS conducts innovative survey design and monitoring strategies and full life cycle biological research with focus on why, how, and at what magnitude mortality, injury, or habitat loss or modification can occur and what that means for the species. Products provided to managers include tools and techniques, software, mapping, and modeling tools. In 2013, results were published on a collaborative study by the USGS and partners, evaluating the effectiveness of ultrasonic acoustic bat deterrents at wind facilities, a database of golden eagle midwinter survey information, greater sage-grouse seasonal space use, an integrative and comparative approach to analyzing bat fatalities at wind turbines, and a statistical model that can be used to estimate wind farm mortality of birds and bats based on data from carcass surveys. The resulting mortality estimates from these kinds of studies can be used to quantify the required amount of compensation actions, inform mortality projections for proposed wind development sites, and inform decisions about the management of existing wind farms. Training for decisionmakers on USGS fatality estimator software was implemented in 2013 at multiple sites. Results expected in 2014 that will assist decisionmakers in managing wind turbine- wildlife interactions include a study of hoary bat insect prey found in dead bats by turbines to evaluate potential connections of strikes to available prey, research on how tree bats use air currents and visual cues when approaching wind turbines, a study improving species distribution models for wide ranging bats to evaluate potential interactions with turbines across the landscape, and work on acoustic deterrent devices for reducing bat fatalities. The USGS is a major contributor to survey and monitoring design at wind and solar facilities and will continue to work with managers and facilities on these issues in 2015.

Pollinators – Our Nation relies on a highly diverse suite of species including wild bees, butterflies, moths, bats, and domestic honey bees to pollinate both native plants and agricultural crops. Recent die-offs of honey bees have brought scientific and public attention to the status of pollinator species across the United States. The issue goes beyond honey bees, as the FWS lists more than 50 species of pollinators as threatened or endangered. While there are various causes of this decline, there is an overarching concern about the impacts that the loss of pollinators will have on ecosystems across the country. In the United States, pollination by honey bees and native wildlife produces $40.0 billion worth of products annually. In 2013, results from a study to detect insect pollinator declines on regional and global scales was published, a key analysis in determining the extent of the problem and to help identify areas for possible conservation investments.

The USGS is well suited to lead research efforts to better understand the environmental factors influencing the status of native pollinators. Current small scale pilot studies are focusing on native bee monitoring techniques, understanding pollination ecology, and the values of differing land uses such as USDA Conservation Reserve Program managed land on bees. The USGS has relevant capabilities in ecology, wildlife monitoring, wildlife disease, toxicology, species-habitat interactions, and adaptive management, which complements the work by the USDA on honey bees.

Changing Arctic Ecosystems: *Polar Bears and Walrus* – At the heart of many management decisions about the polar bear (*Ursus maritimus*) is the need for monitoring data that are reliable and relevant to the management questions being asked. For example, setting sustainable harvest levels for Native peoples' hunting activities requires robust information on bear abundance. The USGS and partners have identified several potential improvements to the design and analysis of polar bear population studies using data from Western Hudson Bay. With further development and testing of these methods, recommendations can be made which have the potential to reduce the costs and improve the efficacy of polar bear studies throughout the polar bear's range. Because polar bear management and recovery involves multiple agencies within and outside the United States, this may be the appropriate time for an agency wide examination of the issues and a unified approach reflecting the true context of polar bear management. In 2013, study results with important information for managers were published on walrus and polar bears including walrus areas of use in the Chukchi Sea during sparse sea ice cover, estimating age ratios and size of Pacific walrus herds on coastal haulouts using video imaging, mapping polar bear maternal denning habitat in the Alaska National Petroleum Reserve, and the role of ecosystem changes across the Boreal–Arctic transition zone on the distribution and abundance of wildlife populations.

Activity: Ecosystems
Subactivity: Environments Program

2013 Actual: $34.0 million (185 FTE)
2014 Enacted: $36.2 million (197 FTE)
2015 Request: $37.5 million (191 FTE)

Overview

The Department of the Interior (Interior) is responsible for the stewardship of approximately 20 percent of our Nation's lands, the largest supplier of water in the 17 Western States, the Nation's second largest producer of hydroelectric power, oversees 27 percent of oil and 15 percent of natural gas produced domestically, and manages conventional and renewable energy development on 41 million acres within the Outer Continental Shelf. In addition, the Interior upholds Federal trust responsibilities to Indian tribes and Alaska Natives, is responsible for migratory wildlife and endangered species conservation, and works in partnership for conservation activities on non-Federal lands and priority ecosystems across the United States.

> *"USGS science is an important component of our landscape-scale science in Everglades National Park. We depend heavily on USGS-developed tools, such as the Everglades Depth Estimation Network (EDEN). This tool allows our biologists to estimate real-time water levels across all of the Park landscape – even in places where there are no water level gages. Other USGS science helps us to understand how mercury bioaccumulates in the Park's food web, to model threatened and endangered species, to understand the ecology and impacts of invasive constrictors such as Burmese pythons, and to monitor population trends of indicator species used to track success of Everglades restoration."*
>
> *Dan Kimball*
> *Superintendent of Everglades National Park*

The Environments Program assists in Interior land stewardship responsibilities by providing the science required to make informed decisions on sustainable resource use, protection, and adaptive management. The USGS conducts research to assess, understand, model, and forecast the impacts of both natural and human-induced changes to our ecosystems, natural resources, and communities. Informed forecasting of landscape structure, function, composition, and condition requires a fundamental understanding of the factors that control, constrain, and regulate ecosystem dynamics. USGS science is focused on understanding these driving factors using historical ecological studies, controlled long-term field studies, remote sensing, geospatial technologies, and empirical and mechanistic ecosystem modeling. In addition, the USGS evaluates trade-offs of varying strategies for land management, land use, conservation, and restoration for the benefit to landscapes, infrastructure, and economies.

Responsiveness, integration, and application are important characteristics of the research and science delivery conducted by the USGS Environments Program, which integrates ecological science with research from other mission areas and universities, government agencies, and non-governmental organizations. The products of integrated USGS research represent science-based solutions that reconcile

and accommodate both the conservation and use of natural resources to problems faced by decision- and policymakers, local land and resource managers, and community planners.

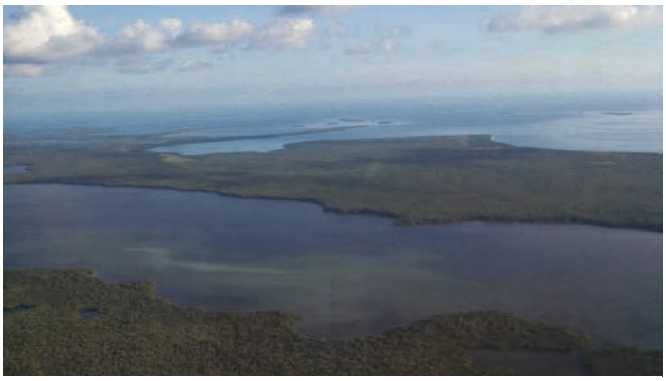
USGS scientists have expertise in coastal ecology and in wetland science to understand the interactions of coastal marshes and forests with stressors like storms and oil spills against the backdrop of longer-term impacts such as sediment deposition and sea-level changes. A group of these scientists was mobilized, with the support of a special congressional appropriation, to study the impacts of Hurricane Sandy, which made landfall in North America on October 29, 2012. Since 2013, the USGS has continued to support coastal Interior-managed lands in the Mid-Atlantic and Northeast states to assess the impacts of Hurricane Sandy. USGS scientists are studying how the hurricane impacted wetlands, forests, terrapin turtles, and birds. The USGS will be using these data, and data from other USGS projects focused on physical processes to construct maps of impacts and models of how these habitats can be expected to respond to future storms. The models, in turn, support assessment of how vulnerable coastal habitats are, and to help determine where more-resilient habitats are located or may be restored.

Program Performance

Landscape Science – The USGS conducts broad-scale research and monitoring in some of the large, iconic landscapes of the Nation, including the Everglades, San Francisco Bay, the Chesapeake Bay, the Great Lakes, and the Great Basin. These projects share similar features because they study local species and processes and seek to determine how those species and processes operate over large landscapes over time. The USGS's focus on important Interior decisions remains a driving factor in considering what species and habitats to study.

Everglades

More than one-half of the Greater Everglades is under the Interior's stewardship, including national parks, national wildlife refuges, and numerous fish and wildlife trust species. The Everglades are a living laboratory of change, affected by decreased water flow, poor water quality, non-native plants and animals, development pressure, and climate change. Restoration and protection of this global treasure and Interior trust resources depend heavily on USGS science focusing on the dynamics of change and the integration of science into planning and policy for sustainable restoration. Science topics span a wide range, from fundamental biogeochemistry through ecosystem-level studies, and utilize monitoring, experimental research, and modeling approaches. In 2013, the USGS completed research into a variety of topics including Burmese python invasions, nutrient transport, water-level change, and the effects of toxins on fish populations.



The Everglades

In 2013, the USGS continued its focus on ecosystem history, water quality and contaminants, surface and groundwater flows, and species response to hydro-pattern

dynamics. Over the next several years, the program will expand its research to include climate change, increasing the scope of research into the spread of non-native animals such as large constrictor snakes, and on increasing detection probabilities of hard-to-see species in the environment, including several threatened and endangered species (e.g., Snail kite, Cape Sable Seaside Sparrow) and non-native invasive species (e.g., Burmese python).

USGS paleoecological research, which uses buried sediment layers to determine ecosystem history, was coupled with hydrologic models in 2013 to show that current estuarine and coastal ecosystems were historically much fresher than previously realized, and that a major cause of increased salinity was due to significant reduction in freshwater flows. That information was used during the selection of the preferred alternative for the Central Everglades Planning Project; the most important project in decades intended to restore more freshwater flow to the Everglades. The USGS also completed a study in 2013 in the Ten Thousand Island National Wildlife Refuge that coupled a hydrologic model with a manatee model to aid in predicting future response of manatees and other estuarine species to restoration. In 2014 and beyond, the USGS will continue to develop the Everglades Depth Estimation Network (EDEN), an integrated, multi-agency, hydrologic monitoring network designed and operated by the USGS that provides depth estimates at specific locations in the Everglades lacking water-level gages. Because water depths are crucial in the Everglades ecosystem, EDEN improves the understanding of the pattern and distribution of species throughout the Greater Everglades.

San Francisco Bay-Delta

The USGS conducts long-term, interdisciplinary ecosystem level research of the San Francisco Bay-Delta, which is presently threatened by declining fresh water resources necessary to support California's $40.0 billion agriculture industry, drinking water for more than 27 million Californians, and habitat for endangered and threatened species. The USGS uses multi-decadal field observations, conceptual models, and linked numerical models (climate, hydrology, hydrodynamics, geomorphology, sedimentology, contaminants, and ecology) to understand how changes in precipitation, sea-level rise, frequency and magnitude of storm events, drought, and human actions could affect water availability, water quality, and sustainability of restored habitats. In 2013, salinity, turbidity, and water temperature modeled from four 100-year scenarios of climate change were evaluated for possible effects on the threatened Delta smelt, which is endemic to the Sacramento–San Joaquin Delta. Projected higher water temperatures in current models suggest that these Delta smelt habitats may no longer be available into the next century. In 2014 and 2015, USGS scientists will use linked computational models to assess future scenarios of change driven by climate, earthquake-induced levee failure, and new water conveyance structures in the California Delta. The USGS will examine responses of variables critical to water supply and species of concern such as endangered fish including salinity, temperature, suspended sediment, primary productivity, contaminants, distributions of exotic species, and marsh sustainability. The USGS will provide data and synthesis that is directly useful to natural resource managers as they manage the co-equal goals of

San Francisco Bay

ecosystem health and a sustainable water supply in the Bay Delta Ecosystem as directed by California law.

Chesapeake Bay

The USGS provides critical science to restore the Nation's largest estuary and carry out the Presidents' Chesapeake Executive Order (EO). The USGS has the lead responsibility under the EO to provide watershed science to Chesapeake Bay Program (CBP) partners, including Interior agencies, the EPA, other Federal agencies, and six States in order for them to work to restore water quality, recover habitat, sustain fish and wildlife, and conserve lands and increase public access. The USGS Chesapeake Bay studies are an interdisciplinary effort to conduct monitoring, research and modeling to improve ecosystem management. The USGS is enhancing studies of the effects of endocrine-disrupting compounds (EDCs) and other toxic contaminants on fish and wildlife. In 2013, the USGS completed a food-web study of EDCs, pharmaceuticals, and other contaminants to assess the transfer of these chemicals between fish and osprey, and conducted foraging trails and data collection to develop models of bay habitats and their relation to black ducks and other waterfowl. The model results will be used by the FWS, State natural resource departments, the Black Duck Joint Venture, and Ducks Unlimited to develop strategies to restore habitats to increase the number of black ducks and other waterfowl wintering in the bay, and to improve the knowledge of the effect of groundwater on nitrogen transport on the Eastern Shore of Chesapeake Bay. The results are being used to assess the nitrogen load reaching the bay through groundwater transport and assess how groundwater influences the surface-water response to nutrient-management actions by partners. Results will be used to improve the reporting of agricultural conservation practices. These activities contribute to the CBP effort to improve verification of management practices implemented in support of the bay total maximum daily loads (TMDL; Clean Water Act requirement). The USGS is studying Chesapeake Bay food webs, including the potential for contaminant transfer and biomagnification beginning in 2014 and beyond.

Osprey found in the Chesapeake Bay

Greater Sage-Grouse – A candidate for listing under the Endangered Species Act, greater sage-grouse occupy approximately half of their historical range across Western North America. It is challenging to characterize their habitat because sage-grouse use a diversity of sagebrush environments across their widespread distribution. In 2013, the USGS and a partner analyzed information about the environment within a three-mile radius of 3,000 sage-grouse breeding areas, or leks. Ninety-nine percent of active leks were in

Greater Sage-grouse

landscapes with less than three percent of a developed category of land cover, and most leks were in regions containing at least 40 percent sagebrush in the surrounding landscape. Large populations within the interior of the sage-grouse range were highly interconnected, in contrast to smaller populations along the range periphery that often were connected to one or two populations. The maps delineated from these results help target conservation actions to areas that contain adequate habitat and where existing corridors connect outlying populations.

Fire Ecology – USGS fire ecologists conducted studies across the western United States evaluating the effectiveness of activities focused on mitigating wildfire risk by reducing hazardous fuels. In California, scientists found that certain fuel reduction techniques in chaparral ecosystems can contribute to the spread of non-native plants, which can have undesired consequences for future wildfire. In 2013, USGS scientists studied the effects of forest thinning, mowing, and herbicide fuel reduction treatments on the longevity of sagebrush communities and rangeland condition in the Great Basin. This research has resulted in a set of recommendations that resource managers can use to prioritize areas for treatment and determine how to most effectively use limited resources for fuel reduction and ecological restoration. Fuel effectiveness research continues to be a main focus of USGS wildland fire science and helps wildland fire managers mitigate and predict the risk of future wildfires, assess effects of management activities on native species and wildlife habitat, and assess the short- and long-range impacts of fuel reduction activities on additional ecosystem services such as rangeland condition and water quality and supply.

Conducting a prescribed burn in sagebrush in Idaho

Raptors and Wind Development: Developing Science-Based Conservation Tools – Land-use change across the North American West is a primary threat to wildlife populations. Energy development is a major driver of habitat loss and fragmentation in some of the last large and connected landscapes. Development of renewable energy poses a difficult challenge for conservation, because proliferating emission-neutral energy sources expand the human footprint in previously undeveloped areas. Raptors are of particular concern with wind energy development because wind turbines are a known source of raptor mortality, and these otherwise long-lived species have low reproductive capacities. Effects of development can be cumulative to raptors and their prey base as roads, transmission lines, and increased noise and human use rise in concert with development. Balancing the need to achieve energy independence through renewable sources, while maintaining robust wildlife populations, requires the development of tools that help managers proactively conserve landscapes. Working with State, Federal, and non-governmental entities, the USGS collected extensive records of raptor nest locations across Wyoming. Using the USGS's spatial data library, the USGS extracted and created data layers representing features that raptors key in on when choosing nest sites, including topographic indices, land cover, and human use. Combining spatial data with statistical models helps to reveal relationships between landscape features and raptor nest-site selection, allowing for predictions (in a geographic information system, or GIS) of relative habitat quality. In 2013, USGS and scientists from the University

of Waterloo and Colorado State University finalized models for nesting golden eagles, prairie falcons, and ferruginous hawks. These models form the basis for multiple-species conservation planning at the largest spatial scales available to date. The USGS then overlaid spatial data that represents habitat quality with layers representing wind energy potential that provides agencies with the most rigorous planning tool available to date. Partners, including the FWS, can use the models to guide energy development companies with project siting decisions at the project level.

Activity: Ecosystems
Subactivity: Invasive Species

2013 Actual: $12.1 million (51 FTE)
2014 Enacted: $13.1 million (53 FTE)
2015 Request: $17.6 million (65 FTE)

Overview

Nonindigenous invasive plants and animals cause significant economic losses and diminishing opportunities for beneficial uses of forests, croplands, rangelands, and aquatic resources. Costly effects include clogging of water facilities (quagga and zebra mussels) and waterways (hydrilla, giant salvinia), wildlife and human disease transmission (West Nile virus, monkeypox), threats to commercial, native, and farmed fisheries (Asian carps, snakehead fish, whirling disease, hemorrhagic septicemia), and increased fire vulnerability and adverse effects for ranchers and farmers (leafy spurge, cheatgrass, brome, buffelgrass).

Many species introduced decades ago have spread rapidly in U.S. ecosystems and pose increasing threats to lands and waters. They harm native ecosystems and are contributing factors in the listing of 40 percent of all threatened and endangered species. It is estimated over 6,500 non-native species cause more than $137 billion in damages annually to the U.S. economy as the country battles to control the economic, ecological, and health threats these invaders pose. Increased global travel and trade are providing more pathways for both intentional and unintentional introductions of invasive species.

The USGS works on each of the species mentioned above, working collaboratively on all significant groups of invasive organisms in terrestrial and aquatic ecosystems in all regions of the United States. Across the Nation, the USGS partners with States, tribes, other Federal agencies, businesses, agriculture, natural resource managers, and the private sector to help solve problems posed by these invaders. The USGS joins Federal efforts to combat invasive species in natural and semi-natural areas by providing information on early detection and assessment of newly established invaders; monitoring invading populations; improving understanding of the ecology of invaders and factors in resistance of habitats to invasion; and developing and testing prevention and alternative management and control approaches.

USGS science is also key to implementing the National Invasive Species Management Plan, developed by the National Invasive Species Council, as called for in the Presidential Executive Order 13112 on invasive species. The Interior bureaus work in partnership with other Federal agencies; State, local, and tribal governments; and private sources to conduct activities related to prevention, early detection and rapid response, control and management, restoration, and organizational collaboration.

Program Performance

Prevention, Early Detection, and Rapid Assessment

USGS research focuses on developing and enhancing capabilities to forecast and predict invasive species establishment and spread. Early detection helps resource managers identify and report new invasive species and assess risks to natural areas.

Modeling and Forecasting – The USGS develops and tests spatial models and data management and decision support tools. These efforts directly assist land managers and other decisionmakers in their efforts to detect and predict potential ranges and effects of harmful invasive species by documenting, mapping, and predicting their spread. In 2013, the USGS created the "Software for Assisted Habitat Modeling (SAHM)" to expedite habitat modeling and help maintain a record of the various input data, processing steps, and modeling options incorporated in the construction of a species distribution model. This tool helps researchers and managers explore and maintain records of multiple parameters and different iterations in the habitat modeling process and to develop a meaningful interpretation of results. Along with creating SAHM, the USGS has created and offered a training course to land managers and researchers to learn the basics of SAHM. Participants in the SAHM training ranged widely including participants from the USGS, Department of Agriculture, Animal and Plant Health Inspection Service (USDA, APHIS), USDA, Plant Protection and Quarantine (PPQ), The Nature Conservancy, Colorado Natural Heritage Program, National Aeronautics and Space Administration (NASA), NPS, U.S. Forest Service, and Colorado State University. These participants have gone on to create models for gypsy moth spread, cheatgrass habitat models, and various climate change modeling efforts. This course will be offered twice in 2014 and each year after. In 2014, models will continue to be developed using SAHM for tamarisk, Russian olive, cheatgrass, gypsy moth, and Africanized honey bee hybrids among others.

Early Detection of Invasive Species – Tracking the establishment and spread of existing and new invasive species is a critical component in the effort to manage invasive species. In addition to the standard means of monitoring, the USGS is developing new tools and techniques to assist in the early detection of invasive species. In 2012, the USGS worked with partners to develop a rapid and quantitative genetic-based (eDNA) method to detect Asian carp. In 2013 and into 2014, this tool is being refined to allow for better understanding and interpretation of results. This tool has also been applied to detect other invasive species. In 2014, USGS researchers are developing multi-species eDNA probes for invasive giant constrictor snakes. These probes will allow resource managers to collect water samples in Florida or elsewhere and submit them for molecular analysis to determine whether any of these species are present in an area. Results will be useful for assessing the spread of established invaders such as Burmese pythons, as well as for early detection of high-risk species such as anacondas that are not yet known to be established. Early detection of invaders greatly increases the odds that populations can be eradicated before they spread.

Nonindigenous Aquatic Species Database – The USGS hosts the Nonindigenous Aquatic Species (NAS) database, which provides the latest information on the distribution of introduced aquatic species across the United States. The online database (*http://nas.er.usgs.gov*) contains locality information for more than 1,100 species of vertebrates and invertebrates introduced as early as 1850. It is a primary source of invasive species information and early alert system for State and Federal resource managers and the

public with over 90,000 page views per month. Species of recent concern include Asian carp, zebra mussels, quagga mussels, lionfish, and Asian tiger shrimp. The USGS has been tracking and documenting reports of both lionfish and Asian tiger shrimp as they invade the South Atlantic and Gulf of Mexico. Recent advances in data acquisition have allowed the program to more than double the number of records in a single year, and have incorporated much of the historical museum data for the country. The presence and maintenance of a comprehensive aquatic invasive species database and mapping system made this information easily available to managers attempting to address this issue. In 2013, the USGS worked with the FWS to increase occurrence data in states in the Southeast Aquatic Resources Partnership (SARP). The USGS refined the data both spatially and temporally and doubled the number of specimen records for the region to make it more robust for modeling projects to be undertaken by SARP. In 2014, the USGS will complete a project to design and build an early detection data repository for Asian Carp monitoring efforts. This will enhance the ability of partners such as the FWS in their monitoring efforts for Asian Carp in the Great Lakes area.

Effects and Risks Posed by Invasive Species

The USGS provides methods and information to assess risks posed by invasive species to native species and their habitats. Understanding both the potential and realized effects of invasive species helps managers allocate resources for control and management.

Biology, Ecology and Population Dynamics of Invasive Species – Understanding life history and the environmental requirements, tolerances, and thresholds of targeted invasive species is critical to developing effective control and management options. The USGS conducts research on numerous aquatic and terrestrial fish, wildlife, and plants, including Burmese pythons, nutria, Asian carp, buffelgrass, brome, cheatgrass, tamarisk, leafy spurge, snakehead fish, brown tree snakes, zebra/quagga mussels, and feral pigs to provide the information needed by management agencies.

Burmese python

Invasive reptiles such as pythons and carnivorous lizards are emerging as potentially devastating predators on native species in the United States. Burmese pythons that are part of the large and widespread invasive population have been documented to consume endangered species such as wood storks and Key Largo woodrats. In 2013, USGS and university colleagues conducted research that implicated predation by invasive Burmese pythons as a cause of widespread mammal declines in the Everglades. Future USGS research aims to understand how these mammal losses affect southern Florida ecosystems, and how native species will be affected outside the Everglades as the expanding python population invades new habitats. The USGS also recently reached an agreement with the NPS to manage python-related issues in park units in southern Florida, and in 2014, USGS will expand regional capacity for removing pythons and conducting research to improve control tools.

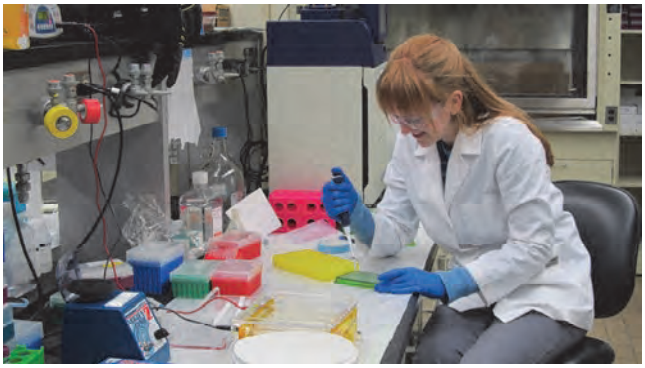
Multiple populations of invasive predatory Argentine tegu lizards are established and breeding in Florida. Tegus are large omnivorous lizards introduced to Florida via the pet trade. USGS researchers are working with other State, Federal and academic scientists to determine if these lizards may be nest predators of endangered species such as sea turtles and American crocodiles. In 2013, the USGS

completed research on the movement and hibernation behavior of invasive Argentine tegus in Florida using radiotelemetry and automated cameras. These studies provided information that will help resource managers understand when and where to deploy traps and other tools to control tegu populations. USGS scientists are conducting research in 2014 and beyond, using distributional and ecological information to predict the potential impacts of tegus, including whether tegus are likely to invade larger areas of the United States. The USGS is also initiating work to prevent the spread of tegus into the Everglades National Park and to build more effective tegu traps.

Control and Management of Invasive Species

USGS research improves existing invasive species control methods and develops and tests new chemical, physical, molecular, and biological methods of control. This permits managers to understand and minimize environmental impacts at landscape, regional, and local scales.

Asian Carp Control – The USGS is developing options to control Asian carp and other aquatic invasive species by chemical, physical and biological methods. In 2013, scientists worked with partners to develop a selective control technology for Asian carp based on increasing the selectivity of the piscicide antimycin. The goal is to deliver a control tool that kills Asian carp with little to no impact on other species. Research will continue in 2014 to refine the new method followed by testing on Asian carp and native aquatic animals. USGS scientists worked with partners in 2013 to evaluate an integrated pest management approach to control Asian carp integrating algal feeding attractants, mobile acoustic surveys, air cannon barriers, and commercial fishing to remove nearly 15,000 lbs of Asian carp from a backwater of the Illinois River. Research will continue in 2014 to evaluate the potential of barriers and integrated controls to prevent Asian carp from moving into critical habitat. A new technique developed and validated by the USGS to extract DNA from environmental DNA (eDNA) samples is now in use by the FWS in its Asian carp eDNA surveillance program. Research will continue into 2014 to validate species-specific bacterial markers for Asian carps and non-native fishes, to validate new genetic markers for Asian carps, to expand research correlating eDNA detection with population-level events of aquatic invasive species, and to explore more efficient methods to characterize the quality of DNA sequences present in eDNA samples.



eDNA sampling at USGS lab

Invasive Species in Hawaii and the Pacific – Non-native species often pose the primary threat to biodiversity in the Pacific. USGS research focuses on the ecology and control of highly invasive plants (e.g., miconia, faya tree, strawberry guava, Kahili ginger), animals (e.g., mouflon, rats, feral pigs), insects (e.g., Argentine ant, invasive wasps), wildlife disease organisms, and methods for reducing impacts of invasive species on the region's unique native flora and fauna. USGS scientists were partners in a study completed in 2013 that examined the distribution of invasive ant species in the Hawaii Volcanoes National Park and tested the efficacy of baits as a control mechanism for small populations of ants. The USGS recently completed a major survey of invasive brown tree snakes populations across the entire

island of Guam based on collecting ecological and reproductive data from 1,800 hand-captured snakes. Results of this survey are being used to refine prescriptions for landscape-level snake suppression using snake toxicants. In 2014, the USGS is conducting research to understand and mitigate threats posed by brown tree snakes to the endangered Mariana swiftlet, a small cave-dwelling bird only found on Department of Defense (DOD) lands on Guam.

Restoration of Invaded Habitats

USGS develops strategies and techniques to understand and facilitate restoration of native species and habitats affected by invasive species. This is critical because control without restoration can leave the ecosystem vulnerable to subsequent costly species invasions.

Weeds in the West –USGS conducts multi-scale, integrated assessments to map infestations and accurately monitor the spread of invasive plants, particularly weeds, in western forests and arid rangelands; predicts areas most vulnerable to invasive species; assesses the effects of management practices and natural disturbances on invasive species; evaluates how invasive grasses alter the frequency and intensity of wild fires; and improves methods to restore public rangelands affected by weed invasions. USGS is evaluating techniques to control populations of harmful weeds (cheatgrass, Sahara mustard, buffelgrass, brome) while maintaining or increasing the abundance and diversity of native annual plants.

Cheatgrass found across the West

Non-native cheatgrass is widely distributed in arid lands of the Western United States where its presence affects native plants, nutrient cycles, and the frequency of wildfires. In a study completed in 2013 involving 75 sites in the Great Basin, scientists from the USGS, Augustana University, and Oregon State University investigated factors controlling cheatgrass invasions in sagebrush systems, including the influence of livestock grazing. Researchers found that cheatgrass invasion was limited where few and small gaps existed between bunchgrass and where biological soil crusts were present to stabilize soil and limited where cheatgrass could establish. Results also suggest that grazing reduces invasion resistance by decreasing bunchgrass abundance and trampling biological soil crusts. Managing grazing to ensure abundance and variety of bunchgrasses and to preserve biological soil crusts could help restore sagebrush ecosystems.

Invasive riparian plant control and restoration – Researchers debate the extent to which tamarisk and other riparian invasive species such as Russian olive and Siberian elm have had negative effects on waterways in the arid Southwest, but it is clear that they can alter habitat quality for wildlife, water use by floodplain vegetation, and the frequency and intensity of wildfires. USGS is addressing some of the most compelling research questions related to these and other non-native plant species that occur in riparian ecosystems in the Western United States. In 2013, USGS evaluated the rate of spread of leaf-eating beetles released as a biological control of invasive tamarisk. In addition, USGS monitored the effects of biological control on vegetation communities and water use along the Virgin River in Arizona and Nevada and the Colorado River in Utah. Understanding these vegetation dynamics is integrated with

USGS research on post-control strategies and techniques to restore native species and habitats—critical information for land managers seeking to revegetate and restore function to riparian habitats. Other USGS research on riparian invasives in 2013 included a study aimed at understanding how climate change could affect the future distribution of Russian olive; another aimed at understanding what factors control the spread of Russian olive; and one aimed at understanding the distribution and dynamics of Siberian elm in the West. Results of these efforts are transferred to the broader scientific community and to stakeholders who want to apply the results of USGS science to their riparian management concerns.

Activity: Ecosystems
Subactivity: Cooperative Research Units

2013 Actual: $17.4 million (156 FTE)
2014 Enacted: $17.4 million (156 FTE)
2015 Request: $18.6 million (162 FTE)

Overview

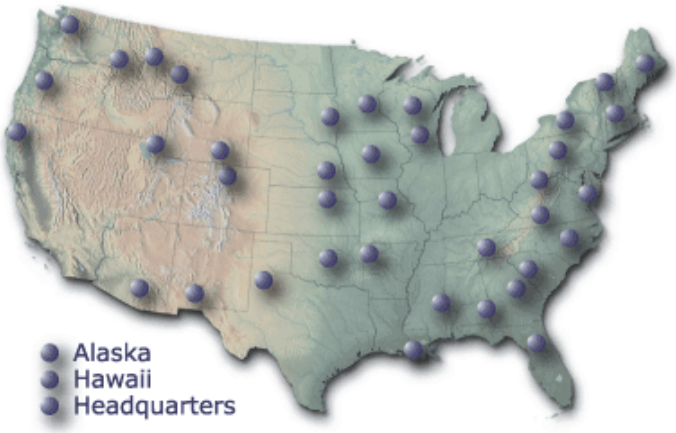
The Cooperative Research Unit (CRU) program is a unique and cooperative relationship among the USGS, State fish and wildlife agencies, host universities, and the Wildlife Management Institute. The FWS is a formal cooperator in most of the individual Units. Since 1935, this cooperative relationship has provided a strong connection between the USGS, State and Federal management agencies, and the national university community. Individual resources of each cooperator are leveraged to deliver program outcomes that far exceed what any one cooperator could achieve alone.

> *"As a product of the CRU System, I have seen first-hand how important CRUs are to education, natural resource conservation and cooperative efforts. The CRU System is a long standing example of what can be achieved when the state, university and federal government truly work together to achieve important conservation objectives."*
>
> *H. Dale Hall*
> *CEO, Ducks Unlimited Inc.*
> *Director, U.S. Fish and Wildlife Service (Retired)*

The goals of the CRU program are to sustain and maintain —

- A cost-effective, national network of Federal, State, and university partnerships pursuant to the Cooperative Research Units Act of 1960, with a legislated mission of research, education, and technical assistance focused on fish, wildlife, ecology, and natural resources;
- A customer-oriented network of expertise for research, teaching, and technical assistance that is responsive to information needs of State and Federal resource agencies;
- Science capabilities responsive to resource management needs of Interior bureaus; and
- A premiere program for graduate education and training of future natural resources professionals having skills to serve the broad natural resources management community successfully.

The CRU program is comprised of 40 CRUs located at universities in 38 States, with a headquarters office in Reston, VA. The program is designed to leverage cooperative partnerships



Locations of the Cooperative Research Units

with Federal and State agencies to address mutual needs of all partners in a cost effective manner. The USGS stations Federal scientists at universities to: help identify and respond to natural resource information needs through pooling of resources among agencies; participate in advanced scientific training of university graduate students; and provide Federal and other natural resource managers' access to university expertise and facilities.

Federal support of the CRUs is multiplied by State and university cooperator contributions of expertise, equipment, facilities, and project funding, thereby enhancing the program's cost-effectiveness. Through university affiliations, CRU scientists train future natural resource professionals and provide opportunities through graduate education to diversify the Federal workforce.

> *"The CRU Program today is the major vehicle in our public universities for the training of our nation's graduate students in the fish and wildlife sciences, who in turn become our future scientists, managers, and resource agency leaders. The administration and budget requirements of this program are shared in a strong three-way federal, state, and university partnership, which has proven to be an efficient use of scarce resources that fund a program that is invaluable for the future welfare of our nation's natural resources."*
>
> *Jack M. Payne*
> *Senior Vice President of*
> *Agriculture and Natural Resources*
> *University of Florida (former Unit student)*

Each CRU is directed by a Coordinating Committee comprised of Federal, State, university, and Wildlife Management Institute representatives. Each Coordinating Committee establishes goals and expectations for its unit within the program's mission of research, education, and technical assistance. The mix of priorities is established locally and is updated annually based on needs of cooperators and available funding. Program accountability measures, performance standards, and oversight of Federal scientists are used to ensure research and the resulting scientific information products support the goals of the USGS and Interior.

University and State agency contributions to the program remain strong, as does Federal, State, and local government reimbursable funding for research and technical assistance. Regular cooperator-focused satisfaction surveys continue to indicate a satisfaction rate of 95 percent or greater with CRU program execution of the education and science mission at local units. The program's appropriated dollars continue to be matched by State, university, Federal, and other entities' contributions at a ratio of approximately three matching dollars to each appropriated dollar.

"As a student of the Mississippi Cooperative Fish and Wildlife Research Unit I have been able to pursue my interest in animal population ecology. My research experience has better prepared me to continue with doctoral studies and provided me with the tools needed in population dynamics and animal resource selection" (Bradley Strickland, right)

Program Performance

To meet future natural resource management challenges, the program continually invests in new approaches to help State and Federal cooperators implement science-based decision making more effectively. These approaches will further provide a framework for cooperators to work together across State and regional

boundaries and address large-scale, trans-boundary issues. The CRU program is recognized by Interior as the primary source of technical expertise on structured decision making and adaptive management and is actively working with Interior bureaus to bring science to bear on regulatory and management decisions. Interior bureaus are faced with significant resource decisions and complexities in the face of unpredictable effects of climate change. Currently, expert knowledge and application of structured decision making and adaptive management is limited and does not meet management's need for this expertise.

To meet this need, the CRU continued its partnership with Oregon State University to develop and deliver an online, graduate level course in structured decision making and adaptive management. In 2013, 13 graduate students from across the Nation were competitively selected and completed this course and have incorporated learned principles into their research projects. This online course has, though limited in number of seats available, expanded the opportunity of CRU graduate students from multiple universities to learn systematic and innovative approaches to science-based natural resources management. As these graduates populate the workforce of our State and Federal partners, an increased capacity will be realized across all agencies, which will foster collaboration and more rapid adoption of the overall approach. Because many of the CRU graduates find employment within the Interior, these efforts will ensure the Department is better positioned to achieve its strategic goal of enhancing science-based natural resources decisionmaking, and supports the Interior's Strategic Plan goal of building a 21st century workforce.

Plans to develop new ways of working across State and regional boundaries have been incorporated as a key goal of the decision support initiative. In fact, CRU cooperators fully support broad-scale research projects aimed at understanding mechanisms affecting species and habitats at unprecedented scales. For example, trans-boundary collaboration is currently being used to address climate change, the most pressing challenge natural resource managers are currently facing. CRU Units in Wyoming, Utah, and Montana, in conjunction with multiple Western States, are coordinating an assessment of elk data across their geographic range to identify options for managing elk herds in ways not possible from a single-State perspective. This type of trans-boundary approach to wildlife research is an important precursor to the multitude of landscape-level wildlife management research issues that will arise as climate changes. CRU's extensive work in climate change research directly supports and aligns with Interior and the USGS strategic science vision that in many cases will require a trans-boundary approach.

> *"We rely on the Unit to the degree that we consider it the research arm of our agency. The proof is in the products: reliable management-based science and well educated students who are our future employees. We are proud of the partnership we have enjoyed for decades."*
>
> *Richard Hatcher*
> *Director, Oklahoma Department of Wildlife Conservation (former Unit student)*

Through 2013, CRU scientists used the approaches as described to support National and Interior interests in balanced energy development, climate change, and threatened fish and wildlife conservation. The continuing effort to strengthen science capacity in the CRU will ultimately lead to enhancement and expansion of graduate education and science training as mandated in the Cooperative Units Act, and thereby contribute to the science expertise and capacity needed to meet future natural resource challenges.

The CRU program has more than 800 active projects at the start of 2014. Many of these projects exemplify how CRU scientists are bringing decision support tools to Interior agencies for making important decisions on managing our Nation's natural resources. Consistent with the program initiatives highlighted above, many of the projects are using structured decisionmaking or adaptive management to address landscape level issues associated with climate change and energy development. CRU scientists at 23 Units currently have 52 active research projects (48 are in support of Interior) to better understand and predict the potential effects of climate change on the future availability of habitat and resulting distribution of species in the future. Similarly, five Units have nine projects related to understanding the impact of energy projects on the distribution and life history of a variety of ecologically or economically important species. These studies are not only critical for understanding the biological and environmental processes but also for informing decisions that integrate the underlying biology with societal needs and values.

A few examples of ongoing research projects that highlight how CRU scientists are helping our State and Federal partners make science-based management decisions include **—**

Assessing Lake Shrinkage in Alaskan National Wildlife Refuges – Lakes and wetlands in Alaskan National Wildlife Refuges (NWRs) provide habitat diversity in boreal forests and critical breeding habitats for millions of migratory waterfowl and shorebirds in North America. This multi-year project provides the first comprehensive analysis of lake shrinkage and identifies at-risk lakes and landscapes and potential impacts on biological resources and on traditional subsistence hunting areas.

Whooping Crane Introduction in Louisiana – Based on evaluations by the Louisiana Cooperative Research Unit, the White Lake Wetlands Conservation Area in Louisiana was selected for establishment of a resident Whooping Crane population. Multiple releases of cranes from the Patuxent Wildlife Research Center began in 2010 and habitat use, movements, and survival are being assessed by Unit scientists to assist the Louisiana Department of Wildlife and Fisheries and the U.S. Fish and Wildlife Service with efforts to establish this experimental population.

Migratory Waterfowl – Scientists from multiple Units are assisting State and Federal agencies to estimate populations and evaluate habitat use and movements of waterfowl to optimize harvest management practices. Among the many waterfowl studies are: work by the Missouri Unit assessed the effects of late season white goose hunts on the habitat use and energetics of other waterfowl species; the Alabama Unit is integrating habitat and population modeling for American Black Ducks in an effort to understand why the population is not increasing under current management activities; the Kansas Unit is conducting a risk assessment of Mottled Duck exposure to lead in coastal Texas; and the Louisiana Unit is studying the ecology and management of Lesser Scaup.

Wind Energy Development – Units are conducting 13 different research projects related to wind energy development across the United States. Collectively, the projects are designed to facilitate "smart" development and placement of wind energy projects to minimize potential impacts and conflicts by identifying important species and habitats, establishing methods for monitoring and assessing impacts, and prioritizing research needs. In the Northeast, the Maine and Massachusetts Units are conducting research along the North Atlantic coast to understand the potential impacts better of offshore-wind energy

development on marine species. The South Carolina Unit is developing an atlas of seabird nesting sites along the Southeastern United States to be used subsequently for spatial planning including site selection. The Wyoming, Colorado, and Nebraska Units are evaluating biological impacts of wind energy projects on birds and mammals near wind development sites. The Texas Unit is focused on the seasonal distribution and habitat use of golden eagles in relation to wind energy developments throughout their range to identify areas where potential conflicts are minimized.

Effect of Climate Change on Trout Fisheries in Minnesota – Trout fishing annually provides more than $150 million in direct expenditures to local economies in Minnesota. The Minnesota Unit is evaluating the potential vulnerability of trout streams to climate change. Climate changes can increase stream temperatures, alter the cold-adapted aquatic insects that form trout diets, and affect trout reproduction. The research will identify streams and food species that are most vulnerable to increasing temperatures and translate results into management strategies to protect and conserve this valuable biological and recreational resource.

2013 in Review – Achieving the Unit Mission

In 2013, Unit scientists and their cooperators advanced the mission of the CRU program through joint research, education, technical assistance, and science support. Unit scientists continued their productivity in 2013, with 921 active projects with Federal and State partners. Unit scientists and their students remained actively engaged in service to professional societies delivering 684 presentations. In addition, Unit scientists gave 51 invited seminars, indicating their research activities and findings are held in high regard by the scientific and management communities. The CRU's service to university cooperators continued to be strong, with 73 academic classes taught in 2013, and 25 additional workshops and short courses delivered to partners and cooperators.

Productivity Summary	**2011**	**2012**	**2013**
Peer Reviewed Publications	349	358	369
Invited Seminars	56	69	51
Workshops and Short Courses	25	33	25
Total Projects (State+Fed+other)	793	862	881
Papers Presented	684	840	684
Academic Courses Taught	75	74	73
Total Number of Students	550	555	563
Master's Degrees Awarded	61	60	59
Doctoral Degrees Awarded	23	23	12

Each year, over 500 students engage in graduate education and training in natural resources conservation through the CRU program. About 15 percent of these students matriculate each year and enter the natural resources management workforce as employees of State and Federal agencies, non-governmental organizations, and universities. The number of advanced graduate degrees awarded to Unit students in 2013 was 71 (59 M.S. and 12 PhD).

The CRU program is dependent on participation and contributions of all signatory parties. In 2013, CRU invested approximately 90 percent of program funding in scientists salaries and six percent in administration, with all funding for research projects supplied by program partners. Of the 119 research scientist positions authorized for the program, 101 are currently funded and staffed. Improvements in program performance in the form of increased publications, students mentored and graduated, courses taught, and other product-oriented elements of scientific outreach are related to science staffing levels. Reinvesting in science capacity to fully-staff vacant Unit positions that, through attrition, now affect Units in 16 States will have a direct and near immediate benefit in improving the number of students the program can support and the distribution of scientific expertise available to address contemporary resource management needs.

"Being a graduate student at the South Dakota Cooperative Fish and Wildlife Research Unit helped me to think outside the box and I was grateful to share my time with many great students and faculty while at SDSU"—Hilary Meyer (recent MS graduate).

Activity: Climate and Land Use Change

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Climate Variability								
National Climate Change & Wildlife Science Center/DOI Climate Science Centers (CSC) ($000)		23,735	23,735	50	0	11,550	35,335	+11,600
	FTE	40	40	0	0	9	49	+9
Climate Research and Development ($000)		20,495	20,495	154	0	4,600	25,249	+4,754
	FTE	123	123	0	0	11	134	+11
Carbon Sequestration ($000)		8,359	9,359	31	0	2,000	11,390	+2,031
	FTE	25	29	0	0	5	34	+5
Science Support for DOI Bureaus ($000)		2,220	0	0	0	0	0	0
	FTE	12	0	0	0	0	0	0
Subtotal: Climate Variability ($000)		**54,809**	**53,589**	**235**	**0**	**18,150**	**71,974**	**+18,385**
	FTE	**200**	**192**	**0**	**0**	**25**	**217**	**+25**
Land Use Change								
Land Remote Sensing ($000)		67,894	67,894	192	0	-1,547	66,539	-1355
	FTE	154	154	0	0	-12	142	-12
Land Change Science ($000)		10,492	10,492	76	0	0	10,568	+76
	FTE	61	61	0	0	-2	59	-2
Subtotal: Land Use Change ($000)		**78,386**	**78,386**	**268**	**0**	**-1,547**	**77,107**	**-1279**
	FTE	**215**	**215**	**0**	**0**	**-14**	**201**	**-14**
Total Requirements ($000)		**133,195**	**131,975**	**503**	**0**	**16,603**	**149,081**	**+17,106**
	Total FTE	**415**	**407**	**0**	**0**	**11**	**418**	**+11**

Summary of Program Changes

Request Component	($000)	FTE	Page
National Climate Change and Wildlife Science Center/DOI Climate Science Centers (CSCs)	**+11,550**	**+9**	
Climate Adaptation and Resiliency - Vulnerability Assessment Database & Field Guide	+800	+0	B-6
Interagency Coordination	+2,250	+4	B-6
Translational Science Grants	+3,000	+2	B-6
Tribal Climate Science Partnerships	+2,500	+0	B-6
Grand Challenge: Drought Impacts & Adaptive Management	+3,000	+3	B-8
Climate Research & Development	**+4,600**	**+11**	
Emerging Science Needs	+2,600	+7	B-7
Grand Challenge: Climate & Land Cover Change Effects	+2,000	+4	B-10
Carbon Sequestration	**+2,000**	**+5**	
Grand Challenge: Carbon Inventory & Decision Support Tools	+2,000	+5	B-11
Land Remote Sensing	**-1,547**	**-12**	
Landsat Science Products for Climate and Natural Resources Assessments	+1,000	+0	B-44
National Civil Applications Program/Civil Applications Committee	-2,547	-12	B-54
Land Change Science	**+0**	**-2**	
Ecosystem Priority: Chesapeake Bay	+500	+2	B-15
Landsat Science Products for Climate and Natural Resources Assessments	+500	+3	B-45
Land Change Science Research	-1,000	-7	B-54
Total Program Change	**+16,603**	**+11**	

Justification of Program Changes

The 2015 Budget Request for Climate and Land Use Change (CLU) is $149,081,000 and 418 FTE, a net program change of +$16,603,000 and +11 FTE from the 2014 Enacted level. For more information on the CLU Mission Area changes, please see Section B, Program Changes as indicated in the table.

Activity Summary

The U.S. Geological Survey (USGS) plays a leadership role in providing critical science needed to inform decisionmaking for environmental management and for mitigating and adapting to climate change. In particular, the CLU Mission Area undertakes scientific research, monitoring, remote sensing, modeling, synthesis, and forecasting to understand the effects of climate and land use change on the Nation's natural resources better. The results provide a scientific foundation to inform decisions by resource managers, and policymakers at State, local, tribal, and national scales. The CLU Mission Area's core mission is to improve the understanding of past and present change and to identify those lands, natural resources, and communities most vulnerable to climate and land change, including impacts to fish, wildlife, ecological, and coastal processes.

The science needed for a landscape-level understanding of natural resources, and for improved understanding of, adaptation to, and mitigation of climate change, are top priorities for the Administration and the Department of the Interior (Interior). The CLU Mission Area has responsibility for—

- National Climate Change and Wildlife Science Center (NCCWSC)/Department of the Interior Climate Science Centers (CSCs) (*http://nccwsc.usgs.gov/*)
- Climate Research and Development (R&D, *http://gcp.usgs.gov/rd/*)
- Carbon Sequestration (Biological: *http://www.usgs.gov/climate_landuse/land_carbon/;* Geologic: *http://energy.usgs.gov/HealthEnvironment/EnergyProductionUse/GeologicCO2Sequestration.aspx)*
- Land Remote Sensing (LRS, *http://remotesensing.usgs.gov/*)
- Land Change Science (LCS, *http://gam.usgs.gov/*)

The CLU Mission Area supports the following Interior 2014 – 2018 Strategic Plan goal to "Provide Science to Understand, Model, and Predict Ecosystem, Climate, and Land Use changes at targeted and landscape-levels (biota, land cover, and Earth and ocean systems)." In particular, the CLU Mission Area supports the following two strategies: (1) "Identify and predict ecosystem and land use change", and (2) "Assess and forecast climate change and its effects". The goal of CLU programs is to be a primary provider of science needed for adaptation to and mitigation of the impacts of climate and land use change on Earth and human systems. Policymakers, land, and other resource managers use the results to inform their decisions.

The CLU Mission Area programs also contribute to and coordinate with national and international scientific activities including the U.S. Global Change Research Program (USGCRP). The CLU Mission Area participates in various working groups that address topics such as fresh-water resources

management, climate-change decision tools, and carbon sequestration. In addition, CLU Mission Area projects support the USGCRP goals to—

- Advance scientific knowledge of the integrated natural and human components of the Earth system.
- Provide the scientific basis to inform and enable timely decisions on adaptation and mitigation.
- Build sustained assessment capacity that improves the Nation's ability to understand, anticipate, and respond to global change impacts and vulnerabilities.
- Advance communications and education to broaden public understanding of global change, and empower the workforce of the future.

The *USGS Climate and Land Use Change Science Strategy: A Framework of Understanding and Responding to Global Change* (*http://pubs.usgs.gov/circ/1383a/*) was released in 2013. The Science Strategy provides a number of high-level goals for CLU programs and is a vehicle for scientists and partners to get a general overview of our activities. The plan outlines seven broad goals for USGS climate change science for the coming decade:

1. Rates, causes, and impacts of past global changes.
2. The global carbon cycle.
3. Biogeochemical cycles and their coupled interactions.
4. Land use and land cover change rates, causes and consequences.
5. Droughts, floods, and water availability under changing land use and climatic conditions.
6. Coastal response to sea-level rise, climatic change and human development.
7. Biological responses to global change.

In June 2013, President Obama unveiled his Climate Action Plan (http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf) that aims to reduce carbon pollution, create more clean energy sources and minimize the impacts of climate change. The President's Climate Action Plan highlights a number of areas in which the CLU Mission Area makes significant contributions. For example, the CLU Mission Area is developing data and tools that support resilience planning. An important tool is the series of Landsat satellites, which provide data used by natural resource managers around the world to make water resource decisions, track forest health, and manage agriculture. Landsat data are used to document how local land use practices contribute to global change. For example, Landsat data were the first to quantify tropical deforestation, an insight that fundamentally changed Earth scientists' and public perception of the connection between land use and climate change. The USGS is currently developing Landsat-based science products to be updated every eight days for the United States, including surface temperature, fire disturbance, snow covered area, and green biomass. These datasets will support both natural resource managers and the climate monitoring community. The Climate Action Plan also encourages interagency coordination on climate change activities, which the CLU Mission Area does through the participation on USGCRP and the Council on

Environmental Quality working groups that are addressing topics such as fresh-water resources management, climate change decision-tools, and carbon sequestration.

Another aspect of the Climate Action Plan is the mandate for actionable climate science, which the CSCs are designed to meet through their climate vulnerability studies and database and through their "climate-adaptation strategies that promote resilience in fish and wildlife populations, forests and other plant communities, freshwater resources, and the ocean". CSC researchers (e.g. Federal, State, and university scientists) work closely with resource managers to define issues, identify science gaps, and co-conduct the research so the outcomes are directly usable. For example, the Southeast CSC is working with the U.S. Fish and Wildlife Service to identify strategies for National Wildlife Refuge management at both the refuge scale and East Coast-wide scale. The North Central CSC is providing the climate information needed to implement the Greater Yellowstone Coordinating Committee's whitebark pine strategy. The Northwest CSC is initiating literature reviews of the information available about proposed adaptation strategies, to assist managers in identifying appropriate options. The biological carbon sequestration project and Land Change Science Program also align closely with the Climate Action Plan focus on forest carbon measurement and projections. The Administration's new interagency forest carbon effort focuses on "managing our public lands and natural systems to store more carbon." With the U.S. Forest Service (USFS) and the U.S. Agency for International Development (USAID), the USGS provides Landsat satellite data, tools, and training to help developing nations inventory and track their forest resources and carbon stocks. Finally, the Climate Research and Development (R&D) Program conducts research to ensure that we understand the processes through which climate change affects different aspects of the Earth system. For example, Climate R&D researchers are expanding the understanding of how climate variability and change influences water availability. This includes documentation of regional to national patterns of droughts and floods, as well as the response of critical ecosystems to changes in water availability.

The successful launch of Landsat 8 in February 2013 enables near-term continuation of the 41-year Landsat record. In 2014, the National Aeronautic and Space Administration (NASA) will meet Congressional and Administration directives to devise an aerospace architecture designed to ensure 20 years of sustained land imaging that will provide data compatible with the past 41 years of Landsat data. As a major part of this effort, a NASA/USGS Sustainable Land Imaging Architecture Study Team (AST) is examining numerous long-term operational alternatives, in consultation with the Landsat Science Team. Under the architecture plan, NASA will develop Landsat-compatible land-imaging capabilities, while the USGS will continue to fund ground system development, post-launch operations, and data processing, archiving, and distribution. Near-term activities will focus on studies to define the scope, measurement approaches, cost, and risk of a viable long-term land imaging system that will achieve national objectives. Evaluations and design activities will include consideration of stand-alone new instruments and satellites, as well as potential international partnerships. Based on the results of the AST study, the Administration will propose and execute a capable, affordable, sustained system to provide land imaging information for the science and user communities, as a component of the nation's overall space-borne Earth observation programs.

Federal law requires the USGCRP to submit an assessment (the U.S. National Climate Assessment, NCA) to the President and Congress once every four years on climate change and its impacts. In 2013, the

USGS scientists led or co-led teams that completed reports, articles, and books that underpinned several chapters of the third NCA. The CLU-led reports focused on coastal impacts, climate change adaption, and vulnerabilities; global sea level rise; biodiversity, ecosystems, and ecosystem services; and land use/land cover change. An NCA synthesis report is scheduled for publication in 2014 with lead authors from CLU on chapters that describe: (1) changes in land use and land cover and how those changes affect the climate, and (2) impacts and adaptation for the Nation's ecosystems, water resources, the Southeastern United States, and Alaska. In addition to the NCA reports, several CLU-supported scientists served as lead authors of the Fifth Assessment Report (AR5) of Working Group II of the Intergovernmental Panel on Climate Change (IPCC). This report will be released in spring, 2014.

The CLU Mission Area had many accomplishments in 2013. Most notably was the successful launch of Landsat 8 on February 11, 2013, by NASA, after years of joint development by both NASA and the USGS. The USGS assumed management responsibility for Landsat 8 in May 2013 following a post-launch review. The Landsat program is a long-standing joint effort between NASA and USGS; Landsat 8 is the latest in this series of remote-sensing satellites, which have been providing global coverage of landscape changes on Earth since 1972. The USGS collects at least 400 Landsat 8 scenes every day from around the world; these are processed and archived at the USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota. The newest satellite joins Landsat 7, which launched in 1999 and continues to collect images. The two observation instruments aboard Landsat 8 feature improvements over their earlier counterparts while collecting information that is compatible with 41 years of data from previous Landsat satellites. With two satellites in orbit, the USGS can provide data every eight days for any location on the Earth’s landmasses, supporting natural resource managers and commodities markets.

CLU successfully decommissioned Landsat 5 in June 2013. After a mission-ending gyroscope failure and 28 years of global data collection, Landsat 5 obtained its last data in January 2013 before being safely lowered to a disposal orbit and having all systems permanently shut down. The mission recorded land surface conditions around the world for 29 years, 3 months, and 4 days, and orbited the planet over 150,000 times. Landsat 5 provided data on many significant events including the nuclear accident at Chernobyl in 1986, and the devastating tsunami in Southeast Asia in 2004.

Also in 2013, the CLU Mission Area established a new Federal Advisory Committee, the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS). This committee will provide advice to the Secretary of the Interior on the operation and scientific contribution of the NCCWSC and the CSCs. The ACCCNRS is expected to provide recommendations on ways to increase the amount of actionable climate science produced by CSCs, and on methods for evaluating the performance and effectiveness of the NCCWSC/CSC program. The ACCCNRS is composed of 25 members that represent Federal agencies; tribal, state, and local governments; nongovernment organizations; academic institutions; and the private sector. At the first meeting, held in September 2013, Secretary of the Interior Sally Jewell inaugurated the committee.

Another important CLU accomplishment was the release of the Western United States biological carbon sequestration assessment in December 2012, in a report entitled *Baseline and Projected Carbon Storage and Greenhouse Gas Fluxes in the Ecosystems of the Western United States.* In addition, the first ever-

detailed national geologic carbon sequestration assessment was released June 2013 (in coordination with the Energy, Minerals, and Environmental Health Mission Area). The biological carbon sequestration assessment for the Western United States was the second in a series of studies, mandated by Congress, comprising a national assessment of carbon storage and sequestration capacities by ecosystems. The Western United States sequestration study confirms the important role that the Nation's natural landscapes play in absorbing carbon and helping to counter-balance the Nation's carbon emissions. The Eastern United States report will be published in 2014. The geologic carbon sequestration project will continue research on the "potential volumes of oil and gas recoverable by injection and sequestration of industrial carbon dioxide in potential sequestration formations."

Finally, the USGS geologic carbon sequestration assessment methodology was endorsed by the International Energy Agency (IEA) and representatives from multiple international geological surveys, which recommend that a regional-scale assessment of geologic CO_2 storage capacity should follow the USGS methodology. The USGS methodology was praised by IEA because it is geologically based and incorporates a probabilistic approach that allows for the CO_2 storage resource to be assessed with any given level of uncertainty in the data collected, and because its assumptions are based on today's available technology and standard industry practices. The IEA stated that use of the USGS assessment methodology would allow for a transparent and robust assessment of geological storage resources throughout the world.

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #2: Provide Science for to Understand, Model, and Predict Ecosystem and Land use Changes at Targeted and Landscape Levels (biota, land cover, and Earth and ocean systems)
Strategy #2: Assess and Forecast Climate Change and Its Effects

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
USGS Climate Variability	40,628	63,117	64,334	58,189	54,809	53,589	71,974		+11.7%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #3: Assess and Forecast Climate Change and Its Effects									
Number of natural resource and cultural habitat, population, or ecosystem models, assessments, or major data sets developed by scientists and in cooperation with land managers.	USGS	n/a	n/a	n/a	n/a	n/a	10	20	20
Percent of climate research and development program products cited/used within three years of publication.	USGS	n/a	n/a	n/a	n/a	n/a	94%	92%	92%
							354	322	322
							376	350	350

Supporting Performance Measures

Outputs, Supporting Performance Measures, and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Percent of the baseline, reference projection, and mitigation evaluation units completed for a national biological carbon sequestration assessment (Bio Carbon)	USGS	NA	NA	14% 45/330	40% 120/300	75% 225/300	75% 225/300	100% 300/300	N/A
Number of systematic analyses and investigations completed (Climate Variability)	USGS	93	121	130	177	137	137	148	148
Number of masters' and doctoral level students supported at CSC consortium universities (NCCWSC/CSC)	USGS	NA	NA	NA	NA	Baseline is 20 for 2013	19	20	20

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #2: Provide Science for to Understand, Model, and Predict Ecosystem and Land use Changes at Targeted and Landscape Levels (biota, land cover, and Earth and ocean systems)
Strategy #1: Identify and Predict Ecosystem Change

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
USGS Land Use Change	72,316	74,842	73,807	83,214	78,386	78,386	77,107		
Total	226,480	240,429	234,644	241,482	227,472	231,197	239,132		+0.5%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #1: Identify and Predict Ecosystem Change									
Percent of U.S. surface area with contemporary land cover data needed for major environmental monitoring and assessment programs (Land Change Science Program)*	USGS	46%	95%	100%	15%	59.9%	78.0%	98.0%	100.0%
		213	440	463	70	272	354	445	454
		463	463	463	454	454	454	454	454

*Note: 2013 Actual refers to the 2011 National Land Cover Dataset.

Supporting Performance Measures

Outputs, Supporting Performance Measures, and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Number of terabytes managed cumulatively (Land Remote Sensing)	USGS	3,010.90	2,873.40	3,723.00	5,073.20	6,655.10	7,397.00	10,520.00	14,420.00
# of remote sensing products distributed (LRS)	USGS	3,127,040	5,600,000	4,710,757	5,923,825	6,101,540	8,249,372	12,623,424	13,002,126
Number of systematic analyses and investigations completed (Land Use Change)	USGS	90	79	92	84	82	106	80	92

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Activity: Climate and Land Use Change

Subactivity: Climate Variability

Program Element: National Climate Change and Wildlife Science Center/Department of the Interior Climate Science Centers

2013 Actual: $23.7 million (40 FTE)
2014 Enacted: $23.7 million (40 FTE)
2015 Request: $35.3 million (49 FTE)

Overview

Managers of natural and cultural resources need to understand the impacts of a changing climate—which can exacerbate ongoing stresses such as habitat alteration and invasive species—in order to design effective response strategies. The National Climate Change and Wildlife Science Center (NCCWSC) and the network of eight Climate Science Centers (CSCs) provide this understanding in the form of high quality, science-based tools and information. Partnering closely with managers of lands, waters, fish and wildlife, and other natural and cultural resources from start to finish in a research project ensures that NCCWSC/CSC-supported science is founded on stakeholder needs and that research products are ready for use.

The NCCWSC/CSC Program is closely linked to other USGS and larger Federal science capabilities and consists of Federal-university research centers to provide the varied expertise needed to address key resource management needs. All eight CSCs now have permanent Federal directors, and the partner universities' science staffing at each CSC continues to grow, allowing the CSCs to expand their science outputs, ensure effective links with other partners, and conduct effective program operations.

Strategic science planning at the CSCs takes input from natural and cultural resource management partners in the region. Each CSC has a Stakeholder Advisory Committee (SAC) with representatives from the Department of the Interior Landscape Conservation Cooperatives (LCCs), other State and Federal agencies, and tribes, as well as other science providers in the region. All CSCs have five-year strategic plans that outline regional science priorities. These plans, with ongoing stakeholder input, are used to guide annual science planning and funding decisions. The CSCs will continue to focus on high-priority science that identifies potential impacts to various natural and cultural resources, and will expand collaboration with other science providers in these focus areas. The NCCWSC has created a draft national science plan to provide a framework for the climate change- impact research conducted or coordinated by the NCCWSC. This plan also establishes a context for regional and national synthesis of science products and information across the CSC network. The NCCWSC Federal Advisory Committee, the Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS is providing guidance on this plan. Along with advising on this national science plan, the ACCCNRS is also

developing recommendations on ways to increase the amount of "actionable science" produced by CSCs, and on methods for evaluating the performance and effectiveness of the NCCWSC/CSC program.

The NCCWSC/CSC Program is a new approach for the way science is planned, conducted, and delivered. Overall, the CSCs' main goal is to provide actionable science that can be used for adaptation planning. New funding in 2015 would enable the program to expand its delivery of ready-to-use science, expand support for tribes planning for climate change, and link Federal science efforts regionally to achieve maximum results with minimum duplication. Also in 2015, the NCCWSC/CSC Program will use an increase in funding to begin work on a "grand challenge" to address the scientific and management issues associated with impacts of extreme and extended drought across multiple CSC regions in the midcontinent. Much research is available on the effects of drought on human systems, notably agriculture, but the ecological effects are not as well studied. As research continues to indicate that the future will hold more and longer droughts, it is critical to understand thresholds and tipping points and provide managers with early action options. The CSCs' proposal to bring together diverse stakeholders across a large region of the Nation would provide regional stakeholders with a science-based, integrative understanding of drought impacts to their resource management responsibilities, and of their potential adaptive management responses. This effort would make use of existing decision support tools and expertise from the LCS Program. For more information on this "grand challenge", go to the Program Changes section.

Program Performance

Continue to Focus on Meaningful and Significant Scientific Findings: NCCWSC and CSC projects initiated in earlier years of the program are coming to fruition and are providing meaningful and useful results, findings, data, and tools. In 2013, over 60 publications were released that resulted from NCCWSC/CSC-supported science projects and this number is expected to significantly grow in 2014 and 2015 as projects are completed. The scientific products resulting from the research projects span a large range of topics and geographic areas, including research on how climate will affect native plants in Hawaii and desert birds in the Southwest, effects of warming on native fish such as trout and salmon, and whether culturally important plants and animals will remain available to Native Americans. USGS publications can be found at *http://pubs.er.usgs.gov/*.

For example, a project scheduled for completion in 2015 by the Southeast CSC predicts and maps the location and extent of mangrove forests in the U.S. Gulf of Mexico and the Atlantic Coast. Mangroves are critical elements of a storm-resilient shoreline; understanding where they will persist enables managers to plan for future storms. This project utilized the NCCWSC Geo Data Portal, developed in 2011, which provides access to and manipulation tools for very large datasets (such as climate model output). In 2014, Southeast CSC scientists are beginning work with the U.S. Fish and Wildlife Service (FWS) Refuge System to identify both refuge-level and coastwide opportunities to ensure adequate habitat for waterfowl populations in the face of rising sea levels and other challenges. The NCCWSC Web site provides details for these and all other NCCWSC and CSC scientific activities.

Providing Actionable Science: The NCCWSC/CSC Program focuses on providing scientific products, tools, and information that responds to the needs of resource managers and are amenable to use in policy

or management of natural and cultural resources. The CSCs support a number of research projects that involve "Structured Decision Making (SDM)" as a core component. The SDM and related methods help managers and scientists to identify and focus on the most relevant information needed for a specific decision, thus enabling a more efficient use of scientific assets and ensuring greater utility of the results.

For example, scientists in the Southeast CSC are assisting water managers by providing data on the impact of climate change on stream and river flows in a way that informs water policy and management scenarios. Providing scientific results closely matched with real options enables decisionmakers and their stakeholders to understand the effects and tradeoffs of specific choices better. Beginning in 2014, researchers at the South Central CSC are modeling the impact of climate change on water flows in the Arkansas/Red River basin as well as the larger South Central region. Once completed in 2017, this information will provide water and other resource managers with information on how climate will affect water availability, how these changes will affect ecological services, and how changes in consumptive use (by farms, cities, and industry) will interact with these changes. This approach highlights choices and tradeoffs of particular water management strategies.

The North Central CSC is implementing a Resource for Vulnerability Assessment, Adaptation, and Mitigating Planning (ReVAMP). This state-of-the-art computing and visualization laboratory serves as a central tool to connect the climate impacts research being conducted at the North Central CSC to decision-focused tools and information useable by resource managers in the region. Beginning in 2013 and continuing to 2016, North Central CSC scientists are using the ReVAMP approach to provide important climate-related information for use in the implementation of the Greater Yellowstone Coordinating Committee's white bark pine strategy and mitigate the impact of white bark pine beetles—a native beetle that is experiencing major outbreaks potentially linked to climate change. This project has participants from the U.S. Forest Service (USFS), the National Park Service (NPS), and the Great Northern Landscape Conservation Cooperative (LCC), ensuring direct links to management applications. Another project at the North Central CSC is continuing to identify areas where waterfowl and other species in the Prairie Pothole Region will have suitable habitat in the future. Participants include the FWS Prairie Pothole Joint Venture and four other FWS offices, and the Prairie Pothole LCC, in a partnership enabling managers to direct resources to high priority conservation areas that will provide future habitat needs to a broad suite of migratory waterfowl.

Regional/National Synthesis of Science: Individual CSC research activities are crucial for informing local management decisions, but also serve as the anchor for developing multi-regional perspectives (e.g., across the full range of a species or habitats). This can provide the basis for multi-jurisdiction management strategies. National integration projects led by the NCCWSC build on CSC-level projects to understand larger trends in climate change impacts, synthesize regional information, and ensure that species, habitats, and climate impacts that span across multiple geographies are addressed. The NCCWSC conducts national-level synthesis of climate impacts for different topical and thematic areas. As part of the National Climate Assessment, the NCCWSC led the technical input on the impacts of climate on biodiversity, ecosystems and ecosystems services. This work, published in November 2013, provided information on ways that species ranges will shift due to climate change and on the expected novel arrangements of animal and plant communities that will have unexpected impacts to terrestrial and aquatic habitats.

Using new funds in 2015, the NCCWSC would initiate several new regional-to-national synthesis activities in 2015. These new activities would focus on three key issues of high management interest. The first would be a project led by the Alaska CSC, that would highlight climate-induced impacts to migratory birds and marine and coastal waterfowl based on CSC research activities at all eight CSCs. The second, led by the North Central and South Central CSCs, is a "grand challenge" to address the socioecological effects of extended and severe drought, drawing on expertise, to break important new scientific ground and provide stakeholders an integrative understanding of drought impacts to each other's resource management responsibilities, and of each other's potential adaptive management responses. Finally, the NCCWSC plans to work with other agencies and scientists to improve the guidance available to managers on the selection and use of future climate projections. The science of "downscaling" to obtain local projections of climate change has advanced rapidly, with many potential choices facing users. The NCCWSC will work with multiple partners, including USGS modelers, the USFS, and groups organized under the USGCRP.

Next Generation Scientists/Managers: A core component of the NCCWSC/CSC Program is to ensure that decisionmakers are supported by well-trained scientists with an understanding of how to develop and communicate scientific findings that are relevant and applicable to future natural resource challenges. The CSCs currently provide support to approximately 100 undergraduate and graduate students and post-doctoral researchers who contribute to CSC priority science work. The CSCs host and support a number of interactive training and collaboration workshops for students, early-career scientists, and resource managers. In 2014 and 2015, NCCWSC and the CSCs will continue to place a strong emphasis on learning opportunities related to climate change impacts science.

Tribal Engagement: The NCCWSC and CSCs are committed to addressing the needs of Native American tribes and other tribal and indigenous communities for climate related information and adaptation planning tools. Tribal representation is an important component of both the CSC SACs as well as the ACCCNRS. These efforts will be closely coordinated with the Bureau of Indian Affairs efforts in Cooperative Landscape Conservation. The CSCs also actively look for opportunities to support tribal climate research projects. In a project started in 2013, researchers in the Northwest CSC are currently studying whether Native American tribes of the Columbia River Basin and coastal areas of Washington and Oregon will continue to be able to rely upon Pacific lamprey, Pacific eulachon, and anadromous salmon, which are important to the tribes.

National Climate Change and Wildlife Science Center

(2013 Actual, $3.8 million; 2014 Enacted, $4.2 million; 2015 Request, $7.2 million)

The NCCWSC manages the operations of the eight CSCs, and leads additional research and assessment activities related to climate impacts on fish, wildlife and their habitats. NCCWSC scientists are managing a national effort to identify overall impacts of climate change on fisheries in the United States, assessing the coverage of vulnerability assessments undertaken by Interior, and will provide critical integration of efforts at CSCs addressing drought, migratory birds, and downscaled climate modeling.

Department of the Interior Climate Science Centers

(2013 Actual, $19.2 million; 2014 Enacted, $18.8 million; 2015 Request, $28.1 million)

The eight CSCs, established between 2010 and 2012, provide information needed by natural and cultural resource managers to understand and adapt to a changing climate. Each CSC is a Federal-university collaboration, and develops a science portfolio in consultation with regional resource managers and science partners. In December 2013, the eighth and final permanent CSC Director at the Pacific Islands CSC was hired. The focus now will be increasing their science capabilities and linkages with partner science agencies. Listed below are the locations and host institutions of each of the eight CSCs:

DOI CSC (date established)	**Host Institution**
Alaska (2010)	University of Alaska
Northwest (2010)	Multi-institution consortium headed by Oregon State University
Southeast (2010)	North Carolina State University
Southwest (2011)	Multi-institution consortium headed by University of Arizona
North Central (2011)	Multi-institution consortium headed by Colorado State University
South Central (2012)	Multi-institution consortium headed by University of Oklahoma
Northeast (2012)	Multi-institution consortium headed by University of Massachusetts, Amherst
Pacific Islands (2012)	Multi-institution consortium headed by University of Hawaii, Manoa

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Activity: Climate and Land Use Change

Subactivity: Climate Variability

Program Element: Climate Research and Development Program

2013 Actual: $20.5 million (123 FTE)
2014 Enacted: $20.5 million (123 FTE)
2015 Request: $25.2 million (134 FTE)

Overview

The Climate Research and Development (R&D) Program conducts research to advance the understanding of the physical, chemical, and biological components of the Earth system, the causes and consequences of climate and land use change, and the vulnerability and resilience of the Earth system to such changes. Climate R&D Program researchers draw on expertise in past climate, geology, hydrology, geography, and biology to document patterns of climate and land use change on daily to millennial timescales and to assess and model the impacts of changes on local, regional, and national spatial scales. This research provides the basic data needed to understand the rates and patterns of Earth system response to a range of climate and land use changes. Integration of these data with modeling efforts provides a means to advance the understanding of how changes in climate and land use change interact to influence the Earth systems. Climate R&D Program data contributions improve model performance and the program's ability to forecast likely changes under a range of climate and land use scenarios.

Climate R&D Program research is broken out into eight focus areas: abrupt climate change; carbon cycle; climate data and model integration; documenting patterns and magnitudes of natural climate variability; hydrologic extremes (patterns, causes, and impacts); impacts of climate and land use change on terrestrial and marine systems; rates, causes, and consequences of land use and land cover change; and sea-level rise (SLR) and coastal regions. Detailed information about each of these focus areas and their respective projects can be found on the Climate R&D Program Web site (*http://www.usgs.gov/climate_landuse/clu_rd/*).

Climate R&D Program activities are planned and conducted over five-year increments to address specific research questions. This strategy provides sufficient time and stability for projects to accomplish their stated goals and produce products and outcomes. It also provides the Climate R&D Program with the flexibility to address emerging critical issues (such as hydrologic extremes of drought and flooding) by coordinating among existing areas of expertise to establish appropriate research teams. Climate R&D Program activities are reviewed bi-annually by a program council of subject matter experts to ensure that adequate progress is being made to achieve the stated goals and allow for modification of objectives as appropriate. Climate R&D Program research supports national and international efforts to understand climate change, such as the U.S. National Climate Assessment (NCA), the U.S. Global Change Research Program (USGCRP) Strategic Plan process, and the Intergovernmental Panel on Climate Change (IPCC).

The Climate R&D Program continues to fund climate change research needed to understand the patterns of climate and land use change and their impacts on the Earth system. In 2014, the Climate R&D Program will focus on multidisciplinary research and modeling efforts in key habitats, including wetlands, mountains, and coastal areas that will increase the understanding of the impacts of climate and land use change. Additionally, the Climate R&D Program will initiate research on emerging science needs to improve the understanding of regional responses to climate and land use. This research will contribute to synthesis efforts that are jointly supported by the Climate Science Centers in those regions. These emerging-science needs include the identification of long-term patterns and causes of drought; the use of geologic records to improve estimates of potential magnitudes and ranges of SLR; the response of coastal ecosystems to changing sea level; and the application of process-based research to resource management issues. In 2015, the Climate R&D Program will use an increase in funding to begin work on a "grand challenge" to improve the understanding of how changes in climate and land use change interact to influence the Earth systems between climate and land use change. These efforts are aimed at providing data needed to improve: (1) forecasts of impacts of specific land use changes on regional and global climate patterns; (2) capabilities to predict changes in water availability based on specific management actions; and (3) the likelihood of sustainable restoration outcomes by understanding how changes in climate and land use change interact to influence the Earth systems. For more information on this "grand challenge", go to the Program Changes section.

Program Performance

Documenting Historical Levels of Climate Variability on Regional to National Scales: The USGS has a long history of research designed to document long-term patterns and impacts of climate variability across the Nation. In 2011, the Climate R&D Program began a new initiative to establish historical North American climate baselines based on climate and instrumental records. In 2014, the Climate R&D Program will collaborate with researchers in other Federal, State, local, international, and academic institutions to develop long-term records of temperature and moisture availability from a national network of sites. These records illustrate how continental-scale climate patterns vary on decadal to millennial timescales and improve the USGS's capability to model climate changes and impacts on the Earth system. These long-term baselines also provide a context to evaluate impacts of human-induced change to the system and can inform resource managers how specific systems respond to climate and environmental stressors. In 2015, Climate R&D scientists will begin synthesizing local and regional data to advance the understanding of long-term patterns of drought, storms, and other climate variables on a national scale. These syntheses should advance our understanding of how atmospheric and ocean processes interact to affect climate patterns across the Nation. Such data are needed to improve our capabilities to forecast impacts of different climate and land use scenarios across North America.

Increase the Understanding of the Impacts of Climate and Land Use Change on Our Nation's Ecosystems: Climate R&D Program research uses a combination of process-based research and monitoring to document past ecosystem variability and model potential ecosystem response to different climate and environmental stressors. In 2014 and 2015, Climate R&D Program researchers will expand research and modeling efforts in key habitats that include wetlands, mountains, and coastal areas. The projects focus on energy and nutrient flow through ecosystems over long timescales and record the impacts of both natural climate variability and land cover change. This research will provide evidence on

how processes critical to the health of the Nation—such as carbon sequestration, water table recharge, and nutrient filtration—respond to different climate and environmental changes. For example, the R&D Program has established a new working group on carbon cycling in the environment to contribute to, but also take input from, the biological carbon sequestration project. Collaborative planning among Climate R&D Program researchers, the CSCs, resource managers, and policymakers will help managers develop sustainable management policies for key habitats across the Nation.

Visualizing Results of Climate Model Simulations: In 2013, Climate R&D researchers developed two Web applications to make it easier to visualize climate model simulations of the 21st century and to see how climate model outputs vary in space and time. The intent of the viewers is to provide basic access and understanding of climate modeling for a wide range of users and user expertise. The first application allows users to inspect and compare projections of temperature and precipitation for all the countries of the world as simulated by 30 global climate models. The second application allows users to visualize projected climate change for any State or county in the continental United States from any of 30 climate models. It provides a number of useful tools for characterizing climate change such as: climographs (plots of monthly averages), histograms that show the distribution or spread of the model simulations, monthly time series spanning 1950-2099, and tables that summarize changes in temperature and precipitation extremes. In 2014, researchers are developing a parallel release of the Web application focused on USGS hydrologic units (river basins). This will provide additional capabilities to visualize water balance components such as runoff, snowpack, and evapotranspiration for telescoping hydrologic units analogous in areal coverage to states and counties for the same 30 climate models. In 2015, the Climate R&D Program will continue to update the viewers and create new applications for the data.

Improving understanding of feedbacks between land use change and climate: Humans have modified the Earth's surface for thousands of years, through activities such as forest clearance, expansion of agriculture, drainage of wetlands, and alteration of river flow. Such actions alter radiative forcing (i.e., whether energy is absorbed by the Earth or reflected back to the atmosphere) and regional climate patterns. Such forcings may affect how broad-scale climate patterns interact and lead to a global climate response. Land use and land cover changes can cause the boundaries between wet and dry regions to shift, altering local to regional vulnerability to droughts and floods, and there is a recognized need to integrate these forcings into climate modeling efforts. In 2015, Climate R&D researchers would initiate new research to improve understanding of how feedbacks between land use change and climate affect hydrology in regions susceptible to changes in water availability. Scientists would develop high-resolution land cover datasets that realistically model soil moisture and the water cycle for the present day and pre-Colonial time. These paired datasets would be used in regional climate simulations so that researchers can quantify changes in temperature, precipitation, and other climate variables that are attributable solely to land-cover change. These results can be coupled with other modeling efforts to improve forecasts of future climate changes that would result from specific land-management strategies. This work will be a unique advance in connecting long-term paleoclimate records of land change with Landsat-based satellite records of modern land change (see Florida maps below).

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Activity: Climate and Land Use Change

Subactivity: Climate Variability

Program Element: Carbon Sequestration

2013 Actual: $8.4 million (25 FTE)
2014 Enacted: $9.4 million (29 FTE)
2015 Request: $11.4 million (34 FTE)

Overview

Carbon sequestration is a method of securing carbon dioxide (CO_2) to prevent its release to the atmosphere and its contribution to global warming as a greenhouse gas (GHG). Geologic storage of CO_2 in porous and permeable rocks involves injecting high pressure CO_2 into a subsurface rock unit and displacing or dissolving into the fluid that initially occupied the pore space. Biological carbon sequestration refers to both natural and deliberate processes by which CO_2 is removed from the atmosphere and stored as carbon in vegetation, soils and sediments. The Energy Independence and Security Act (EISA) of 2007 (P.L. 110-140) called for the USGS to develop a methodology for and then complete a national assessment of geologic storage capacity for CO_2. The legislation also required the Secretary of the Interior to complete a quantitative national assessment of the carbon stored in and released from ecosystems. The Carbon Sequestration Program is responsive to EISA and supportive of the President's Climate Action Plan, which highlights the need for unlocking long-term investment in many energy commodities, and innovative technologies to address the avoidance, reduction, or sequestration of anthropogenic emissions of greenhouse gases.

In 2013, the geologic carbon sequestration project completed and published the first-ever comprehensive, fully probabilistic and quantitative assessment of the potential for geologic carbon sequestration in the United States (USGS Circular 1386, *http://pubs.usgs.gov/circ/1386*). The assessment indicates that there are ample geologic storage resources available for carbon capture and sequestration technologies outlined in The President's Climate Action Plan. Also in 2013, the biological carbon sequestration project published their second regional assessment, the Western United States (USGS Professional Paper 1797, *http://pubs.usgs.gov/pp/1797/*).

The EISA also requested the USGS to evaluate the national technically recoverable hydrocarbon resources resulting from CO_2 injection and storage through CO_2-enhanced oil recovery (CO_2-EOR). Anthropogenic CO_2 captured from industrials sources is currently being used to recover oil from some reservoirs. The utilization and storage of captured of CO_2 capture helps to decrease the carbon footprint of the produced oil. In 2014, the geological carbon sequestration project is developing an assessment methodology and plans to conduct a national assessment of the volumes of recoverable soil and resulting in CO_2 storage associated with CO_2 EOR in the next three years. The project also conducts research to better define the geologic controls on CO_2 storage in geologic reservoirs.

The biological carbon sequestration project has developed an innovative methodology to incorporate Landsat satellite data, develop models and tools, and collect field observations in testing these tools. In 2014, work will focus on development of tools for use in land management applications. In this effort, the USGS will actively engage with the CSCs and with Interior land management agencies, such as the FWS, and partner with them to conduct fine-scaled applications such as monitoring the impacts of land use decisions on carbon sequestration and other greenhouse gas emissions, and developing mitigation and adaptation scenarios. USGS scientists are beginning work with the U.S. Fish and Wildlife Service (FWS) to use the assessment results in support of National Wildlife Refuge restorations in eastern coastal wetland ecosystems damaged by Hurricane Sandy in 2012. Enhanced carbon storage and reduced methane emissions from these wetlands are among key ecosystem services being addressed. In addition, the biological carbon sequestration project is contributing to, and taking input from, the Climate R&D Program's newly established working group on carbon cycling in the environment.

In 2015, the biological carbon sequestration project will complete the Alaska and Hawaii assessments, providing comprehensive ecosystem carbon estimates for the first time in the two states. Also in 2015, the biological carbon sequestration project will begin work on a "grand challenge" to implement a carbon inventory and tracking system for carbon stocks and flows on all Interior lands, complete with online tools to support regional natural resource decisionmaking. For more information on this "grand challenge", go to the Program Changes section.

Geologic Carbon Sequestration

(2013 Actual, $4.2 million; 2014 Enacted, $4.2 million; 2015 Request, $4.2 million)

In 2010, the USGS published an assessment methodology (*http://pubs.usgs.gov/of/2010/1127/*) to estimate carbon sequestration-storage potential suitable for uniform application to geologic formations throughout the United States. The USGS methodology, a unique, robust approach to assessing the CO_2 storage potential of individual storage assessment units in sedimentary basins, is a geology-based, probabilistic methodology. The International Energy Agency and representatives from multiple international geological surveys have endorsed the methodology and recommend that regional-scale assessment of geologic CO_2 storage capacities should follow the USGS methodology. The results of the USGS national CO_2 storage assessment, which were released in 2013 (*http://pubs.usgs.gov/circ/1386/*), reported that the United States has 36 underground basins that could store 3,000 metric gigatons of CO_2. Those resources could be used by carbon-capture technology applied to coal-fired power plants and other industrial CO_2 sources to reduce carbon emissions. For comparison, the U.S. Energy Information Administration reports that the United States emitted 5.3 metric gigatons of energy-related CO_2 in 2012. Although the potential for sequestration described in this assessment is unprecedented, injecting CO_2 into geologic formations is not a new process or technology. Carbon dioxide injection has been one method used in enhanced oil recovery since the 1980s. This study provides new information needed for the potential management of CO_2 by various means.

The EISA also requests that the USGS, the U.S. Department of Energy (DOE), and other agencies coordinate efforts to conduct research related to geologic carbon sequestration. The USGS has unique expertise needed to understand the injection of CO_2 into saline formations, as well as provide baseline information in order to understand potential seismicity induced by sequestration activities. As geologic

carbon sequestration implementation begins, Interior land and resource managers will need this research and subsequent assessments to plan for future leasing activity and the Environmental Protection Agency (EPA) will use it to better predict and inform the permitting process. The DOE uses products from this research in their Annual Energy Outlook predictions and as a foundation to plan future demonstration projects. All of this work aligns with a 2012 National Research Council Report (*http://www.nap.edu/catalog.php?record_id=13355*) that recommended that the USGS work with other government and private agencies to collect new data to better understand the risks associated with injection of CO_2 into deep saline formations.

In 2014, the geologic carbon sequestration project will continue work to estimate the "potential volumes of oil and gas recoverable by injection and sequestration of industrial carbon dioxide in potential sequestration formations" as required by the EISA. A comprehensive reservoir engineering and geologic database, developed in 2013, helps to determine which U.S. reservoirs may be available for the CO_2-EOR process. In early 2014, the USGS completed a draft of the assessment methodology for assessing the technically recoverable oil and gas resulting from carbon sequestration associated with CO_2-EOR. Once a panel of experts in late 2014 reviews the methodology, the USGS would start a three-year national assessment of recoverable hydrocarbons resulting from CO_2-EOR. The USGS would also use the existing USGS National Oil and Gas Assessment methodology to assess the availability of recoverable natural CO_2 found in many natural gas reservoirs. The national resources of recoverable natural CO_2 in the United States are unknown and would be evaluated along with industrial CO_2. The USGS will develop economic assessment methodologies in 2014 to evaluate the results of both the 2013 national geologic carbon sequestration assessment and the national assessment of recoverable hydrocarbons resulting from carbon sequestration associated with CO_2-EOR. Additional project activities in 2014 will focus on the completion and publication of scientific reports that describe the geologic models that formed the basis of the national CO_2 storage assessment. Research activities will continue on the identification of the controls on geologic CO_2 storage, issues related to storage of CO_2 in unconventional reservoirs (primarily coal), and the potential impacts of induced seismicity on storage of CO_2.
The USGS is currently investigating the possible causes of induced seismicity related to the subsurface injection of fluid CO_2 and plans to continue this work in 2015. The significance of induced seismicity associated with wastewater disposal from natural gas production has been highlighted by recent USGS research; likewise, there is a potential seismic hazard associated with geologic carbon sequestration projects. The primary focus of the CO_2 sequestration induced seismicity research will be on the operation of an independent USGS seismic monitoring network (installed 2013-2014) at the largest operating underground CO_2 injection and storage facility in the United States, located in Decatur, Illinois. Data collected from the USGS seismic monitoring installation at Decatur will be used to interpret the potential seismic hazard associated with geologic CO_2 sequestration in the Illinois Basin and in similar geologic settings such as at the proposed Illinois Basin FutureGen project. Leveraging collaborative research and data sharing with these demonstration efforts is critical for expanding the knowledge of fate and behavior of CO_2 in the subsurface, which can then be used to refine future assessments and understanding of potential risks.

Finally, the USGS in 2015 would continue to conduct focused detailed geologic studies of reservoirs and seals in selected basins with high potential for carbon sequestration or that have demonstrated capacity to trap naturally occurring CO_2. More information is needed on these geological parameters to ensure safe

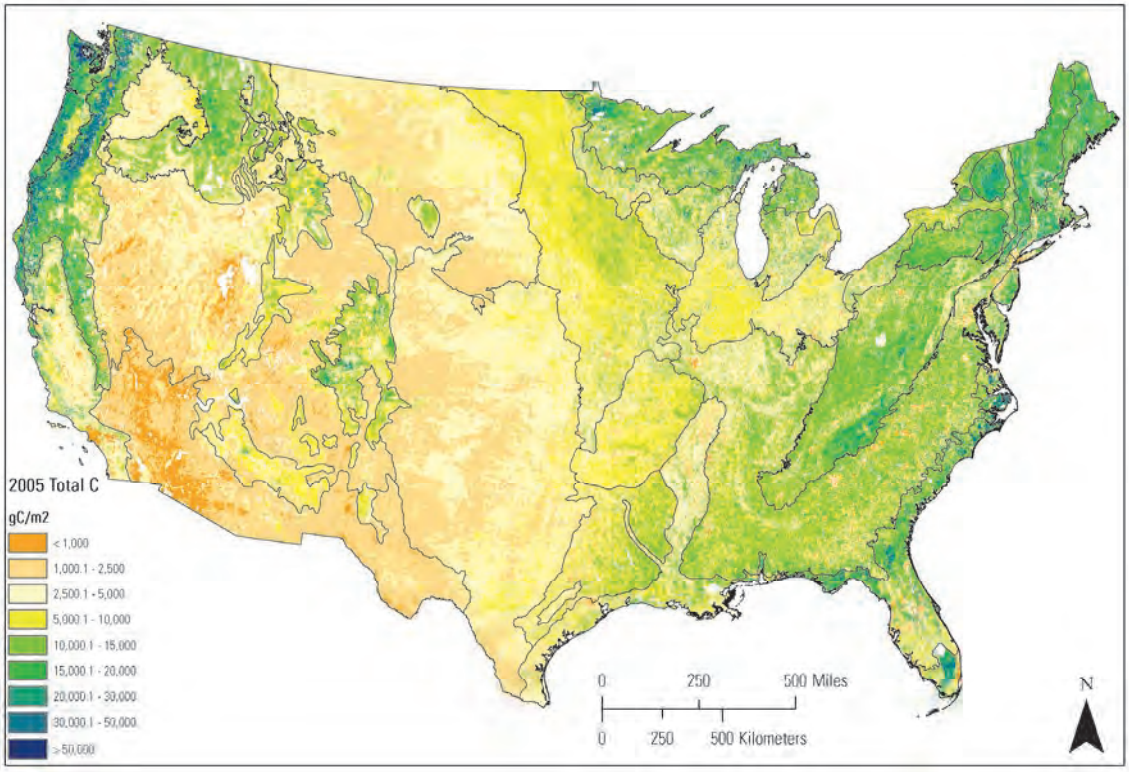
and long-term storage of CO_2. Research would also include characterizing variations in reservoir temperature and pressures related to CO_2 injectivity and storage. The USGS would also investigate the effects of subsurface CO_2 injection on water and rock chemistry for enhanced oil and gas recovery, geologic carbon sequestration, and naturally occurring CO_2 reservoirs. Very little is known about the effects of injecting high pressure, liquid CO_2 into the subsurface and the changes it will cause there. Collaborative efforts will continue with industrial partners, State Geological Surveys, universities, the U.S. Department of Energy National Energy Technology Laboratories (DOE NETL) Regional Carbon Sequestration Partnerships, and the EPA.

Biological Carbon Sequestration

(2013 Actual, $4.2 million; 2014 Enacted, $5.2 million; 2015 Request, $7.2 million)

The USGS released the biological carbon sequestration-assessment methodology in 2010. A wide range of stakeholders view this assessment as a major advance in scientific understanding of the relationships between ecosystem capacities to store carbon (or ecosystem vulnerability to release carbon into the atmosphere) and natural and anthropogenic processes, particularly land use change, ecosystem disturbances, management practices and climate change. All major ecosystems are included in the assessment, including forests, agricultural lands, grasslands, wetlands, rivers, lakes, and estuaries. By design, the biological assessment is conducted on a regional basis: Great Plains, Western United States, Eastern United States, Alaska, and Hawaii.

The USGS has already completed and delivered the Great Plains (December 2011) and the Western United States (November 2012) regional assessments. The Great Plains and Western United States assessments confirmed that both the Great Plains and Western United States are overall “carbon sinks,” meaning their ecosystems take up more carbon than they emit. While the Western ecosystems are a greater carbon sink than that of the Great Plains, estimates of carbon sinks and sources, as well as their strengths, are variable across the landscape (see Figure 1 below). On a national scale, the amount of carbon that is currently stored per year in ecosystems of the Great Plains and the Western United States combined is about 8.5 percent of total fossil fuel emissions nationwide.



Estimated amount of carbon stored in all major pools (biomass, woody debris, and soil) of major ecosystems (forests, grasslands, wetlands, and agricultural lands), on a per-unit-of-area basis, in 2005 (Data for east of the Mississippi River are preliminary).

The assessment of the Eastern United States is currently being conducted, with results analyzed and the report in the final editing stages for release by the summer of 2014. This report will complete the assessment for the entire conterminous United States. In addition, by the summer of 2014, data products (including carbon stock and sequestration estimates, emissions and fluxes in and out of ecosystems, land use change, and wildland fire) for the entire United States will be available for analysis and download via the Internet. As required by EISA, the USGS plans to complete an assessment of carbon storage and sequestration, as well as GHG emissions, in all of the ecosystems of Alaska and Hawaii in 2015. Because these two States have never been included in any major national-scale reports such as the annual EPA greenhouse gas inventory report, the two regional assessments will, for the first time, help provide critically needed information about the status and trends of carbon stored in their ecosystems, the carbon and methane emitted from wet soils and permafrost, as well as the impacts of fast changing climate conditions.

In 2014, the USGS will open the LandCarbon Atlas online tool to the public, which will enable managers and the public to view, analyze, and download carbon sequestration data via the Internet. This tool will be a significant step forward in supporting ecological carbon sequestration management, allowing land managers to ask “what-if” questions regarding the impacts of potential land management activities on carbon stocks and sequestration capacity, as well as on other ecosystem services (such as biodiversity, water quality, etc.). In addition, using existing USGS decision support tools as a foundation, an enhanced decision support system will be developed to quantitatively assess which areas should get the highest

priority for afforestation, reforestation and restoration activities. Initially, the USGS will prototype the system by developing applications with the FWS. The USGS and the FWS are working to incorporate ecological carbon sequestration into refuge management and refuge restorations in eastern coastal wetland ecosystems damaged by Hurricane Sandy in 2012. The FWS pilot sites include the Great Dismal Swamp, Alligator River, and Pocosin Lakes National Wildlife Refuges. For these sites, USGS scientists are focusing on key ecosystem services from these wetlands, including enhanced carbon storage and reduced methane emissions.

In 2015, the USGS will continue to work on areas of high priority authorized by EISA and emphasized in the President's Climate Action Plan. This includes completing the first assessment in Alaska and Hawaii, developing capabilities to routinely and reliably update the assessments to provide a steady source of scientifically credible and policy relevant information, and working closely with land management agencies of the Department of the Interior in support of their carbon sequestration and climate mitigation actions using the assessment results. A suite of implementation projects will be conducted in partnership with land management agencies. Various mitigation scenarios will be tested, including expanding conservation areas and management practices; increasing intensive forest management; increasing restoration activities in coastal carbon-rich wetlands; and enhancing ecosystem resilience to reduce emissions of carbon dioxide and methane from disturbances. Facilitated workshops will be conducted to incorporate local knowledge into tools that accurately value these ecosystem services and enable land managers to make decisions based on the best available scientific information. USGS scientists have developed a unique new methodology to incorporate Landsat satellite data, develop models and tools, and collect field observations in testing these tools; interagency agreements and partnerships will be developed to ensure that these data and tools will achieve practical uses in day-to-day land management decisionmaking.

Activity: Climate and Land Use Change

Subactivity: Land Use Change

Program Element: Land Remote Sensing Program

2013 Actual: $ 67.9 million (154 FTE)
2014 Enacted: $ 67.9 million (154 FTE)
2015 Request: $ 66.5 million (142 FTE)

Overview

The Land Remote Sensing (LRS) Program collects, interprets, and provides the Nation with Earth surface information, using data from satellite and airborne instruments. These data are provided under a free and open access policy via the Internet (*http://eros.usgs.gov/find-data*). LRS Program data help scientists to understand the dynamics of land use change and climate change and support efficient water resource management, agricultural crop monitoring and forecasting, forest-health determination, wildfire-recovery monitoring, and disaster management. The LRS Program provides a comprehensive, permanent, and impartial record of the planet's land surface through the National Satellite Land Remote Sensing Data Archive and aerial photography archives at the USGS Earth Resources Observation and Science (EROS) Center in Sioux Falls, South Dakota. These archives currently contain more than ten thousand terabytes of information.

The LRS Program also supports research and applications that use remotely sensed data to detect and monitor changes to the Earth's land surface, land cover, and inland and coastal waters. In addition, the LRS Program provides Federal civil agencies with access to classified Earth observation data and supports the development of unclassified information products derived from such data. This is done through the National Civil Applications Program (NCAP)/Civil Applications Committee (CAC), which is proposed for a funding decrease in 2015.

Since 1972, Landsat satellites have provided the only continuous authoritative global record of changes to the Earth's land surface, at a scale allowing the differentiation between natural and human-induced change. Under the Land Remote Sensing Policy Act of 1992 and associated Presidential Decision Directives, Interior and the USGS share responsibility for Landsat program management with NASA. Within this successful partnership, NASA develops and launches Landsat satellites while the USGS develops the associated ground systems and, following launch and on-orbit checkout, assumes ownership and operation of the satellites. Further, the USGS manages and maintains the data stream produced by the Landsat satellites, and makes data products available to support decisionmakers.

In December 2013, the USGS released a report on "The Users, Uses, and Value of Landsat Satellite Imagery – Results from the 2012 Survey of Users" (*http://pubs.usgs.gov/of/2013/1269/*). Responses from over 11,000 current users of Landsat data indicate an ongoing and increasing demand for Landsat imagery, and the report provides a conservative estimate of Landsat's annual economic benefits at

approximately two billion dollars. Also in 2013, the National Research Council 7released a report, "Landsat and Beyond: Sustaining and Enhancing the Nation's Land Imaging Program," which makes a strong case for sustained land-imaging satellite operations in order to ensure continuation of the Landsat data stream.

Program Performance

Landsat Satellite Missions: Following the February 2013 launch of Landsat 8 and thanks to the continued operation of Landsat 7, the USGS can provide data for any location on the Earth's surface every eight days. In 2014 and 2015, the LRS Program will continue to work with intramural and extramural scientists and data users to advance the science, usability, and centralized sharing of data applications and software for the Landsat program. The LRS Program will develop useful land-change data products, available in electronic form in consistent, user-friendly forms.

Landsat 7 was launched in 1999, and continues to collect useful data, though with significant data gaps in each scene due to a partial failure of its imaging sensor in 2003. Now a decade beyond its design life and operating on back-up subsystems, Landsat 7 has enough fuel to maintain its orbit through early 2017. Landsat 8 has an estimated five-year design life (to 2018) for the satellite and its primary sensor, and a three-year design life (to 2016) for its thermal sensor (a key tool used for water management). Landsat 8 is functioning well and providing excellent data.

> "*Agricultural Forecasting and Management – The U.S. Department of Agriculture uses* ***Landsat*** *data to monitor global crop supplies and stocks to forecast shortfalls or gluts of various crops on the market. The multimillion-dollar U.S. agricultural commodities market relies on these crop predictions when conducting futures trading. These important functions benefit U.S. food and economic security as well as national security.*"
>
> The National Research Council
> of the National Academies, 2013

In 2014, NASA will meet Congressional and Administration directives to devise an aerospace architecture designed to ensure 20 years of sustained land imaging that will provide data compatible with the past 41 years of Landsat data. As a major part of this effort, a NASA/USGS Sustainable Land Imaging Architecture Study Team (AST) is examining numerous long-term operational alternatives, in consultation with the Landsat Science Team. Under the architecture plan, NASA will develop Landsat-compatible land-imaging capabilities, while the USGS will continue to fund ground system development, post-launch operations, and data processing, archiving, and distribution. Near-term activities will focus on studies to define the scope, measurement approaches, cost, and risk of a viable long-term land imaging system that will achieve national objectives. Evaluations and design activities will include consideration of stand-alone new instruments and satellites, as well as potential international partnerships. Based on the results of the AST study, the Administration will propose and execute a capable, affordable, sustained system to provide land imaging information for the science and user communities, as a component of the nation's overall space-borne Earth observation programs.

Data Management Operations: Land remote sensing data acquired by the USGS and its government, commercial, and foreign partners are managed and archived at the EROS Center. The EROS Center has the ongoing challenge of managing and distributing a massive volume of stored data, while efficiently processing, and making available large volumes of new data ingested daily from the two Landsat satellites

and other Earth observation systems. In addition to 5 million Landsat images, the archive holds current and historical global image data from several other satellite systems and over 7 million aerial photos of the United States and its territories. In 2014 and 2015, the LRS Program will continue to disseminate millions of land remote sensing data products, free of charge, via the Internet.

The USGS continues its leadership role in remote sensing science and technology in the international arena by providing global remote sensing data sets and information products in support of a broad spectrum of societal benefits. The USGS also provides leadership to coordinate international Earth observation efforts through the International Committee on Earth Observation Satellites (CEOS) and the Group on Earth Observations (GEO). The USGS also serves as the lead U.S. agency to the International Charter for Space and Major Disasters. The Charter supports coordinated access to satellite data and products collected by many international satellite systems, and the Charter enables data and product delivery to those affected by natural or human-induced disasters.

Product Improvement: In 2013, the LRS Program initiated work with intramural and extramural scientists to develop the Landsat-based remote sensing science required for new value-added data products. These new products will support improved natural resource management decisions in both the public and private sectors. In 2014 and 2015, the LRS Program will continue work to increase to the usability of Landsat and other remote sensing data sets. The Landsat Advisory Group (LAG), a working group of the Interior National Geospatial Program's FAC (*www.fgdc.gov/ngac*), is providing recommendations on directions for those activities. In 2013, the LAG recommended that the LRS Program modify its current digital land-image products to make them more useful for commercial, value-added information providers and other customers who wish to extract maximum value from the imagery. In 2014 and 2015, the LRS Program will work to address the following recommendations:

- Make the standard Landsat product simpler to access and investigate ways to enable portions of the large-area, large-file sized Landsat scenes to be selected by the user and downloaded.
- Define the types of future products the LRS Program plans to produce and avoid competition with commercial entities.
- Refine the ground-area measurement accuracy of Landsat products to improve change detection.
- Improve co-registration of same-area Landsat scenes obtained on different dates.

Science Support to Decisionmakers: Consistent global measurements are necessary to advance understanding of the Earth's changing land surface and climate. Satellite observations are often the most efficient and cost-effective means to address these information needs. For example, the USGS Land Change Science Program relies heavily upon Landsat data to produce the National Land Cover Database (NLCD), estimate biological stocks of carbon, and to map ecosystems. In 2014 and 2015, the LRS Program will contribute to the international and interagency climate monitoring community's initiative to develop Landsat-based products to serve as Climate Data Records (CDRs) and related Essential Climate Variables (ECVs). The CDRs are long-term, time-series measurements that support the development of the ECVs such as snow cover; glaciers and ice caps; permafrost; land surface albedo; land cover; absorbed photosynthetically active radiation; leaf area index; biomass; and fire disturbance. The CDRs and ECVs provide an authoritative basis for regional to continental scale identification of historical change,

monitoring of current conditions, and prediction of future scenarios. In 2013, the LRS Program released its first CDR, a surface reflectance product.

In 2014, the LRS Program will capitalize on the unique characteristics and long-term continuity of Landsat observations to generate one provisional CDR, a land surface temperature product, and three high-priority ECV products to include burned area, surface water extent, and snow cover. In 2015, the USGS will refine its provisional products for public release in consistent, user-friendly forms via online interfaces.

The LRS Program will continue to support the Landsat Science Team in developing Landsat applications that support natural resource management in critical sectors of the Nation's economy. For example, water-resource managers in at least 12 states are using a Landsat-based tool (developed by the University of Idaho and the Idaho Department of Water Resources) for water management and impartial, data-driven adjudication of water rights. The tool, a computer model called METRIC, uses Landsat thermal data to produce water-use maps of irrigated fields more efficiently than using traditional, labor-intensive methods.

The LRS Program is also supporting researchers from the USGS, the University of Maryland, the State University of New York, and other collaborators developing the first global Landsat-derived land cover and land cover change data product at 30-meter spatial resolution. This product will portray land change at a scale pertinent to human activity, offer increased flexibility for environmental modeling, and provide more detailed information than has been previously available to resource managers and the climate research community. In 2013, the USGS compiled a prototype global tree-cover database and validated a database of South American land cover change. In 2014, the LRS Program will release to the public a database showing global forest gain and loss from 2000 to 2012.

Unmanned Aircraft Systems (UAS) Evaluation: On behalf of Interior and its bureaus, the LRS Program leads the operational test and evaluation of the UAS for new ways to acquire remote sensing data for science and operational activities. UAS technology, typified by relatively small, remotely controlled aircraft capable of carrying various types of miniaturized land-imaging sensors, can enable increased monitoring of Earth surface processes (erosion mapping, forest health conditions, wildfires, earthquake zones, invasive species, etc.) in areas difficult to access, and at lower human risk and potentially lower cost than traditional methods using piloted aircraft or ground exploration methods. All Interior UAS missions are flown in full compliance with Federal laws and Department policies and procedures, which include operating flights primarily over Interior lands and obtaining written permission from landowners if flights operate over private lands. Working with Interior and through partnerships with the National Oceanic and Atmospheric Administration (NOAA), NASA, and others, the USGS has completed numerous proof-of-concept missions to determine this technology's utility in meeting Interior's current Earth observation requirements.

In 2014 and 2015, the LRS Program will investigate next-generation UAS capabilities and potential commercial sources for UAS-acquired data. The LRS Program will also participate in interagency policy activities to support the transition of the UAS from limited-permit research flights to Federal Aviation Administration-approved operations, lowering a barrier to Interior bureaus' use of the UAS. The LRS Program will seek operational test and evaluation partnerships with Interior bureaus, NOAA, NASA,

DOD, and others to leverage missions and share technology. The LRS Program will continue to coordinate with Interior and its bureaus to develop a plan for implementing UAS technology, data, and services and will complete a USGS UAS Road Map as a foundation for future investments in support of USGS requirements.

Civil Applications Projects: Data from classified systems and commercial satellites are used to investigate climate change and other Earth dynamics, ecosystems, natural hazards, and manmade disasters (such as wildland fires), and to improve land and resources management. This is managed through the NCAP. In 2013, NCAP provided data for a downed aircraft search in Antarctica for the National Science Foundation, Typhoon Haiyan damage assessment in the Philippines, and other investigations. In 2014, NCAP data will be used for wildfire suppression efforts in the United States and for damage assessment from natural hazards and other investigations.

A Presidential Directive established the CAC on October 3, 1975. The Interior was charged with forming and chairing a coordinating and oversight committee, and delegated the role of chairing the CAC to the USGS. The 2010 updated National Space Policy specifies that Interior/USGS has the role to provide remote sensing information for the environment and disasters to civil government agencies that have been acquired from national security space systems.

In 2014 and 2015, the LRS Program will begin to decrease lower-priority, outdated, or duplicative functions of the NCAP. The USGS will maintain its civil science leadership of the CAC and assess ways to use classified assets for hazards, environmental, and natural resources applications strategically. The acquisition, archive, and dissemination of classified remotely sensed data to support science programs will be continued. Support for the Volcano Hazard Program and Volcano Disaster Assistance Program will be continued. The NCAP Global Fiducials Project will continue to collect high-resolution images of environmentally sensitive sites for use by cooperating scientists documenting Earth's surface processes and change. The CAC is also supporting some Global Fiducials Library work. In 2014, unclassified imagery derived products will be generated from the Global Fiducial images and made available on a public access server.

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Activity: Climate and Land Use Change

Subactivity: Land Use Change

Program Element: Land Change Science

2013 Actual: $10.5 million (61 FTE)
2014 Enacted: $10.5 million (61 FTE)
2015 Request $10.6 million (59 FTE)

Overview

The goal of the Land Change Science (LCS) Program is to understand the Nation's most pressing environmental, natural resource, and economic challenges by providing the information and tools necessary for identifying possible solutions to these challenges. The LCS Program conducts research on land cover, which provides a historical record of resource use and indicates the availability and quality of natural resources; assessing the impacts of land cover change; and by developing tools for decisionmakers to use for resource allocation decisions. Comprehensive land cover information is essential in a wide variety of investigations, such as assessing the impacts of climate change, evaluating ecosystem status and health, understanding spatial patterns of biodiversity, and informing land use planning. The LCS Program's research activities include understanding of—

- Environmental consequences of land change and its impacts on people, environment, economy, and resources.
- Ecosystem functioning and the services delivered by these functions.
- Improving the scientific basis for vulnerability and risk assessments, as well as disaster mitigation, response, and recovery.

The LCS Program manages the creation, updates, and distribution of the National Land Cover Database (NLCD), which is the standard land cover map of the Nation and based on data from the Landsat satellites. The NLCD provides valuable information on the types of land cover, changes that are occurring, their distribution, and patterns, and the potential consequences of these changes. Land cover information is critical for identifying and assessing climatic changes since surface energy fluxes between the land and the atmosphere have a major impact on climate. This information is also essential in assessing water quality and quantity, biodiversity conservation efforts, and the risks from natural hazards.

The LCS Program's activities use land cover information, remote sensing data, land change models, sensitivity analyses, and the probabilities of specific landscape disturbances, to develop tools so that land and community managers can make knowledgeable resource allocation decisions and assess the impacts of natural hazard events. These projects include developing case studies, interpretive assessments, and workshops involving stakeholders and other partners in collaborative decisionmaking processes. In 2015, the LCS Program's decision support tools and expertise will be leveraged by the biological carbon sequestration project and by the CSCs' "grand challenge" on mid-continent drought. The LCS Program

is an active participant in international global science initiatives through training and capacity building in the use of USGS data and science results.

The LCS Program collaborates with other USGS programs, and contributes to bureau initiatives, including the Science Application for Risk Reduction (SAFRR), LANDFIRE, WaterSMART, Chesapeake Bay restoration effort, and the New Energy Frontier. In 2015, the LCS Program will continue to expand the Chesapeake Bay restoration effort and will be focusing on a new initiative (along with the LRS Program) to accelerate the development of Landsat science and applications supporting natural resource management.

Program Performance

Land Cover Monitoring and Assessments: The LCS Program studies land use and land cover change at multiple scales, developing the science to understand the geographic variability of change and defining the environmental, social, technological, and political drivers of change, as well as assessing the impacts of these changes. Current land cover activities include the NLCD and regional activities in areas such as the Great Plains, Rocky Mountains and the Chesapeake Bay watershed. Regional assessments involve analyzing the impacts of land cover change on water quality, biodiversity and community risk and vulnerability, as well as conducting land cover change-modeling, used to assess impacts of future resource use and climate change.

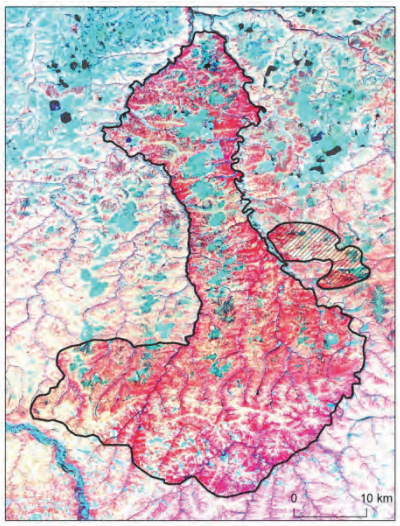
The NLCD has a five-year production cycle, which provides the Nation with current and accurate land cover information, while allowing for technological advances to be incorporated and accuracy assessments to be conducted. Completed in 2013, the accuracy assessment of the 2006 iteration of the NLCD provides the first comprehensive evaluation of a continental, Landsat-based land-cover change database. Results demonstrate that the 2006 NLCD provided high-quality data for assessments requiring land cover data and dynamic assessments, such as deforestation, urbanization, and changes in water availability. In 2014, the mapping will be completed for the next NLCD, utilizing Landsat images acquired in 2011. In 2015, the accuracy assessment of the 2011 NLCD will be conducted, as well as preparation for the 2016 NLCD. This 2016 NLCD will be the first to incorporate data from Landsat 8 (launched in 2013), which will entail an assessment of the differences between data acquired by that satellite and Landsat 7.

Land Change Modeling: At the request of the LCS Program and NASA in 2012, the NRC established a committee to assess the state of land change modeling, and describe ways to improve the integration of observation strategies into the models. The National Research Council report (*http://www.nap.edu/catalog.php?record_id=18385*) verified and sharpened the focus of several LCS Program directions, and concluded that the next generation of models should be increasingly process based; link processes in both social and natural systems; and make use of better methods for process validation, in order to enhance both their predictive skill and their utility for policy analyses. In addition, the NRC report stated that these new models should be routinely used with greater confidence for a wider range of scientific and policy purposes and support a better understanding of land systems, the effects of economic and social processes, and their effects on important environmental and social outcomes. In

2014 and 2015, the LCS Program will use the NRC report findings to improve its land change modeling activities, especially in assessing future carbon sequestration in ecosystems.

Fire Science: The LCS Program supported a number of fire science activities in 2013, including an update to the LANDFIRE Program's database and regional assessments of fire history. As with many large-scale ecological datasets, vegetation and landscape conditions must be updated periodically to account for disturbances, vegetation growth, and natural succession. In 2013, LCS researchers completed the first attempt to consistently update these products nationwide, resulting in a number of specific systematic improvements to the original LANDFIRE database, which was created in 2009. These updated products will be used in the future to assess fire behavior and develop prediction models. The LCS Program in 2014 and 2015 will incorporate new Landsat 8 data into fire monitoring activities and improve the mapping and monitoring of burned areas and estimating severity.

Also in 2013, Alaskan LCS researchers studying vegetation and permafrost-terrain characteristics discovered two large, previously unrecognized tundra fires, with the Meade River fire burning an estimated 500 square kilometers (km^2) and the Ketik River fire burning an estimated 1200 km^2. Based on radiocarbon dating of charred twigs, analysis of historic aerial photography, and regional climate proxy data, these fires likely occurred between 1880 and 1920. Together, these events double the estimated burn area on the North Slope of Alaska over the last 100 to 130 years. This research will be used in 2014 and 2015 to assess future fire conditions and impacts on permafrost as arctic temperatures increase due to climate change.

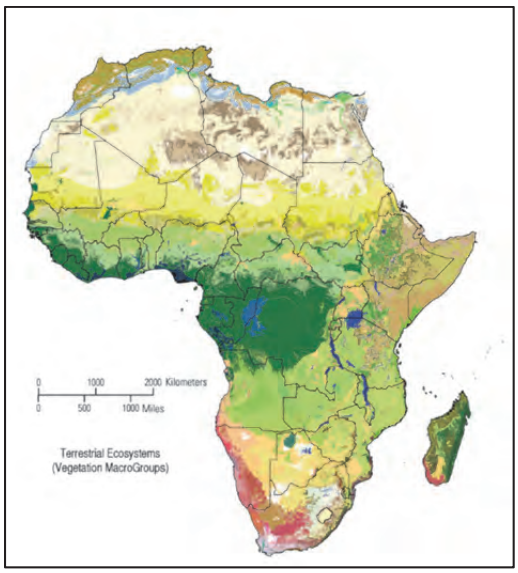


2010 Landsat 5 image of the Ketik River fire scar showing vegetation recovery. Red areas denote upland shrubby vegetation, while blue areas denote herbaceous wetlands.

Conducting Ecosystem Services Assessment and Valuation: The LCS Program develops spatially explicit models of ecosystem extent and functioning, and analyzes the services provided by these ecosystems, including carbon sequestration, water availability, and biodiversity conservation. In 2013, researchers evaluated the carbon fluxes and trends (e.g., carbon budget, source, or sink) of potential biofuel feedstock sites identified in the Greater Platte River Basin. Their results demonstrated that dynamic modeling of ecosystem performance using remote sensing could successfully identify productive and sustainable areas for biofuel feedstock development. This study provides useful information for land

managers and decisionmakers to make optimal land use decisions regarding biofuel feedstock development and sustainability. During 2014 and 2015, the methodology developed for the Platte River Basin will be applied across the northern Great Plains to assess the potential of biofuel crops in that region.

Support provided by the U.S. Agency for International Development (USAID) allowed LCS researchers in 2013 to classify and map the terrestrial ecosystems and vegetation of Africa, as part of a larger effort led by the international Group on Earth Observations (GEO). This classification of the entire African continent represents the most current and finest spatial and thematic resolution characterization of African vegetation in its biophysical context available today. The new ecosystem map for the continent has considerable potential utility for conservation priority setting and for conducting climate change impacts studies, focusing on the relationship between climate variability and ecosystem condition and distribution. In 2014 and 2015, the LCS Program, in cooperation with the Esri Corporation, will apply the methodology developed for Africa across the globe.

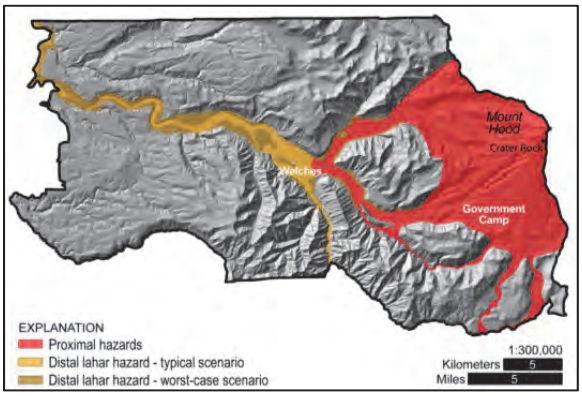


2013 Map of African Ecosystems. Green areas denote humid forests, brown grasslands and yellow and red deserts.

Assessing Societal Vulnerability to Natural Hazards: This research utilizes models, sensitivity analyses and geographic distributions of people and infrastructure, along with the probability of specific disturbance factors, to evaluate a community's vulnerability and risk. The LCS Program helps local and State governments assess their vulnerability by augmenting the USGS's traditional expertise in natural hazards with the ability to assess the exposure, sensitivity, and resilience of a community. These projects include case studies, interpretative assessments, and science impact studies involving stakeholders and other partners in collaborative processes. Specific projects include assessing multiple hazards in the western United States and flood hazards in the southeast United States.

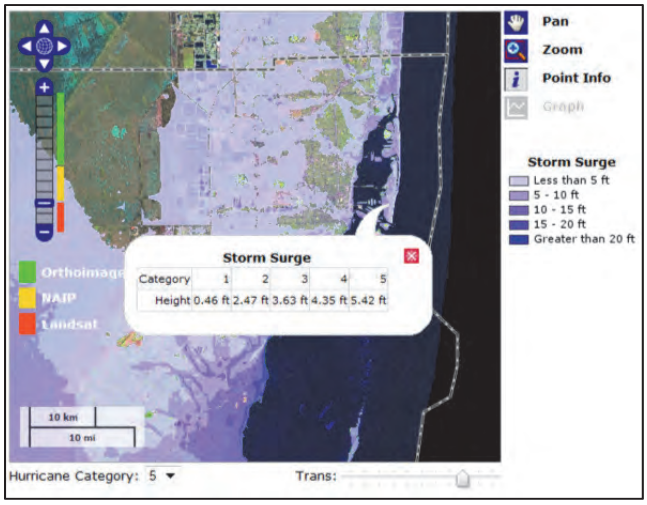
In 2013, LCS researchers analyzed residential and service-population exposure to natural hazards in the rural communities of Clackamas County, Oregon, near Mount Hood. The Mount Hood region of

Clackamas County has a long history of natural events that have affected its small, tourism-based communities. To support preparedness and emergency-management planning in the region, an analysis of population exposure to natural hazard risk was used to determine the number of residents and service populations in flood-, wildfire-, and volcano-related hazard zones. Results reveal that population exposure to flood hazards is low (less than 10 percent of residents) and does not vary substantially between 100-year and 500-year flood-hazard scenarios. For wildfire, moderate, moderate-to-high, and high-risk areas within the study region account for 72 percent of residents, 62 percent of employees, and 60 percent of daytime visitors to recreation sites. A volcanic event at Mount Hood could directly affect up to 60 percent of residents in their homes and 87 percent of employees at their workplaces. In 2014 and 2015, this methodology will be used to assess the vulnerability of other communities in the Pacific Northwest.



Map of volcano hazard zones for the study region Clackamas County, Oregon. Three different hazard zone types noted: (1) Red is the proximal hazard zone, (2) yellow is the distal lahar (i.e. destructive mudflow on the slopes of a volcano) hazard zone for a typical eruption event, and (3) brown is the extended distal lahar hazard zone for a worst-case scenario event.

South Florida's Greater Everglades area is particularly vulnerable to sea level rise. Rising sea levels are expected to have substantial impacts on inland flooding, the depth and extent of surge from coastal storms, the degradation of water supplies by saltwater intrusion, and the integrity of plant and animal habitats. Planners and managers responsible for mitigating these impacts require advanced tools to help them more effectively identify areas at risk. To address this problem, LCS researchers developed the Internet-based Modeling, Mapping, and Analysis for the Greater Everglades (IMMAGE) Web site (*http://lcat.usgs.gov/_immage/)* that provides more convenient access to SLR projections, their impacts on surface water and groundwater resources, the extent of storm surges and resulting economic losses, and the distribution of wildlife habitats. IMMAGE provides an advanced geographic information system (GIS) interface to support decisionmaking, and includes topic-based modules that explain and illustrate key concepts for nontechnical users. LCS research in 2014 and 2015 will focus on increasing the precision of SLR estimates and applying the IMMAGE methodology to the mid-Atlantic region.



Screenshot of the USGS's IMMAGE Web site forecasting the geographic location and depth of surge forecasted in the Miami area for a Category 5 hurricane.

Activity: Energy, Minerals and Environmental Health

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Mineral and Energy Resources								
Mineral Resources ($000)		45,931	45,931	414	0	0	46,345	+414
	FTE	319	319	0	0	0	319	0
Energy Resources ($000)		25,970	25,970	182	0	750	26,902	+932
	FTE	141	141	0	0	0	141	0
Subtotal: Mineral and Energy Resources		**71,901**	**71,901**	**596**	**0**	**750**	**73,247**	**+1,346**
	FTE	**460**	**460**	**0**	**0**	**0**	**460**	**0**
Environmental Health								
Contaminant Biology ($000)		8,647	9,647	80	0	2,273	12,000	+2,353
	FTE	61	64	0	0	8	72	+8
Toxic Substances Hydrology ($000)		9,967	9,967	78	0	3,781	13,826	+3,859
	FTE	60	60	0	0	11	71	+11
Subtotal: Environmental Health		**18,614**	**19,614**	**158**	**0**	**6,054**	**25,826**	**+6,212**
	FTE	**121**	**124**	**0**	**0**	**19**	**143**	**+19**
Total Requirements ($000)		**90,515**	**91,515**	**754**	**0**	**6,804**	**99,073**	**+7,558**
	Total FTE	**581**	**584**	**0**	**0**	**19**	**603**	**+19**

Summary of Program Changes

Request Component	($000)	FTE	Page
Subtotal: Energy and Mineral Resources	***750***	***0***	
Energy Resources	**750**	**0**	
Alternative Energy Permitting on Federal Lands	1,300	2	B-45
Hydraulic Fracturing	950	1	B-24
Energy Research	-1,000	-2	B-54
Oil, Oil Shale, and Gas Assessments	-500	-1	B-55
Subtotal: Evnironmental Health	***6,054***	***19***	
Contaminant Biology	**2,273**	**8**	
Ecosystem Priorities: Chesapeake Bay	100	0	B-15
Ecosystem Priorities: Columbia River	100	0	B-16
Environmental Impacts of Uranium Mining	673	3	B-35
Hydraulic Fracturing	1,400	5	B-24
Toxic Substances Hydrology	**3,781**	**11**	
Ecosystem Priorities: Chesapeake Bay	100	0	B-15
Ecosystem Priorities: Columbia River	100	1	B-16
Emerging Contaminants & Chemical Mixtures	1,450	2	B-45
Environmental Impacts of Uranium Mining	2,500	9	B-34
Contaminants in Wastewater Projects	-369	-1	B-55
Total Program Change	**6,804**	**19**	

Justification of Program Changes

The 2015 Budget Request for Energy, Minerals, and Environmental Health (EMEH) is $99,073,000 and 603 FTE, a net program change of +$7,558,000 and +19 FTE from the 2014 Enacted Budget. For more information on the EMEH Mission Area changes, please see Section B, Program Changes as referenced in the table.

Activity Summary

The EMEH Activity is comprised of two major programs. The Energy and Minerals program conducts research and assessments on the location, quantity, and quality of the Nation's and world's energy and mineral resources, including economic, and interactions of these resources with the environment (both natural and as a result of extraction) and utilization. The Environmental Health program conducts research on environmental impacts of human activities that introduce chemical and pathogenic contaminants into the environment and threaten human, animal (fish and wildlife), and ecological health.

The EMEH Activity is made up of four subactivities—

Energy and Mineral Resources

- Mineral Resources Program (*http://minerals.usgs.gov*)
- Energy Resources Program (*http://energy.usgs.gov*)

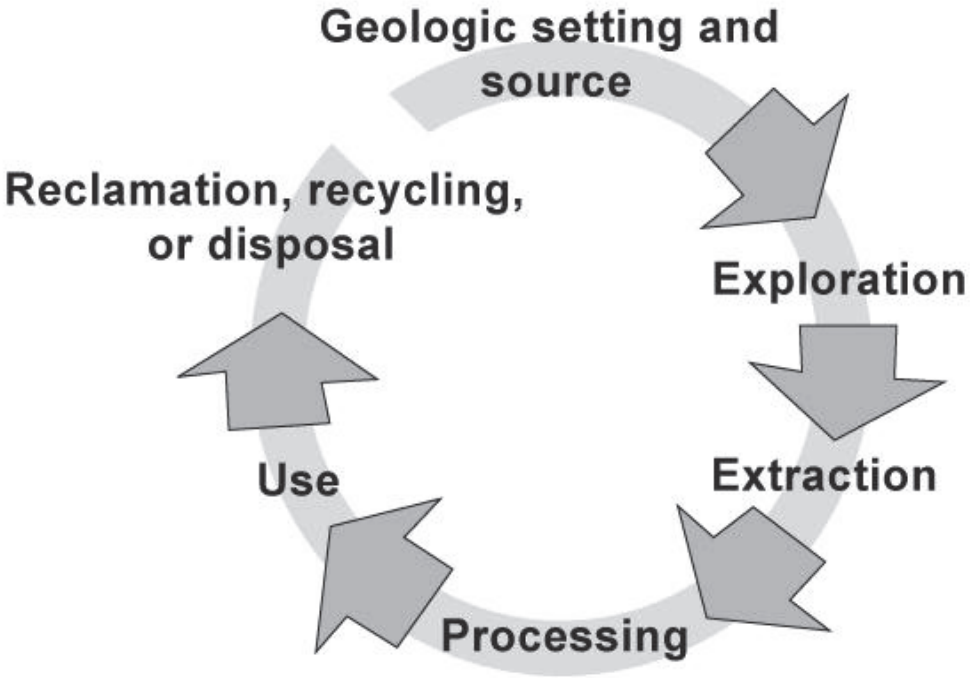
Environmental Health

- Contaminant Biology Program (*http://www.usgs.gov/envirohealth*)
- Toxic Substances Hydrology Program (*http://toxics.usgs.gov*)

Energy and Mineral Resources

The Energy Resources and Mineral Resources Programs conduct research on the location, quantity, and quality of the Nation's and the world's energy and mineral resources, including economic parameters and interactions of these resources with the environment, both natural and as a result of extraction and utilization. Together these two programs provide information to resource managers, policymakers, and the public to support science-based policy development, land and resource management, and decisionmaking on a range of critical resource issues. These include energy and mineral development and use, informing a variety of energy-mix scenarios, developing energy policy, determining mineral resource needs, understanding domestic resources and production in the context of global resource supply chains, and evaluating trade-offs including environmental risks. The Mission Area provides impartial, trusted science and information for understanding both the occurrence and distribution of national and global energy and mineral resources.

In 2013, the USGS published an Energy and Minerals Science Strategy which summarizes national science priorities that the USGS is best suited to address, and will serve as a strategic framework for USGS Energy and Mineral science goals, actions, and outcomes for the next decade. This plan describes the USGS role and important partnership opportunities, and outlines steps to take in the next 10 years to continue to provide the Nation with energy and minerals science and information on both current and emerging issues. This plan provides a framework of complete life cycle analysis (see figure below) within which to build upon and expand current work for understanding trade-offs and informing decisionmaking with respect to such issues as economic vitality, environmental health, national security, and responsible resource management and protection on U.S. Department of the Interior (Interior) and other lands.



Conceptual diagram that depicts a resource lifecycle for energy and minerals. Society faces key decisions within each stage of the resource lifecycle. Scientific understanding is essential to providing information for these decisions

Over the past several years, external technical committees reviewed portions of the Energy Resources Program. Each time, the Energy Resources Program develops a new assessment methodology, an external panel of technical experts formally reviews the methodology and approach. The methodology is revised based on the review and is not considered final until it has received expert review and revision. Recently external experts reviewed the following methodologies:

- Estimate carbon sequestration potential for uniform application to geologic formations across the Unites States.
- Assess reserve growth in oil and gas fields (assessment of both undiscovered resources and additions to reserves from discovered fields and reservoirs requires estimation of reserve growth).
- Determine economically recoverable resources of unconventional petroleum resources (coalbed methane, tight gas sands, shale gas, and shale oil).

Other methodologies, as they are developed and the draft approach finalized, such as that for uranium assessments and the water budget associated with unconventional oil production, will be reviewed in 2014 and 2015. Also in 2014, the Interior Office of Inspector General is initiating an evaluation of the Energy Resources Program. The objective is to assess the efficiency and effectiveness of the programs and how the results are used. This is a proactive review of the Programs within the Department that support the Secretary of the Interior's priorities.

Using guidance developed by the National Academy of Sciences Committee on Critical Minerals published in 2008, the Mineral Resources Program identified 16 mineral commodities as the focus of the next National Mineral Resource Assessment. These commodities include metals and rare earth elements needed for new energy and "green" technology development and industrial minerals important to agriculture. The USGS conducted a Mineral Resource Assessment Forum in 2012 to examine methodologies for producing mineral assessments and to determine the science needed to produce the most relevant and useful assessments in anticipation of starting the next National Assessment. New mineral deposit and mineral environmental model development for critical commodities continued in 2012 and deposit models were completed in 2013.

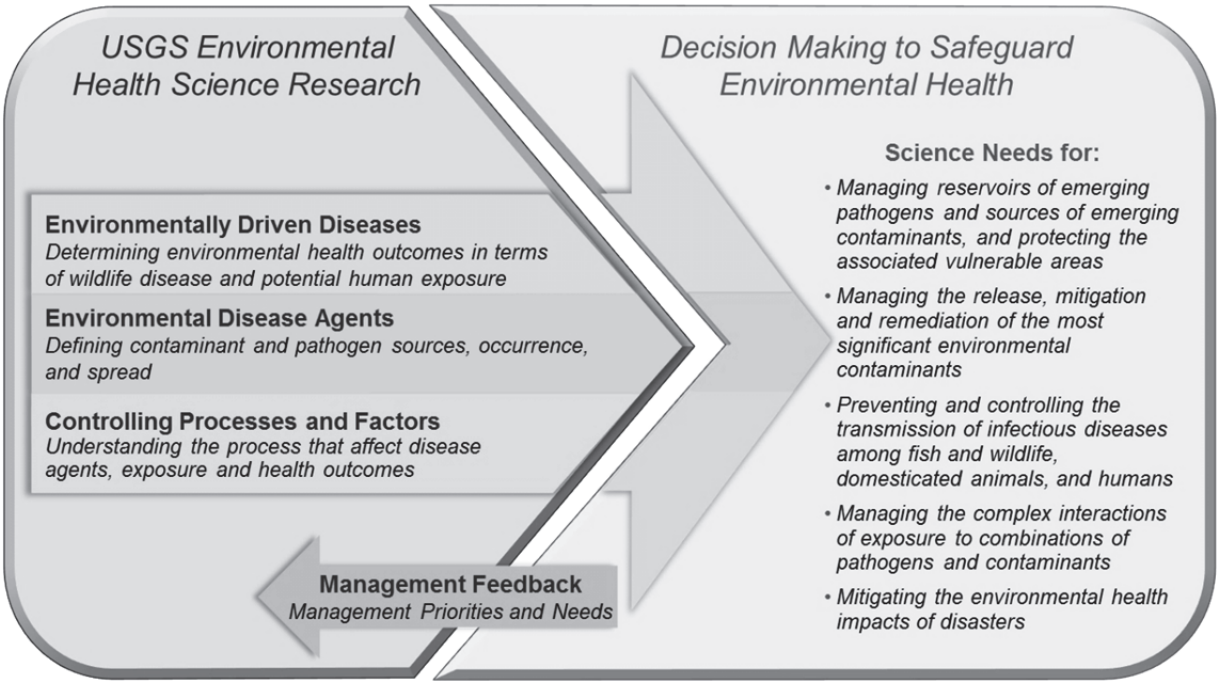
The Energy and Mineral Resources Program continues to increase focus on integrating its core capabilities more broadly. The programs are jointly developing approaches to natural resource assessments that incorporate energy and mineral resource information, as well as environmental and economic information. Several pilot projects, including a uranium study, are under development or are in the early stages of implementation. These projects will help decisionmakers consider a more comprehensive set of trade-offs for the increasingly complex set of conflicting and competing resource needs the Nation faces.

Environmental Health

The Contaminant Biology and Toxics Substances Hydrology Programs conduct research on the environmental impacts of chemical and pathogenic contaminants that enter the environment through natural and anthropogenic mechanisms, and threaten human health and the health of the Nation’s environment, including fish and wildlife populations. In 2013, the USGS published its first Environmental Health Science Strategy, which summarizes national environmental health priorities that will serve as a strategic framework for USGS environmental health science goals, coordination of research efforts, partnerships, and outcomes for the next decade. This strategy delineates the connection between USGS scientific research and its ability to support decisionmaking to safeguard environmental health.

The USGS is a lead Federal agency in providing information and tools to address occurrence, behavior, and effects of environmental contaminants, including impacts on susceptible ecosystems and implications for human, wildlife, and fish health. This information includes identifying chemical and pathogenic environmental contaminants (pesticides, surfactants, human and veterinary pharmaceuticals, and other industrial and naturally occurring contaminants); developing methods to identify sources of environmental contamination and measuring those contaminants in habitats and biota; assessing toxicological significance of contaminant exposure to vulnerable organisms; characterizing effects on organisms exposed in susceptible environmental settings, including potential human exposure; and providing information on performance of best management practices and treatment alternatives. This informs decisionmaking by the public and industry and helps resource managers and policymakers to assess environmental risks; prevent contamination; license and approve chemicals; and manage, protect, and restore natural resources, contaminated lands, and important natural ecosystems, including Trust resources of the Interior. These efforts complement other USGS programs by focusing on new and

currently understudied issues and contaminants, and by developing and improving methods to detect and characterize toxic substances in the environment.



The USGS role in environmental health science is providing scientific information and tools to environmental, natural resource, agricultural, and wildlife, and public health management agencies for management and policy decision making.

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #4: Provide Water and Land Data to Customers
Strategy #3: Assess National and International Energy and Mineral Resources

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
U.S. Geological Survey									
Minerals Resources	52,427	53,780	52,168	48,760	45,931	45,931	46,345		
Energy Resources	25,749	27,237	27,750	27,570	25,970	25,970	26,902		
Total	78,176	81,017	79,918	76,330	71,901	71,901	73,247		-6.3%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #4: Assess National and International Energy and Mineral Resources									
Number of times USGS mineral resource program products were (successfully) accessed online (in millions)	USGS	n/a	17.5	22.4	21.9	20.5	19.8	20.0	20.1
Number of times USGS energy resource program products were (successfully) accessed online (in millions)	USGS	8.2	6.9	5.0	5.0	5.0	4.8	4.8	4.5

Supporting Performance Measures

Outputs, Supporting Performance Measures and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Number of systematic analyses and investigations delivered to customers (MRP)	USGS	3	4	3	3	2013 is the year of baselining	559	560	570
Number of outreach activities provided to customers (MRP)	USGS	NA	NA	NA	NA	2013 is the year of baselining	1355	1300	1350
Number of mineral commodity reports available for decisions (MRP)	USGS	707	748	705	729	730	759	700	715
Number of megabytes collected annually (ERP)	USGS	18,702	1,707	2,323	2,147	1,500	549	1,425	1,354
Number of systematic analyses and investigations delivered to customers (ERP)	USGS	6	5	205	149	150	454	143	135
Number of outreach activities provided to customers (ERP)	USGS	8	9	1,570	2,482	2,000	2,161	2,100	2,000

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #3: Provide Scientific Data to Protect, Instruct, and Inform Communities
Strategy #2: Provide environmental health science to guide decision making

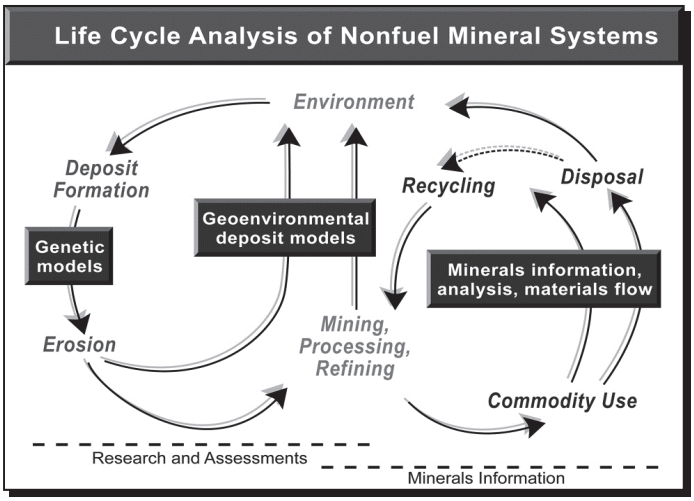
Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
U.S. Geological Survey									
Contaminant Biology	9,201	9,411	9,216	9,180	8,647	9,647	12,000		
Toxic Substance Hydrology	10,767	11,084	10,778	10,580	9,967	9,967	13,826		
Total	19,968	20,495	19,994	19,760	18,614	19,614	25,826		+14.9%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #2: Identify the connection between the natural environment and wildlife and human health									
Number of knowledge products on the quality and health of the environment that informed the public and the decision makers.	USGS	n/a	246	234	209	TBD	224	185	201

Activity: Energy, Minerals, and Environmental Health
Subactivity: Mineral Resources

2013 Actual: $45.9 million (319 FTE)
2014 Enacted: $45.9 million (319 FTE)
2015 Request: $46.3 million (319 FTE)

Overview



The Mineral Resources Program (MRP) supports data collection and research on a wide variety of nonfuel mineral resources that are important to the Nation's economic and national security. The MRP's Research and Assessment function helps to understand the geologic processes that concentrate known mineral resources at specific localities in the Earth's crust and to assess quantities, qualities, and distribution of undiscovered mineral resources for potential future supply. The program also conducts research on a wide range of critical minerals such as rare earth elements (REE), as well as the interactions of mineral resources with the environment, both natural and as a result of resource extraction, to develop geochemical baselines and better predict the impact that resource development may have on human and ecosystem health. The MRP's Minerals Information function supports collection, analysis, and dissemination of data that document production and consumption for about 100 mineral commodities, both domestically and internationally for 180 countries. This full spectrum of mineral resource science allows for a comprehensive understanding of the complete life cycle of nonfuel mineral resources and materials—resource formation, discovery, production, consumption, use, recycling, and reuse—and allows for an understanding of environmental issues of concern throughout the life cycle. Modernization of the Minerals Information function in 2015 includes increased emphasis on materials flow and supply chain analysis.

Program Performance

The MRP is focusing program efforts to advance the goals identified in the Energy and Minerals Science Strategy and other national priorities. The goals in this plan translate into prioritization of projects that address the following areas:

- Assessment of rare earth elements and other critical minerals.

- Develop new science and tools to understand the mineral life cycle and reduce the impacts of minerals extraction, production and recycling on the global environment.
- Advance modernization of the minerals information activity.

Efforts like these to advance the Science Strategy goals and National priorities are highlighted in the program performance section below.

Research and Assessment

(2013 Actual, $31.9 million; 2014 Enacted, $30.5 million; 2015 Request, $30.5 million)

Assessments of Rare Earth and Other Critical Minerals and Undiscovered Resources

Geologic and Mineral Resource Studies in Alaska – The MRP is expanding its activities in Alaska to provide an up-to-date geologic foundation for mineral resource assessment activities. This work includes acquisition of new airborne hyperspectral data in the Western Alaska Range. In addition, the MRP and the State of Alaska are continuing a three-year joint effort, known as the Alaska Critical Minerals Cooperative, part of expanded research nationwide on critical minerals to evaluate critical and strategic mineral commodities such as rare earth and platinum group elements that are vital to defense, renewable-energy, and electronics technology development. The MRP will analyze information from its extensive statewide databases, and use its expertise in regional and economic geology to outline areas of Alaska with the highest potential for critical minerals. Follow-up investigations of specific geologic belts and regions will be carried out by both agencies. A specific area of focus has been the Bokan Mountain REE deposit. Another area of investigation is geophysical and geological understanding of the Yukon-Tanana region along the border between Alaska and Canada.

Characterization and Identification of Critical Mineral Resources – Global demand for critical mineral commodities is on the rise with increasing applications in consumer products, computers, automobiles, aircraft, and other advanced technology products. Much of this demand growth is driven by new technologies that increase energy efficiency and decrease reliance on fossil fuels. The MRP is expanding its research and assessment activities to address the need for more up-to-date information on the Nation's and the world's critical mineral resources. In 2014 and 2015, the MRP will conduct geologic, geochemical, geophysical, and remote sensing surveys to comprehensively characterize the unconventional REE potential of the Appalachian front and coastal plain regions of the Southeastern United States. These include resources concentrated from the weathering of older rare-earth-bearing rocks, rare-earth-bearing placer deposits on the coastal plain associated with heavy-mineral titanium resources, and rare-earth-bearing phosphate deposits. The MRP has established working agreements with industry partners to better characterize significant domestic REE resources, at Mountain Pass, CA, Bear Lodge, WY, Bokan Mountain, AK, and Elk Creek, NE. This USGS-Industry collaboration includes geophysical data acquisition and processing that will provide a better understanding of the extent of REE resources in the subsurface and help delineate geologic controls on resource distribution. What is learned from these studies will be applied in future assessments of undiscovered REE resources. A major new focus is on critical minerals in southeast Missouri including acquisition in 2014 of new geophysical data to image the subsurface. Other projects focus on less conventional critical metals in black shales, placer deposits, and certain types of gold deposits. New analytical, remote sensing, and geophysical techniques

also are being developed that can aid in the understanding and characterization of critical minerals in a wide variety of geologic settings.

Global Assessment of Undiscovered Copper, Platinum Group Metals and Potash - With the recent completion of a 10-year cooperative project providing the first-ever global assessment of undiscovered resources of copper, platinum group metals and potash, commodities essential to infrastructure, food security, and environmental health, the MRP is now rolling out the products of this large project. Never before have scientists and decisionmakers had access to a publicly available, globally consistent assessment of this type. This USGS-led international cooperative effort was conducted on a regional, multi-national basis with the participation of dozens of interested national and internal geologic, mineral resource, and other governmental and nongovernmental institutions. The final products of this international collaboration include maps and text describing the distribution of areas permissive for undiscovered deposits of copper and potash for specific regions of the world and the estimated quantity of metals contained in each permissive area. This body of work will form the basis for decisions about land use and mineral supply in the United States and around the world. Fifteen of the individual assessment studies have already been published and cooperative projects with other stakeholders such as the World Bank and the Department of State are being explored. A continuing project involves understanding the mineral resource potential of Afghanistan and Central Asia to assist with economic development and stabilization for both regions, emphasizing the important role the USGS and the MRP play in the area of science diplomacy.

A**ssessment of Undiscovered Resources –** The results of topical and geographic-based research conducted by the MRP is applied to evaluate the potential of undiscovered mineral resourses and to decrease the uncertainty in probabilistic assessments. These assessments are used to inform decisions regarding potential domestic and global resource supply and decisions regarding land management of future resource development. New work includes integrating remote-sensing alteration mapping into resource assessments. The MRP is continuing a collaborative effort with the Energy Resources Program (ERP) to prepare for and initiate a national uranium assessment. This project, "Uranium Resources and the Environment," is drawing on ERP and MRP funded expertise to update uranium deposit models with environmental components, develop and vet an assessment methodology, and conduct a national assessment for undiscovered uranium resources. The MRP is continuing with research and development on assessment methodology and protocol to ensure of the efficient use of all available knowledge and data in the assessment process.

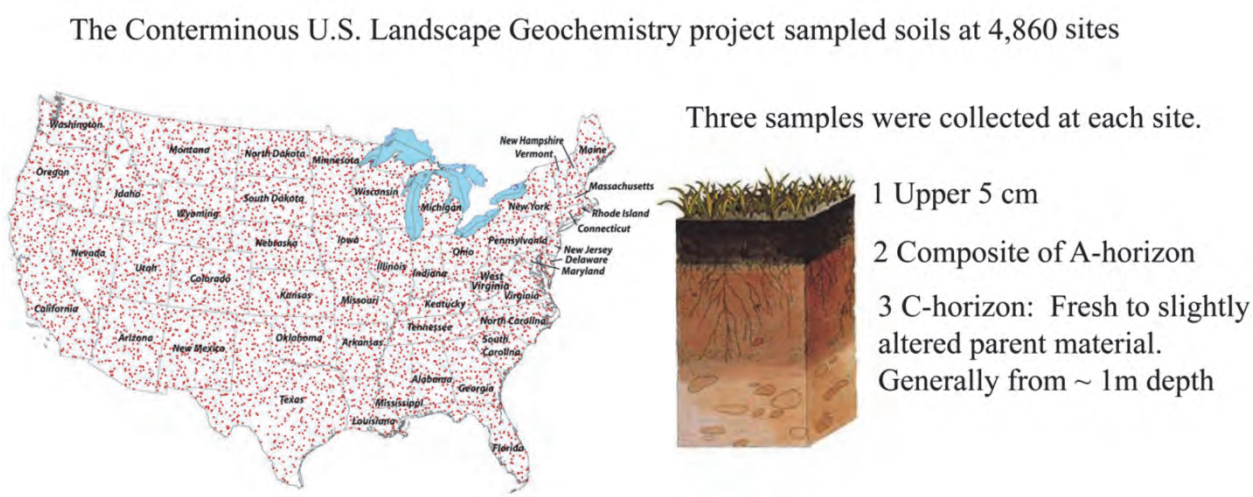
Mineral Resource Research and Information – The MRP continues to collect and analyze mineral resource data and conduct research on the genesis of and regional geologic controls for a wide variety of types of mineral resources. This includes a nationwide compilation of non-metallic mineral resources used in the industrial, construction, and agricultural industries. Work will be completed in 2014 on updating mineral deposit models for phosphate, REE, and gold, as such deposit models are the keystone to conducting mineral resource assessments. The MRP will support research to better understand the genesis and regional controls on significant precious-metal resources in the Walker Lane region of the Great Basin and research to document the basement tectonic framework of the United States as a foundation for understanding large-scale events and structural features and their role in localizing domestic mineral resources. A study of the Yellow Pine antimony-gold resource in central Idaho is a new

project in 2014 and 2015. It involves working with industry partners and newly available geologic data, which will lead to better understanding of the regional geology, deposits, and future resources for this type of mineralization.

New Science and Tools to Assess Minerals and Reduce Impacts of Mineral Development

Minerals and the Environment – The MRP will develop geochemical baseline parameters to better understand, predict, and develop information and tools to minimize the impact that resource development may have on human and ecosystem health. In addition, the MRP will continue and significantly expand in FY 2015 research on the interactions of mineral resources with the environment, both natural and as a result of resource extraction. A particular focus is in the Great Lakes Region as part of the midcontinent rift studies. Other activities include efforts to better understand emerging environmental geochemical challenges for future mining and the uses, characteristics, and environmental/health implications of metal and mineral commodities in the built environment.

In 2014, the first ever soil landscape geochemistry study of the conterminous United States was completed. This huge undertaking built on 4,860 sampling sites across the country that resulted in an atlas of maps showing the distribution of 45 major and trace elements and major mineralogical components (see figure below). Another achievement in 2014, is an overview of more than 20 critical and strategic elements, that represents the first update of Professional Paper 820 from 40 years ago. This is in direct response to increased funding and national interest in critical minerals.



Further research and analysis is anticipated utilizing the recently completed MRP's Soil Landscape Geochemistry data. For example, identified anomalies for elements such as arsenic, mercury, and lead will be examined to determine possible sources and geochemical vectors for mobility. This can be combined with ongoing work to understand the compounding effect of multiple metal contaminates in the same watershed.

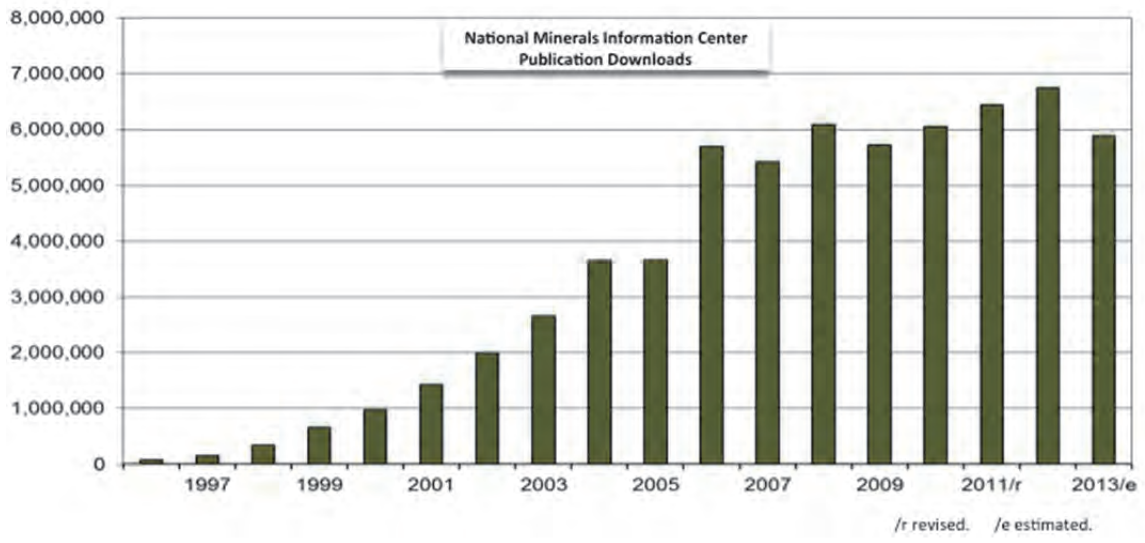
Characterization of the Midcontinent Rift and Related Mineral Resources – The MRP is refocusing efforts in data acquisition and multidisciplinary research to image and characterize the midcontinent rift and related mineral resources, to document mineral resource potential, and to evaluate mineral environmental impacts of past and future mineral resource development in the region. The midcontinent rift is a 1.1 billion-year-old structural feature exposed in the Lake Superior region, but covered by younger rocks as it extends to the South through Iowa, Nebraska, Kansas, and Missouri. Rocks that formed in response to development of the rift, such as the Duluth layered igneous complex in northern Minnesota contain significant known resources of copper, nickel, and platinum group metals. Collaboration with industry partners includes sharing geophysical data and information about new resource discoveries to better understand this world-class geologic region. Other midcontinent rift studies in progress include environmental geochemistry research to evaluate impacts of past and future mining in the Lake Superior region, and an assessment of the platinum-group element resources in igneous intrusions of the Duluth complex and vicinity of the Lake Superior region. The environmental geochemistry work will explore new ways of measuring the impact of past, present, and future mineral extraction, as well as ways to mitigate those impacts.

Laboratory and Analytical Research and Development Support – The MRP supports research on analytical techniques and methods development to help characterize mineral resource genesis and mineral environmental interactions and provide analytical support to understand the nature and distribution mineral resources. These capabilities also provide critical support to science and research in many other parts of the USGS. Analytical chemistry, isotope, and geochronology labs supported by the MRP provide high-caliber data to projects and programs in all USGS Mission Areas. Geophysical capabilities developed by MRP-funded scientists to discover more about mineral resource potential are now being applied to study a variety of USGS earthquake and volcanic hazard issues, groundwater aquifer characterization, and the extent of permafrost.

Minerals Information

(2013 Actual, $14.0 million; 2014 Enacted, $15.4 million; 2015 Request, $15.4 million)

In 2013, the use of the USGS minerals information continued to increase. Every year, more than 700 reports are prepared by the USGS and added to the minerals information Web pages (*http://minerals.usgs.gov/minerals*). Downloads from the MRP Web site continued its upward trend in 2013, except for the time period when the Web site was not accessible during the government shutdown, attesting to the increasing demand for USGS minerals information, with a signature product being the annual *Mineral Commodities Summary*. In providing information on materials flow, reports were published in 2013 on mineral supply chain mapping using tantalum as an example, REE in manufactured products, global mineral industries and outlook to 2017, and the effect of recent strikes in South Africa's platinum mines on world platinum-group metal supplies. In progress is an update and release of a study of "Metal Prices in the United States through 2012" (previously through 1998) as well as a new study on the role of China in world mineral production and consumption.



In 2014 and on a continuing basis, MRP mineral economists and minerals information specialists provide minerals information on a regular basis to other Federal agencies, including the U.S. Census Bureau, the Department of Defense, Federal Reserve Board, and the Office of the U.S. Trade Representative. MRP specialists also chair and contribute to several Office of Science and Technology Policy (OSTP) - convened working groups that will inform Federal critical minerals policy related to supply chain sustainability, research and development, and mineral information collection, analysis, and dissemination.

Modernization of the Minerals Information Capabilities

As part of an ongoing effort to modernize the data collection abilities of the National Minerals Information Center, a major update to the automated data information system (AMIS) began in 2014. This involves conversion from M204 to SQL programming languages and integration of AMIS and the Minerals Information Forms System into the new Minerals Information Data System. Expected completion is in 2016, with expected program savings of $500,000 per year and increased efficiency of data collection. In addition, increased funding for materials flow and supply chain analysis will expand program capabilities to deliver needed information and analysis for this critical national area of interest. For more information, please go to *http://minerals.usgs.gov/*.

Activity: Energy, Minerals, and Environmental Health
Subactivity: Energy Resources

2013 Actual: $26.0 million (141 FTE)
2014 Enacted: $26.0 million (141 FTE)
2015 Request: $26.9 million (141 FTE)

Overview

The USGS is the sole provider of unbiased, publicly available estimates of geological energy resources for the United States, exclusive of the U.S. Outer Continental Shelf, and provides publicly available estimates related to global oil and gas resources. The USGS also performs research to advance the science of energy resources and assessments and understand key impacts and issues. Major consumers of the Energy Resources Program (ERP) products are the Department of the Interior's (Interior) land and resource management bureaus, other land management and environmental agencies, national security agencies, policymakers and Congressional offices, State geological surveys and other State agencies, Tribes, energy industry, environmental groups, international energy community, nongovernmental organizations, academia, and the public. The ERP provides science and information used to make decisions supporting energy security, energy policy, and environmentally sound production and utilization. The ERP-funded activities are reviewed for alignment, accountability and productivity with respect to priorities identified in the USGS Energy and Minerals Science Strategy, Secretarial priorities, Administration initiatives, Congressional mandates, and customer needs. ERP activities contribute to the DOI strategic plan goal to provide science for sustainable resource use, resource protection, and adaptive management.

In recognition of the USGS reputation for impartial unique, robust, geologically based research and assessments, the USGS was directed by the Energy Policy Act of 2005 (Act), and the Energy Independence and Security Act of 2007, to study and assess energy resources including geothermal, alternative energy sources such as gas hydrates and oil shale, unconventional gas resources, conventional oil and gas resources, and to conduct a national geologic carbon sequestration research and assessment (found under the Climate and Land Use (CLU) Change mission area section).

Program Performance

Energy Policy Act of 2005 Implementations – The USGS science is a critical component to implementation of the Energy Policy Act of 2005. The Act addresses a range of energy sources, including geothermal resources, alternative energy sources such as gas hydrates and oil shale, and research on unconventional gas resources. The act also reauthorized the Energy Policy and Conservation Act Amendments of 2000 (EPCA), in which the USGS was directed to assess oil and gas resources underlying Federal lands in the United States.

Energy Independence and Security Act of 2007 Implementation – The Energy Independence and Security Act (EISA) of 2007 called for the USGS to develop a methodology for a national geologic carbon sequestration assessment and to conduct a national assessment using the new methodology. Activities related to geologic carbon sequestration are implemented in the ERP; however, funding resides in the CLU mission area and a description of those activities can be found in the CLU section. EISA also called for the USGS to assist the BLM in evaluating geologic carbon sequestration on public lands. In addition, EISA directed the USGS to complete a comprehensive nationwide geothermal resource assessment that examines the full range of geothermal resources of the United States.

In addition to these congressional mandates, research funded by the Energy Resources Program aligns with a number of OMB-OSTP priorities, including (1) Clean Energy - gas hydrates, geologic carbon sequestration, geothermal energy, unconventional gas, uranium, and wind energy impact assessment; (2) Global Climate Change - geologic carbon sequestration; (3) R&D for Informed Policymaking and Management - Alaska petroleum studies that impact Extended Continental Shelf and U.S. Conventional on Law of the Sea efforts, wind energy impact assessment methodology, gas hydrate life cycle studies, produced waters studies, water budget studies, uranium resource and environmental assessment, world petroleum studies; (4) Information Technology - enhanced discovery and delivery of products via the Web; and (5) Innovation in Biology and Neuroscience - wind energy impact assessment methodology, methanogenesis (formation of methane) studies.

The Energy Resources Program invests in science that supports the Administration's Grand Challenges, including "Catalyzing Breakthroughs for National Priorities – unleashing a clean energy revolution." The ERP supports research in unconventional (shale) gas resources, geologic carbon sequestration, enhanced geothermal systems, wind energy impacts, and uranium resource and impacts assessment. Further, all research funded by the ERP supports the Department's Powering Our Future and the Administration's "all-of-the-above" approach to responsible energy development.

The ERP portfolio consists of six components: National and Global Oil and Gas Resources, Geothermal Resources, Powering Our Future – Wind, National Coal Resources, Energy Information and the Environment, and the Science and Decisions Center. Brief summaries of these components are given below.

National and Global Oil and Gas Resources

(Estimates for 2013 Actual, $14.1 million; 2014 Enacted, $14.1 million; 2015 Request, $13.8 million)

Sources of fossil fuel supplies include a mix of domestic oil and gas fields, oil and gas imports, and unconventional resources such as shale gas, tight gas sands, coalbed methane and, possibly in the longer term, unconventional resources such as natural gas hydrates. Location information and type of undiscovered global petroleum resource are critical to energy policy and energy security, and have important geopolitical implications.

Oil and gas priorities have evolved in the United States over the past 12 or so years. In 2000, focus, was on coal-bed gas resources and the volumes of oil and gas resources potentially underlying Federal lands. By 2005, the massive application of horizontal drilling and hydrofracturing in tens of thousands of wells

shifted attention to shale gas. The resulting glut of shale gas caused the bottom to fall out of U.S. gas prices, and recently several permits have been submitted for once-unthinkable exports of U.S. natural gas. Simultaneously, the rise in domestic oil production had led many entities to postulate a day when the United States achieves energy independence with respect to oil production. The fundamental question is, does the United States have the potential resource base to support long-term gas exports or independence from oil imports? The USGS assessments of oil and gas resources provide both insight and a baseline to begin to answer these questions.

A related issue concerns the impact on air, water, biota, and land use brought about by the tens of thousands of wells drilled, coupled with the USGS estimates of upwards of one to two million wells that could be required to access undeveloped unconventional resources in the United States. Estimating the potential impacts on this magnitude of potential wells requires an interdisciplinary approach that involves water, biology, air-quality, and land-use expertise. To address these issues, the ERP is initiating in 2014 and 2015, an effort to explore the practicality and potential application of the "life-cycle approach" to oil and gas assessments, as mentioned in the USGS Science Strategy and in the Energy and Minerals Science Strategy (http://pubs.usgs.gov/circ/1383d/).

In 2014 and 2015, particular emphasis, for both domestic and global oil and gas resources, will be placed on understanding undiscovered, continuous (unconventional), technically recoverable accumulations, such as tight gas, tight oil, shale gas, and coalbed gas. Because there is currently no global unconventional resource assessment, the ERP has made this a priority. Assessments will be published as they are finalized to be timely in the release of this information. In 2013, the ERP released assessments of conventional and unconventional resources of parts of China, North Africa, New Zealand, the Arabian Peninsula, and Canada. Work will continue in 2014 and 2015, encompassing most of the world.

The ERP is estimating the volume of undiscovered oil and gas resources in the United States, including those under Federal lands, in support of the scientific inventory of oil and gas resources mandated by the EPCA. The ERP is also participating in the interagency coordination activities in support of the 2012 Memorandum of Understanding (MOU) among Interior (USGS), DOE, and EPA, aimed at providing research and technologies that support sound policy decisions by Federal, State, and local agencies responsible for ensuring the prudent development of oil and gas resources while protecting human health and the environment: *http://unconventional.energy.gov/*. The ERP developed a set of hydraulic fracturing FAQs (frequently asked questions) in order to provide fundamental answers to the many questions asked about this growing oil and gas production technique.

The USGS will continue to update its oil and gas resource assessments for the United States and the world using a consistent, peer-reviewed methodology as authorized in the Energy Policy Act of 2005. The ERP released several domestic assessments including the first-ever unconventional oil and gas assessment of the Alaska North Slope and updated its assessment of the Bakken and Three Forks Formations. In 2014 and 2015, the USGS will complete assessments of the Barnett Shale and continue work on the Green River Shale. In 2013, the ERP also produced a map of all assessed shale gas resources in the United States.

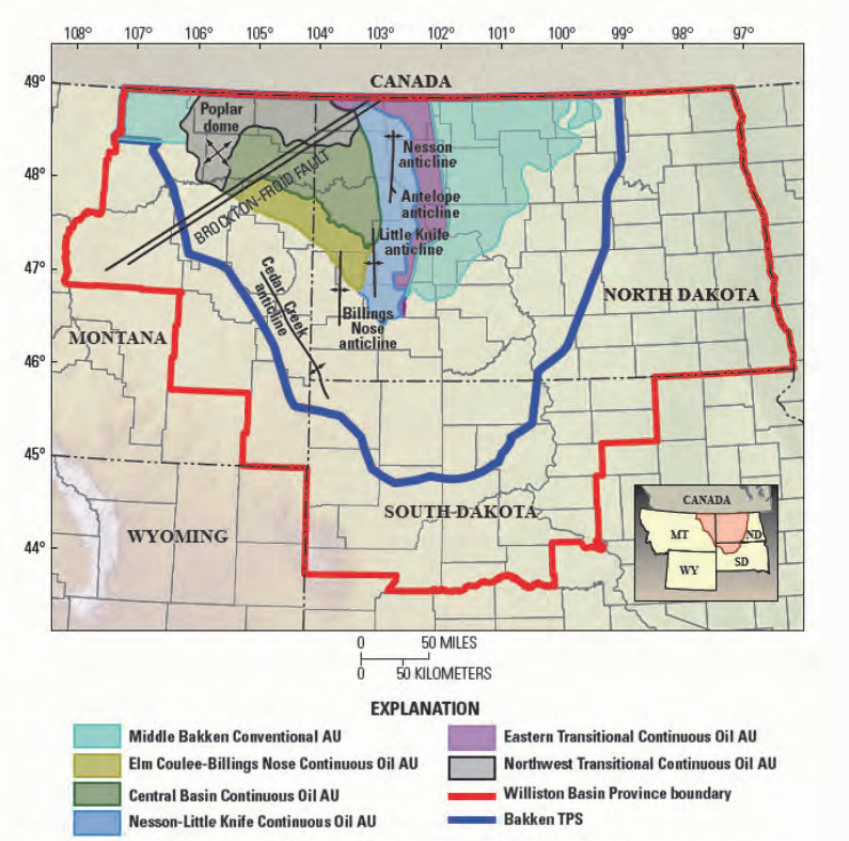


Figure 1. *Map showing the Williston Basin Province, Bakken Total Petroleum System (TPS), and the Bakken Formation Assessment Units (AUs). Major structural features are also shown. Inset map shows location of the Bakken TPS (pink).*

Bakken-Three Forks assessment area.

Figure 2. Map graphic that links to the hardcopy map.

Composited map of shale assessment areas.

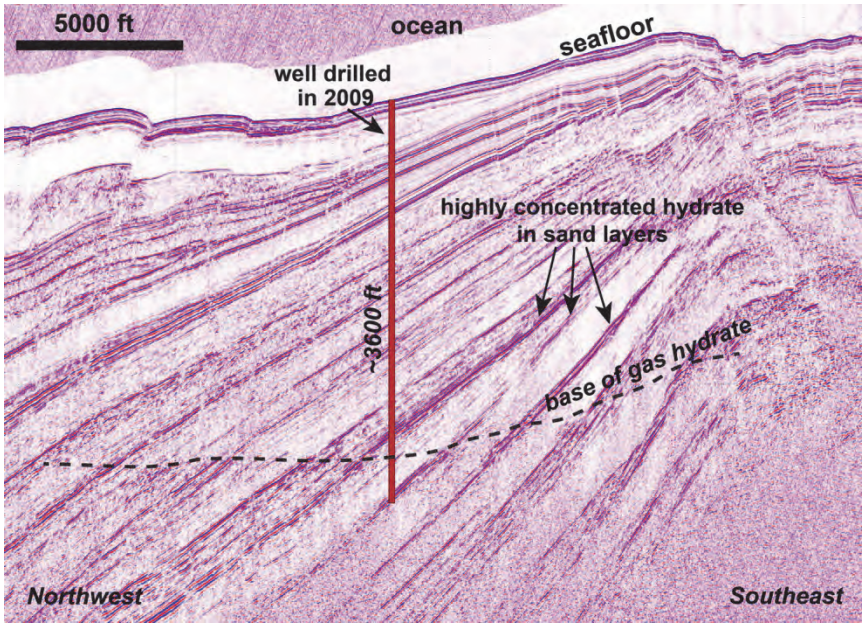
Reserve growth in existing oil and gas fields is a phenomenon important to understanding overall petroleum supplies. Thus, the ERP has a research activity focused on this aspect of the resource spectrum. Reserve growth is the increase in estimated volumes of oil and natural gas that can be recovered from discovered (known) fields and reservoirs through time because of delineation of new reservoirs, field extensions, or improved recovery techniques. In 2014 and 2015, work will continue on publishing additional scientific and information products stemming from the reserve growth assessments, such as that for the L.A. Basin, published in 2013.

The ERP also published a number of studies related to stranded gas resources, to inform policymakers about this important, but currently unutilized resource. Stranded gas resources are gas resources in discrete accumulations that are not currently commercially producible, or producible at full potential, for either physical or economic reasons. Studies of stranded gas included those from Alaska, Asia, Russia, Australia, and the global supply in general.

The North Slope of Alaska is thought to have the greatest remaining petroleum resource potential of any U.S. onshore area. The USGS conducts in-depth studies of the geology and the oil and gas resources in this world-class petroleum province. Work in 2014 and 2015 focuses on (1) improving the stratigraphic resolution of Jurassic–Tertiary strata of the Chukchi Shelf, which will help improve the understanding of petroleum systems of all of Arctic Alaska and may have implications for the U.N. Convention on Law of the Sea, and (2) including research to improve our understanding of source and reservoir rocks in continuous petroleum systems, such as the Triassic Shublik Formation.

The gulf coast region is one of the major hydrocarbon-producing areas of the world. This ERP-funded effort provides geologic, geophysical, and geochemical framework studies necessary to enable USGS scientists to better understand and assess potential for undiscovered resources of oil, gas, and coal-bearing rocks of Texas, Louisiana, Mississippi, and Alabama; and extend potential onshore plays to the State offshore for use by the Bureau of Ocean Energy Management (BOEM) for resource assessments. During 2014 and 2015, project staff will continue framework studies, including those of the Austin Chalk, and to help in the geological identification of "sweet spots" within continuous assessment units, such as the Haynesville and Bossier Formations.

Gas Hydrates – The USGS works extensively on U.S. gas hydrates, most notably on the Alaska North Slope and the Gulf of Mexico, and applies lessons learned from elsewhere to these domestic resources. In 2013, the USGS participated in a major research expedition in the northern Gulf of Mexico and obtained the best high-resolution seismic data and imagery ever obtained of sediments with high gas hydrate saturations. The recently completed expedition, planned jointly with the DOE, and the BOEM, was executed by the USGS. USGS scientists collected details about the nature of the gas hydrate reservoirs and about geologic features of the sediment between the reservoirs and the seafloor. The new data also provide information about how much gas hydrate exists in a much broader area than can be determined from using standard industry seismic data, which is typically designed to image much deeper geologic units.



Collected during a seismic study, the high-resolution image shown above depicts study locations with high concentrations of gas hydrate in the northern Gulf of Mexico in April and May 2013 (*http://www.usgs.gov/newsroom/article.asp?ID=3588#.Uuv5T_ldV8E*). The data were collected at the Walker Ridge location, where 2009 drilling at the site of the well (shown in red revealed) the distribution of gas hydrates and methane gas in the sediments. Sand layers with high concentrations of gas hydrate are marked, but hydrate also occurs elsewhere in this sedimentary section.

The USGS ERP is also working with the BLM to conduct a geologic-based analysis of the occurrence of gas hydrates within northern Alaska. This analysis is part of a larger Gas Hydrate Development Lifecycle Assessment Project (a cradle-to-grave "assessment" of several representative gas hydrate "fields" in northern Alaska), designed to determine the role gas hydrates may play as a future domestic energy resource and to characterize the potential environmental and economic impact of gas hydrate exploration and development. There is substantial international interest in gas hydrates, and the USGS works closely with the governments of several countries, including the Indian Directorate General of Hydrocarbons (DGH) and the Government of the Republic of Korea, to study, characterize, and explore for hydrates off the coasts of India and the Republic of Korea. These collaborative efforts will continue in 2014 and 2015, to help move forward the collective knowledge of this underexplored resource, and are directly applicable to studies in the United States.

Oil Shale Resources – The Energy Policy Act of 2005 recognized the need for updated information on domestic oil shale resources and in accordance with the legislation, the USGS has completed assessments of Green River Formation oil shales (this is a distinctly different resource type compared to shale oil produced from wells following hydraulic fracturing). These assessments are of the in-place resources because there is currently no economically viable method to develop oil shale resources. Subsequent work is focusing on assessments of what is technically recoverable using various production technology scenarios. In 2013, the ERP published an evaluation of in-place resources examined by grade in the Green River Formation, one of the richest oil shale deposits in the world. In 2015, the ERP will decrease funding to oil shale research, curtailing research to understand this enormous domestic potential oil resource.

Geothermal Resources

(Estimates for 2013 Actual, $1.5 million; 2014 Enacted, $ 1.5 million; 2015 Request, $2.8 million)

In support of the Energy Policy Act of 2005, the USGS published a national assessment of geothermal resources capable of producing electric power. The majority of geothermal resources in the United States are on public lands and data are important for responsible management of public resources. New research and assessment work is critical to understand geothermal systems and to determine the extent to which geothermal resources can play a part in the domestic energy mix.

There are unconventional geothermal resources with potential for electrical generation; the most promising are Enhanced Geothermal Systems (EGS). EGSs are geothermal resources that require some form of additional engineering to develop permeability necessary for circulation of hot water or steam and recovery of heat for electrical power generation. New research studies, in coordination with the DOE and BLM, will focus on understanding geologic and hydrologic aspects of EGS development and providing a framework for future assessments of EGS resource potential. In 2014 and 2015, research will include studies of geothermal potential in sedimentary basins, and on developing an improved understanding of formation and evolution of permeable faults and fractures that form most geothermal reservoirs, and how they may affect resource use and relate to induced seismicity. Using this information in future assessments, will better quantify the potential contribution from this domestic, renewable energy source.

In 2015, an increased emphasis will be placed on geothermal resources on Federal lands, which have a substantial unconventional resource potential. With increased funding, the ERP will use core capabilities in geothermal research to evaluate the geology and subsurface characteristics to identify likely areas of potential geothermal resource exploration and development. The BLM and other bureaus use this information for land use planning and potentially a targeted Environmental Impact Statement for high-grade areas. Proposed funding increases would allow for a focused effort to survey and subsequently track the impacts of geothermal development over time that, to date, have been poorly characterized. The increase would also allow for additional support for researching induced seismicity related to geothermal development on Federal lands, and help to determine the risks and potential mitigation plans should development be proposed.

Powering Our Future – Wind

(Estimates for 2013 Actual, $1.0 million; 2014 Enacted, $ 1.0 million; 2015 Request, $0.70 million)

In response to the Secretary of the Interior's Powering Our Future Initiative, the USGS is developing a quantitative methodology applied nationwide to assess the impacts associated with wind energy development on wildlife. In 2013, the ERP sponsored workshops that brought together experts, from BLM, BIA, BOEM, FWS, NOAA, academia, industry, and nongovernmental organizations to work toward common approaches in the development of a wind energy impact-assessment methodology. Results of these workshops are guiding research and the methodology development. These efforts facilitate collaboration and ensure long-term viability of information products that contribute to the Nation’s understanding of the management and effects of wind energy. Work in 2014, will include continuing to reach out to stakeholders and those with technical expertise in wildlife impacts associated with wind energy and to start developing a draft assessment methodology. Evaluation of the various methods used to evaluate wind energy impacts are being conducted, as well as an evaluation of the availability and robustness of wildlife datasets, especially for their use in an assessment. The ERP will release the first major product—a national turbine dataset—in 2014. This is the first publicly available dataset of industrial-scale wind turbine locations and descriptions in the United States. In addition to the dataset, the ERP developed a Web-based, GIS data viewer application to explore and access all the database content. The database has more than 47,000 wind turbine records collected, digitized, locationally verified, and internally quality controlled. The assessment methodology will be finalized in 2015, and submitted to external, expert, peer review.

National Coal Resources

(Estimates for 2013 Actual, $1.1 million; 2014 Enacted, $ 1.1 million; 2015 Request, $1.1 million)

The USGS recently revised its assessment methodology to determine the subset of U.S. coal resources that are available for mining and are technically and economically recoverable (the coal reserve base). Federal and State land managers use these results to support land use decisions; environmental regulators use the information to evaluate compliance with regulations stemming from the 1990 Amendments to the Clean Air Act; and economists use the results to forecast economic trends at regional and national scales. The ERP works closely with counterparts at other organizations (for example, BLM and the Energy Information Administration) to ensure revised products address a variety of needs. In 2013, the ERP published an updated assessment, including the first-ever basin-wide assessment of economically

recoverable coal, of the Powder River Basin, the largest source of domestic coal supply. The analysis shows how much in-place resource there is, as well as how much technically recoverable and economically recoverable resource. Analysis of the coal resources in the Colorado Plateau, begun in 2013, will continue into 2015.

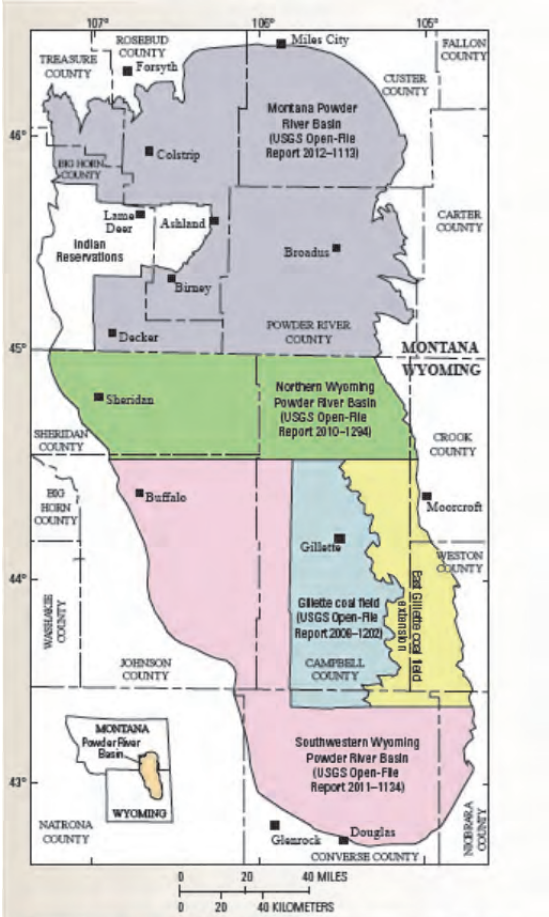


Figure 1. Location of individual coal assessment areas in the Powder River Basin, Wyoming and Montana. From Haacke and others (2013).

Outline of the Powder River Basin coal assessment area

Energy Information and the Environment

(Estimates for 2013 Actual, $7.7 million; 2014 Enacted, $7.7 million; 2015 Request, $7.5 million)

Coal Quality – Currently, coal is used as fuel for a substantial portion of domestic and international electric power generation. Although coal is a reliable, plentiful, and inexpensive energy source, coal usage carries significant environmental challenges and impacts. An understanding of coal quality is key for developing ways to make coal utilization cleaner and safer through engineering advances and integration of geologic and geochemical studies on coal usage. USGS coal-quality research focuses on a range of issues that affect our Nation and the world, including land disturbances, coal emissions, coal combustion by-products, and waste handling. The USGS provides information on how sulfur, trace elements, and other substances occur naturally in coal, how these substances partition during coal

combustion, and how to quantify the fate of coal-combustion products in the environment. In 2014 and 2015, the ERP is supporting efforts to nationally characterize the coking quality of U.S. coals, and to develop holistic approaches to characterize mercury in U.S. coals. The research and information products from these studies will support future coal assessments and are available to land managers and decisionmakers at Interior and other Federal agencies, State agencies, industry, and the general public.

Energy Information – Delivering information, improving the capacity to do so, and ensuring information quality and accountability are high priorities for the ERP. The ERP has worked with the DOE and OSTP, to make a number of ERP products available. The ERP is working closely with the USGS Web Reengineering team to build a new USGS Web site that complies with Administration and Interior requirements to improve consistency, delivery of information on mobile devices, and improve access to disabled users. Initial release of the top-level parts of the Web site will be completed in 2014. The ERP is currently developing a program-wide data management plan for all its seismic data holdings, and ERP-funded laboratory and data activities are working in concert to develop a program-wide data management plan for all laboratory data to maintain data accessibility. An ERP-wide laboratory audit effort is underway that will eventually review activities of all ERP-funded labs to ensure data quality and accountability. All of these efforts will continue in 2014 and 2015, so that ERP science and information is served through a number of means and is more readily available to a variety of users.

National Coal Resources Data System (NCRDS) – The NCRDS contains information on location, quantity, attributes, stratigraphy, and chemical components of U.S. coal deposits. A long-term partnership of the USGS and State Geological Surveys enables this sustained effort to collect and analyze basic data, build and verify the digital databases, and serve these USGS-maintained datasets. In 2014 and 2015, the State Co-op activity will continue to collect data on coal and shale gas from those States for which the USGS has current agreements.

Produced Waters – Oil and gas production often uses and yields significant quantities of water, thus information related to water and fluids associated with energy resource development is critical. ERP research will provide information on the volume, quality, impacts, and possible uses of water produced during oil, gas, and coalbed natural gas production and development. In 2014 and 2015, the ERP will continue collaborative research on naturally occurring radioactive materials in produced waters and controls on them. This effort will develop a methodology to estimate water budgets associated with oil and gas production and will complement oil and gas resource assessments. The ERP's base activities to understand environmental impacts associated with oil and gas development will support the aforementioned interagency hydrofracturing.

Uranium – Nuclear energy now accounts for about 20 percent of U.S. generated electricity. Updated knowledge of the geologic setting, occurrence, and estimates of the magnitude of the undiscovered U.S. uranium resource endowment is critical to inform planning efforts about potential domestic uranium supplies. In 2013, the ERP published a critical analysis of global uranium resources. The ERP is supporting, in conjunction with the Mineral Resources Program, development of a methodology and framework for an updated assessment of undiscovered uranium resource potential of the United States. This effort is part of an integrated study, with additional support from the Environmental Health mission area, to include quantitative and qualitative estimates of undiscovered uranium resources with the

environmental health vulnerability related to their exploitation. The assessments from this integrated study are designed to be both data and knowledge-driven in their approach, using geospatial and statistical techniques, and will provide a scientific knowledge base to guide land use decision making and inform national energy policy. Research in 2014 and 2015, will expand beyond resource assessment to develop a life-cycle approach that complements the national resource assessment with evaluating the effects of mining in various geological environments.

Science and Decisions Center

(Estimates for 2013 Actual, $0.9 million; 2014 Enacted, $0.9 million; 2015 Request, $0.9 million)

The mission of the USGS Science and Decisions Center (SDC) is to advance the use of science in resource management decisions through research and applications on ecosystem services, decision science including adaptive management, and resilience and sustainability. In fiscal year 2013, the SDC worked with partners to begin developing a framework for integrating energy and mineral resource assessments with water and biological resources data to consider biophysical and economic interrelationships and the consequences of alternative decisions. An initial proof-of-concept effort was developed in the Powder River Basin in Wyoming. These efforts will advance our ability to make landscape-level decisions that consider impacts and tradeoffs from multiple natural resources and alternative decisions. In addition, the USGS continued collaboration with Federal and non-Federal organizations to improve linkages between ecosystem services science and application through leadership in developing the scientific program for ACES (A Community on Ecosystem Services), an international conference on linking science, practice, and decisionmaking. USGS scientists worked with the USDA Natural Resources Conservation Service (NRCS) to evaluate the ecosystem services and benefits of the Sage Grouse Initiative. USGS scientists collaborated with partners in conducting an economic analysis of ecosystem services impacts on California rangelands from climate change. The SDC worked with partners to explore urban ecosystem services and how they connect with green infrastructure through a symposium held in Philadelphia with the University of Pennsylvania. USGS scientists also continued research on exploring applications of adaptive management and worked with partners to develop a framework for integrating adaptive management decision processes with an ecosystem services analytical framework.

In fiscal year 2014 and 2015, the SDC is working with partners to extend a framework for multidisciplinary resource analyses to specific areas. The USGS is working with partners to explore methods for applying an ecosystem services framework to climate change adaptation-decisions. The SDC is working with the USDA Office of Environmental Markets to establish a foundation for biodiversity and habitat market structures. The USGS is continuing collaboration with the U.S. Forest Service to complete a publication for middle school students on adaptive management.

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Activity: Energy, Minerals, and Environmental Health
Subactivity: Contaminant Biology

2013 Actual: $8.6 million (61 FTE)
2014 Enacted: $9.6 million (64 FTE)
2015 Request: $12.0 million (72 FTE)

Overview

Contaminant Biology Program (CBP) science is a key resource for managing and protecting the health of the Nation's environment, including the health of fish and wildlife populations. In its 2007 science strategy, the USGS identified *The Role of the Environment and Wildlife in Human Health* as a strategic focus through which the USGS "can make substantial contributions to the well-being of the Nation and the world."

The CBP, working in close collaboration with the Toxic Substances Hydrology Program (TSHP), will implement the USGS Environmental Health Strategic Science Plan (EH SSP). The Program will fund research and activities that support the priorities identified in the EH SSP. To maximize resources, the CBP will continue working in close partnership with other USGS mission areas and a multitude of State and Federal agencies and non-government organizations (NGOs). These collaborative activities provide a valuable foundation for USGS leadership in the field of environmental health science. In 2015, the CBP will emphasize providing the natural science needed by resource managers, health professionals, policymakers and the public in three main areas—

- Anticipating, detecting, and preventing adverse health impacts from newly emerging environmental diseases.
- Reducing the impact of environmental diseases on the environment, fish, wildlife, and people including improving management approaches for mitigating the health effects of combined exposure to contaminants and pathogens.
- Coordinating and supporting the portfolio of USGS activities to help the Nation prepare for and respond to health related threats resulting from natural and manmade disasters.

Through these activities, the CBP provides leadership and science to inform regulatory decisions; enhance remediation and restoration technologies, and improve best management practices to prevent or mitigate the adverse health impacts of environmental diseases and disasters.

Program Performance

Providing the Natural Science Needed to Anticipate, Detect, and Prevent the Health Impacts of Emerging Environmental Diseases.

Environmentally driven diseases are caused by disease agents such as contaminants and toxins (e.g., endocrine disruptors, pesticides, pharmaceuticals, mercury) and infectious pathogens (e.g., prions, viruses, bacteria, parasites) that constitute a critical threat to environmental health including fish, wildlife, and people. Threats from newly emerging disease agents will continue to increase, resulting in increased health risks and economic vulnerability. Historically, scientists relied on established monitoring programs to assess changes in the environmental conditions that affect disease. That approach allows decisionmakers to react to past changes, but leaves a significant scientific gap in the Nation's ability to identify and anticipate emerging health threats. As the number of environmental health threats continues to grow and become increasingly complex, sound science, informed decisionmaking and early action will be critical for timely and cost-effective prevention and mitigation. Utilizing the strategic actions described in the EH SSP, along with input from natural resource, agricultural and public health managers, the CBP will continue work to ensure that (1) the Nation's capabilities for anticipating and identifying emerging environmental health threats are enhanced; (2) resources are leveraged among partners; (3) data gaps are identified and filled; and (4) information is made available to decisionmakers in a useful and timely manner.

New and continued activities in 2015 will support assessing the health and ecological impacts of resource extraction such as hydraulic fracturing and uranium mining. These activities will be conducted in collaboration with Federal agency partners and will complement concurrent work being done by the USGS Toxic Substances Hydrology program. In 2013 and 2014, the program supported research to establish baseline concentrations of radiation and uranium exposure in sentinel species at selected new extraction sites (prior to extraction beginning). Pre-mining species inventories (currently at 200 species) and sampling of those species continued in 2014, with a primary focus on birds and bats. At the present time these samples are being archived.

In 2015, the CBP proposes to complete the uranium baseline assessment, analyzing the pre-mining background levels of uranium in dust water, and biota, and begin modeling the 'natural' transport and occurrence of uranium and radiation in native animals and plants. Once the baseline analysis is completed (early 2015) the focus of activities would shift to characterizing the mobilization of uranium during mining activities. Samples that parallel those collected before mining would be collected during uranium extraction at active mines, and results from these samples will contribute to a modeling tool to assess ecosystem health before, during, and eventually after uranium extraction. The goal of a completed model of uranium extraction, from pre-mining to post-remediation, would be to identify management options that would best maintain environmental health and allow a healthy balance between our national mineral and biological resources. The knowledge gained from these studies will be used for developing prevention and mitigation strategies to ensure that the health and sustainability of natural resources are balanced with economic development. This study will provide science needed by the Secretary of the Interior for making sound decisions regarding extraction activities on Federal lands.

The Natural Science Needed to Reduce the Impact of Environmental Diseases.

Environmental factors also influence the distribution, transmission, and severity of existing diseases. Estimates are that 24 percent of global disease and 23 percent of all human deaths are attributable to environmental factors; understanding these factors is critical. Environmental changes resulting from increasing demands for resources and changes from natural processes can increase the risk of exposure to disease agents. Exposure can occur directly from the environment (via water, soil, etc.) or from contact with other organisms (via the food chain, vector-borne, etc.). There is a significant gap in understanding how changes in environmental processes affect the health of animals and people. The CBP combines research, monitoring, and predictive models to identify and understand the sources, bioavailability, spread, and physiological impacts of emerging disease agents on fish and wildlife species.

In 2013, the USGS began leading a tri-national (United States, Canada, Mexico) effort to assess how geochemical, land-use, and climatological factors affect mercury deposition across Western North America. This effort integrates geospatial information on habitat, land-use, and climate models to identify species that are most at risk and to provide resource managers with a tool to control mercury impacts more effectively. In 2014, the CBP is studying mercury cycling, bioaccumulation, and risk across Western North America. This synthesis effort is integrating all existing, publicly available data from the United States, Canada, and Mexico to determine how mercury risk varies across Western landscapes and to evaluate land use practices and climatological factors that influence mercury risk to humans and wildlife. The CBP mercury studies are being leveraged with mercury research work being supported by the TSHP to link mercury methylation processes with toxicological responses in sensitive wildlife. In 2015, the CBP will conduct studies to expand and better quantify our understanding of the endocrine disrupting properties of mercury in aquatic wildlife.

Historically, researchers studied the effects of pathogens and contaminants in isolation; yet animals and people are often exposed to both simultaneously. It is critical to identify and assess the potential combined effects of toxicological and infectious agents in the environment. Endocrine disrupting chemicals (EDCs) can cause reductions in reproduction, deformities, behavioral abnormalities, as well as immune dysfunction. In 2014, the CBP will continue to support ongoing high priority, EDC related work. This work includes complementary laboratory research and field investigations focused on (1) understanding how EDCs impact the immune function and disease resistance; (2) assessing sources and effects of agricultural-related EDCs on the health of birds, fish and amphibians; (3) identifying both trans-generational genetic effects and behavioral effects in fish and wildlife species; and (4) investigating the movement of EDCs through ecosystems to characterize risk across species and identify vulnerable species. The results of these studies will be used to better quantify risk and evaluate potential tools that resource managers might use to reduce EDC exposure and impacts in fish and wildlife species.

In 2014, CBP also received an additional $1,000,000 in new appropriated funds for research focused on identifying and evaluating the long-term impacts of EDCs on fish and wildlife health in the Chesapeake Bay watershed. This supplemental funding will enhance existing activities in the Chesapeake. The impact of EDCs on fish, wildlife and the environment is a national as well as global issue. In 2014, there is a team of USGS scientists assessing EDC related research needs from the national perspective. The national assessment enables the USGS to address the issue more strategically (on local as well as regional

and national scales) and to identify opportunities where the USGS can coordinate and leverage EDC-related research and expertise. The USGS used National research priorities, in conjunction with the existing Chesapeake Bay Science Plan, to identify the highest priority science needs in the Chesapeake Bay Watershed. The science questions being addressed for the Chesapeake will provide valuable insights for important watersheds in the United States.

In 2015, the USGS will continue to fund EDC related activities across the country with a strong focus on the Chesapeake Bay. Activities are also being conducted in the gulf coast, the Columbia River and the Missouri River watersheds. The CBP will continue to investigate EDC-related effects on fish and wildlife through laboratory and field investigations in four critical areas: (1) investigations into adult on-set immune suppression following early life stage exposure of EDCs; (2) development and application of fish models to better understand EDC-induced immune suppression and disease resistance; (3) characterization of fish and wildlife models for trans-generational effects of EDCs; and (4) studies to identify reproductive effects of chronic low-dose exposure in several species including endangered sturgeon.

Disaster resilience: helping the Nation prepare for and respond to health related threats resulting from natural and man-made disasters.

The USGS has internationally recognized expertise related to the environmental health impacts of disaster, impacts that can affect public health, animal health, and the economic well-being of the Nation. The USGS provides science to Federal agencies tasked with responding to immediate and long term environmental health impacts of natural and anthropogenic disasters. A disaster event can be a catalyst for the release of hazardous materials containing contaminants or pathogens into the environment (e.g., leaking of radiation after earthquake damage to a nuclear reactor, release of contaminants or pathogens from a wastewater treatment plant due to flooding) or can result in environmental conditions that can promote infectious disease outbreaks.

The CBP serves as the USGS point-of-contact for coordinating the portfolio of the USGS chemical and biological threat preparedness and response activities. The USGS partners with and provides expertise to Interior, the Department of Homeland Security (DHS), the U.S. Department of Agriculture (USDA) , the Department of Health and Human Services (HHS), the U.S. Department of State (DoS), the Department of Defense (DoD), the Smithsonian Institute, and the U.S. Agency for International Development (USAID) to develop disease models, maps, and diagnostic tools for detecting health threats related to disasters and provides advice on response strategies for fish, wildlife and zoonotic diseases. For example, *"The White House National Science and Technology Council Subcommittee on Foreign Animal Disease Threats (FADT) 2012-2016 Research and Development Plan"* identifies as a high priority development of an interagency framework for preparing for and responding to high consequence diseases (HCDs) in wildlife such as migratory birds and whitetail deer. The HCDs have the potential to produce significant public health, agricultural, ecological and economic impacts.

In 2014, the CBP served as the Federal wildlife lead, co-produced with the DHS, a report that identifies national research and development gaps and needs related to high consequence diseases. The report identifies existing available data and capabilities; gaps in knowledge and tools; and Federal

communication needs that are critical for protecting human and animal health as well as the economic well-being of the Nation. The report will be used by State and Federal agencies and the White House to inform discussions on development of the national framework. In 2015, the CBP will lead an interagency effort to develop a *National Framework on Preparing For and Responding to High Consequence Diseases in Fish, Wildlife and the Environment*.

Due to concerns regarding terrorism there is an increasing awareness of the value of using fish and wildlife disease events as a system for detecting human health threats due to naturally occurring or intentionally introduced chemical agents and zoonotic diseases (diseases transmissible between animals and people). Many of the "Select Agents and Toxins" listed in the National Select Agent Registry (a list of select pathogens and toxins deemed a potential threat to human or animal health) can affect or be transmitted by fish or wildlife. At the request of State and Federal partners, CBP scientists conducted field investigations of fish and wildlife mortality events and developed new methods for detecting and understanding the effects of environmental disease agents. In 2014, the USGS continued to lead and expand this effort by working closely with State and Federal agencies, non-governmental organizations and academia on high priority tasks such as the development of predictive modeling and forecasting tools for assessing the risk of emerging health threats. In 2015, USGS will continue to serve as Federal lead agency in this area.

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Activity: Energy, Minerals, and Environmental Health
Subactivity: Toxic Substances Hydrology

2013 Actual: $10.0 million (60 FTE)
2014 Enacted: $10.0 million (60 FTE)
2015 Request: $13.8 million (71 FTE)

Overview

The Toxics Substances Hydrology Program (TSHP) supports environmental contamination research, which provides reliable scientific information and tools that explain the occurrence, behavior, and effects of toxic substances in the Nation's natural environments.

Contamination problems addressed by the TSHP are widespread and pose significant risk to human health and the environment. The TSHP focuses on contamination issues of emerging concern based on input from Federal, State, tribal and local entities, nongovernmental organizations, and others. The program supports laboratory and field based research conducted by large multidisciplinary teams of USGS and other scientists. Field studies are conducted at representative sites, watersheds, or regions. Results provide a foundation for informed decisionmaking by resource managers, regulators, industry, and the public, helping to improve environmental monitoring, characterize and manage contamination, develop best management practices, form regulatory policies and standards, register the use of new chemicals, and guide chemical manufacture and use.

The TSHP reacts rapidly to emerging issues; develops new methods and collects field data in the most susceptible environmental settings across the Nation; maintains field networks and research sites that provide a focal point for interdisciplinary research; addresses contamination problems at a wide range of geographic scales and environmental settings, and provides fundamental knowledge of the inherent clean-up capacity of our natural environments. Scientific findings are distributed broadly via briefings, workshops, technical meetings, and scientific reports. In the five-year period from 2009–2013, the TSHP produced about 772 scientific publications. The program directly supports the USGS Science Strategy and Interior goals by providing a landscape-level understanding of point and non-point sources of contamination as a foundation for decisionmaking. In 2014 and 2015, the TSHP will work closely with the CBP to develop a national research strategy for environmental endocrine disruption as well as an implementation strategy for the new USGS Environmental Health Science Strategy. More information about the TSHP is available on the Web at *http://toxics.usgs.gov/*.

Program Performance

The TSHP has two primary components: “Contaminated Site Characterization and remediation (point-source contamination)”; and Investigations of the Environmental Impacts of Watershed and Regional-Scale contamination (non-point source contamination)”.

Contaminated Site Characterization and Remediation

(2013 Actual, $4.0 million; 2014 Enacted, $4.0 million; 2015 Request, $6.2 million)

These investigations improve capabilities to describe, manage, and remediate subsurface contamination from local releases, such as chemical spills, leaking storage tanks, industrial discharges, and leakage from landfills and other waste facilities. The knowledge and new methods developed at intensely studied, representative sites are applied to similar sites across the Nation. In 2014, the TSHP continues to expand long-term investigations and understandings of subsurface movement of contaminants associated with: (1) an oil spill from a ruptured pipeline (Bemidji, MN), (2) radionuclides associated with a legacy mill tailings site (Rifle, Colorado) , (3) contaminants associated with storage of low-level radioactive waste sites (Amargosa Desert, Nevada), and (4) solvent contamination at a closed Navy testing facility in a sedimentary fractured rock aquifer (New Jersey) in order to develop more accurate tools and help inform management and remediation decisions.

Remediation of Oil Spill from Pipeline Still Challenging after 30 Years – An environmental release of crude oil occurred at Bemidji, MN, in 1979. The Bemidji spill is now over 30 years old and the TSHP supported research site there is the only long-term study site in the world available for understanding the controls on the timeframe for remediation and natural attenuation of petroleum hydrocarbons in the subsurface. In 1998, the pipeline company installed a dual-pump recovery system designed to remove crude oil remaining in the subsurface at the site. The remediation from 1999–2003 resulted in removal of about 115,000 liters of crude oil, representing between 36–41 percent of the volume of oil (280,000 to 316,000 L) estimated to be present in 1998. In 2013, the TSHP scientists documented evidence of iron-mediated methane oxidation in anoxic groundwaters. In 2014, the TSHP will provide evidence that management of wastes associated with the dual-pump recovery system used at the spill site is linked to expansion of the anoxic zone of groundwater upgradient and beneath the existing natural attenuation plume. Consequently, this research shows that oil-phase recovery was limited and considerable volumes of mobile and entrapped oil remain in the subsurface despite remediation efforts for 30 years. In 2014, TSHP researchers will publish a book chapter summarizing the state-of-science on petroleum fingerprinting using organic compounds. This technique distinguishes contamination due to current petroleum spills from baseline contaminant levels before spills. These research activities will continue in 2015 and contribute to our increased knowledge about the long-term dynamic nature of petroleum spills and the efficacy of clean-up activities.

Modeling the Transport of Uranium from a Former Uranium Mill Tailings Site, Colorado – In order to provide scientific underpinnings to remediation and management of uranium contamination TSHP scientists have used geophysical mapping techniques to delineate aquifer properties at the site. This unique approach to providing aquifer-scale information will be used to calibrate a numerical model currently under development to depict the potential movement and fate of contaminants in the impacted areas. Related research has recently shown that uranium can remain sequestered in the aquifer for long periods of time but subsequently can be released if land use or other activities alter the aquifer chemistry. More information is available on the Internet at: *http://toxics.usgs.gov/highlights/uranium_cleanup.html*

Environmental Impacts of Watershed- and Regional-scale Contamination
(2013 Actual, $6.0 million; 2014 Enacted, $6.0 million; 2015 Request, $7.5 million)

These investigations address nonpoint-source contamination problems typical of widespread land uses or human activities that may pose a threat to human and environmental health throughout a significant portion of the Nation. These investigations include developing laboratory and field methods to ensure accurate measurement of contaminants, characterizing contaminant sources, investigating mechanisms by which contamination affects aquatic ecosystems, and investigating the processes that transform contaminants into different and possibly more toxic forms. In 2014 and 2015, the TSHP is increasing research emphasis on contamination potentially associated with a range of energy extraction including conventional and unconventional oil and gas (hydraulic fracturing flowback and produced waters) and uranium; and in 2015, new method development activities will expand to include more disinfection byproducts as well as chemicals associated with unconventional oil and gas wastewaters.

The potential for biocides and other chemicals known, or suspected, to be associated with wastewaters from unconventional oil and gas (UOG) activities may inhibit indigenous soil and aquifer bacteria from normal microbial functions such as the natural attenuation of contaminants. Therefore in 2014, TSHP research will focus on the relations between these microbial communities and the chemistry of the wastewaters as the first step in determining what impacts may occur in the environment. In addition, research will assess soils and streambed sediments for contamination where UOG wastewaters are land applied and will begin working on new analytical methods to detect a range of chemicals known, or suspected to be, associated with UOG wastewaters. In 2014, TSHP is analyzing environmental samples previously collected from streams across the Nation to characterize complex chemical mixtures and identify new environmental contaminants using forensic approaches. The USEPA is participating in this study and is using field samples and chemical analyses provided by the USGS to test new screening assays for biological activity and these collaborative efforts will continue in 2015.

In 2014, the TSHP is continuing studies of new and commonly used pesticides such as neonicotinoids and their environmental impacts in settings across the Nation. The TSHP is continuing in 2014 and 2015, to expand method development activities and field studies to include the active pesticide ingredients as well as the so-called inert ingredients (e.g. surfactants) commonly used in pesticide formulations to enhance their efficacy in the field. Other scientists have associated some of these inert ingredients to adverse environmental health impacts such as pesticide enhancements when mixed with various other chemicals. In 2014, the TSHP is integrating assessments of the processes controlling mercury methylation in the world's major oceans.

The TSHP also is studying the environmental impacts of metals and uranium mining coordinated with the Energy Resources, Mineral Resources, and Contaminant Biology Programs. During 2014 and 2015, the TSHP in collaboration with the Contaminants Biology Program will determine the sources of contaminants causing endocrine disruption (e.g., intersex) in fish of the Chesapeake Bay watershed. The programs will build upon collaborative endocrine disruption research in the Chesapeake Bay, several National parks including Rocky Mountain National Park, Congaree National Park and the Northern Colorado Plateau Network, Boulder Creek, Colorado, and elsewhere to develop a national strategy to investigate endocrine disruption in aquatic and terrestrial organisms.

Measuring the Inert Ingredients in Common Herbicide Formulations – POEA (polyoxyethylene tallow amine) is added to the original formulation of the herbicide glyphosate to aid in its application and effectiveness at controlling weeds. A variety of these inert ingredients, commonly called adjuvants such as POEA (a surfactant) are commonly mixed with active pesticide ingredients to increase their efficacy in field settings although little is known about these ingredients and their occurrence, transport, and effects on exposed organisms. Some adjuvants such as POEA have demonstrated toxic effects on aquatic or other non-target organisms. USGS scientists have developed methods to measure POEA in the environment, which have shown that it is a complex and variable mixture of related compounds, and that POEA is a common additive in several newer agricultural and household glyphosate formulations. Since glyphosate is one of the most widely used pesticides in the United States, the findings could indicate that POEA may be widely available for transport into surface water and groundwater; a question that TSHP scientists will investigate in 2014, and 2015. More information is available on the Internet at: *http://toxics.usgs.gov/highlights/glyphosate_poea.html*

Pesticides Common in California Estuary – In 2013, pesticides found in estuary water increased during the summer months as pesticide application increased in the adjacent agricultural watershed; pesticides in bed sediment decreased with increasing distance from potential sources. Fish and sand crabs collected from the mouth of the estuary accumulated a number of pesticides in their tissues. Limited information is also available documenting the accumulation and effects of pesticides on aquatic organisms, especially in small, agriculturally dominated estuaries. This study provides a baseline that will allow resource managers to track changes in ecosystem performance with changes in pesticide contamination levels. The tools developed in this study will help resource managers and scientists assess the health of coastal environments in 2014 and 2015. More information is available on the Internet at: *http://toxics.usgs.gov/highlights/pest_estuary.html*

Toxic Disinfection Byproducts Are Formed When Waters Produced During Energy Extraction Activities Are Treated – Waters produced as a byproduct of oil and gas development were found in 2013 to yield high concentrations of disinfection byproducts (DBPs) when treated. USGS scientists sampled stream waters upstream and downstream of the outfall of Publicly Owned Wastewater Treatment Works (POTWs), POTWs that receive and treat waters produced by conventional and unconventional oil and gas development, and commercial treatment plants that treat similar produced waters. The samples were analyzed for a range of DBPs and selected precursors. The study was designed to determine if produced waters resulted in elevated levels of DBPs in the streams to which the treated wastewaters were discharged. The resulting data indicate that significantly higher concentrations of brominated DBPs are discharged in the effluents of commercial or publicly owned wastewater treatment plants that treat produced waters than POTWs that do not treat produced waters. The evidence strongly indicates that naturally high bromide levels in the produced waters react with other chemicals when the water is disinfected and these reactions form high levels of the brominated DBPs (brominated DBPs are among the most toxic DBP forms currently known). This is the first time it has been shown that these activities contribute DBPs to streams where the wastewaters are discharged. TSHP research on DBPs as environmental contaminants will continue in 2014, and 2015 as researchers analyze samples collected from a range of potential sources and pathways to the environment such as municipal wastewater treatment plants, public swimming pools, drinking water, and dairy operations. More information is available on the Internet at: *http://toxics.usgs.gov/highlights/dbp/*

Environmental Mercury Cycling and Global Change – Recent research by USGS scientists supported by the Toxic Substances Hydrology Program in collaboration with Harvard University has shown that rising global temperatures and changing human actions will significantly affect the environmental distribution of mercury worldwide. Higher temperatures and weaker air circulation patterns from climate change will likely have significant impacts on the atmospheric lifetime and patterns of mercury deposition. In most climate change scenarios, storms will be less frequent but more intense, resulting in larger amounts of mercury being released from the soil through erosion that may end up in rivers, lakes and oceans. Mercury that reaches these surface waters can be processed by naturally occurring bacteria into methylmercury an extremely toxic form of mercury that bioaccumulates in the food web. A majority of present mercury releases to the environment are atmosphere emissions from human activities and reemissions of previously deposited mercury from soils and the oceans. The largest sources of manmade mercury emissions are small-scale gold mining and burning coal for electrical generation. Changes in human behavior also will have substantial impacts on global mercury. Current human emissions of mercury total 2,000 metric tons per year. Under the best-case scenario of curbing human emissions, that number could fall to 800 metric tons per year by 2050. If no actions are taken, the number will likely increase to 3,400 metric tons per year by 2050. More information is available on the Internet at: *http://toxics.usgs.gov/highlights/mercury_science.html*

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Activity: Natural Hazards

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Earthquake Hazards ($000)		50,753	53,803	314	0	0	54,117	+314
	FTE	241	244	0	0	0	244	0
Volcano Hazards ($000)		22,721	23,121	187	0	0	23,308	+187
	FTE	144	145	0	0	0	145	0
Landslide Hazards ($000)		2,985	3,485	26	0	0	3,511	+26
	FTE	20	22	0	0	0	22	0
Global Seismographic Network ($000)		4,853	4,853	13	0	0	4,866	+13
	FTE	10	10	0	0	0	10	0
Geomagnetism ($000)		1,888	1,888	17	0	0	1,905	+17
	FTE	13	13	0	0	0	13	0
Coastal & Marine Geology ($000)		40,336	41,336	296	0	-1,000	40,632	-704
	FTE	226	227	0	0	-1	226	-1
Total Requirements ($000)		**123,536**	**128,486**	**853**	**0**	**-1,000**	**128,339**	**-147**
	Total FTE	**654**	**661**	**0**	**0**	**-1**	**660**	**-1**

Summary of Program Changes

Request Component	($000)	FTE	Page
Earthquake Hazards	**+0**	**+0**	
Hydraulic Fracturing - Induced Seismicity	+700	+2	B-24
Eliminate Geodetic Monitoring and Active-Source Seismic Profiling	-700	-2	B-55
Coastal & Marine Geology	**-1,000**	**-1**	
Coastal Vulnerability Studies	-1,000	-1	B-55
Total Program Change	**-1,000**	**-1**	

Justification of Program Changes

The 2015 Budget Request for Natural Hazards is $128,339,000 and 660 FTE, a net program change of -$147,000 and -1 FTE from the 2014 Enacted Budget. For more information on the Natural Hazards Mission Area changes, please see Section B, Program Changes.

Activity Summary

The Natural Hazards Activity is comprised of six subactivities:

- Earthquake Hazards Program (EHP; *http://earthquake.usgs.gov*)
- Volcano Hazards Program (VHP; *http://volcanoes.usgs.gov*)
- Landslides Hazards Program (LHP; *http://landslides.usgs.gov*)
- Global Seismographic Network (GSN; *http://earthquake.usgs.gov/monitoring/gsn*)
- Geomagnetism Program (*http://geomag.usgs.gov*)
- Coastal and Marine Geology Program (CMGP; *http://marine.usgs.gov*)

Natural hazards threaten the safety, security, and economic well-being of our Nation's communities as well as impact natural resources and surrounding ecosystems. Much of the Nation's infrastructure is aging and vulnerable to sudden extreme events and the cost of response to and recovery from disasters continues to rise. Expanding population in coastal zones, floodplains, wildland-urban interfaces, and areas prone to earthquakes and volcanic eruptions heightens risk of future disasters.

In the face of these challenges, the USGS provides scientific information to emergency responders, policymakers, and the public to reduce losses from earthquakes, floods, hurricanes, landslides, magnetic storms, tsunamis, volcanic eruptions, and wildfires. Working with its partners, cooperators, and customers, the USGS delivers actionable assessments of these hazards and helps to develop effective strategies for achieving more resilient communities.

The USGS is the Federal agency responsible for monitoring and notification of earthquakes, volcanic activity, and landslides in the United States. For many other hazards, the USGS directly supports the warning responsibility of the National Oceanic and Atmospheric Administration.

The USGS response to Hurricane Sandy and scientific support for rebuilding in Sandy-affected areas illustrates the breadth of the Natural Hazards mission, which extends across all of our mission areas. Hurricane Sandy devastated some of the most heavily populated eastern coastal areas of the Nation. With a storm surge peaking at more than 19 feet, the powerful landscape-altering destruction of Hurricane Sandy is a stark reminder of why the Nation must become more resilient to coastal hazards. The USGS developed a Hurricane Sandy Science Plan to focus and prioritize the critical science needed to inform management decisions for recovery of coastal communities, and aid in preparedness for future natural hazards. The science plan has facilitated coordination of continuing USGS activities with stakeholders and other agencies to improve data collection and analysis to guide recovery and restoration efforts.

This mission area includes USGS activities that characterize and assess coastal and marine processes, conditions, change and vulnerability. USGS expertise in marine geology, geophysics, and oceanographic disciplines provides science and information products essential to the implementation of priority objectives, and identifies critical needs for science and information to support broad objectives that include ecosystem restoration and protection, adaptation to climate change, and sustainable development and resources use. The USGS actively engages with other Interior bureaus, Federal agencies, and regional ocean alliances to provide data and tools to support national and regional objectives. USGS efforts to improve and increase understanding in these areas provides managers and policymakers at all levels with tools to make better and more cost effective decisions that anticipate changing conditions and the consequences of resource use, management, and restoration.

Through the Science Application for Risk Reduction (SAFRR) project, the USGS is working with emergency and business continuity managers to improve warning systems, explore vulnerable interdependencies, enhance emergency response, and speed disaster recovery. SAFRR, created in 2011, builds on the successful Multi-Hazards Demonstration Project that innovated ways of applying USGS hazard science to improve the resilience of southern California. Scenarios developed by that project led to the Great ShakeOut public preparedness drills that have grown worldwide to include over 24 million people in 2013. The same approach of building an end-to-end scenario of catastrophic impacts has been

applied to a California-wide winter storm in the ARkStorm scenario. ARkStorm is now being used by emergency managers for drills and by many others to work through the cascading impacts of an event that strikes that State with the same frequency as large San Andreas earthquakes and with potentially even greater consequences. The SAFRR Tsunami Scenario was released in September 2013 through five workshops hosted by the State of California for coastal emergency managers and is being used for a planned exercise in California and Washington in March 2014. The next scenario will look at the impact of a large Hayward fault earthquake on the digital economies of Silicon Valley. The SAFRR project will continue to build alliances and work with communities, businesses, research institutions, and governments, to improve the use of existing USGS natural hazards information, to identify needs and gaps, and to develop new products that increase the effectiveness of USGS science. Scenarios akin to ShakeOut and ARkStorm will remain a cornerstone activity. These science-based scenarios are recognized internationally as a fundamental shift in the way science can communicate to serve society.

The Department of the Interior (DOI) Strategic Sciences Group (SSG) was created by secretarial order in 2012 to provide the Secretary of the Interior with the standing capacity to rapidly assemble trained teams of scientists to construct interdisciplinary scenarios of the cascading consequences of natural disasters and other environmental crises. With co-leaders from the USGS and one other DOI bureau (currently the National Park Service), the SSG provides a new capability that complements the other activities of the USGS Natural Hazards Mission Area during both crisis and non-crisis times. During an environmental crisis, the Secretary can direct the SSG to activate a crisis science team composed of experts from government, academia, non-governmental organizations, and the private sector to build scenarios, develop potential interventions to mitigate adverse effects, and deliver information to decision makers and resource managers. In 2013, the SSG was deployed to support the DOI in its role on the federal Hurricane Sandy Rebuilding Task Force. For this work, the SSG developed scenarios to examine the impacts on the ecology, economy, and people of the affected region. The scenarios included interventions that could improve regional resilience to future major storms. The SSG used scenario results to develop criteria for DOI's selection of projects to be supported by Hurricane Sandy supplemental funds. For 2015, the SSG will be preparing for Secretarial deployment in the event of a future crisis affecting DOI-managed resources. During non-crisis times, the SSG refines the scenario development methodology, makes necessary preparations for future deployments, and conducts training exercises to build a cadre of deployable experts.

As a result of the bureau’s realignment of functions and responsibilities, emergency management was realigned from the Director’s immediate office to the Office of the Associate Director for Natural Hazards. The Deputy Associate Director for Natural Hazards serves as the USGS Emergency Management Coordinator and works closely with the DOI Office of Emergency Management, FEMA and other agencies and organizations to execute the emergency management responsibilities of the bureau. The bureau’s Hazard Response Executive Committee (HREC) also is managed from this office. The skills and expertise of many USGS employees are used to respond to a variety of natural hazards and related emergencies. The USGS takes seriously its responsibility to provide necessary resources to plan, prepare, respond, and recover from emergencies.

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #3: Provide Scientific Data to Protect, Instruct, and Inform Communities
Strategy #1: Monitor and Assess Natural Hazards Risk and Resilience

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
USGS Natural Hazards Total.....	179,899	138,951	135,964	131,145	123,536	128,486	128,339		-9.5%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #1: Monitor and Assess Natural Hazards Risk and Resilience									
Percent completion of earthquake and volcano hazard assessments for moderate to high hazard areas (Earthquake Hazard Program & Volcano Hazard Program) (SP)	USGS	28.5%	30.8%	34.0%	36.9%	38.0%	38.0%	40.0%	40.5%
		57	62	68	73.7	76	76	80	81
		200	200	200	200	200	200	200	200
Percent implementation of optimal earthquake and volcano monitoring for moderate to high hazard areas (EHP & VHP) (SP)	USGS	24.6%	26.1%	29.5%	32.9%	29.9%	34.0%	34.0%	34.5%
		49	52	59	65.8	60	68	68	69
		200	200	200	200	200	200	200	200
Percent of regional and topical ocean and coastal studies that cite USGS products within three years of study completion (Coastal and Marine Geology Program - CMGP)	USGS	80.0%	80.0%	81.3%	78.6%	80.0%	80.0%	81.8%	90.9%
		24	24	26	22	20	20	18	20
		30	30	32	28	25	25	22	22

Supporting Performance Measures and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Number of monitoring stations operated by Volcanoes Hazard Program (VHP)	USGS	743	743	765	785	785	848	785	779
Number of systematic analyses and investigations completed (EHP)	USGS	146	146	146	101	135	130	135	135
Number of systematic analyses and investigations completed (VHP)	USGS	99	75	124	80	75	119	70	70
Number of systematic analyses and investigations completed (Landslide Hazard Program)	USGS	15	15	15	15	15	15	14	14
Percent completion of optimal monitoring (EHP)	USGS	23.0% 1,633/7,100	26.0% 1,846/7,100	30.4% 2,158/7,100	36.1% 2,564/7,100	30.2% 2,142/7,100	38.7% 2,746/7,100	38.7% 2,746/7,100	39.4% 2,796/7,101
Percent completion of optimal monitoring (VHP)	USGS	26.1% 2,299/8,800	26.2% 2,308/8,800	28.6% 2,520/8,800	29.7% 2,610/8,800	29.6% 2,604/8,800	29.6% 2,604/8800	29.6% 2,604/8,800	29.6% 2,609/8,800
Percent completion of optimal monitoring (GSN)	USGS	86.0% 87.7/102	86.5% 88.2/102	88.6% 90.4/102	89.8% 91.55/102	88.2% 90/102	86.3% 88.0/102	86.3% 88/102	86.3% 88/102
Percent completion of optimal monitoring (Geomagnetism)	USGS	45.0% 13.5/30	57.3% 17.2/30	84.7% 25.4/30	85.8% 25.76/30	83.3% 25/30	86.0% 25.8/30	83.3% 25/30	83.3% 25/30
Cost of collection and processing of Light Detecting and Ranging (LIDAR) data for coastal characterization and impact assessments (per megabyte of data collected) (CMGP)	USGS	0.44	0.39	0.34	0.53	0.35	0.31	0.25	0.25
Number of gigabytes of LIDAR data collected annually (CMGP)	USGS	100	555	300	100	2,000	1,471	8,000	12,000
Number of systematic analyses and investigations completed (CMGP)	USGS	200	214	152	190	178	186	185	190

Activity: Natural Hazards
Subactivity: Earthquake Hazards

2013 Actual: $50.8 million (241 FTE)
2014 Enacted: $53.8 million (244 FTE)
2015 Request: $54.1 million (244 FTE)

Overview

Of all natural hazards facing the United States, earthquakes have the greatest potential for inflicting catastrophic casualties, damage, economic loss, and disruption. Damaging earthquakes are infrequent, but their consequences can be immense. According to recent studies, a major earthquake in an urbanized region of the United States could cause several thousand deaths and approximately $250 billion in losses. In addition to California, many other parts of the country are also at risk, including the Mississippi River Valley, Pacific Northwest, Intermountain West, Alaska, Hawaii, U.S. Territories, and parts of the Eastern seaboard. Population growth over the past decade has increased exposure to earthquake risk, putting a large percentage of American households and businesses at risk for earthquake damage.

The USGS provides the scientific information and knowledge necessary to reduce deaths, injuries, and economic losses from earthquakes and earthquake-induced tsunamis, landslides and liquefaction. The USGS is the only U.S. agency that routinely and continuously reports on current domestic and worldwide earthquake activity. Through the Advanced National Seismic System (ANSS), the USGS and its State and university partners monitor and report on earthquakes nationwide.

The Earthquake Hazards Program (EHP) is the applied Earth science component of the four-Agency National Earthquake Hazards Reduction Program (NEHRP, reauthorized by the Earthquake Hazards Reduction Authorization Act of 2004, P.L. 108–360). A reauthorization bill for the program is currently under consideration in Congress. Through NEHRP, the USGS partners with the Federal Emergency Management Agency (FEMA), the National Science Foundation (NSF), and the National Institute of Standards and Technology (NIST), to reduce earthquake losses in the United States.

The EHP includes the following four program components, described in more detail below: Assessment and Characterization of Earthquake Hazards; Monitoring and Reporting Earthquake Activity and Crustal Deformation; Conducting Research into Earthquake Causes and Effects; and Earthquake and Safety Information for Loss Reduction.

Partnerships are crucial to the program's success. Approximately one-quarter of the total EHP budget is directed toward research grants and cooperative agreements with universities, State agencies, and private technical firms to support research and monitoring activities. This external funding is leveraged by funds from other Federal agencies, States, and the private sector.

Direction for the EHP is established in the strategic plans of the USGS and the Department of the Interior, through periodic reviews by the congressionally established external Scientific Earthquake Studies Advisory Committee, and through communication with partners and stakeholders. EHP-funded activities undergo both management and scientific review of project concepts and of final project proposals when submitted for initial funding using a Program Council responsive to regional and topical needs.

Program Performance

Assessment and Characterization of Earthquake Hazards

The USGS contributes to earthquake hazard mitigation strategies by developing seismic hazard maps that describe the likelihood and potential effects of earthquakes Nationwide, especially in the urban areas of highest risk. Federal, State, tribal, and local government agencies, architects and engineers, insurance companies and other private businesses, land use planners, emergency response officials, and the general public rely on the USGS for earthquake hazard information to refine building codes, develop land-use strategies, safeguard lifelines and critical facilities, develop emergency response plans, and take other precautionary actions to reduce losses from future earthquakes.

The USGS National Seismic Hazard Maps are used to develop new, unified model building codes for the United States. These digital maps integrate a wide range of geological and geophysical information to estimate the maximum severity of ground shaking that each given location is expected to experience in the coming decades. The USGS works closely with earthquake researchers, engineers, and State and local government representatives across the Nation to ensure the maps represent the most current and accurate information available. USGS science underlies the 2012 version of the International Building Code (IBC), the code that has been adopted throughout most of the United States as the standard for building design. In addition, work is underway to utilize the latest USGS hazards assessments in a planned 2018 update to the IBC.

Because the scale of the national seismic hazard maps precludes taking into account local variations in the size and duration of seismic shaking caused by small-scale geologic structures and soil conditions, the USGS also partners with State and local experts to produce more detailed urban seismic hazard maps for high-to-moderate risk areas. These products make it possible for local officials to make precise and informed zoning and building code decisions. Modeling of ground motion is also provided for engineering applications. In conjunction with release of these targeted products, the USGS conducts workshops to assure the proper transfer of knowledge and to help design effective mitigation strategies.

Key projects in assessment and characterization include:

National Seismic Hazard Maps – USGS scientists are developing the next version of the national hazard maps. The latest generation of maps is being prepared for delivery during 2014, following an extensive review process, replacing those from 2008. During 2014, the USGS is producing engineering design maps, derived from new hazard maps using specifications from the Building Seismic Safety Council (BSSC). The BSSC is working to incorporate these design maps into 2014 NEHRP Recommended Provisions, the 2016 construction engineering standards of the American Council on Seismic

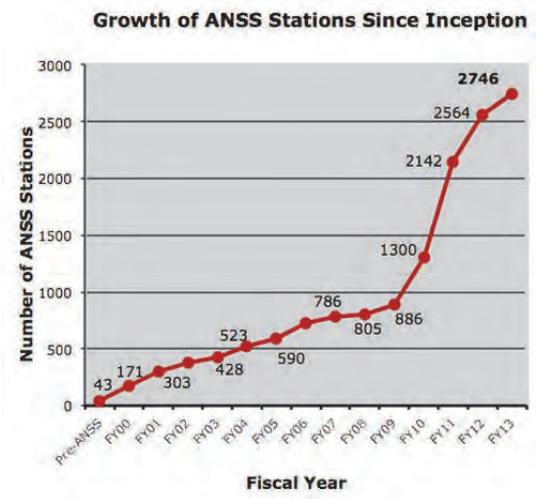
Engineering, and the 2018 International Building Code. In 2014 and 2015, the USGS will also produce and update a variety of other products derived from the seismic hazard map for use by engineers, city planners and other end-users.

Updated California Earthquake Model – The USGS has developed a new earthquake rupture forecast for California in partnership with the California Geological Survey and the Southern California Earthquake Center (SCEC, a university research consortium). This model, which incorporates new research results on how stress in the earth's crust is released in earthquakes, underlies the California portion of the 2014 National Seismic Hazard maps. Draft maps received extensive public and professional review in 2013 prior to submission to the Building Seismic Safety Council. In 2014, the USGS will complete and release a special version of the model that addresses the evolution of seismic hazard over time, which the California Earthquake Authority will use to refine earthquake insurance premiums.

Hazard Maps for Urban Areas – Urban seismic hazard maps are a refinement of the National Seismic Hazard Maps that include details about local geologic site conditions that effect earthquake ground motions and liquefaction. Past projects have produced detailed hazard maps for the urban regions around Seattle, WA, Oakland, CA, Memphis, TN, and the Tri-State (Evansville) area of Indiana, Kentucky, and Illinois. In 2014, the USGS is focusing on completing a large, collaborative urban seismic hazard mapping project in the high-risk St. Louis area. Partners in the St. Louis project include the University of Missouri at Rolla, Missouri Department of Natural Resources, and the Missouri State Geological Survey. In 2014 and 2015, work will continue on seismic hazards assessments for the Salt Lake City, and Reno-Carson City urban areas. The USGS is partnering with geoscientists from Utah's and Nevada's geological surveys and academic institutions in multi-year efforts to collect the necessary geological and geophysical field data and to develop models that will be the basis for urban hazard maps.

Monitoring and Reporting of Earthquake Activity and Crustal Deformation

Deployment of the Advanced National Seismic System (ANSS) is focused on expanding and improving the performance and integration of national, regional, and urban seismic monitoring networks in the United States. The system consists of a national ANSS Backbone network, the National Earthquake Information Center (NEIC), 13 partner-operated regional networks in areas of moderate-to-high seismic activity, and the National Engineering Strong Motion Project for monitoring earthquake shaking in structures.



Graph shows a large increase in the number of ANSS monitoring stations in 2010-2013. This growth is a result of investments through the American Recovery and Reinvestment Act and by the Veterans Administration (VA), for the instrumentation of VA hospitals, nationwide.

At the end of 2013, the development of the ANSS was about 38 percent completed. The USGS and partners had installed a cumulative total of 2,746 ANSS earthquake monitoring stations, including

1,634 channels of data recorded in buildings and other structures. The network is capable of detecting almost all felt earthquakes in the United States, except in remote areas of Alaska. Thanks to substantial improvements to station coverage and methods for rapid analysis, the NEIC now typically reports on domestic earthquakes within minutes of their occurrence.

The NEIC provides information on potentially damaging earthquakes to the National Command Center; the White House; the Departments of Defense, Homeland Security (including FEMA), Transportation, Energy, and Interior; State offices for disaster services; numerous public and private infrastructure management centers (e.g., highways, railroads and pipelines); the news media; and the public. Rapid earthquake notifications are delivered by e-mail and text message to nearly 400,000 subscribers, and a suite of earthquake information products such as *ShakeMaps*, *Did You Feel It?* maps, rapid *PAGER* estimates of financial and human impacts, and technical data are available on the program's Web site, which receives more than two million page-views every day. The USGS also provides near-real-time data to NOAA's tsunami warning centers, supporting tsunami monitoring in the Pacific Rim and disaster alerting in Alaska, Hawaii, Washington, California, and U.S. Territories in the Western Pacific and Caribbean.

Earthquake Early Warning – In favorable circumstances**,** modern seismic networks can provide seconds to a minute or more of warning before the onset of strong shaking from an earthquake (enabling Earthquake Early Warning, or EEW). For the past eleven years, the USGS has funded both research and development toward establishing an earthquake early warning capability in California. Funds from the American Recovery and Reinvestment Act were used in 2010 and 2011 to support the modernization of seismic instrumentation necessary to support the generation of warnings. A test system is now operational, and two ANSS university partners (CalTech and U.C. Berkeley) have been delivering warnings to a small group of test users since January 2011.

However, the test system is still in the development phase, and considerable additional investment must be made to demonstrate reliability, improve accuracy, establish products for public warning, and expand geographic coverage. The additional funding for EEW that was appropriated by Congress in 2014 is being used to complete the R&D phase for the seismic system (an effort that is jointly supported by the Gordon and Betty Moore Foundation) and to improve the operational robustness of the system. Additional funding will be needed for fully integrating GPS into the EEW system, and for operating the system continuously, 24 hours a day and seven days a week.

Regional Earthquake Monitoring – As part of the ANSS, the USGS and cooperating universities operate regional seismic networks in areas of high seismicity. Data from all U.S. seismic networks are used to monitor active faults and ground shaking, in much greater detail and accuracy than is possible with the national-scale network. Each region has appropriate local data processing capabilities; regional data are contributed to a new national ANSS catalog of earthquakes. ANSS regional networks serve as State or local distribution points for information about earthquakes to the public, local and State agencies, and other regional interests. The regional data centers also relay earthquake data in real time to the USGS NEIC, as well as to other regional networks. The centers provide information about regional earthquake hazards, risks, and accepted mitigation practices, and those centers located at universities provide training and research facilities for students. To support partner activities in earthquake monitoring, approximately

$6.3 million was provided in 2013 through cooperative agreements for regional seismic and geodetic networks, and structural and geotechnical arrays, operated by the following colleges and universities:

Seismic Monitoring Networks Supported by the USGS in 2013	
California Institute of Technology	University Nevada Reno
Columbia University, Lamont-Doherty Earth Observatory	University of Memphis
Montana Bureau of Mines and Geology	University of Oregon
Saint Louis University	University of South Carolina
University of Alaska Fairbanks	University of Utah
University of California Berkeley	University of Washington
University of California San Diego	

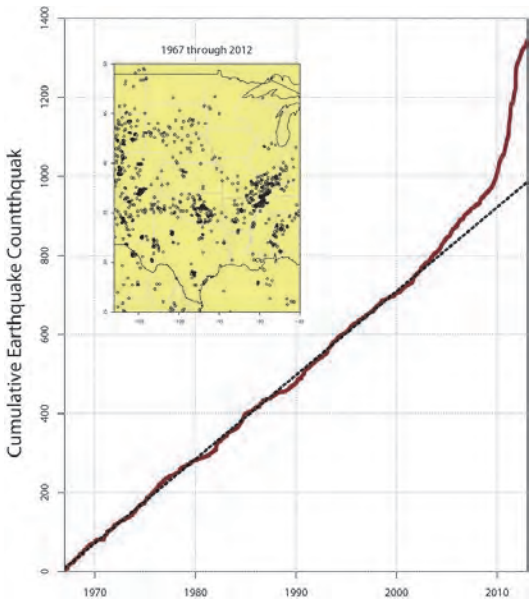
Geodetic Monitoring Networks Supported by the USGS in 2013	
Central Washington University	University of Memphis
San Francisco State University	University of Nevada Reno
University of California Berkeley	University of Utah
University of California San Diego	

For 2015, funding for regional seismic and geodetic network operations remain a high priority, and will be directed toward ensuring robust regional network operations and maintenance.

Research into Earthquake Causes and Effects

The USGS conducts research on the causes, characteristics, and effects of earthquakes. This research has direct application in increasing the accuracy and precision of the Agency's earthquake hazards assessments, earthquake forecasts, earthquake monitoring products, and earthquake mitigation practices.

Induced Seismicity – The development of underground oil and gas (UOG) resources has the potential to induce earthquakes, primarily through wastewater disposal. Researchers have long known that human actions can cause earthquake activity, from petroleum extraction to water reservoir impoundments and fluid injection into the subsurface. Although very small magnitude ("microseismic") events are commonly produced by hydraulic fracturing operations, current understanding suggests that the potential risk of felt or damaging earthquakes is greatest from high-volume wastewater disposal.



Increased Rate of Earthquakes in the U.S. mid-continent

The seismicity rate doubled in 2001 and increased seven-fold in 2009; the increase is likely tied to wastewater injection.

Although the risk of inducing felt seismic events directly stemming from hydraulic fracturing operations is believed to be low, there is some concern that potentially hazardous seismic events can be induced through disposal of flowback and produced water through underground injection control disposal-wells. Confidence can be built by demonstrating that the extensive set of empirical observations on operations to date is consistent with predictive models over a range of geologic conditions and operational parameters. There is a need for more data and analysis to relate UOG operations to induced seismic events, to connect these events to specific operational parameters and geologic conditions, and to develop mitigation plans for decisionmakers attempting to minimize seismic risks. The USGS is working with the DOE and EPA to undertake this research, and working with industry on case studies that will illuminate the physical factors controlling the phenomenon.

In 2013-2014, the USGS has responded to significant increases in earthquake rates in Oklahoma, Kansas and Texas, accompanied by moderate-magnitude, lightly damaging earthquakes. The additional funding for induced seismicity research that was appropriated by Congress in 2014 is being used to develop methods to forecast whether or not a particular type of injection operation in a specified geologic setting would be likely to induce or trigger earthquakes, to perform comprehensive studies at two carefully selected field sites, to establish procedures to adapt the USGS National Seismic Hazard Maps to take account of the additional hazard due to earthquakes induced in association with the production of oil and gas. See separate “Hydraulic Fracturing” section of this document.

Forecasting Hazards from Earthquake Sequences – Earthquakes occur in sequences, typically a largest event followed by many aftershocks, some of them large and potentially damaging. A large earthquake may also trigger the occurrence of an earthquake on a nearby fault at a later time. The USGS is engaged in research to quantify changes in earthquake likelihoods with time, in response to observations of the seismogenic process from data such as earthquake catalogs or geodetic deformation.

New research and development efforts that began in 2012 will continue in the proposed Program plan. In 2014 and beyond, the USGS will develop, validate, and use state-of-the-art scientific methods to—

- Estimate earthquake probabilities, hazard, and risk over relevant time periods and spatial windows when probabilities may have changed.
- Provide a suite of new products useful to society, ranging from one-time earthquake forecasts, to continuously updated, online releases, to user-customized estimates for decision support and situational awareness.
- Work in cooperation with international partners so that USGS forecasts of earthquake hazard in foreign countries are compatible with those made by authoritative sources in those countries. The products released abroad from these forecasts, however, need to be explored in more depth.

Eastern U.S. Earthquake Research and Monitoring – The USGS continues to work toward assessing the hazard posed by Eastern U.S. earthquakes. The work includes geological reconnaissance of target areas for evidence of prehistoric earthquakes; airborne geomagnetic and gravity surveys; high resolution Light Detecting and Ranging (lidar) imaging; three-dimensional seismic exploration surveys to identify buried faults; seismic analyses of attenuation of seismic shaking with distance; and analyses of amplification of shaking due to soft soils within urban centers. The goal is to improve the seismic hazard

criteria used in building codes, land-use decisions, and mitigation strategies, to reflect regional earthquake potential and local near-surface sediment and soil conditions.

By the end of 2013, the "Transportable Array" (TA), a massive array of portable seismometers that is part of the NSF-sponsored EarthScope facility, had moved into the Eastern United States. Also in 2013, the National Science Foundation began to invest in a cooperative project to operate 150-200 of the TA stations for a longer-term, at least through 2017. Of the additional funding appropriated to the USGS by Congress in 2014 for ANSS products and monitoring in the Central and Eastern States, a portion is being used to extend NSF's investment. Over time, operations of the TA stations will be transferred to the USGS—that is, making the temporary TA resource a 'permanent' feature of the USGS Advanced National Seismic System.

Supporting External Research Partnerships – External collaboration advances targeted research and addresses specific needs of the USGS using the experience and knowledge of world experts. The EHP provides competitive, peer-reviewed, external research support through competitive grants and cooperative agreements that enlist the talents and expertise of the academic community, State government, and the private sector.

External program activities include: mapping seismic hazards in urban areas; developing credible earthquake planning scenarios including loss estimates; defining the prehistoric record of large earthquakes; investigating the origins of earthquakes; improving methods for predicting earthquake effects; and developing a prototype system for an earthquake early warning system (see previous discussion). The USGS also has a cooperative agreement with the Southern California Earthquake Center (SCEC), a 40-institution research consortium funded by the USGS and the NSF. The following table lists the institutions and agencies that received grants and cooperative agreements in 2013. It is anticipated that a similar number and range of partners will receive assistance in 2014.

USGS 2013 Grants for Earthquake Research and Hazard Assessments	
Association of Bay Area Governments	Portland State University
Berkeley Geochronology Center	San Diego State University
Boise State University	Stanford University
Boston College	Stony Brook University
Brown University	Tufts University
California Geological Survey	University of Alaska Fairbanks
California Institute of Technology	University of California Berkeley
California State University Northridge	University of California Riverside
Columbia University	University of California San Diego
Cornell University	University of Memphis
Durham University	University of Nevada Reno
Earthquake Engineering Research	University of Nevada Reno
Earthquake Insight LLC	University of Oklahoma
Fugro Consultants	University of Oregon
Gail Atkinson	University of Texas Austin
Lettis Consultants International	URS Group, Inc.
M. Tuttle & Associates	Utah Geological Survey
Millsaps College	Virginia Polytechnic Institute and State
Oregon State University	

Earthquake and Safety Information for Loss Reduction --The Earthquake Hazards Program produces a large (and growing) quantity of data and information on earthquakes and related hazards. For that science information to be effectively used to mitigate risk and limit losses, the USGS takes a proactive role with various user communities in the application and interpretation of program results. Active engagement with users provides opportunities for dialogue on modifications to USGS existing products and advice on new products that make USGS work and results more relevant and applicable. Opportunities for engaging users take place at both national and regional levels.

Improved Earthquake Information Products – The Earthquake Hazards Program strives to create and refine a variety of earthquake information products that accurately and effectively communicate earthquake science to key audiences, including decisionmakers. Collaboration is underway with the USGS SAFRR project to improve understanding of how best to share earthquake safety information to the general public, through research with social scientists with expertise in risk communication. In 2014, experts will develop a consistent language and practices for communicating Earthquake Early Warning messages. In 2015, attention will turn to communicating rapidly evolving information about aftershocks and other hazards following large earthquakes.

50th Anniversary of the Great Alaska Earthquake and Tsunami – It has been half a century since a great earthquake of magnitude 9.2 occurred in the Prince William Sound region of Alaska on March 27, 1964. The "Good Friday" earthquake lasted approximately 4.5 minutes, and is the most powerful recorded earthquake in U.S. history. It is also the second largest earthquake ever recorded. The young and growing city of Anchorage, and many smaller Alaskan towns, sustained heavy damage from strong shaking and huge landslides. Vast areas of coastal Alaska subsided or were uplifted by as much as 40 feet. The shock generated a tsunami that devastated many towns along the Gulf of Alaska, and left serious damage along the west coasts of the United States, in Canada, and in Hawaii.

The 50th anniversary of the event provides a prime opportunity to raise awareness of earthquake hazards and encourage planning and activities to reduce losses from future earthquakes and tsunamis. To this end, the USGS is leading or participating in a large number of activities, many in partnership with the NOAA National Weather Service, the State of Alaska, and local tsunami working groups. A large number of educational resources are being collected at a new USGS Web portal. In addition, the USGS has created the earthquake scenario and related *ShakeMap* and *PAGER* products for use in "Alaska Shield," a multi-agency, Federal and State emergency response exercise in 2014.

Activity: Natural Hazards
Subactivity: Volcano Hazards

2013 Actual: $22.7 million (144 FTE)
2014 Enacted: $23.1 million (145 FTE)
2015 Request: $23.3 million (145 FTE)

Overview

Volcanic eruptions are among the most destructive phenomena of nature, and even a small event can cause significant damage and economic impact. The 2010 eruption of Eyjafjallajökull Volcano in Iceland was minor in almost every respect, except that its ash plume drifted over Western Europe creating a worldwide disruption in air travel that cost the global economy billions of dollars. Unlike many other natural disasters however, volcanic eruptions can be predicted well in advance of their occurrence, providing the time and breathing room needed to reduce the worst of their effects.

The USGS is responsible for issuing issue timely forecasts and warnings of potential geologic disasters, including volcanic eruptions, to the affected populace and civil authorities. The USGS has the experience and expertise necessary to make such forecasts. Advanced warning can mean the difference between a natural spectacle and a natural disaster.

Volcanic hazards can take many forms, some direct and immediate like lava flows and explosive eruptions, and some more insidious like air pollution or the effect of abrasive particles of fine ash on aircraft and other vehicles or infrastructure. What all these destructive phenomena have in common is that they can be forecasted and their threats can be mitigated. For example, commercial and military aviation take great care to organize their operations to minimize the chance of an unexpected aircraft encounter with ash, and they reply on the USGS to provide timely information about potential and ongoing volcanic activity. Likewise, citizens living on or around active volcanoes rely on the USGS to provide not only short term predictions of volcanic activity, but also the information and advice needed to minimize risk and reduce their exposure to volcanic hazards over the long term.

Effective volcano monitoring requires not only a robust network of instruments, but also the skill and experience needed to understand the resulting data. The USGS Volcano Hazards Program (VHP) conducts thorough hazard assessments of threatening volcanoes that consist of geologic field investigations and observations, laboratory work, and data analysis. These result in formal, published "Hazard Assessment" products that are both scientifically accurate and accessible to the non-specialist. VHP scientists also conduct geological and geophysical research into basic volcanic processes. Such research identifies patterns and trends in data that create deeper insights into the meaning and significance of monitoring data and early recognition of eruption precursors.

The Nation's volcano monitoring infrastructure remains incomplete. In 2005, the VHP conducted an inventory of the Nation's volcanoes, assessing the overall threat posed by each and comparing this to the

existing monitoring capability. The resulting document (*pubs.usgs.gov/of/2005/1164/)* details the monitoring gaps present at many of the most threatening volcanoes, and serves as a blueprint for a National Volcano Early Warning System (NVEWS). Since then, progressive implementation of NVEWS has been a VHP priority, and several notable successes have been achieved (e.g., major modernization of the Hawaii and Yellowstone monitoring networks).

The VHP works closely with other Federal science agencies to leverage their strengths and capabilities in support of volcano monitoring, and to provide them the information they need for their missions. The National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), and National Aeronautics and Space Administration (NASA) all cooperate with the VHP, providing satellite and sensor data that are critical for volcano monitoring. The VHP sends information and data about volcanic activity and ash plumes/fall to the National Weather Service (NWS), the Federal Aviation Administration (FAA), and the Department of Defense (DoD). The VHP engages State and local officials to develop eruption response plans and scenarios for response exercises that are critical for effective and coordinated response to eruptive activity.

Program Performance

Response to Eruption and Volcanic Unrest – the VHP's primary goal is to provide timely and accurate forecasts of potential volcanic hazards. Much attention, therefore, focuses on those volcanoes already erupting, or those showing elevated levels of seismic activity, abnormal ground deformation, or excess gas or thermal output. Kilauea Volcano, in Hawaii, now in its 31st year of near-constant eruption, continues to require close attention by USGS scientists at the Hawaiian Volcano Observatory (HVO). Lava output from Kilauea averages five cubic meters per second, enough to fill 200 Olympic-sized swimming pools each day. While most of the lava flows produced during this eruption have covered vast areas of Hawai`i Volcanoes National Park, the last five years of lava activity has been predominantly on State of Hawaii Natural Area Reserve lands and a now-abandoned subdivision immediately adjacent to the Park. This long eruption has taken a significant permanent toll: lava from Kilauea has destroyed hundreds of homes and other structures and resulted in several deaths. Ongoing USGS studies underscore the reality that Kilauea eruptions can sometimes produce large, ash-producing explosions, making it the most threatening volcano in the United States. The HVO works closely with National Park Service and State and county emergency management agencies to minimize the damage and health risks posed by Kilauea's ongoing eruption.

Long Valley Caldera in California, near the resort town of Mammoth Lakes, has entered a period of renewed volcanic unrest with increased seismicity and ground uplift of about one inch per year. The California Volcano Observatory has stepped up volcano monitoring in Long Valley, and continues to follow the situation closely.

In addition to the activity described above, volcanoes erupted or showed signs of elevated unrest elsewhere in the US including Cleveland, Little Sitkin, Veniaminof, Pavlof, and Iliamna volcanoes in Alaska; Pagan volcano in the Commonwealth of the Northern Mariana Islands, and small swarms of earthquakes in Yellowstone.

Organizational Improvements – Accurate forecasts of volcanic activity are by themselves insufficient to mitigate the risks posed by volcanoes to surrounding communities and the Nation; the affected populace must also have the knowledge and information necessary for effective action. Since 2012, each of the five volcano observatories have designated geographical areas of responsibility, which taken together, contain all of the Nation's potentially hazardous volcanoes as set forth in the NVEWS threat analysis.

Areas of Responsibility:

- Hawaiian Volcano Observatory – Hawaii
- Cascades Volcano Observatory – Idaho, Oregon, and Washington
- Alaska Volcano Observatory – Alaska and the Commonwealth of the Northern Mariana Islands
- California Volcano Observatory – California and Nevada
- Yellowstone Volcano Observatory – Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming

The five observatories are responsible for volcano monitoring, community preparedness, managing volcanic crises, and coordinating research in their areas of responsibility.

An especially noteworthy achievement of 2013 was the collaboration of the California Volcano Observatory (CalVO), with the California Office of Emergency Services (CalOES) to generate a Volcano Hazards Annex to the 2013 State of California Emergency Management Plan issued by the Office of the Governor. The Volcano Hazards Annex presents a statewide volcano hazard and risk assessment that will allow for improved and coordinated response to the next volcanic crisis in California. California has several Very High-Threat to High-Threat volcanoes within its borders including Shasta, Lassen, Clear Lake, Medicine Lake, Long Valley Caldera, Mono-Inyo Chain, and Salton Buttes, along with about 15 other lower threat volcanic centers. CalVO and CalOES have also partnered with NOAA and FAA representatives to create the first California Volcanic Ash Hazard Plan for Aviation.

In 2013, the USGS reorganized the Yellowstone Volcano Observatory from a three-part cooperative among the National Park Service, the USGS, and the University of Utah to a broader consortium that includes several more agencies, including the University of Wyoming, the Wyoming State Geological Survey, the Idaho Geological Survey, the Montana Bureau of Mines and Geology, and UNAVCO. The new consortium broadens the YVO's constituency, better serves the local communities, better engages local emergency managers, and clarifies the leadership role of the USGS and NPS.

Community Preparedness and Public Communication – The Internet is the primary tool for the VHP to inform the public of volcanic activity (or to confirm that no activity is occurring). The VHP has completed a reengineering of its public Web site infrastructure, and is about 75 percent through a complete redesign of the Web site's content. This effort aims to provide better and timelier information about volcanoes and related hazards to the public and USGS partner agencies, and to do so reliably under conditions of very high demand. Since October 2012, the VHP provides a Volcano Notification Service (VNS), a free service that sends e-mail notifications about the status of volcanic activity and other significant events at volcanoes in the United States. The VNS can be customized to deliver reports for

certain volcanoes, or a region of volcanoes, and for the types of notifications desired. At present, the VNS has about 5000 subscribers. The full suite of VHP Web-based products is now registered in the safety.data.gov and the hazards.data.gov databases as of August 2012. In 2014, the VHP will finish the upgrade and redesign of its Web presence, thereby freeing resources to explore new technologies (e.g., social media) that will improve our ability to disseminate notifications and forecasts quickly.

The VHP organized and conducted the "Volcanism in the American Southwest" conference in October 2012, in Flagstaff, AZ, in partnership with Northern Arizona University, University at Buffalo, and the New Mexico Bureau of Geology and Mineral Resources. Though volcanic eruptions are comparatively rare in the American Southwest, the States of Arizona, Colorado, New Mexico, Nevada, and Utah host geologically-recent volcanic eruption deposits and are vulnerable to future volcanic activity. Compared with other parts of the Western United States, little research has been focused on this area, and eruption probabilities are poorly understood. The meeting included interdisciplinary talks, posters, and panel discussions, providing an opportunity for volcanologists, land managers, and emergency responders to meet, converse, and begin to plan for the response to future volcanic activity. This meeting was the first time Federal, State, and local agencies met to discuss their roles, responsibilities, and resources, should an eruption or notable activity occur.

Scientific and Technical Achievements – Ash from explosive eruptions is the most far-reaching of volcanic hazards, affecting transportation, utility operations, agriculture, and human health. In 2013 the physics-based numerical model, Ash3d, developed by VHP scientists to forecast deposition of ash on the ground and to track the dispersion of ash clouds in the atmosphere became fully operational. Ash3d now provides all USGS Volcano Observatories with the operational capability to generate ash fall forecasts that address the public's questions regarding ash fall – where, when will it begin, when will it stop, and how much will accumulate – and thus guide their actions appropriately. Selected external partners, notably, the National Weather Service and Air Force Weather Agency now have access to the Web interface for Ash3d and can directly initiate model runs as needed. The software can be used for an eruption of any volcano worldwide, an important capability for the Air Force.

Complementary to operational Ash3d is a new Web site unveiled in 2013 called, "*Is Ash Falling?*" (*https://www.avo.alaska.edu/ashfall/ashreport.php*) that enables citizens to report their ash fall observations in their respective communities. Comparison of ash fall reports provided by citizens with Ash3d model results will facilitate refinements of the model for more accurate ash fall predictions and improved situational awareness.

Important scientific publications in 2013 include a special volume of the *Journal of Volcanology and Geothermal Research* on the 2009 eruption of Redoubt Volcano, Alaska featuring 27 articles plus preface, 13 with USGS scientists as first authors. The VHP completed the geologic map of the Three Sisters volcanic cluster in Oregon's Cascade Range. A high-resolution digital elevation dataset for Crater Lake National Park and vicinity, Oregon was released, based on lidar and bathymetric surveys (*http://pubs.usgs.gov/ds/716*).

In May 2013, the VHP re-organized and internalized its satellite-based remote sensing of Alaskan volcanoes as a cost-saving measure and developed new satellite image viewing software called VolcView

that allows USGS observatory scientists and NWS meteorologists to perform satellite-based remote sensing checks of Alaskan volcanoes and presence of volcanic ash clouds. Refinements of VolcView and expansion of capacity to incorporate newer satellite data are expected to continue in 2014 and 2015 as new data become available. In 2014, the VHP began the collection and utilization of nighttime thermal infrared data acquired over approximately 50 target volcanoes using the available thermal infrared sensors on the Landsat 8 satellite as part of its satellite-based remote sensing monitoring of active volcanoes.

The VHP installed monitoring equipment at Pagan, a High-Threat volcano in the Commonwealth of the Northern Mariana Islands in collaboration with the U.S. Army Corps of Engineers in 2013. The seven seismic stations, two infrasound arrays, and two Web cameras allow for early detection of volcanic unrest, forecasts of eruptive activity, and much improved situational awareness at a volcano that previously lacked any ground-based instrumentation.

2014 – VHP planned activities

- Improve volcano monitoring networks at Very High-Threat and High-Threat volcanoes including the network at Mount Hood 50 miles east of Portland, OR,
- Establish permits for instrumenting Glacier Peak, a Very-High-Threat volcano with virtually no real-time monitoring network in place; continue geologic investigations at Glacier Peak in support of hazard delineation and assessment, a multi-year project with anticipated duration of approximately five years
- Develop a sustainable plan for operating real-time monitoring networks on Alaskan High-Threat and Very High-Threat volcanoes and when possible, redesign networks for increased performance, reliability and lower yearly maintenance costs. Conversion of analogue seismic systems to digital systems
- Expand use of satellite-based remote sensing to detect and track eruptions and assess hazards in near real-time as eruptions develop
- Improve lava flow inundation modeling through partnership with the Instituto Nazionale di Geofisica e Vulcanologia (INGV) of Italy with application towards future eruptions in Hawaii, the southwestern US, and support of the USGS-Saudi Geological Survey joint project to produce a volcanic hazard assessment for the Harrat Rahat volcanic field in the Kingdom of Saudi Arabia (see description below in International Efforts)
- Work with NOAA, and AFWA on VolcView and Ash3d improvements for improved coordinated response to ash forming eruptions
- Network together observatory critical NVEWS systems for more resilient monitoring and improved access to observatory data by observatory scientists irrespective of their physical location.

2015 – VHP planned activities

The VHP will continue many of the long-term activities planned for 2014 in 2015 as needed, due to the long-term nature of some projects with anticipated durations of three to four years.

- Grow and improve the Nation's volcano monitoring infrastructure (NVEWS) and begin efforts to install a real-time monitoring network at Glacier Peak 70 miles northeast of Seattle, WA, with installation of some ground-based instruments anticipated in 2015, and possible additional installations in 2016
- Continue to restore monitoring networks on High-Threat Alaskan volcanoes and redesign networks for improved performance where possible; continue geologic investigations at Glacier Peak in support of a new hazard assessment
- Continue geologic investigations leading to a new hazard assessment for Mt. Shasta, a Very High-Threat volcano in California
- Establish new criteria for USGS volcano Hazards assessments and delivery of hazard information in digital form that is easily accessible by end users
- Update the National Volcano Early Warning System threat rankings, hazard exposure, and level of monitoring reports: the "Chronology and References of Volcanic Eruptions and Selected Unrest in the United States, 1980-2008".
- Continue to expand the use of satellite-based remote sensing and infrasound detection of eruptive activity, particularly at remote volcanoes lacking ground-based instrumentation.

International Efforts – The Volcano Disaster Assistance Program (VDAP), a joint project with USAID Office of Foreign Disaster Assistance (OFDA), continues to build monitoring infrastructure and crisis response capacity in Latin America and the Western Pacific regions, including new project work in Indonesia, Papua New Guinea, Colombia and other Latin American countries. The VDAP is supported by the OFDA and brings important hazard mitigation lessons home for use in the United States. Noteworthy recent VDAP activities include crisis responses to unrest and eruptions in Colombia, Chile, and Indonesia. All of the VDAP's foreign responses follow requests from foreign governments made through their U.S. Embassies, which are evaluated by the Department of State and the OFDA in terms of humanitarian benefit and U.S. foreign policy. Of particular note is the assistance VDAP provided to the Indonesian government's Center for Volcanology and Geologic Hazard Mitigation (CVGHM) response to the ongoing eruption of Sinabung volcano in northern Sumatra, where over 28,000 people have been evacuated because of explosive activity, hazardous lava flows, and lava dome collapses that often generates lethal pyroclastic flows (hot avalanches of ash, gas, and volcanic rock fragments that travel at speeds up to 100 miles per hour).

In 2013, the VHP began a five-year collaborative project with scientists of the Saudi Geological Survey (SGS) for a volcano hazard assessment for the Harrat Rahat volcanic field. The city of Al-Madinah al-Munawarrah (herein referred to as Al-Madinah) is located at the northern edge of this very large and historically active volcanic field. The most recent eruption from this field, 755 years ago, sent lava flows into the area of the present city. This joint USGS-SGS project will provide specific information on the expected frequency of eruptions, and where these eruptions can threaten population centers and critical

infrastructure. Research findings of the project will guide development of a permanent sophisticated integrated monitoring infrastructure and data analysis system, based in Jeddah.

Collaboration with National Science Foundation (NSF)

The USGS is a major participant in the NSF's $5 million per year GeoPRISMS (Geodynamic Processes at Rifting and Subducting Margins) Program, which will study the geology and geophysics of continental margins, focusing on the Cascadia and the Alaskan-Aleutian subduction zones. VHP scientists worked closely with their academic partners to secure $3 million in GeoPRISMS funding for a "slab-to-surface" geophysical and geochemical imaging effort at Mount St. Helens. This collaboration will take place over the next three years and promises to reveal the volcano's internal systems with unprecedented resolution. Similar collaborative research opportunities for projects in the Alaskan-Aleutian subduction zone are anticipated in 2014, and will most likely be projects with two to three year durations extending into 2015 and 2016. VHP scientists have already taken active roles in GeoPRISMS prioritization workshops focused on the Alaskan-Aleutian margin.

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Activity: Natural Hazards
Subactivity: Landslide Hazards

2013 Actual: $3.0 million (20 FTE)
2014 Enacted: $3.5 million (22 FTE)
2015 Request: $3.5 million (22 FTE)

Overview

Landslide hazards research concentrates on understanding landslide processes, developing and deploying instruments that monitor threatening landslides, and forecasting the onset of catastrophic movement of future landslides. Research on processes and forecasting methodologies is conducted on the types of landslides that result in human and economic losses in the United States such as landslides related to steep slopes, heavy rains, and vegetation loss due to wildfires.

USGS scientists respond to landslide emergencies and disasters nationwide. Federal, State, and local agencies are assisted through landslide site evaluations and are provided strategies for reducing ongoing and future damages from landslides. USGS expertise is used when foreign disasters occur; the USGS works with the USAID OFDA in responding to appeals for technical assistance from affected countries.

The USGS deploys near-real-time monitoring systems at active sites to gather continuous rainfall, soil-moisture, and pore-pressure data needed to understand the mechanisms of landslide occurrence. Such understanding can form the scientific underpinnings for early warning of conditions that may trigger landslides.

For example, the Landslide Hazards Program (LHP) works in conjunction with the National Weather Service (NWS) to issue advisories regarding the potential for debris flow activity (fast moving landslides that are potentially deadly and destructive) in previously burned areas in southern California. The models used for these advisories are being applied to other areas in the intermountain West as well.

Consistent with Interior's goal to protect lives, resources, and property by providing information to assist communities in managing risks from natural hazards, the USGS provides timely information through the National Landslide Information Center (NLIC). The Center communicates with the public about current emergency responses and provides information to the external user-community through fact sheets, books, reports, and press releases.

Program Performance

Primary LHP activities include conducting landslide hazard assessments, landslide monitoring, and disseminating landslide information.

Landslide Hazard Assessment Activities

In 2013, the LHP delivered emergency assessments of debris flow hazards following several major fires in Colorado and California. The report and maps generated from these assessments were provided to the public, the U.S. Forest Service (USFS), the NWS, and local county emergency response, public works, and flood control agencies before the onset of winter rains. In addition, LHP scientists responded after a record-breaking rainstorm hit northern Colorado in September 2013, causing major flooding and over 1,200 debris flows and landslides. Of the deaths reported in this event, half were caused by debris flows. A hazards assessment of this major event is underway.

The LHP provides susceptibility maps, hazard assessments, and emergency warnings to a broad range of Federal and State agencies ranging from the USFS to local community emergency managers. All of these jurisdictions use USGS products to mitigate the effects of landslides and debris flows through land use planning, response planning, and warning systems. In 2014 and 2015, the LHP will continue to provide information to counties and other jurisdictions in Oregon, California, Colorado, Pennsylvania, New York, Tennessee, and to Interior land management agencies along with other Federal agencies that incorporate this information into emergency response and land use plans and warning systems. Because of the record-breaking storm in Colorado during September of 2013 that caused major flooding and landslides, the LHP will be concentrating considerable effort in 2014 and 2015 to characterize and understand the causes and conditions that contributed to the over 1,200 landslides and debris flows that took place. These landslides caused major damage to property and infrastructure, and killed three people. The LHP will work closely with county emergency managers and the USFS in this effort.

In 2013, the LHP published a large number of major research publications with a broad range of applications including: (1) a text book on hillside hydrology and stability which provides a framework to analyze and predict rainfall-induced landslides, low-cost method to measure the timing of post-fire flash floods and debris flows; (2) a study of landslide dams and their stability that is critical for assessing dam-breach and consequent flooding downstream (3) a comprehensive inventory of rockfalls in Yosemite National Park that can be used to calibrate and refine rockfall run-out models used for hazard analyses; and (4) a new model that may be useful for predicting debris flow surges based on the characteristics of basins and channels.

Landslide Monitoring Activities

Sustained efforts in landslide monitoring have led to significant advances in understanding slope stability and landslide processes. In 2013 and 2014, the LHP will continue to develop rainfall thresholds for areas burned in the desert Southwest, and Western and Rocky Mountain States that will refine the predictive capabilities of the joint NOAA/USGS early warning system. This will also monitor and analyze the rainfall response of landslides and landslide-prone areas in western Oregon, at the Ferguson landslide near Yosemite National Park along U.S. Highway 50 in California, and at Chalk Cliffs in Colorado.

In 2014 and 2015, the LHP will to expand and improve our post-fire debris flow warning system. Improvements will include a new product delivered in near real-time that provides debris flow susceptibility maps to emergency responders. Getting these products to first responders more quickly and

in more areas affected by major wildfires is the main consideration of the LHP. In 2014 and 2015, the USGS's partnership with the National Weather Service will expand to involve interactions with more Weather Field Offices in Western States, and will include landslide warnings related to hurricanes in the Eastern States.

Landslide Information Dissemination Activities

The LHP will continue to respond to inquiries from the public, educators, and public officials on hazard mitigation, preparedness and avoidance strategies for landslide hazards. The NLIC will continue to provide leadership for the National Landslide Hazard Exchange Group, a group of landslide experts from the USGS and State geological surveys who are striving to create an inventory of landslides in the United States.

The Landslide Handbook, "*A Guide to Understanding Landslides,*" was translated into Portuguese, Japanese, Chinese, and Spanish with the dedicated help of the Geological Survey of China and the World Bank. This publication, coauthored by USGS and Geological Survey of Canada scientists, is an important layperson's guide that explains what citizens can do to mitigate the threat of landslide hazards. In 2011, this publication won the Geological Society of America Burwell Award and the International Coalition of Landslides Best Publication Award. In 2012, the translation of this handbook into Ukrainian was begun; in 2014, the handbook is being republished by the International Consortium on Landslides and will be distributed to its members around the world.

In 2012, the LHP launched a new Web site called "*Did You See It*", which allows citizens to report landslides that then become part of a national inventory. The USGS hopes that this new interactive citizen-science initiative will go far in educating the public about landslide hazards, as well as eventually contributing vital data to the national inventory of landslides. In 2014, the program plans to conduct a customer satisfaction survey of citizens who have contributed to the Web site.

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Activity: Natural Hazards

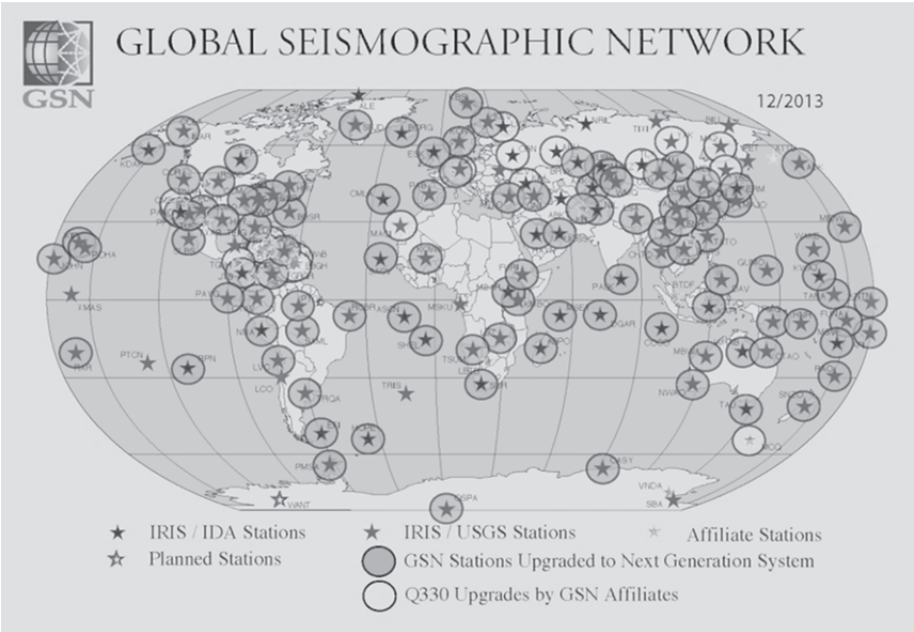
Subactivity: Global Seismographic Network

2013 Actual: $4.9 million (10 FTE)
2014 Enacted: $4.9 million (10 FTE)
2015 Request: $4.9 million (10 FTE)

Overview

The Global Seismographic Network (GSN) provides high-quality seismic data needed for earthquake alerts and situational awareness products, tsunami warnings, national security (through nuclear test-ban treaty monitoring and research), hazard assessments and earthquake loss reduction, as well as research on earthquake sources, and the structure and dynamics of the Earth. The GSN is a joint program between the USGS and the National Science Foundation (NSF), and is implemented by the USGS, the Institute for Geophysics and Planetary Physics (IGPP) of the University of California at San Diego, and the Incorporated Research Institutions for Seismology (IRIS, a consortium of universities). The network currently consists of more than 150 globally distributed seismic stations, installed over two decades by the USGS and the IGPP.

Network operation is accomplished in cooperation with international partners who, in most cases, provide facilities to shelter the instruments and personnel to oversee the security and operation of each station. USGS responsibilities include station maintenance and upgrades, overseeing telecommunications, troubleshooting problems and providing major repairs, conducting routine service visits, training station operators, providing limited financial aid in support of station operations at sites lacking a host organization, and ensuring data quality and completeness.



Because of its real-time data delivery, the GSN has become a critical element of USGS hazard alerting activities, as well as the tsunami warning system operated by the National Weather Service of NOAA. Ninety-seven percent of GSN stations transmit real-time data continuously to the USGS National Earthquake Information Center in Golden, Colorado, and the NOAA Tsunami Warning Centers in Hawaii and Alaska, where they are used to rapidly determine the locations, depths, magnitudes, and other parameters of earthquakes worldwide, in conjunction with data from other networks. The high quality of GSN data allows for the rapid determination of the location and orientation of the fault that caused the earthquake, and provides an estimate of the length of the fault that ruptured during the earthquake. These parameters are essential for modeling earthquake effects.

An additional important aspect of GSN activities is evaluating, developing, and advancing new technologies for seismic instrumentation, sensor installation, and data acquisition and management. Stations with unusually high background noise are relocated to quieter sites or configurations (e.g., burying sensors in boreholes) to improve performance so that smaller events (earthquakes or explosions) or other signals of interest may be detected. Between 2010 and 2013, the USGS and its partners upgraded and standardized more than 130 GSN stations, reducing operating costs-per-station and building future operating efficiencies into the network.

All GSN data are available to the public and scientists around the world via the IRIS Data Management Center (DMC). Data from the GSN are used extensively for basic and applied research on earthquakes, Earth structure, and other geophysical problems by studies conducted and supported by the USGS and agencies such as the NSF, the U.S. Department of Energy, and the U.S. Air Force.

Program Performance

In 2013-2014, the USGS is procuring replacements for the borehole seismometers that make up one-third of the stations of the network, which have been failing in recent years, degrading the quality of the global dataset. The funding for the purchase and testing of the new sensors was provided to the USGS, in 2012, by the Department of Energy's National Nuclear Security Administration. Anticipating success with the procurement, the USGS will require future additional funding to install the sensors in 2015-2016,

In 2015, the USGS will—

- Continue to operate the 100-station, USGS portion of the GSN at a high level of data recovery, real-time telemetry performance, and high cost efficiency.
- Begin testing of new GSN sensors, which are being procured in 2014 with funds provided by the Department of Energy.
- Work with partners such as IRIS, the U.S. Air Force, the Comprehensive Nuclear Test Ban Treaty Organization, and the International Federation of Digital Seismographic Networks, to improve the efficiency of station operations and reduce maintenance costs.

Other Agency programs will continue to be supported through this effort, including—

- NOAA's Tsunami Warning Program and National Tsunami Hazard Reduction Program;
- The U.S. Air Force and Department of Energy nuclear test monitoring research programs; and
- The NSF, which funds projects that use GSN data for basic research on Earth structure and dynamics, seismic wave propagation, earthquake source complexity, and climate change.

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Activity: Natural Hazards
Subactivity: Geomagnetism

2013 Actual: $1.9 million (13 FTE)
2014 Enacted: $1.9 million (13 FTE)
2015 Request: $1.9 million (13 FTE)

Overview

Ground-based observations of geomagnetic activity, such as those provided by the USGS Geomagnetism Program, play a key role in space weather monitoring. The Program provides magnetic field data and related products to governmental, academic, and private institutions. The Program also conducts research on the nature of geomagnetic variations for purposes of scientific understanding and hazard mitigation. USGS work is coordinated with Department of Defense, NOAA, NASA, and NSF, through the National Space Weather Program (NSWP). The Program also cooperates on an international scale through INTERMAGNET, a worldwide consortium of magnetic observatory programs, and through the International Association of Geomagnetism and Aeronomy.

Magnetic storms result from the dynamic interaction of the solar wind with the Earth's magnetosphere and ionosphere. Large magnetic storms represent a potential hazard for the activities and infrastructure of a modern, technologically-based society. For example, during the magnetic storm of October 2003, orientation systems used for directional drilling for oil and gas in Alaska were disrupted, as were aircraft navigation systems around the world that rely on accurate magnetic readings. Interference with over-the-horizon radio communication forced cancellation of airline polar routes and their diversion to lower latitudes. Communication interference forced the Department of Defense to cancel a maritime interdiction mission. GPS accuracy was significantly degraded, affecting land and ocean surveys, as well as commercial and military aircraft navigation. Civilian and military satellites were put into a protective operating mode, other satellites were damaged, and a Japanese scientific satellite was permanently disabled. Astronauts onboard the International Space Station took precautionary shelter to avoid excessive levels of radiation. A recent study sponsored by the National Academy of Sciences estimated that an even larger storm could have an economic impact of one to two trillion dollars on the United States economy.

Damaging magnetic storms occur an average of four times each decade, with smaller events occurring more frequently. Magnetic storms can be detected up to two days in advance by monitoring the sun. They come in all sizes, but the largest storms tend to occur when sunspots (concentrations of magnetic energy on the surface of the sun) are most numerous. The monitoring of such "space weather" is a shared responsibility of the NSWP. Within the NSWP, the USGS has the unique responsibility of monitoring geomagnetic activity at the Earth's surface, where most of the damaging effects of magnetic storms occur.

Program Performance

Program activities include operating geomagnetic observatories, managing data and developing products, and conducting scientific research to develop ground-based diagnostics for hazard mitigation. These activities will continue in 2015, with an emphasis on developing products useful for mitigating the consequences of geomagnetic storms.

Geomagnetic Observatory Operations

The USGS operates a network of 14 magnetic observatories, distributed across the United States and its territories. Data are collected continuously from each observatory by sensitive instruments housed in buildings designed to provide environmental stability and to ensure long-term baseline accuracy. Each site is visited regularly to conduct calibrations of the instruments. Data are transmitted in real time to project headquarters in Golden, Colorado, via a set of satellite and Internet linkages. Ongoing operational systems upgrades, combined with portable acquisition system design for testing of new operational configurations and rapid deployments, will benefit users through improved data quality, timeliness, and availability.

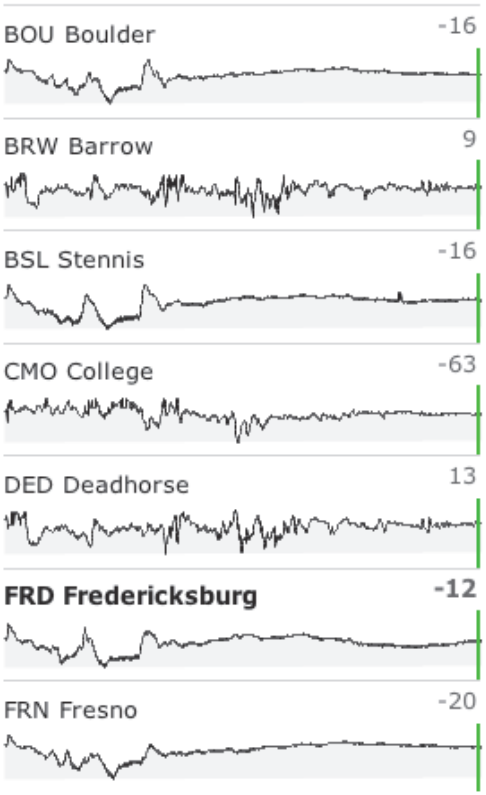
Within this program element, 2015 performance will build upon the following 2013 and 2014 accomplishments:

- Established a new partnership with Schlumberger (SLB) to design a new magnetic observatory in the Yamal peninsula of Russia. Pending an agreement with the Geophysical Center, Russian Academy of Sciences (GCRAS), USGS staff will travel to Russia to assist with the installation of observatory equipment that is modeled on USGS practice. The USGS also hosted specialists from the GCRAS to discuss collaborations centered on observatory improvements in Russia.
- Initiated collaboration with Natural Resources Canada for a joint instrument calibration facility at the USGS Fredericksburg, Virginia, observatory.
- Produced quasi-definitive data for eight observatories monthly, and delivered to the geomagnetism and Intermagnet Web pages for public download.
- Completed initial testing of a newly-designed “ObsRio” data acquisition system. Due to its low power requirements and high real-time operational reliability, this system will be deployed as the primary acquisition system for the new Russian observatory.
- Negotiated a draft agreement with the NOAA Space Weather Prediction Center, to address joint activities for fostering development and dissemination of space weather data, tools, and models to enhance products and services for the power grid industry.

Data Management and Product Development

As data from the observatories are received at the USGS Geomagnetic data center in Golden, Colorado, they undergo initial processing and are organized for immediate transmission to both NOAA's Space Weather Prediction Center (SWPC) in Boulder, Colorado, and the Air Force Weather Agency in Omaha, Nebraska. For longer-term studies, the magnetic data are further refined through scheduled calibrations of magnetometer systems at each observatory. This ensures that the data are useful for research on rapid magnetic field variations and for mapping the field on a global scale. Fully calibrated, definitive data are published yearly in cooperation with foreign national geomagnetism programs (through INTERMAGNET). The USGS also distributes magnetic field data, maps, and real-time data products via the Internet (*geomag.usgs.gov*).

Key among these products is a real-time index of magnetic activity, called *Dst*, which is widely used. Kent Tobiska, the President of Space Environment Technologies, recently stated that the USGS *Dst* product allowed his company to provide guaranteed forecasts to the USAF Joint Space Operations Center —a system that is considered part of the national defense critical infrastructure.



USGS records of the October 1, 2012 geomagnetic storm. The main phase of this storm had a minimum of -119nT, placing it in about the 65th percentile.

Within this program element, 2015 performance will build upon the following 2013 and 2014 accomplishments:

- Significant progress was made on migration of critical operational processes to virtual servers, thereby providing redundancies with real-time systems monitoring capabilities;
- Data from four Russian observatories are now being imported and utilized in Auroral Electrojet index calculations, as a result of collaboration with NOAA/SWPC and Roshydromet;
- Initial back-up capabilities were implemented with NOAA/SWPC;
- Several major operations software packages will be upgraded and deployed to improve methods of display, calibration, and processing of magnetic data;
- Plans are being made to transition to a centralized database for all real-time and historical magnetic data, and a robust public-facing user-interface for accessing this data.

Scientific and Applications Research

The USGS Geomagnetism Program conducts research to better understand basic physical processes and the effects of solar-terrestrial interaction on the infrastructure and activities of our modern, technologically-based society. In response to recent heightened concern for the security of the Nation's electrical power-grid infrastructure, USGS staff have been developing methods for estimating, in real-time, the storm-time induction of electric fields in the Earth's crust and regional electric field estimates. This work is being conducted in collaboration with the Colorado School of Mines, the USGS Crustal Geophysics and Geochemistry Science Center, and the NOAA/SWPC.

USGS scientists are also conducting research on methods for estimating the rate of occurrence of rare magnetic storms, including methods for estimating the uncertainties associated with these occurrence rates. Results from these projects will greatly improve assessments of geomagnetic hazards and the risks that they pose.

Within this program element, 2015 performance will build upon the following 2013 and 2014 accomplishments:

- Completed an interagency agreement for the National Space Weather Capability.
- Published research on: (a) an investigation of possible solar-terrestrial triggering of earthquakes, (b) the frequency-domain spectra of quiet-time geomagnetic variation, (c) the investigation of possible correlations between sunspots and climate, (d) the analysis of crustal electric fields for historical magnetic storms, (e) magnetospheric current modeling, and (f) the interpolation of magnetic disturbance over North America.
- Began new scientific analysis on: separation of global magnetic variation related to the magnetospheric ring current from those induced in the Earth's lithosphere; statistics of disturbances on electric power grids possibly caused by geomagnetic activity; multi-variate statistical analysis of ground magnetic disturbance; and automated statistical classification of magnetic disturbance types.
- National and international coordination activities, including: INTERMAGNET; National Space Weather Program; Geomagnetic Inter-agency Working Group; North American Electrical Reliability Corporation, Geomagnetic Disturbance Task Force; Natural Environment Observing (NEO) systems assessment for the Office of Science and Technology Policy; Space Weather Workshop power-grid meeting; and Space Weather Community Operations Workshop.

Activity: Natural Hazards
Subactivity: Coastal and Marine Geology

2013 Actual: $40.3 million (226 FTE)
2014 Enacted: $41.3 million (227 FTE)
2015 Request: $40.6 million (226 FTE)

Overview

The Coastal and Marine Geology Program (CMGP) applies capabilities in marine geology, geochemistry and oceanography to provide information and research products on conditions and processes critical to the management of the Nation's ocean, coastal and Great Lakes environments. Program activities include characterizing and understanding ocean and coastal geological settings and processes to provide the data and tools for regional and national assessments of coastal and marine conditions, change, and vulnerability. Integrated mapping and research activities support development of data resources, models and decision-support tools to address policy and management issues at national and regional scales.

Program Performance

In 2015, ongoing priority studies will address coastal resilience and climate adaptation through regional and national studies of coastal change hazards; cooperative research on marine gas hydrate systems as part of the global carbon systems; and delineation of the Extended Continental Shelf as an expressed policy of the Administration consistent with the UN Convention on the Law of the Sea. Relevant projects additionally include studies of coral reef health to support Ecosystem-Based Management and Climate Adaptation; integrated research to inform regional restoration of coastal estuaries; cooperative mapping, including lidar and seafloor mapping to support State, tribal, and Federal objectives; and improved provision of data, models, and assessments to inform policy and management of coastal and ocean resources. Planning and implementation of this portfolio of activities is the result of cooperative partnerships with other agencies and local stakeholders who expect timely project completion and provision of products.

The CMGP supports field and interpretive activities to provide environmental mapping to meet management needs within Marine Sanctuaries, National Parks, Fish and Wildlife Refuges, Marine Monuments, and for management of fisheries and other living marine resources in State and Federal Waters. In 2015 and beyond, benthic habitat and other mapping for State and Federal management agencies will only be supported where it enables scientific studies addressing CMGP research priorities and where substantial cost-sharing from partnering agencies is available.

Follow-on Research related to Impacts of Hurricane Sandy

The CMGP partnered with the USGS Center for Integrated Data Analysis (CIDA) to develop a Web-based version of the Digital Shoreline Analysis System, called DSASweb. This is a tool that coastal

scientists, managers, and the public can use to analyze their own historical shoreline data, perform custom analyses on USGS data, or browse completed USGS shoreline change datasets. The CMGP and CIDA began development on a Coastal Change Hazards Portal, and completed an initial public release in 2013. The portal is populated with published data and vulnerability assessments for extreme storms, long-term coastal change, and sea-level rise. Users can search, view, and share multiple USGS coastal vulnerability products. Sandy supplemental funds will be used in 2014 to continue development of the Coastal Change Hazards Portal. The CMGP and CIDA plan two to three new releases to enhance portal functionality and support user application of CMGP developed data and tools.

The USGS has produced numerous reports, data series, and Web pages because of pre- and post-storm assessments of Hurricane Sandy impacts. Days before Sandy made landfall in southern New Jersey, the USGS Hurricanes and Extreme Storms team set out to determine how the storm was likely to affect the coastal landscape. The team used NOAA wave height and water level forecasts in combination with a USGS storm-impact scale to predict patterns of sediment erosion and deposition (*http://coastal.er.usgs.gov/hurricanes/sandy/coastal-change/*) from the landfalling storm. In addition, a pre-storm Global Positioning System (GPS) ground survey was conducted for Fire Island, New York, an area that experienced substantial coastal change during the storm. Along the severely impacted New Jersey coast pre-storm topographic measurements were made using EAARL-B (Experimental Advanced Airborne Research lidar). These pre-landfall measurements provided crucial baseline information for assessing and understanding the storm's impacts. After the storm, the team acquired imagery from a variety of sources, documenting beach and dune erosion, overwash (occurs when storm waves overtop dunes and carry sand inland), and inundation (complete submersion of beach and dunes). This imagery provided objective observations to "ground-truth," evaluate, and improve USGS pre-storm assessments. Aerial photographs were acquired during a two-day mission flown along the shoreline from the Outer Banks of North Carolina to coastal Massachusetts. Post-storm photographs were compared with those taken before the storm to get a qualitative look at coastal change throughout the impact zone. To view examples, visit *http://coastal.er.usgs.gov/hurricanes/sandy/photo-comparisons/*. Many more photo pairs are posted at *http://coastal.er.usgs.gov/hurricanes/sandy/post-storm-photos/obliquephotos.html.*

Hurricane Sandy probabilities of coastal erosion (10/29/12).

Seven projects, funded by emergency Hurricane Sandy disaster relief appropriations, use scientific monitoring, mapping, modeling, and forecasts to support broader recovery efforts throughout the impacted region. This scientific work assists Interior's efforts to restore Federal lands and facilities and assists States, cities and communities to recover and rebuild in a more resilient manner.

The projects are—

(1) Coastal Mapping Products and Impact Assessments – will improve digital elevation products for the coastal United States as part of a full systems project that documents performance of EARRL-B detector, enhances lidar-processing algorithms, and rapidly produces digital interpretive products that document coastal change and establishes the post-storm vulnerability of coastal communities.

(2) Impacts to and Vulnerability of Coastal Beaches – will validate and refine forecasts of impacts of extreme storms 24 to 96 hours before an extreme storm makes landfall.

(3) Coastal Hazards Information and Decision Support Portal – will deliver hazards information that is easily retrieved and applied by non-scientists so that data, model outputs, and vulnerability forecasts inform emergency measures before, during and after storms and other coastal hazards.

(4) Barrier Island and Estuarine Wetland Physical Change Assessment – will aid coastal ecosystem managers in understanding long- and short-term impacts of storms on physical conditions of wetland-dominated ecological habitats.

(5) Fire Island, NY: Linking Coastal Processes and Vulnerability – offshore and shoreline mapping and oceanographic observations and models will improve understanding of sediment supply and exchange between offshore sand features and beach/dune systems along Fire Island to model long-term barrier evolution and storm response and recovery.

(6) Delmarva Peninsula: Coastal Vulnerability and Resource Assessment – will improve knowledge of the geologic framework and sand transport of a series of Federal and State wildlife reserves to provide regional resource managers with the region's first high-resolution geologic, elevation, and coastal condition maps.

(7) Estuarine Response to Storm Forcing – will measure and model hydrodynamics and sediment transport within Atlantic lagoonal estuaries in order to produce alternative future scenarios that combine natural changes with different management strategies to enhance resilience.

Coastal Lidar Mapping

The 2014 enacted appropriations included an increase of $1,000,000 for coastal mapping using lidar. These funds will enhance USGS mapping and research to enhance the availability and application of lidar and lidar -based products. Ongoing CMGP efforts (in support of the 3DEP program and in collaboration with NOAA and the USACE) to develop seamless topographic/bathymetric coastal elevation models (CoNED) based on accurate and up-to-date lidar data will be enhanced, thereby accelerating development of several regional CoNED models. Support will also be provided for development of improved methods for mapping coastal features, including coastal bluffs and complex wetland shorelines. These will facilitate application of lidar data to more diverse coastal settings, expanding the value and use of lidar for research and management. A substantial portion of these funds will provide additional collection of lidar data for USGS research supporting regional restoration partnerships and coastal change modeling in the Pacific Northwest, Gulf of Mexico, and elsewhere.

Sandy supplemental funds are supporting USGS efforts to develop and deliver lidar -based products to forecast coastal storm vulnerability and to assess storm impacts. Resources provided here will ensure those tools are available outside the Sandy impact zone in the event of major hurricane landfall in 2014.

Barrier Island Evolution, Gulf of Mexico

The Barrier Island Evolution Project addresses a research gap between the short time scale of individual storms (hours to days) and the longer time scales associated with the historic and geologic evolution of the coastal system (decades to millennia). The project integrates two of the Coastal and Marine Geology Program's strengths in studying coastal-change hazards—assessment of storm impacts and characterization of coastal geologic framework. Combining these strengths with modeling of morphology will make possible predictions of barrier-island behavior over time scales useful to resource managers (one to five years). This project was sparked by an explosion on the Deepwater Horizon oil rig (on April 10, 2010) drilling at the Macondo Prospect site in the Gulf of Mexico that resulted in a marine oil spill that continued to flow through July 15, 2010. One of the affected areas was the Breton National Wildlife Refuge, which consists of a chain of low-lying islands, including Breton Island and the Chandeleur Islands, and their surrounding waters. A sand berm was constructed seaward of, and on, the island chain. Repeated Landsat and SPOT satellite imagery and airborne lidar were used to observe the disintegration of the berm over time. The methods used to analyze the remotely sensed data and the resulting derived, released in two publications, can be accessed using the new (January 2014) project Web site: *http://coastal.er.usgs.gov/bier/*.

Coral Health Research Off the Northern U.S. Atlantic Coast Aided by Telepresence-Enabled Research Cruise

USGS scientists worked with colleagues from NOAA and several academic institutions to explore submarine canyons, landslides, methane seeps, and seamounts off the northeast U.S. Atlantic coast. "Telepresence" video technology enabled USGS research staff to participate in the expedition of the NOAA Ship *Okeanos Explorer* without actually being onboard. The telepresence capability supplied by the University of Rhode Island (URI) Inner Space Center and NOAA's Ocean Exploration Research (OER) program enabled most USGS scientists to participate in the ROV's discoveries from their own offices and homes, or occasionally from the Exploration Command Center located at the URI Bay Campus. Exploring and imaging submarine canyons facilitated a better understanding of the distribution, species diversity, habitat affinities, and patchiness of enigmatic deep-sea animals. The canyons were found to contain diverse communities of habitat-forming foundation species (for example, corals and sponges) that host a wide variety of associated fauna, including, but not limited to, squat lobsters, brittle stars, shrimp, crabs, fishes, shark egg cases, and octopuses. Population size and species diversity of canyon fauna appeared to be a function of water depth, the presence and strength of bottom currents, and substrate type and morphology. Thus, the geology, biology, and ecology of submarine canyon environments are tightly intertwined. Use of telepresence capability is a boon for USGS coral health research, drastically reducing travel costs and staff overtime associated with onboard ship research.

North Atlantic Cruise – Extended Continental Shelf Characterization

The USGS will conduct a multi-purpose ocean exploration cruise in August-September 2014 to conduct geophysical surveys to characterize the geologic structure along deep-water portions of the U.S. North Atlantic Margin. This cruise will meet objectives for (1) delineating the geologic features that extend the limits of the U.S. Continental Shelf in the North Atlantic, (2) advancing understanding of the geologic conditions that could produce submarine landslides resulting in tsunamis, and (3) identifying geochemical conditions associated with methane seeps and changes in carbonate chemistry that drive ocean acidification. The USGS is working with the National Science Foundation to maximize use of Federal oceangoing vessels and to provide opportunities for young/early career scientists. This effort is planned to continue in 2015, as part of a strategy to ensure the USGS maintains a viable marine geophysics capability as required to meet its unique responsibilities as the Federal marine geologic research program.

Sediment Transport in San Francisco Bay, Delta and Coastal System, CA

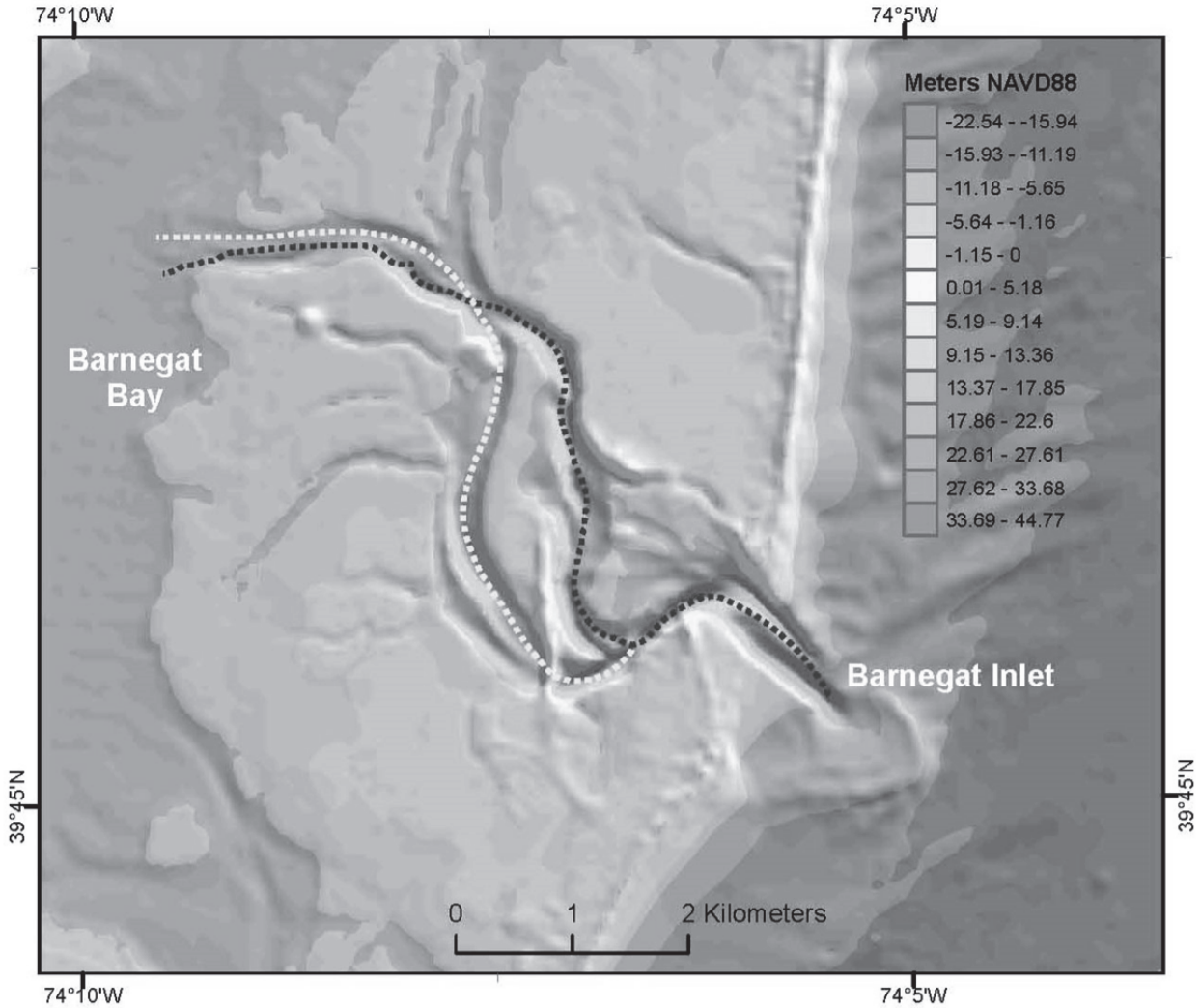
Wherever water flows, it almost always carries sediment—particles of sand, silt or clay that flow, scour, accumulate and disperse to help form and reform Earth's features over time. Sediment helps to create natural habitats and to alter geography, and an understanding of the complex processes of sediment transport and accumulation is key to many planning and conservation decisions. In the San Francisco Bay Area—an estuarine region defined by its bay, rivers, delta and coast—sediment plays a particularly major role. Sediment helps shape the Bay Area's quality of life, from its water quality to the health and stability of its coastal beaches to the ongoing restoration of its tidal wetlands. Dams, dredging and a

legacy of hydraulic mining have left their marks on the Bay Area's system of "sediment transport, making USGS science crucial to charting the potential impacts of future human interventions.

The first ever compilation of research focused on sediment transport in the San Francisco Bay coastal system was published in November as a special issue of the journal *Marine Geology*, edited by USGS scientists. "The information provided in the *Marine Geology* special issue has fundamentally changed the way managers are thinking about the sediment supply to San Francisco Bay and the outer coast, and how we manage projects," said Brenda Goeden, Sediment Program Manager of California's San Francisco Bay Conservation and Development Commission. "For example, the suspended-sediment research is helping managers understand how sediment supply will affect habitat restoration projects around the Bay that are funded by millions of public dollars, and it offers a rare opportunity to intervene where sediment supply may not support a given restoration site in the face of rising seas. Similarly, the coarse-grained-bedload findings inform policy analysis of projects proposing to extract large quantities of coarse-grained sediment from the Bay system."

Water Quality Dynamics in Barnegat Bay–Little Egg Harbor Estuary, NJ

Water quality in the Barnegat Bay–Little Egg Harbor estuary along the New Jersey coast is the focus of a multidisciplinary research project. USGS scientists have collected data with a suite of geophysical tools, such as a swath bathymetric sonar for measuring seafloor depth, sidescan sonar for collecting acoustic-backscatter data (which provides information about seafloor texture and sediment type), and a subbottom profiler for imaging sediment layers beneath the floor of the estuary. The resulting data provide the first comprehensive look at the estuary's morphology (shape of shore and seafloor) and geology (composition and geometry of seafloor and subseafloor materials). Seafloor-mapping data and hydrologic measurements provide the foundation to develop and calibrate models of the estuary, which predict how the water and sediment within it move in response to tides, storm currents, and other influences. The parallel application of mapping, measuring, and modeling ensures that all efforts are complementary and optimized for the widest possible use. Results from this integrated study will help guide efforts to manage and improve water quality in the estuary, as well as provide the framework for many new research projects being conducted by regional, State, and Federal agencies and universities. These projects will shed light on how past, present, and future water quality in the Barnegat Bay–Little Egg Harbor estuary will affect seagrass, benthic invertebrates, phytoplankton, zooplankton, harmful algae, and shellfish. Ongoing collaborative field programs, combining expertise in coastal geology, hydrologic science, and physics-based modeling, are a template for fruitful interdisciplinary science by the USGS and partners.



Barnegat Inlet, showing changes in the inlet navigation channel and island morphology between the 1930s (light line and 2011 (dark line).

Gas Hydrates

This USGS project will build upon recent discoveries related to the distribution of gas hydrate seeps on the northern Atlantic margin, which is much greater in extent than previously known. Researchers will continue to collect imagery that tracks the size of gas-bubbles and emission rates thereby improving the understanding of methane gas fluxes/plumes. These seeps are also characterized by special carbonate minerals formed as a result of anaerobic methane oxidation, mussel communities that rely on methane or hydrogen sulfide, and widespread bacterial mats. Future data collection will result in valuable information on the biodiversity of chemosynthetic communities at newly discovered seeps and greatly expand the basis for comparison with seeps that had been previously described on the northeastern and southeastern U.S. margin. Work in the Arctic will include coring into the subsea floor permafrost layers that are sources of methane to the ocean. Scientists will calculate the concentration of organic carbon isotopes that are absorbed into the ocean versus the amount released to the atmosphere. These

calculations will better inform models of change of atmospheric temperatures from increasing concentrations of greenhouse gases.

Sea-Level Rise Hazards

Projections of sea-level rise (SLR) for the next century indicate that future impacts will be large and sustained, including land loss from inundation and erosion, migration of coastal landforms, increased elevation and duration and frequency of storm-surge flooding, wetland losses, and changes in coastal aquifer hydrology. The ability to assess and forecast the form and magnitude of these changes is limited by uncertainties in both the input data that describes the current coastal environment and knowledge of the underlying processes associated with SLR that will generate the future environment. The USGS is developing an effective means to integrate geologic, biologic, and hydrologic assessments of SLR impacts such that the interactions between important processes are considered. During 2015, the USGS will develop mobile applications that leverage crowdsourcing to better document and understand changes to the shape and elevation of islands and coastal beaches that impact critical habitats. The USGS is partnering with the U.S. Fish and Wildlife Service, the National Park Service, several mid-Atlantic and New England States' natural resource managers and The Nature Conservancy to formulate portable app criteria to address breeding and nesting needs for the islands and beaches that are the backbone of the North Atlantic Flyway.

Coral Reef Ecosystems Studies (CREST)

Coral reefs are massive, bio-mineralized structures that protect coastlines by acting as barriers to coastal hazards such as hurricanes, tsunamis, and other assaults. Presently under threat from global climate and land-use change impacts, there is a critical need for science that can guide management policies for these critical natural resources. The goal of the CREST project is to increase understanding of the constructive processes of calcification and reef building and how they are and have been influenced by ocean temperature, chemistry (acidification), and water quality. The CREST calcification monitoring network (in operation since 2009) was expanded in 2013 to include two additional species of corals that are being considered for listing as endangered under the Endangered Species Act. One site was relocated so that the five CREST task leaders can work together on a new, integrated and co-located study. Using a deployed instrumentation package (the ocean carbon system, "OCS"), USGS researchers will quantify water-column carbonate chemistry over multiple scales and correlate those data with calcification rates, microbial processes, reef geomorphology, and sediment production. The researchers will also continue retrospective studies to understand how environmental variables have influenced coral and reef growth historically and use geologic and geochemical records to reconstruct paleotemperature, salinity, and ocean chemistry. Important partners include three National Parks (Dry Tortugas, Virgin Islands, and Biscayne), the Florida Keys National Marine Sanctuary, the Florida Fish and Wildlife Commission, and the NOAA Atlantic Oceanographic and Meteorological Laboratory.

Leadership on Coordinated Mapping and Coastal Data Interoperability

Beginning in 2012, the USGS ramped up efforts to provide prioritized seafloor mapping activities to address coastal resources management requirements of Massachusetts and California. As part of this, the USGS increased investment for conceptualizing a coastal component of the National Elevation Data (CoNED) as an integral part of the National Geospatial Program's 3DEP initiative. Accurate and up-to-date elevation data is a foundational requirement for Coastal and Marine the function of Spatial Planning (CMSP) implementation. The USGS co-authored the draft National Coastal Mapping Strategy (NCMS) in cooperation with NOAA, the U.S. Army Corps of Engineers and various other agencies. The goal of the National Coastal Mapping Strategy is to build upon existing interagency cooperation in coastal mapping to improve coordination on the acquisition, processing, dissemination, archiving, and broad use of airborne lidar elevation and other associated aerial mapping data in the coastal zone.

Since 2012, the USGS has supported the development of the National Information Management System (NIMS) as a fundamental element that would underpin implementation of Coastal and Marine Spatial Planning. The USGS participated in national and regional collaborative efforts to define a structure, adopt data standards consistent with Government-wide information quality needs, to ensure priority USGS datasets (including topography, seabed characterization, and imagery-based land use/landcover) are accessible through ocean.data.gov, and to build a prototype data portal about coastal hazards. A list of accomplishments and future plans follow:

2013 – CMSP NIMS Accomplishments

The USGS fully integrated three major Coastal and Marine Geology systems (Coastal and Marine Geology InfoBank, USGS Coastal and Marine Geoscience Data System, and Coastal Map) into the Core Science Metadata Clearinghouse. The integration of these three major systems complements the work of the USGS Science Data Catalog to establish the USGS Data Plan for accessibility through Data.gov and subsequently through Ocean.data.gov. The Core Science Metadata Clearinghouse harvests the records from these three systems weekly, and currently has 890 datasets ready to be incorporated into Ocean.data.gov once the DOI Catalog is implemented.

The USGS began development on a Coastal Change Hazards Portal, and completed an initial public release. The portal is initially populated with published data and vulnerability assessments for extreme storms, long-term coastal change, and sea-level rise. Users can search, view, and share multiple USGS coastal vulnerability products.

2014 – CMSP planned activities

The USGS will publish a Report, "Data Categories for Marine Planning," written as a collaborative effort between USGS, EPA and NOAA. This document establishes data categories that will provide a framework to both describe ocean datasets and improve find ability and access. The USGS will also refine and document the managed workflow USGS coastal and marine data and ensure that the associated metadata meet the additional requirements for publication in the DOI Catalog, the Data.gov Catalog, and ultimately the Ocean.data.gov community.

2015 – CMSP planned activities

In 2015, the USGS will expand the implementation of the managed workflow throughout the USGS to increase the amount of ocean data and the number of analytical tools being made available to the Ocean community. In 2015, USGS will also use supplemental funds, resulting from Hurricane Sandy, to continue development of the Coastal Change Hazards portal to include a decision-support functionality that integrates vulnerability products across three assessment themes: (1) Understanding and Predicting Storm Impacts, (2) Measuring Long-Term Change, and (3) Understanding Vulnerability to Sea-Level Rise. The USGS co-chaired working group on Climate Change and Ocean Acidification will work with the Subcommittee for Disaster Reduction (USGS co-chaired) and the USGCRP to identify science and technology priorities and opportunities to ensure that preparation and response to extreme events, including federal investments in long-term recovery, effectively promote resilience to climate change. USGS will use this interagency effort to prioritize further development of information and tools that support enhanced resilience, adaptation to climate change, and integration of "green infrastructure" into hazard mitigation. For example, to meet ecosystem-based management goals and objectives, an initial focus is on forecasting coastal habitat sustainability (e.g., availability of suitable piping plover nesting locations).

USGS will continue to prioritize application of its world-class seafloor and coastal mapping capabilities to those regions where partnerships effectively leverage resources and enhance the value of the resulting data and products to USGS research objectives and regional partners, Better characterization of the seafloor and its contribution to sediment transport and providing or removing sand to barrier islands and coastal beaches will be an important component for assessments of vulnerabilities of coastal communities—both human and ecological—from impacts of climate change. In 2015, the CMGP will support collaborative mapping efforts of the Sandy-impacted Delmarva Peninsula.

Activity: Water Resources

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Groundwater Resources ($000)		8,348	8,948	81	0	2,400	11,429	+2,481
	FTE	77	80	0	0	9	89	+9
National Water Quality Assessment ($000)		58,859	58,859	531	0	-300	59,090	+231
	FTE	507	507	0	0	-3	504	-3
National Streamflow Information Program ($000)		27,701	33,701	159	0	1,200	35,060	+1,359
	FTE	153	153	0	0	0	153	0
Hydrologic Research and Development ($000)		10,915	10,915	107	0	301	11,323	+408
	FTE	103	103	0	0	-3	100	-3
Hydrologic Networks and Analysis ($000)		28,884	28,884	289	0	1,250	30,423	+1,539
	FTE	276	276	0	0	-3	273	-3
Cooperative Water Program ($000)		59,474	59,474	351	0	-264	59,561	+87
	FTE	334	334	0	0	-1	333	-1
Water Resources Research Act Program ($000)		3,268	6,500	0	0	-3,000	3,500	-3000
	FTE	2	2	0	0	0	2	0
Total Requirements ($000)		**197,449**	**207,281**	**1,518**	**0**	**1,587**	**210,386**	**+3,105**
	Total FTE	**1,452**	**1,455**	**0**	**0**	**-1**	**1,454**	**-1**

Summary of Program Changes

Request Component	($000)	FTE	Page
Groundwater Resources	**+2,400**	**+9**	
WaterSMART: Groundwater Network	+2,400	+9	B-30
National Water Quality Assessment	**-300**	**-3**	
Ecosystem Priority: California Bay Delta	+1,000	+1	B-14
Ecosystem Priority: Chesapeake Bay	+500	+2	B-15
Ecosystem Priority: Upper Mississippi River	+200	+2	B-17
Water Quality Monitoring	-2,000	-8	B-56
National Streamflow Information Program	**+1,200**	**+0**	
Streamgages	+1,200	+0	B-46
Hydrologic Research & Development	**+301**	**-3**	
Ecosystem Priority: Puget Sound	+200	+1	B-17
Hydraulic Fracturing	+901	+2	B-24
Streamgage R&D	+700	+1	B-46
HR&D Monitoring and Assessments	-1,500	-7	B-56
Hydrologic Networks & Analysis	**+1,250**	**-3**	
Watershed Support, Information Delivery, & Technical Support	-1,500	-7	B-56
National Hydrologic Modeling/Groundwater Sustainability	+750	+3	B-47
WaterSMART: State Water Use Grants	+2,000	+1	B-31
Cooperative Water Program	**-264**	**-1**	
Monitoring and Assessments	-3,264	-9	B-56
Tribes	+1,000	+7	B-47
WaterSMART: Water Use Research	+2,000	+1	B-30
Water Resources Research Act Program	**-3,000**	**+0**	
Funding to State Institutes	-3,000	+0	B-57
Total Program Change	**+1,587**	**-1**	

Justification of Program Changes

The 2015 Budget Request for the Water Mission Area is $210,386,000 and 1,454 FTE, a net program change of +$3,105,000 and -1 FTE from the 2014 Enacted Budget. For more information on the Water Resources Mission Area changes, please see Section B, Program Changes as indicated in the table.

Activity Summary

The Water Mission Area is comprised of seven subactivities—

- Groundwater Resources Program (GWRP, *http://water.usgs.gov/ogw/gwrp*)
- National Water Quality Assessment (NAWQA, *http://water.usgs.gov/nawqa*)
- National Streamflow Information Program (NSIP, *http://water.usgs.gov/nsip)*
- Hydrologic Research and Development (HRD, *http://water.usgs.gov/nrp/hrd)*
- Hydrologic Networks and Analysis (HNA, *http://water.usgs.gov/hna*)
- Cooperative Water Program (CWP, *http://water.usgs.gov/coop*)
- Water Resources Research Act Program (WRRA, *http://water.usgs.gov/wrri*)

Since 1879, the U.S. Geological Survey (USGS) has addressed issues of water availability and quality, drought, and flood hazards. Today, hydrologic professionals and support staff located in all 50 States and Puerto Rico, continue this legacy providing the Nation with critical water information. As the primary Federal science agency for water information, the USGS monitors and assesses the amount and characteristics of the Nation's freshwater resources, assesses sources and behavior of contaminants in the water environment, and develops tools to improve management and understanding of water resources. Information and tools allow first responders, the public, water managers and planners, and policymakers to—

- Minimize loss of life and property as a result of water-related natural hazards, such as floods, droughts, and landslides.
- Manage freshwater, both above and below the land surface, for domestic, public, agricultural, commercial, industrial, recreational, and ecological uses.
- Protect and enhance water resources for human health, aquatic health, and environmental quality.
- Contribute to wise use, development, and conservation of the Nation's water resources for the benefit of present and future generations.

Fundamental to USGS water science is the collection and public dissemination of data describing the quantity and quality of the Nation's freshwater resources. During the past 120 years, the USGS has collected streamflow data at over 26,000 sites, water-level data at over 850,000 wells, and chemical data at over 338,000 surface-water (streams, rivers, natural lakes, and man-made reservoirs) and groundwater

(water beneath the land surface) sites. This data is freely available online through the National Water Information System (NWIS) at *http://waterdata.usgs.gov/nwis.*

Water resources research, information, and monitoring activities support the USGS Science Strategy to provide scientific information on water availability and quality of the United States in order to inform the public and decisionmakers about the status of freshwater resources and how they are changing. Efforts of Water Mission Area scientists also support the USGS Science Strategy themes of understanding ecosystems and predicting ecosystem change, providing a scientific foundation for energy and mineral resources for America's future, climate variability and change, the natural hazards, risk, and resilience assessment program, and the role of the environment and wildlife in human health.

The water quality and hydrologic data, and the analytical information provided through the USGS water programs are used by a variety of stakeholders, including other Department of the Interior (Interior) bureaus, Department of Homeland Security (DHS), the United States Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the National Weather Service, the Army Corps of Engineers, State, tribal and local governments, academia, consulting and advocacy organizations, industry, and private citizens. The long-term data collection and analyses of the streamflow and groundwater data are important to water supply planners to identify the influence of population growth, land use change, and climate variability on current and future water availability.

Research and assessments generated through the USGS water programs, many of which are conducted cooperatively with other agencies, serve as the foundation for many USGS mission goals, including water availability, ecosystem health, water quality and drinking water, hazards, energy, and climate. For example, the water programs support data collection and interpretative studies in 48 USGS Water Science Centers located nationwide. Assessments are conducted to quantify water withdrawals, watershed budgets, groundwater/surface water relations, evapotranspiration, and surface water flows needed for ecosystem sustainability.

Technical excellence and unbiased results are the hallmark of the USGS water programs. The quality assurance of all data and science products are conducted to ensure technical excellence and to ensure that information collected across State boundaries is nationally consistent, comparable and suitable for inclusion in the USGS national hydrologic databases. USGS products are widely recognized as high quality, and readily available to other agencies, the scientific community, and the public.

USGS water programs provide science that informs common societal questions. One of those common societal questions involves water availability and use. The Nation must understand the availability and quality of freshwater, to meet both human and ecological needs, today and into the future. The USGS has an effort called the National Water Census (Water Census) to help answer these issues. The Water Census draws resources from six programs within the Water Mission Area and another six programs from other USGS Mission Areas to fund science efforts toward this end. Together these programs plan the approach and execution of the Water Census tasks that will provide technical information that inform water availability decisions.

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #4: Provide Water and Land Data to Customers
Strategy #1: Monitor and Assess Water Availability and Quality

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
USGS Water Resources	201,597	221,223	212,423	209,614	197,449	207,281	210,386		+0.2%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Strategy #1: Monitor and Assess Water Availability and Quality									
Percent of U.S. with groundwater availability status and trends information (Groundwater Resources Program)	USGS	13%	15%	18%	20%	20%	20%	23%	25%
		5	6	7	8	8	8	9	10
		40	40	40	40	40	40	40	40
Percent of U.S. with current streamwater quality status and trends information (National Water Quality Assessment Program)	USGS	52%	69%	86%	103%	3%	3%	5%	5%
		2,575	3,409	4,273	5,109	1,559	1,546	3,118	3,118
		4,956	4,956	4,956	4,956	60,390	60,390	60,390	60,390
Percent of U.S. with current groundwater quality status and trends information (NAWQA)	USGS	67.46%	77.87%	89.11%	100.2%	8.68%	7.21%	18.23%	17.73%
		570	658	753	847	1,650	1,369	3,464	3,369
		845	845	845	845	19,000	19,000	19,000	19,000
Percent of USGS planned streamgages that are fully funded by the National Streamflow Information Program (National Streamflow Information Program)	USGS	7.3%	7.3%	8.8%	8.8%	9.3%	9.4%	11.6%	13.0%
		349	349	421	421	442	446	550	620
		4,757	4,757	4,758	4,758	4,758	4,759	4,758	4,758
Percent of U.S. with completed, consistent water availability products (Hydrologic Network and Analysis)	USGS	n/a	n/a	n/a	0%	0%	0%	5.0%	5.0%
		n/a	n/a	n/a	-	-		105	105
		n/a	n/a	n/a	2,112	2,112	2,112	2,112	2,112
Number of water monitoring sites supported jointly with State, local, or Tribal cooperators (Cooperative Water Program)	USGS	20,600	20,000	17,850	18,655	18,000	18,500	18,500	18,500

Supporting Performance Measures

Outputs, Supporting Performance Measures, and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Number of knowledge products on the water availability of the Nation's water resources provided to support management decisions (GWP)	USGS	15	25	40	35	20	49	20	20
Number of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions (NAWQA)	USGS	50	80	43	69	30	39	50	50
Number of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions (Hydrologic Research & Development)	USGS	203	220	250	123	120	196	160	166
Number of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions (HNA)	USGS	11	12	11	11	9	9	7	7
Number of knowledge products on the water availability and quality of the Nation's water resources provided to support management decisions (CWP)	USGS	237	230	325	387	300	350	300	300
Number of retrievals of groundwater and surface water quantity and quality data and information (NSIP, HNA, GWP, NAWQA, and CWP)	USGS	154,000,000	175,000,000	283,258,614	314,369,456	301,000,000	406,220,000	400,000,000	400,000,000

Activity: Water Resources
Subactivity: Groundwater Resources

2013 Actual: $8.3 million (77 FTE)
2014 Enacted: $8.9 million (80 FTE)
2015 Request: $11.4 million (89 FTE)

Overview

Groundwater is among the Nation's most precious and increasingly important natural resources. Groundwater is the primary source of drinking water for approximately half of the Nation's population, provides about 40 percent of the irrigation water necessary for the Nation's agriculture, sustains the flow of most streams and rivers, and helps maintain a variety of aquatic ecosystems. Continued availability of groundwater is essential for current and future populations and the economic health of our Nation.

The Groundwater Resources Program (GWRP) provides objective scientific information and interdisciplinary understanding necessary to assess and quantify availability and sustainability of the Nation’s groundwater resources. Results of those efforts provide information used in decisionmaking by resources managers, regulators, other government agencies, and individuals in the public and private sectors. The goals of the program are to—

- Provide fundamental information about groundwater availability in the Nation's major aquifer systems.
- Characterize natural and human factors that impact recharge, storage, and discharge in the Nation's major aquifer systems, and improve understanding of these processes.
- Develop and test new tools and field methods to analyze groundwater flow systems and their interactions with surface water.
- Provide scientific leadership across all Federal programs about the Nation's groundwater resources, including research directions, quality control, technology transfer, and information storage and delivery.

The program coordinates with and complements other USGS programs by providing new methods, tools, and information used in monitoring, assessment, and resource management activities. Goals of the GWRP directly support the USGS Science Strategy focus on the Water Census theme, providing scientific information on water availability and quality of the United States to inform the public and decisionmakers about the status of groundwater resources and how they are changing.

Program Performance

National and Regional Groundwater Evaluations
(2013 Actual, $3.4 million; 2014 Enacted, $4.0 million; 2015 Request, $4.0 million)

The GWRP is the principal entity within the USGS for assessing availability of groundwater resources of the Nation's most important regional aquifers. Studies comprise individual assessments of regional groundwater flow systems that cover a variety of hydrogeologic terrains and are used to develop a comprehensive regional and national perspective. Collectively, these individual studies are the foundation for the national assessment of groundwater availability. Availability studies, conducted in cooperation with other Federal, State, tribal and local governments and the private sector, involve computer-based groundwater flow models to document effects of human activities and climate variability on groundwater levels, depletion, storage, and interaction with surface water.

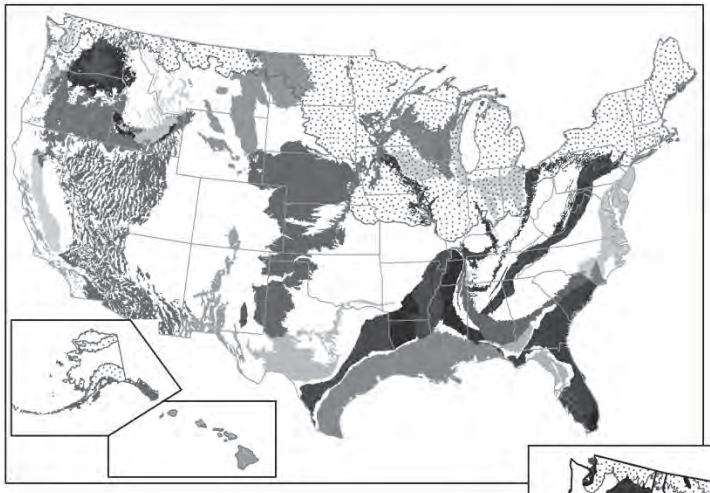
Progress on National and Regional Groundwater Evaluations – The Groundwater Resources Program provides scientific information and understanding necessary to assess and quantify the availability and sustainability of the Nation's groundwater resources. Results of those efforts provide information used in decisionmaking by resources managers, regulators, other government agencies, and individuals in the public and private sectors. Regional studies of groundwater availability are being conducted to quantify current aquifer resources, evaluate how those resources have changed over time, and provide tools to forecast how much water will be available in the future. In 2014, five regional water resource assessments and related data collection took place in the following principal aquifer systems (see figure).

- **Northern Atlantic Coastal Plain Aquifer System** (Long Island, NY, to North Carolina)
  Eleven million people or 41 percent of people living above the aquifer use groundwater as their supply, this is the most densely populated area associated with any single principal aquifer in the United States. Progress continues to be made with focus primarily on completing the synthesis of the hydrogeologic information and development of a groundwater flow model that will be used in the availability analysis. An interim report titled, "Hydrogeology and Hydrologic Conditions of the Northern Atlantic Coastal Plain Aquifer System from Long Island, New York, to North Carolina" (SIR 2013-5133) was approved and published.
- **Williston and Powder River Basins** (Montana, North Dakota, South Dakota, Wyoming)
  The regional Lower Tertiary and Upper Cretaceous aquifer system are the shallowest, most accessible, and in some cases, the only potable aquifers within the Northern Great Plains. These aquifers contain a major part of the Nation's reserves of coal and natural gas and are a water-supply alternative for some of the Nation's most rapidly developing oil reserves in the "Bakken" play. USGS efforts have been directed towards the development of the areas hydrogeologic framework, estimating hydrologic budget components, and refining the conceptual model of groundwater flow.
- **Hawaiian Volcanic-Rock Aquifers** (Hawaii)
  These aquifers are the main and most reliable source of drinking water on the Hawaiian Islands supplying water to 1.4 million residents, diverse industries, and a large component of the U.S. military in the Pacific. The aquifers of individual Hawaiian Islands are isolated by seawater and have limited capacity. Fresh groundwater resources in Hawaii are therefore particularly

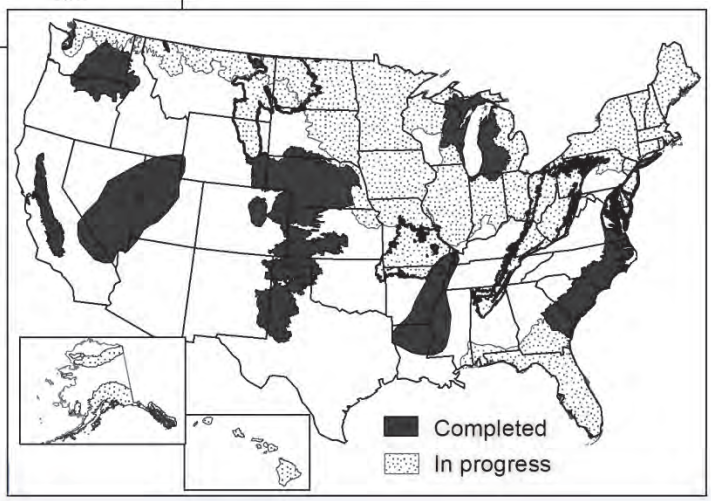
vulnerable to impacts from human activity and climate change. 2013 was the first year of the four-year study. First year accomplishments included completion of preliminary recharge estimates for Kauai, Oahu, and Maui; compilation of water-use data for Kauai, Oahu, Maui, and the Big Island; completion of the preliminary hydrogeoloic framework for Kauai; and, examination of methods for estimating runoff for areas in Hawaii without stream gages.

- **Ozark Plateaus Aquifer System** (Arkansas, Kansas, Missouri, Oklahoma)
  Groundwater from the Ozark system is the primary source of freshwater for most public supply systems that use groundwater exclusively, and for most self-supplied domestic (rural) water users in the area. Population within the study area has steadily increased over the last several decades and is experiencing a corresponding increase in commercial, industrial, and residential water demand. In 2014, the USGS will begin conducting an effort to evaluate groundwater availability in this principal aquifer. The study comes at a time of heighten concern in some areas for the future sustainability of local water resources.
- **Glacial Aquifer System** (all or parts of 25 Northern States from Maine to Washington and Alaska)
  The glacial aquifer system groundwater availability study is one of the USGS efforts in response to the Interior WaterSMART initiative. This study complements other regional aquifer studies through the GWRP designed to develop a national assessment of groundwater availability as part of a national Water Census. The glacial deposits are the source for the largest withdrawals for public and domestic supply in the United States. An estimated 22.5 million people rely on the glacial aquifer system for their drinking water, and of that amount, 17 million people tap these deposits with private wells.

These regional assessments are part of an effort to evaluate more than 30 regional aquifers across the Nation and when added to past and future studies will collectively lead to a national assessment of groundwater availability (see figure). Circular 1323 describes the approach used for the assessment *http://pubs.usgs.gov/circ/1323/*.



Priority Aquifers that Collectively Make Up National Assessment of Groundwater Availability



Status of Regional Groundwater Availability Studies

Groundwater Interactions

(2013 Actual, $2.9 million; 2014 Enacted, $2.9 million; 2015 Request, $5.4 million)

Over the past decade, groundwater issues have evolved in scope and complexity because of escalating demands for the resource. USGS scientists address this increasing complexity by targeting information needs with a multi-disciplinary approach to understanding groundwater and linkages to humans and the natural environment.

Field Methods and Tool Development – The GWRP supports development of new field methods and software tools to enable more cost-effective and reliable management of the Nation's groundwater resources. Applied hydrogeophysics research in 2013 and 2014 included a major focus on development of fiber-optic (*http://water.usgs.gov/ogw/bgas/fiber-optics/*) and infrared temperature sensing methods (*http://water.usgs.gov/ogw/bgas/thermal-cam/*) and time-lapse geophysical monitoring techniques to study groundwater/surface-water exchange, which is critical to management of temperature-stressed aquatic species, assessment of climate change, and basic understanding of hydrologic processes. Methods developed under the auspices of the GWRP have resulted in interagency agreements, grants and other projects supporting the missions of other Federal agencies. Results of these projects include (1) new

understanding of the thermal dynamics in the Delaware River, in support of the U.S. Fish & Wildlife Service's management of endangered, temperature-stressed aquatic species (*http://pubs.acs.org/doi/abs/10.1021/es4018893*); (2) maps showing zones of enhanced river/aquifer exchange to guide future contaminant sampling along the Columbia River adjacent to the Department of Energy's Hanford 300 Area (*http://onlinelibrary.wiley.com/doi/10.1002/wrcr.20458/pdf*); (3) insight into the interaction between lakes, groundwater and permafrost in interior Alaska, in support of the Department of Defense's efforts to preserve critical civil and military infrastructure; and (4) technology demonstrations and training for the National Geospatial Intelligence Agency. In addition to publications of scientific results methodologies, GWRP products include new, publically available, software tools (e.g., *http://water.usgs.gov/ogw/bgas/1dtemppro/*), facilitating adoption of USGS-pioneered techniques by universities, industry, and other Federal and State agencies.

Groundwater Modeling Software Development – The GWRP provided essential support for the application, testing, and development of groundwater flow and solute transport modeling tools currently needed to address the growing concerns regarding short and long-term availability of the United States water resources. Predictive models are needed to make informed decisions in many emerging areas related to the effects of groundwater development, drought and climate change on groundwater systems, benefits and challenges of artificial groundwater recharge, ecosystem health, and saltwater intrusion into coastal aquifers. The critical tools being developed are used by States and local governments, as well as by groundwater scientists and engineers in the private sector, on a regular basis as an integral part of their work.

In 2013 and 2014, collaboration among USGS scientists, academia, and the private sector resulted in publication of multiple enhancements and improvements to the popular MODFLOW program (*http://water.usgs.gov/ogw/modflow/*). One example is a new version of MODFLOW that customers can use to investigate the effects of groundwater development in areas with complex aquifer systems. The improved capability also allows detailed analysis and visualization of the effects of groundwater extraction, streamflow alterations, and lake level changes within regional, statewide, and national-scale models. Prior to this MODFLOW enhancement, a detailed analysis of wells and streams was not possible with larger scale models. This new MODFLOW version is being used for the Los Angeles Basin to predict the effects of groundwater extraction on future water availability. Another example of a substantial MODFLOW enhancement published in 2013 is a new capability to simulate the position and movement of the saltwater and freshwater interface in regional coastal aquifer systems quickly and accurately. With the addition of this new capability, MODFLOW can now be used to quickly and accurately predict the effects of human (groundwater withdrawals) and environmental (landscape change and climate variability) stressors on coastal aquifer systems. By simulating seawater intrusion processes many times faster than with traditional and more complex approaches, this new improvement provides water managers with an integrated view of the regional aquifer system that enables them to evaluate quickly how changes to the system may affect future fresh groundwater availability. Several studies of coastal aquifers in Florida, Massachusetts (Cape Cod), and the Northern Atlantic Coastal Plains are currently applying this new capability.

Groundwater Data, Monitoring Networks, and Information Delivery –The quantity of groundwater in an aquifer is an important factor in determining groundwater availability. The USGS maintains a

database of groundwater data records compiled from about 850,000 wells used in groundwater hydrology studies over the past 100 or more years. Wells are monitored for a variety of purposes such as statewide and regional monitoring of ambient conditions, or for local monitoring of drawdown, aquifer tests, or even earthquake effects on water levels. About 25,000 of these wells are measured in a given year, and the GWRP makes these data available in an easily accessible manner via the Internet at *http://groundwaterwatch.usgs.gov/*.

The USGS water-level network is unable to provide adequate monitoring for all of the Nation's major aquifers, and this information is critical for determining availability. To address this national need, the SECURE Water Act (P.L. 111-11) Section 9507 authorized a collaborative National Groundwater Monitoring Network (NGWMN).

The Advisory Committee on Water Information Subcommittee on Groundwater, through a successful pilot process and using a pilot information "portal" developed by the GWRP, confirmed that a collaborative NGWMN can be successfully implemented by taking advantage of existing monitoring done by Federal, State, tribal, and local agencies *(http://acwi.gov/sogw/index.html)*. Implementation of the NGWMN calls for (a) creating a NGWMN Board to represent stakeholders, (b) expanding the NGWMN beyond the pilot states and selected USGS wells, and (c) providing funds to State and Federal data providers for NGWMN backbone sites.

In response to expanding human and environmental demands, the USGS periodically evaluates water levels on a regional scale to inventory groundwater reserves properly in areas experiencing intense development. Aquifers and aquifer systems have been and are being monitored, such as the High Plains Aquifer, Floridan Aquifer System, Columbia Plateau Regional Aquifer System, the Sparta-Memphis Aquifer, and the Atlantic Coastal Plain Aquifer System.

Technical Support

(2013 Actual, $2.0 million; 2014 Enacted, $2.0 million; 2015 Request, $2.0 million)

This support provides quality control to assure technical excellence of groundwater field programs and provides a structured way of transferring new technology to activities conducted at USGS Water Science Centers in each State. This program component also provides a formal way of establishing research priorities and making groundwater information available to others agencies, the scientific community, and the public.

Activity: Water Resources

Subactivity: National Water Quality Assessment

2013 Actual: $58.9 million (507 FTE)
2014 Enacted: $58.9 million (507 FTE)
2015 Request: $59.1 million (504 FTE)

Overview

In 1991, Congress established the National Water Quality Assessment NAWQA Program within the USGS to address a fundamental question:

"What is the status of the Nation's water quality and is it getting better or worse?"

Since then, the NAWQA Program has been a primary source of objective and nationally consistent water-quality data and information on the quality of the Nation's streams and groundwater. NAWQA data and models provide answers to where, when, and why the Nation's water quality is degraded, and what can be done to improve and protect it for human and ecosystem needs (*http://water.usgs.gov/nawqa/xrel.pdf*).

"NAWQA's findings have and continue to be used by national, regional, State, and local governments and the private sector to develop more effective, science-based policies and actions to protect and restore water quality. Its findings target actions that can achieve the greatest water quality benefits and can determine whether the billions of dollars invested in pollution control are actually having the anticipated results." Testimony of Matthew J. Millea, Deputy County Executive for Physical Services, Onondaga County, NY, representing the Water Environment Federation before the Interior and Environment Subcommittee, Committee on Appropriations, U.S. House of Representatives, April 16, 2013

Program Performance

Two decades of NAWQA monitoring and modeling have resulted in a solid foundation of data and scientific understanding and improved capability within the water community to address current and future water quality issues. During its first decade (1991-2001 or Cycle 1), the NAWQA Program completed interdisciplinary baseline assessments of the quality of streams, groundwater, and aquatic ecosystems in 51 of the Nation's largest and most important river basins and aquifers. The assessments were based on sampling at 505 stream sites and more than 5,000 wells.

During its second decade (2001-2012 or Cycle 2), NAWQA built upon the baseline assessments by reporting on how water-quality conditions are changing over time and by developing regional-scale water-quality models to extrapolate findings to unsampled areas. For example, in 2013, NAWQA released a report documenting how nitrate concentrations have changed at eight long-term USGS monitoring sites in the Mississippi River basin from 1980 to 2010

(*http://water.usgs.gov/nawqa/pubs/nitrate_trends/).* Nitrate concentrations steadily decreased by 21 percent in the Illinois River from 2000 to 2010. Decreases were also noted in the Iowa River during this time but the declines were not as large (10 percent). Unfortunately, similar signs of progress were not widespread. Consistent increases in nitrate concentrations occurred between 2000 and 2010 in the upper Mississippi River (29 percent), the Missouri River (43 percent), and at the Mississippi River outlet (12 percent). The reasons for these changes are unknown. Reliable information on the trends from contributing factors such as fertilizer use, livestock waste, agricultural management practices, and wastewater treatment improvements is needed to better understand what is causing increases or decreases in nitrate. The implication of this finding is that solving the problem of the dead zone in the Gulf of Mexico will not be easy or quick. The USGS is working with States and other Federal agencies that are part of the Hypoxia Task Force to provide the data and information necessary to develop effective strategies for both groundwater and surface water.

Also during Cycle 2, NAWQA began developing tools that resource managers can use to evaluate the likely consequences of different management practices or policy scenarios. For example, in 2013, NAWQA released results of a study on the factors that affect the vulnerability of water from public supply wells to contamination (*http://pubs.usgs.gov/circ/1385/*). The study was designed as a follow up to earlier NAWQA assessment results that found that nearly one in five public-supply wells in the United States need to be treated or blended with more dilute water to decrease concentrations of drinking water contaminants before delivery to the public. Understanding the factors that affect the vulnerability of water from wells is important because removing contaminants from water for drinking is difficult and expensive. Study findings showed that information on contaminant input, contaminant mobility and persistence, as well as the groundwater age mixture of different waters that blend (or mix) in a well help answer the question, *"Which contaminants in an aquifer might reach the well, and when, how, and at what concentration might they arrive?"* Drinking water practitioners can apply findings from the study to not only devise improved programs for monitoring public-supply wells and the aquifers they tap, but also to identify the most beneficial protection mechanisms for a particular well.

"NAWQA has evolved from a water-quality program emphasizing data collection and trend assessments to one that has the potential to predict and forecast pollution occurrence and trends under multiple scenarios at nationally significant scales". National Research Council (2012, p 158)

For NAWQA's third decade (2013-2023 or Cycle 3), a science plan describing a 10-year strategy for assessing the Nation's freshwater quality and aquatic ecosystems was developed. The plan continues strategies that have been central to NAWQA's long-term success, as well as adjusts approaches, monitoring intensity, and study design to address monitoring and science needs identified by NAWQA stakeholders and the National Research Council (NRC, 2012), which reviewed the plan (*http://www.nap.edu/openbook.php?record_id=13464&page=R1).* The plan addresses stakeholder needs for more timely reporting of water-quality information, science and tools, for example (1) annual Web-based reporting of concentrations, loads, and trends of nutrients, sediment, and other contaminants in rivers draining into important coastal estuaries; (2) maps showing the distribution of nitrate, arsenic and other contaminants in important water-supply aquifers at the depth tapped by domestic or public-supply wells; or (3) model-based decision-support tools that allow managers to access water-quality models to

evaluate how water quality or stream ecosystems may change in response to different scenarios of population growth or climate change.

Surface Water-Quality Monitoring and Modeling

(2013 Actual, $26.3 million; 2014 Enacted, $26.3 million; 2015 Request $26.6 million)

Restoring and enhancing water-quality monitoring networks and continued development of water-quality models are the two highest priorities for the surface water component of the NAWQA program during the next decade. The NAWQA program will continue to focus on nutrients, sediment, pesticides and other contaminants in agricultural and urban settings in the Mississippi River Basin, in watersheds of other important estuaries, such as the Chesapeake Bay, San Francisco Bay/Delta and Puget Sound, and in other streams and rivers in selected regions.

Water-quality monitoring in 2014 is continuing at 100 of the 313 sites recommended in the NRC reviewed Science Plan for the third decade of NAWQA. Two additional monitoring sites (seven total) will be instrumented with state-of-the-art water-quality sensors that will provide real-time, continuous data for nitrate, turbidity, and other characteristics. The more frequent measurements will improve the accuracy of estimated in-stream nutrient and sediment loads, which are the basis for water-quality models. Biological assessments of the condition of algal, macroinvertebrate, and fish communities will continue at the urban, agricultural, and undeveloped small stream sites.

A **B**

Figure 1. A. Locations of 313 stream and river sites recommended for sampling during Cycle 3
B. Locations of 100 stream and river sites sampled beginning in Fiscal Year 2013

In 2014, updated water-quality models for the Mississippi River Basin and the Eastern United States will be available along with existing models for the rest of the Nation in a new Decision Support System. This Decision Support System will provide the ability to estimate the magnitude of different sources of nutrients for any watershed or State across the United States, and allow scenario testing for potential

management strategies. The updated system will also provide the capability to evaluate nutrient sources in watersheds draining to each of the Nation's major estuaries.

Also in 2014, findings from the first of a planned series of targeted, collaborative, regional water-quality monitoring studies will be released that will help define which water-quality and hydrologic factors are most responsible for degradation of stream quality and, thus, which approaches to water-quality management will have the greatest benefit in the region.

The Midwest Stream Quality Assessment was done in collaboration with 10 States and the Environmental Protection Agency (EPA) to complement the EPA's 2013 National Rivers and Streams Assessment. Findings from 100 sites intensively sampled by the USGS NAWQA program and Columbia Environmental Research Center during the spring and summer of 2013 will evaluate the condition of aquatic communities in relation to streamflow conditions, water and sediment toxicity and concentrations of nutrients, sediment, pesticides and other contaminants.

The second regional water-quality monitoring study, targeting a six State area of the Piedmont region in the Southeast, will occur during the spring and summer of 2014, with a sampling design similar to the Midwest Stream Quality Assessment. Three additional regional-scale studies, designed to determine the influence of streamflow alteration on aquatic communities, scheduled to complete data collection in 2014 are for the lower Colorado basin, southern California, and parts of New England.

In 2015, NAWQA will continue to work toward expanding the national network of long-term, water-quality monitoring sites to support the goals of the program by partnering with other USGS programs, the States and other organizations in key undeveloped, agricultural, and urban settings in the Mississippi, and other major river basins throughout the United States. Scheduled updates and enhancements in water-quality models that estimate nutrient and sediment loads (SPARROW) and pesticide concentrations in streams (WARP [WAtershed Regressions for Pesticides]) will occur in four large regions (West, Southeast, Northeast, and the Mississippi River Basin). Planned enhancements include providing improved spatial resolution, updated contaminant source data, as well as simulation of seasonal to annual variations in streamflow and contaminant concentrations and loads that will improve decision-support tools used for evaluating how nutrient and sediment loads will change in response to changes in climate, land use, or management policies. Depending on the availability of resources, a third regional water-quality monitoring study will be conducted in collaboration with the States and other stakeholders. Candidate regions include southern California and the Pacific Northwest.

Groundwater Quality Monitoring and Modeling

(2013 Actual, $15.3 million; 2014 Enacted, $15.3 million; 2015 Request, $15.3 million)

NAWQA is the only Federal program that monitors the status of the Nation's groundwater quality and reports on how these conditions are changing over time. In 2013, NAWQA released a synthesis of findings from a study to evaluate the factors affecting public supply well vulnerability to contamination from compounds commonly found in the environment. Study findings show that aquifer development for increased water supply has altered geochemical conditions in some aquifers, causing contaminants such as arsenic and uranium (which occur naturally in aquifer sediments) to dissolve into groundwater and

reach public supply wells. Understanding which factors affect public supply well vulnerability to contamination helps water managers enhance source water assessment and protection efforts, as well as anticipate and measure protection-related outcomes.

During the next 10 years, NAWQA is planning to sample about 1,400 public supply wells in 18 Principal Aquifers to provide regional and National contexts for understanding where and why contaminants occur at concentrations that may be deleterious to human health. In 2013, NAWQA sampled about 400 public supply wells in five Principal Aquifers: the Basin and Range (AZ, CA, NV, UT); the Coastal Lowlands (AL, FL, LA, MS, TX); the North Atlantic Coastal Plain (MD, NC, NJ, NY, VA); the Southeastern Coastal Plain (AL, GA, KY, MS, SC, TN); and Carbonate rocks in the Valley and Ridge, Piedmont, and Blue Ridge (AL, GA, NJ, PA, TN, VA). NAWQA also sampled about 75 public supply wells in the Glacial Principal Aquifer in 2013 (IA, IL, IN, KS, MI, MN, MO, NE, NY, OH, SD), and will complete sampling of public supply wells in this aquifer in 2014 (ME, MA, MI, MN, MT, NH, NJ, NY, ND, PA, SD, VT, WA, WI).

In 2014, NAWQA will publish eight reports synthesizing NAWQA groundwater-quality assessment findings for eight of the Nation's largest and most important Principal Aquifers and one report that summarize findings for the Nation. Principal Aquifers, extend over large areas, often multiple States, and are a significant source or potential source of drinking water. Collectively, the Circulars are based on data collected at more than 6,000 wells—primarily observation and domestic wells—organized into 233 well networks distributed across 49 States. Nationally, about 22 percent of samples (one in five) contained at least one chemical constituent at a concentration greater than a human-health drinking-water benchmark. Most of the constituents detected at high concentrations originate from geologic sources and discharge into groundwater as it interacts with the sediment and rocks that comprise the aquifers; examples include arsenic, manganese, and uranium. However, the detection at low concentrations of a wide range of pesticides, volatile organic compounds, and other manmade chemicals, demonstrated the vulnerability of groundwater to anthropogenic contamination. The reports, available on the USGS Web site, provide important information on the factors that control the concentrations of contaminants in groundwater, including contaminant sources, geochemical conditions, groundwater usage, groundwater age and geology, which is useful to managers and planners responsible for delivering safe drinking water.

During Cycle 3, NAWQA will also resample about 2,300 observation and domestic-supply wells sampled during Cycles 1 and 2 to assess how groundwater quality conditions are changing over time. In 2013, NAWQA sampled about 230 wells in eight networks (CA, CO, FL, GA, MD, NC, NV, and WI). The data obtained from these relatively shallow wells, along with the data from the deeper public supply wells, will be used to develop a three-dimensional perspective on regional ground-water quality conditions that can be used by planners and managers to better understand the vulnerability of existing supply wells and guide decisions on the possible placement of new wells.

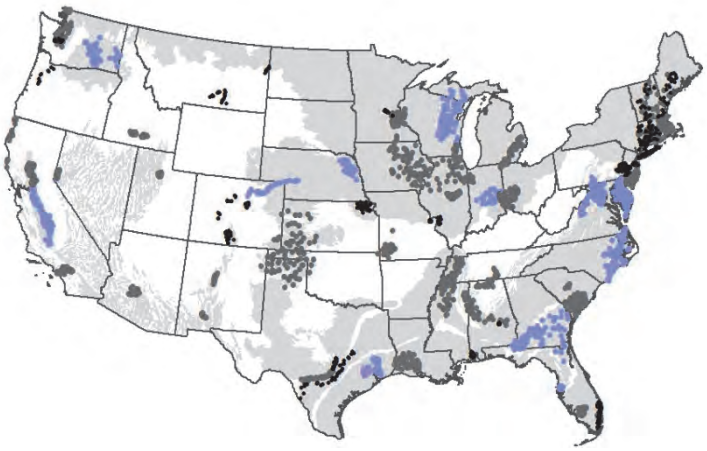


Figure 3. Seventy-nine Trend Networks, each consisting of 25-30 wells sampled by NAWQA during Cycle 1 and 2, in 16 Principal Aquifers (gray areas) will be resampled during Cycle 3. Blue circles are wells that will be resampled in 2013–2015, gray circles are wells to be resampled 2016–2022; black circles are wells that will not be resampled in Cycle 3 due to budget constraints.

Modeling of groundwater flow and groundwater quality is an important component of NAWQA's efforts in Cycle 3. These modeling efforts will be conducted at local, regional and national scales, and will be coordinated with the efforts of the GWRP. NAWQA's efforts at the regional scale will focus on four Principal Aquifer systems: California's Central Valley, the Glacial Aquifer System that extends across 21 Northern States, the North Atlantic Coastal Plain that underlies five Eastern States, and the Mississippi Embayment that underlies six Gulf Coast States. These modeling efforts will provide additional insights about the most important factors that affect the vulnerability of domestic and public supply wells to contamination and will provide capability to extrapolate water quality findings into areas of sparse data. National- and regional-scale maps of contaminant concentrations at the depths of domestic and public supply wells will be made for selected constituents (for example, nitrate and arsenic) using model results. Model results will also provide insight about the length of time needed before water quality changes will be observed in domestic and public supply wells following changes in climate, water use, and (or) land use. At a regional-scale, models will estimate the loading of contaminants by groundwater to streams. This type of information is important for water resource managers to plan for sustained groundwater sources of drinking water.

Supporting Research and Methods

(2013 Actual, $6.2 million; 2014 Enacted, $6.2 million; 2015 Request, $6.2 million)

To ensure NAWQA data collection and analyses are relevant to emerging issues, about 10 percent of program resources are devoted to developing state-of-the art methods and innovative techniques that help to provide greater understanding of the factors affecting water quality conditions and trends. For example, USGS researchers are developing techniques to help quantify the influence of groundwater contributions to streams and other aquatic ecosystems, and the response of these systems to environmental management actions. Recent research in tributaries to the Chesapeake Bay indicates that it

may take several decades for many water-quality management practices aimed at reducing nitrogen input to the Bay to achieve their full benefit due to the influence of groundwater.

Technical and Science Support of USGS Activities

(2013 Actual, $11 million; 2014 Enacted, $11 million; 2015 Request, $11.0 million)

High quality, nationally consistent monitoring data and information used in reporting of trends and in water-quality models across the Nation are signature strength of NAWQA and other water resources research. To ensure this quality and consistency, national-level technical support for staff scientists working on the NAWQA Program is critical. Technical support includes: national-level training in water-quality field techniques, laboratory methods development, quality-control of chemical and biological analyses, improvements to the National Water Information System used for storage and retrieval of hydrologic data; development of the National Hydrography Dataset ; acquiring and processing contaminant source data used in water-quality models; and support of the National Water Quality Monitoring Council.

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Activity: Water Resources
Subactivity: National Streamflow Information Program

2013 Actual: $27.7 million (153 FTE)
2014 Enacted: $33.7 million (153 FTE)
2015 Request: $35.1 million (153 FTE)

Overview

The mission of the National Streamflow Information Program (NSIP) is to provide the streamflow information and understanding required for national, State, and local economic well-being, the protection of life and property, and effective and efficient water resource management. The USGS currently operates over 8,000 streamgages nationwide designed to provide and interpret long-term, accurate and unbiased streamflow information to meet the multiple needs of many users.

The NSIP, when fully implemented, will include five major objectives:

- Develop and maintain an enhanced streamgaging network fully funded by the NSIP to meet national needs for streamflow information.
- Improve timeliness, reliability, and convenience of streamflow information delivery to users.
- Complete regional assessments of existing and future streamflow information to identify trends, estimate streamflow at locations without streamgages, and to provide for the streamgage network evaluation.
- Improve understanding of floods and droughts through expanded measurements and analyses.
- Perform and fund research and development activities to advance equipment technologies and measurement and analysis techniques for a better understanding of flow in rivers and to obtain greater accuracy at lower cost.

Other USGS Programs rely on the NSIP for streamflow information required for their analyses, among them: the National Water Quality Assessment Program, the Climate and Land Use Change Mission Area, the Natural Hazards Mission Area, the Ecosystem Mission Area, and the Ground Water Resources Program. The USGS WaterSMART Availability and Use Assessment will require streamflow information and regional evaluations to assess water availability in different regions of the United States. Aquatic biology programs (such as the Fisheries Program) require streamflow information to help determine timing and quantity of river flow required for different habitats and species.

In addition, other Federal agencies rely on streamflow data and information to meet their obligations. Examples include the National Weather Service (NWS) for predicting floods, the Federal Emergency Management Agency (FEMA) for identifying flood prone areas, the National Park Service (NPS) for managing water resources, the U.S. Army Corps of Engineers (USACE) for operation of locks and dams,

and the Bureau of Reclamation (BOR) for dam and water conveyance systems operation. State and local water management agencies depend on NSIP-provided streamflow information to assess and manage water resources for water supply, waste assimilation, fisheries management, and recreation.

NSIP Streamgages to Uniquely Support Federal Needs

The enhanced streamgage network funded by the NSIP for more long-term network stability is designed to provide streamflow information to meet five federal needs:

- Sentinel (reference) Watersheds – Identify appropriate locations and operate and maintain streamgages to provide streamflow information to describe responses to changes in climate, land use, and water use in watersheds across the country that are relatively unaffected by flow regulation or diversion and typify major eco-regions and river basins.
- Interstate and International Waters – Provide streamflow information to support interstate compacts, court decrees, and international treaties and at State-line and international crossing of rivers that drain at least 500 square miles at the border crossing.
- Streamflow Forecasts – Provide real-time and historic stage and streamflow information to support flood and streamflow forecasting by the NWS and other Federal agencies across the country.
- Major River Basin Outflows – Account for the flow of water from each of the Nation's 350 major river basins to downstream basins, estuaries, oceans or the Great Lakes.
- Water Quality – Provide streamflow information to support national USGS water-quality networks that cover the Nation's largest rivers; intermediate-sized rivers; and small, pristine watersheds.

For more information on the NSIP defined Federal needs for streamflow information, see *http://water.usgs.gov/nsip/federalneeds.html*.

Currently 60 percent of the streamgages in California are showing drought conditions. Information from over 4,000 long record USGS streamgages is in use by the USGS and others to help determine the real extent and severity of the droughts and by water resource managers to allocate the water for critical uses. The NSIP is currently (2014) funded at about 27 percent of full implementation funding. The increase of $6 million in the 2014 Omnibus appropriation will allow expansion of the network in 2014.

The USGS streamgage network provides relevant, high-quality information to all users. Data is collected using nationally consistent methods, which enable comparability of data across jurisdictional boundaries and acceptance of results by water management agencies and courts at all levels of Government.

Program Performance

Streamflow monitoring and information delivery stability – The USGS streamgage network provides streamflow information and understanding for national, State, and local economic well-being, the protection of life and property, and efficient and effective water resource management. The NSIP funded

streamgage network includes over 850 State, local, regional and tribal agencies, other Federal agencies, and the Cooperative Water Program (CWP). Instability of the network occurs when any of the funding partners reduce their funding contribution and the NSIP or others do not have the resources available to make up the difference. To help stabilize the network, the NSIP provides funds, when available, to fully fund or to partially fund with partners, Federal need streamgages that are at risk of discontinuance. In 2012, the NSIP provided full funding for 446 Federal need streamgages, and partially funds with partners 1,442 streamgages. For 2013, the NSIP provided full funding for 353 NSIP streamgages and partial funding for 1,178 streamgages. Due to increased funding levels in 2014 and 2015, the NSIP will continue to provide streamgage network stability by providing funding for Federal need streamgages that are threatened for termination due to partner or funding decreases.

Flood inundation mapping advances – In most years, flooding causes the greatest amount of property damage and loss of human life of all natural disasters. One of the most effective ways of reducing these losses is through advanced warning of the flood, and knowledge of the areas predicted to be flooded. The NWS provides flood forecasts using models calibrated, checked, and verified by USGS streamflow information. Recently, the USGS helped develop a new tool to assist first responders and the public in knowing what areas will be flooded and how deep those floodwaters will be for a given storm based on the NWS flood forecast. This tool produces maps of areas expected to be flooded along a given river reach for given floods and how deep the floodwaters will be, based on the flood forecasts. The maps are developed based on models calibrated with USGS streamflow information. These maps, maintained in a USGS database, are freely available to anyone at any time. For 2014 and 2015, additional river reaches will be mapped for estimates of flood inundation and the USGS will continue to work with other Federal agencies (NWS, USACE, and FEMA) and private companies to enhance and provide consistent flood inundation maps for the public and emergency responders. For more information on flood inundation mapping, see *http://water.usgs.gov/osw/flood_inundation/*.

Rapidly Deployable Streamgages now available – The NSIP has helped develop and utilize streamgages, delivered and put into operation rapidly, providing real-time streamflow information to the USGS and others via the Web within an hour of arriving onsite. These streamgages were used this past year to provide better spatial understanding of the wide spread floods and droughts. These streamgages have been used as a backup streamgage when permanent streamgages have been lost or in danger of being inundated. These temporary streamgages could also be used in areas with recent wildfires to measure the changes caused by the fires and to better describe and understand aquatic habitat, both natural conditions and disturbed. In most cases the rapidly deployable streamgages can be shipped within a day and can stay in operation anywhere from a few days to a few years. For 2014 and 2015, the goal will be to develop additional real time streamgages and deploy them in not only flood situations but also in drought areas, recent wildfire areas, and habitat assessment areas.

For example, the USGS deployed a temporary monitoring network of water-level and barometric pressure sensors at along the Atlantic coast from Virginia to Maine, to continuously record the timing, areal extent, and magnitude of hurricane storm tide and coastal flooding generated by Hurricane Sandy. These records were greatly supplemented by an extensive post-flood high-water mark (HWM) flagging and surveying campaign from November to December 2012. Both efforts were undertaken as part of a coordinated Federal emergency response as outlined by the Stafford Act under a directed mission assignment by the Federal Emergency Management Agency (FEMA).

Federal Network Operations

(2013 Actual $19.1 million, 2014 Enacted, $22.5 million, 2015 Request $23.6 million)

This program component is dedicated to maintaining and operating a stable, reliable, and continuous nationwide Federal-interest streamgage network for measuring streamflow and related environmental variables (precipitation, temperature). As in most previous years, the proposed 2015 increase for the NSIP will enable the USGS to provide additional stability to the streamgage network by either fully funding or partially funding with partners' streamgages that would be discontinued due to a shortage of funds. This helps meet NSIP goals of national and local economic well-being and the protection of life and property. The NSIP fully expects that it will be able to fully fund or partially fund about 100 additional NSIP streamgages compared to 2014, recognizing however, that more streamgages could run risk for discontinuation due to anticipated partner (other Federal, State and local agencies) reduction in funding for streamgages.

In addition to funding the NSIP Federal-goal streamgages, these resources upgrade field equipment to more technically updated equipment in order to provide more accurate and reliable streamflow information at less cost, and to flood-harden streamgages that are in harm's way of floods and are critical to providing information for flood forecasts and warnings.

Hydrologic Extremes

(2013 Actual $1.8 million; 2014 Enacted $2.1 million; 2015 Request $1.8 million)

This program component provides an improved understanding of hydrologic extremes (floods and droughts) by more intensive data collection during and immediately following the event and analyses of the collected information. Recent extreme events such as the floods in Colorado and droughts and California have increased the demand for USGS information. There will be resources available in 2014 and 2015 to fund a NSIP Flood and Drought coordinators. These coordinators will help plan and oversee the USGS's response to ongoing floods and droughts as well as developing documentation for nationally consistent data acquisition and analyses. In addition, the coordinators will direct the deployment of Rapid Deployable Streamgages during times of extreme flows. In 2014 and 2015, a pilot study to develop better drought forecasting will be undertaken.

Regional Streamflow Assessments

(2013 Actual, $0.3 million, 2014 Enacted, $0.4 million; 2015 Request $0.7 million)

This program component provides regional assessments and interpretation of streamflow information to provide estimates of streamflow at ungaged locations and to identify trends in streamflow due to changing land use, water use, and climate. These regional products directly support the USGS Science Strategy priority of a national water census to inform the public and decisionmakers about resource availability. As the effects of climate change on water resources are better understood, it is recognized that existing streamflow information must be continually evaluated to identify trends in streamflow. This will enable water resource managers to plan more effectively for future water supplies. Climate change potentially affects the location, frequency, and severity of floods and droughts. In 2014, methods and technologies will be investigated and developed for future applications. In 2015, the intention is to start one or more pilot regional assessments; these assessments will enable the USGS to assess the current streamgage network's ability to provide the streamflow information required to complete, in an acceptable degree of uncertainty, the regional and trend analyses.

Information Delivery

(2013 Actual, $2.4 million; 2014 Enacted, $3.1 million; 2015 Request, $2.7 million)

The NSIP develops, implements, and maintains a highly reliable system for real-time and historic streamflow information delivery to customers that includes data processing, quality assurance, storage, and easy data access. The funds are necessary to ensure that the operation and maintenance of the NWIS database, which is critical to the success of NSIP, continues to function at peak efficiency and effectiveness—especially during flood hazard events. In addition, further efforts are needed to provide real-time data users information on the range of uncertainty of the streamflow information they use to make decisions on a regular basis. In 2014 and 2015, some of these funds will help upgrade the software for time-series information, which covers most of the USGS streamflow information, and to evaluate the uncertainty associated with real-time streamflow information.

Development of Methods and Equipment

(2013 Actual, $1.7 million; 2014 Enacted $1.7 million; 2015 Request $1.9 million)

The NSIP funds investigation, development, and implementation of new methodologies and equipment to more accurately, safely, and inexpensively obtain and deliver streamflow information. Recent examples include expanded and enhanced use of acoustic methods to measure river velocity and discharge; use of radar to measure water level directly without instrumentation in the river; and development of statistical methods to transfer flow characteristics from measured locations to ungaged locations. In addition, these funds drive the development of Rapid Deployable Streamgages (RDS) and advance processes for providing consistent flood inundation maps. The NSIP continues to fund the development of the StreamStats program that allows the estimation of natural streamflow characteristics at any site on any stream in the Nation. The NSIP will continue to support the development of the USGS model that estimates daily streamflow (PRMS).

Technical Support

(2013 Actual, $3.4 million, 2014 Enacted, $3.9 million; 2015 Request, $ 4.4 million)

The NSIP provides technical support for geographically distributed USGS water resources studies and data collection activities, including mechanisms for quality control, technology transfer, priority setting, and method and technology standardization. Technical support is necessary for the continued success and benefit of the program.

Activity: Water Resources

Subactivity: Hydrologic Research & Development

2013 Actual: $10.9 million (103 FTE)
2014 Enacted: $10.9 million (103 FTE)
2015 Request: $11.3 million (100 FTE)

Overview

The Hydrologic Research and Development (HRD Program supports hydrologic research within the National Research Program (NRP) of the Water Resources Mission Area of the USGS. In addition to the HRD, NRP research is supported by more than a dozen other USGS Programs, as well as numerous external funding organizations, indicating the value, high impact, and productivity of the NRP.

The HRD Program conducts research on complex, multi-disciplinary problems in the hydrologic sciences and supports research and development needs of the other Water Mission Area subactivities, as well as other USGS Mission Areas. HRD program investigations integrate hydrological, geological, chemical, climatic, and biological science to address the full range of water-resources issues.

The long-term goals of HRD are to—

- Improve understanding of physical processes controlling distribution of the Nation's surface-water resources to assist in mitigating effects of floods and droughts.
- Understand the relations between energy production and water resources availability and quality.
- Develop and share new modeling tools for understanding water availability and predicting effects of management activities and climate change on that availability.
- Identify the role of human-produced and natural contaminants on ecological and biogeochemical processes in the hydrologic cycle;
- Develop new tools to document availability and transport of groundwater and associated solutes to inform groundwater management decisions.
- Improve understanding of erosional processes, particularly from burned landscapes, governing the source, mobility, and deposition of sediment and associated contaminants in order to improve management of rivers, dams, and reservoirs, and to reduce effects of contaminated sediments on water quality and stream ecosystems.

Goals of the HRD Program directly support the Interior goal and USGS Science Strategy goals to provide scientific information on water availability and quality of the United States as a means to inform decisionmakers and the public about the status of its freshwater resources, and how they are changing. HRD activities directly support all elements of the USGS Science Strategy. For example, HRD research has led directly to—

- Detection of the effects of climate warming on snowmelt in the West and the possible effects of future warming (Climate Variability).
- Production of methods to better determine frequency of extreme floods (Hazards).
- Development of analytical methods to detect hydrocarbons in groundwater (Energy and Minerals).
- Development of applied watershed models to understand and predict streamflow (Water Availability and Use).
- Identification of mechanisms that allow tree islands to form in the Everglades (Ecosystems and Ecosystem Restoration).
- Documentation of effects of human-use compounds on aquatic ecosystems (Human and Wildlife Health).

HRD Program research has resulted in refinement of existing groundwater and watershed models and development of new modeling techniques to describe uncertainties and forecast changes in the hydrologic cycle. These efforts directly support the WaterSMART initiative. Research activities described in the program performance section have significantly contributed to understanding of climate change impacts on water supply and our basic understanding of climate variability and change.

Program Performance

Long-term Interdisciplinary Research

(2013 Actual, $10.9 million; 2014 Enacted, $10.9 million; 2015 Request, $11.3 million)

Deficit in Nation's Aquifers Accelerating – A new USGS study, conducted in the NRP documents that the Nation's aquifers are depleting at an accelerating rate. *Groundwater Depletion in the United States* (1900-2008) (*http://pubs.usgs.gov/sir/2013/5079/*) comprehensively evaluates long-term cumulative depletion volumes in 40 separate aquifers in the United States, bringing together reliable information from previous references and from new analyses.

There are two facts drawn from the study's wealth of statistics that outline the scale of groundwater depletion across the country. First, from 1900 to 2008, the Nation's aquifers—the natural stocks of water found under the land—depleted by more than twice the volume of water found in Lake Erie. Second, groundwater depletion in the United States in the years 2000-2008 can explain more than two percent of the observed global sea-level rise during that period.

While the rate of groundwater depletion across the country has increased markedly since about 1950, the maximum rates have occurred during the last decade (2000–2008), when the depletion rate averaged almost 25 cubic kilometers per year. For comparison, 9.2 cubic kilometers per year is the historical average calculated over the 1900–2008 timespan of the study.

One of the best-known and most investigated aquifers in the United States is the High Plains (or Ogallala) aquifer. Substantial pumping of the High Plains aquifer for irrigation since the 1940s has resulted in large

water-table declines that exceed 160 feet in places. The study shows that, since 2000, depletion of the High Plains aquifer appears to be continuing at a high rate. The depletion during the last eight years of record (2001–2008, inclusive) is about 32 percent of the cumulative depletion in this aquifer during the entire 20th century. The annual rate of depletion during this recent period averaged about 10.2 cubic kilometers, roughly two percent of the volume of water in Lake Erie.

Nutrient and Sediment Loads to the Chesapeake Bay – As the largest and most productive estuary in North America, the Chesapeake Bay is a vital ecological and economic resource. In recent decades, the Bay and its tributaries have degraded by excessive inputs of nutrients (nitrogen and phosphorus) and sediment from contributing watersheds and, in 1998, the Chesapeake Bay and its tidal tributaries were listed as "impaired" under the Clean Water Act. Consequently, a Chesapeake Bay Total Maximum Daily Load (TMDL) was established for nitrogen, phosphorus, and sediment in 2010 (U.S. Environmental Protection Agency, 2010). The TMDL requires that the seven watershed jurisdictions implement management practices to reduce inputs of nutrients and sediment to meet water-quality standards for dissolved oxygen, chlorophyll, and water clarity in the Bay.

A new, more robust statistical method developed by the HRD (Moyer and others, 2012) was used to estimate loads and trends in loads of nutrients and sediment to the Bay and assess changes in those loads over time. Documentation of trends in nitrogen, phosphorus, and sediment concentrations in the Chesapeake Bay watershed, as well as loads of these constituents entering the Bay, are helping to assess progress in water-quality improvements associated with the TMDL. Findings suggest that there has not been a substantial decline in loads to the Bay from most sub-basins in the last 10–20 years.

Coupled Streamflow and Groundwater Monitoring to Support Enhanced Streamgaging Activities – The approximately 8,000 USGS streamgages yield continuous, long-term information on streamflow conditions in streams across our Nation. Through the HRD, gages in prototype sites in Mississippi, Montana, and Wyoming were recently upgraded to collect stream and near-stream groundwater elevation and temperature data simultaneously that are then transmitted to a satellite and made available to the public (*http://waterdata.usgs.gov/nwis*) within hours of collection. Additional USGS gauges undergoing upgrades at sites in California and the Midwest. These upgrades provide site-specific information on stream and groundwater elevations and temperatures that is applicable to water management, hazard reduction, fishery habitat, and general watershed ecology. For example, ranchers and farmers in southwestern Montana have followed real-time USGS stream and groundwater information to understand the impacts of irrigation schedules on return flows to potentially conserve both water and fertilizer. Groundwater streamgages can also potentially provide enhanced hydraulic parameter estimates, and thereby reduce uncertainty in regional groundwater models.

Climate Change and Permafrost Thaw in Alaska – As warming is occurring in northern latitudes, irreversible change will occur in the permafrost distribution, implying major changes in the hydrologic and ecosystem health of the Arctic and sub-Arctic. This requires greater understanding in order to anticipate and manage changes, possibly mitigating some adverse developments. Within the HRD, the USGS improved characterization and monitoring of permafrost and hydrology in interior Alaska via airborne geophysical techniques, remote sensing, streamgaging, and ground-based observations, and developed a regional groundwater flow and energy model that encompassed the 11 million acre U.S. Fish

and Wildlife Service Yukon Flats National Wildlife Refuge, including over 20,000 wetlands. The Refuge provides critical and extensive breeding habitat for migratory birds in North America. Resource managers are highly concerned with changes in water routing that influences wetlands and lakes. Understanding climate change impacts on critical habitat is necessary for prioritizing land acquisitions. Groundwater flow simulations revealed an increase in the spatial extent of groundwater discharge in the lowlands (center of the basin) as permafrost decreases from continuous coverage to discontinuous coverage. The outcomes related to permafrost degradation identified by this study have broad transferability to other Arctic and sub-Arctic environments. Understanding these system trajectories is critical for managing infrastructure and natural resources in Alaska as warming continues.

Improved Estimates of Evapotranspiration (ET) to Support the Water Census – The semi-arid Klamath Basin has experienced severe water shortages in the last decade, and resource managers are developing a strategy to preserve wildlife habitats and minimum stream flows while still providing irrigation water to the agricultural community. USGS evaporation and ET data, provided through the HRD, and wetland crop coefficients are helping the local water authorities estimate evaporative losses, reducing uncertainty in the Upper Klamath Lake water budget, leading to more informed, objective allocation of water during dry years.

During the early 1900s, wetlands surrounding the Upper Klamath Lake were drained and converted to irrigated-farmland and, in the last several years, were restored to wetland status for ecological reasons. Klamath Basin water stakeholders are currently considering a variety of management plans for agricultural lands, such as restoration or forbearance (fallowing of formerly irrigated cropland) to help reduce the water crisis. Objective comparisons of evaporative losses from various surface types provide the knowledge needed to begin formulating management strategies to balance productivity, resource conservation, ecological health, and citizen expectations in the basin. The approach used in the Klamath Basin has potential to for use in other over-allocated river basins in the Western United States.

Activity: Water Resources
Subactivity: Hydrologic Network and Analysis

2013 Actual: $28.9 million (276 FTE)
2014 Enacted: $28.9 million (276 FTE)
2015 Request: $30.4 million (273 FTE)

Overview

The Hydrologic Network and Analysis Program (HNA) supports long-term national networks for the collection of data on water quality and atmospheric deposition, including the National Stream Quality Accounting Network (NASQAN), the Hydrologic Benchmark Network (HBN), the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), and the National Water Quality Monitoring Network (NWQMN). Data on and analysis of the quantity and quality of water in the Nation's streams, lakes, and aquifers are necessary for wise planning, development, utilization, and protection of the Nation's water resources.

Water-quality and hydrologic data and analytical information provided by this program are used by a variety of stakeholders, including other Interior bureaus. The USGS and the NPS have a water quality partnership funded by this program. The EPA and the USDA are both customers for water-quality information; the NWS uses the real-time flood level information; and State, tribal, local governments, academia, consulting and advocacy organizations, industry, and private citizens all use the water quality and flood-level information data provided by this program.

The HNA provides data for WaterSMART assessment studies and supports climate change research. The HNA program supports WaterSMART and the Water Census through work to estimate flows are ungaged locations, water use information aggregation and analysis, and work on ecological water science. This program funds studies of climate variability and change, watershed-modeling activities in support of the USGS water-quality partnership with the NPS, and support for the NRP in the hydrologic sciences.

The HNA program supports, maintains, and enhances USGS data delivery systems to process and disseminate water data and study results beyond the immediate needs of funding agencies or programs. This activity has two products: publications and the computer-based NWIS.

The HNA program also supports activities of the Advisory Committee on Water Information (ACWI), a Presidential Federal Advisory Committee (FAC), and its subcommittees. The ACWI represents the interests of water-information users and professionals in advising the Federal Government on Federal water-information programs and their effectiveness in meeting the Nation's needs. Member organizations help to foster communications between the Federal and non-Federal sectors on collecting, standardizing, and sharing water information, ultimately resulting in reduced Federal costs for operating resource management and environmental protection programs.

Program Performance

The Global Climate Viewer – The Global Climate Change Viewer (GCCV) is used to visualize future temperature and precipitation changes simulated by global climate models. The application allows the user to visualize projected climate change (temperature and precipitation) for each country, for all available emission models. Data from the experiments are binned into 25-year climatologies that span the 21st century. The GCCV also provides access to plots and quantile breakdowns of monthly temperature and precipitation from 1850-2100. (*http://water.usgs.gov/nrp/software.html)*.

Survival of Delta Smelt in the Sacramento – San Joaquin Delta, California – Delta Smelt – Changes in the position of the low salinity zone, a habitat suitability index, turbidity, and water temperature modeled from four 100-year scenarios of climate change were evaluated for possible effects on delta smelt *Hypomesus transpacificus*, which is endemic to the Sacramento–San Joaquin Delta. The persistence of delta smelt in much of its current habitat into the next century appears uncertain. By mid-century, the position of the low salinity zone in the fall and the habitat suitability index converged on values only observed during the worst droughts of the baseline period (1969–2000). Projected higher water temperatures would render waters historically inhabited by delta smelt near the confluence of the Sacramento and San Joaquin rivers largely uninhabitable. (*http://water.usgs.gov/nrp/publications.php/)*

Planned work in 2014 and 2015 would improve our understanding of quantification of relations between large-scale atmospheric circulation, sea-surface temperatures and surface hydrologic variables (e.g., precipitation, snow, streamflow). This would include development of improved precipitation-runoff models and an examination of the effects of climatic variability and change on water resources.

In 2014 and 2015, the HNA Program will continue investigations of how ecosystems will function in the future under the influence of drivers including climate change, water management, non-native species invasions, and ecosystem restoration. In the CASCaDE project, a series of linked models to assess possible futures for the Sacramento-San Joaquin Delta ecosystem in response to multiple interacting drivers are under development.

Hydrologic Networks

(2013 Actual, $5.4 million; 2014 Enacted, $5.4 million; 2015 Request, $5.3 million)

This program component includes long-term national networks for the collection of data on water quality and acid precipitation, including the NASQAN, the HBN, and the NADP/NTN. This program component also includes activities related to the new NWQMN, a multi-agency effort conducted under the auspices of the Ocean Action Plan.

The goals of this program component are to—

- Monitor the chemical quality of rain and snowfall.
- Monitor streamflow and the water quality of streams to fulfill USGS obligations for specific river basin compacts and treaties.
- Monitor the water quality and trends of selected major rivers.

Investigating Projected Sea-Level Rise in the Chesapeake Bay – Sea level is rising throughout the world because of climate change and variability, but the rate along the east coast of the United States is higher than the global mean rate. The USGS, in cooperation with the city of Newport News, Virginia, conducted a study to evaluate the effects of possible future sea-level rise on the salinity front in two tributaries to the Chesapeake Bay, the York River and the Chickahominy/James River estuaries. Results for both estuaries indicated that high freshwater river flow was effective in pushing the salinity back toward the Chesapeake Bay. Model results indicated that increases in mean salinity will greatly alter the existing water-quality gradients between brackish water and freshwater. This will be particularly important for the freshwater part of the Chickahominy River, where a drinking-water-supply intake for the City of Newport News is located. For more information go to *http://pubs.usgs.gov/of/2011/1191/*.

Hydrologic Analysis

(2013 Actual, $9.7 million; 2014 Enacted, $9.7 million; 2015 Request, $11.7 million)

This program component includes studies of climate variability and change, watershed modeling activities in support of the BOR, the USGS water-quality partnership with the NPS, and support for the NRP in the hydrologic sciences. In part, these efforts support data needs of the USGS WaterSMART efforts. The goals of this program component are:

- Provide direct technical support to Interior bureaus for hydrologic concerns.
- Provide direct technical support to the NPS for water-quality concerns.
- Develop decision-support systems for specific river basins in the Western United States.

Information Delivery

(2013 Actual, $6.1 million; 2014 Enacted, $6.1 million; 2015 Request, $5.6 million)

This program component includes delivery of results and water information beyond the immediate needs of funding agencies or programs. This activity has two products: publications and the computer-based NWIS to serve information to the public. This component of the HNA program also supports activities of ACWI and its subcommittees. The goal of this program component is to maintain and enhance USGS data delivery systems to process and disseminate water data and study results.

Technical Support

(2013 Actual, $7.7 million; 2014 Enacted, $7.7 million; 2015 Request, $7.8 million)

This program component includes national technical support for geographically distributed USGS water-resources studies, including quality control to ensure the technical excellence of water resources programs. Technical support also provides a structured way of transferring new technology to USGS investigative and data activities, primarily conducted in the USGS Water Science Centers located in each State, and a formal way of establishing priorities for water-resources research by the USGS. In addition, this program component supports various bureau-level activities such as CALFED science coordination.

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Activity: Water Resources
Subactivity: Cooperative Water Program

2013 Actual: $59.5 million (334 FTE)
2014 Enacted: $59.5 million (334 FTE)
2015 Request: $59.6 million (333 FTE)

Overview

The Cooperative Water Program (CWP) works in every State and Territory of the United States, in partnership with nearly 1,600 local, State, and tribal agencies (or "Cooperators"). Cooperators choose to work with the USGS because of its broad, interdisciplinary expertise; high-quality, nationally consistent procedures and quality-assurance; innovative monitoring technology, models, and research tools; and robust data management and delivery systems that provide readily available public access to national data.

The USGS participates in jointly funded efforts that support national priorities for monitoring, assessments, and research. Specifically, jointly funded monitoring through the CWP provides the foundation for USGS national hydrologic observations and data networks, real-time capabilities, and data delivery across the Nation, including for example, support for nearly 6,000 (or 72 percent) of the Nation's 8,000 streamgages; 10,000 groundwater observation wells; and 4,000 water-quality monitoring sites.

The jointly funded assessments and research through the CWP provide relevant and timely science to address local, State, and tribal water management needs; raise emerging water issues to regional and national visibility; and support large scale-syntheses and problem solving to address USGS and Interior priorities. Specifically—

- The CWP's significant tie to local, State, and tribal agencies allows the USGS to address emerging water issues—including for example, contamination in urban and agricultural waters; low-flow requirements for healthy ecosystems; and impacts of hydraulic fracturing on water quality and quantity—to which the USGS can respond quickly and raise those issues to regional and national visibility and priority.
- Combined Federal and non-Federal resources help to address many of the Nation's most pressing water resource issues—including, mitigation of hazards (flood and drought) and sustaining water availability—while allowing direct application of science and innovative tools and models to local, State, and tribal regulatory decisions, management, policy, and jurisdictional disputes. The monitoring and science inform decisions related to water availability, ecosystem health, water quality and drinking water, hazards, energy, and climate.

  Because CWP adheres to USGS strict standards and quality assurance, CWP monitoring and science is consistent and comparable through time and across watersheds, State boundaries, and geographic regions. Water issues in a specific watershed, municipality, or State can thereby be

compared to those in other geographic regions and at different periods of time; and large-scale syntheses and problem-solving needed to address USGS and Interior priorities, such as related to water sustainability and healthy ecosystems, are possible.

Program Performance

The CWP continues to work with more than 850 partners to protect long-term and real-time monitoring (streamgaging, groundwater levels, and water quality). Collectively, the national networks contribute significant hydrologic data and science needed to address state and federal priorities, including—

- Flood tracking, warning, and forecasting to protect life and property.
- Inter-jurisdictional and court adjudicated water rights and other legal obligations.
- Management of water supplies, particularly during droughts.
- Sustaining flows for healthy ecosystems.
- Maintaining long-term records without critical data breaks that are needed for analysis of trends related population growth and changes in land use, climate, and water use.
- Trust land and tribal responsibilities and endangered species.

The CWP conducted more than 700 interpretative studies in 2013, resulting in about 350 science and research peer-reviewed publications and journals. The studies were directly aligned with USGS and Interior priorities, including (1) water use and water availability studies; (2) evaluations of ecological flows; (3) water-resource evaluations on tribal lands; (4) assessments of energy development (hydraulic fracturing) on water quantity and quality; (5) assessments of water quality and contaminants of emerging concern in drinking water; and (6) studies relating landscape features, land use, water use, and climate variability on watershed health. The CWP continued the development of models and research decision-support tools, which are applied and transferrable across the Nation to help stakeholders manage vulnerable water supplies, human uses of water, and ecosystems.

Completed in 2013, were national compilations of CWP monitoring, assessment, and research activities related to tribal issues (*http://water.usgs.gov/coop/tribes_2014.pdf*), ecological health (*http://water.usgs.gov/coop/enviroflows_summary.pdf*), hydraulic fracturing (*http://water.usgs.gov/coop/products/energy/shale.cwp.summary.pdf*), and cyanobacteria and other harmful algal blooms (*http://water.usgs.gov/coop/products/qw/cyanobacteria.studies.WSCs.09122012.for.web.pdf*). Three USGS Top Stories on the USGS Web site on streamgaging (Part 1 [*http://www.usgs.gov/blogs/features/usgs_top_story/measuring-the-flow-part-1-the-importance-of-streamgages/?from=image*] and Part 2 [*http://www.usgs.gov/blogs/features/usgs_top_story/measuring-the-flow-uses-of-streamflow-information/?from=textlink*]), drought (Part 1 [*http://www.usgs.gov/blogs/features/usgs_top_story/drought-the-stealth-disaster/*] and Part 2 [*http://www.usgs.gov/blogs/features/usgs_top_story/drought-the-stealth-disaster-part-2-science-for-drought-planning/*]), and working with tribes (*http://www.usgs.gov/blogs/features/usgs_top_story/usgs-and-tribes-work-together-to-gain-water-knowledge/?from=title*) were also completed . Additionally, two

national stakeholder webinars were hosted on ecosystem health and impacts of groundwater pumping on streamflow depletion, each of which were widely attended by up to 580 stakeholders.

A national synthesis and modeling on drought were initiated in 2013 to characterize and estimate drought flow frequency, duration, magnitude, and probability—all of which are needed to better understand and anticipate drought streamflow conditions across the United States. Two journal articles and models are expected in 2014.

Summaries of selected accomplishments and products (categorized by USGS Mission Area topics); national compilations; Top Stories; and audio webinar presentations are available via the Cooperative Water Program Web site (*http://water.usgs.gov/coop/*).

Water Availability/Water Census – In 2013, the CWP conducted foundational and often long-term assessments and research on water availability issues in every State. These studies also provide critical input to the USGS national Water Census in determining water use, environmental flows, water budgets, and groundwater/surface water relations. Development of statistical models and other research tools helped to assess conditions over broad geographical areas and to allow forecasting into the future. For example the USGS, in cooperation with the Verde River Basin Partnership (*http://vrbp.org/*) and the Town of Clarkdale *(http://www.clarkdale.az.gov/*), assessed streamflow of the Verde River—one of Arizona's largest streams with year-round flow, showing declines from 1910 to 2005, as the result of human stresses, primarily groundwater pumping. The study modeled the impact of human stresses on the hydrologic system in and around the Verde Valley from 1910 to 2005, and predicted future conditions using three hypothetical human-stress conditions through 2110. The study's findings suggest that streamflow reductions will continue and may increase in the future. The model serves as a sophisticated tool to help communities responsibly manage, develop, and use their groundwater resources while avoiding streamflow depletion that could negatively affect healthy ecosystems in our Nation's rivers.

In 2015, monitoring, assessments and research on water availability and sustainability will remain a high priority of the CWP. In support of the national water census, additional focus will be placed on estimating streamflow at ungaged sites for more accurate water budgets; tracking site-specific public-supply and other water use information; developing consumptive use coefficients and methodology (particularly associated with irrigated agriculture); assessing watershed water budgets; developing climate models to track long-term patterns in groundwater and surface water flow; modeling environmental flows for sustained ecosystems; and advancing evapotranspiration measurements and assessment techniques.

Tribes depend on USGS science to help maintain tribal traditions.

"Our Tribe relies on USGS streamflow gaging activities to maintain aquatic habitat and the seasonal harvesting of a variety of native medicinal flora of importance to our tribal lifestyle and long-standing tribal ceremonies. In addition, USGS streamgages, such as on the Meduxnekeag River in Eastern Maine, provide us valuable real-time information on river flow and water-quality that is critical to native fish habitat, including for spawning Atlantic Salmon, a native species the Tribe hopes to restore to healthy populations."

(Ms. Sharri Venno, Environmental Planner with the Houlton Band Maliseet Indians in Houlton Maine)

Tribal Water Issues – The CWP worked in partnership with tribal leaders in more than 20 States around the country in 2013 to address water availability issues related to quantity and quality on tribal lands. An

extensive network of USGS streamflow gages and groundwater monitoring stations provided objective data information that can be used by the tribes to address water rights, water use, flood-warning predictions, water supply, hydrologic conditions, and water-quality issues. For example, in 2013, the USGS monitored streamflow at nearly 530 sites on tribal lands, and more than 1,160 and 1,720 sites within five and ten miles of Tribal lands, respectively.

Working with the Osage Nation

"This is an important study which will help establish water conservation and responsible water planning in the Osage. The mission of the Osage Nation's Environmental Natural Resources Department is to protect human health, the environment and Osage cultural resources, and to protect and develop natural resources, while preserving the diverse human cultures and animal and plant ecosystems existing in the Osage." (Osage Principal Chief John D. Red Eagle)

In addition, USGS hydrologists developed quantitative hydrologic models that provide information on how natural and human factors, such as groundwater pumping and climate change, affect water resources so that tribal river managers can effectively maintain and restore critical habitats and healthy ecosystems. For example, in July 2013, the USGS, in partnership with the Osage Nation in Oklahoma, jointly developed a "State of the Science" four-year effort that employs the latest advancements in USGS technology in order to assess water types, fresh and saline, and water supply and demand. The CWP study incorporates conventional hydrologic data gathering along with high-resolution aerial geophysical surveys, establishment of real-time surface water/groundwater interaction monitoring sites, and development of a hydrogeologic framework model. An integrated three-dimensional surface-water/groundwater model will be developed to analyze changes in flow, storage and recharge in the different hydrologic regions of the Osage under different climate and water-use scenarios. Study results will provide the knowledge base needed to develop a water resources management plan in the Osage for decades to come so that the Osage Nation and their partners can plan for sustained water resources now and into the future.

In 2015, monitoring, assessments and research needed to address tribal issues will remain a high priority in the CWP.

Energy – The CWP jointly funded activities were conducted in more than 20 States in 2013 to establish baseline water quantity and quality observations and assessments as natural gas exploration and production accelerates among different geologic and environmental settings across the United States. For example, the USGS, in cooperation with the Arkansas Natural Resources Commission, Arkansas Oil and Gas Commission, Duke University, Faulkner County, Shirley Community Development Corporation, and the University of Arkansas at Fayetteville, examined water quality in 127 shallow domestic wells in the Fayetteville Shale natural gas production area of Arkansas, which is the fourth largest recoverable gas play in the United States, and found no groundwater contamination associated with gas production. This study was important in terms of finding no significant effects on groundwater quality from shale gas development within the area of sampling and to provide a baseline to evaluate possible changes in the future (*http://pubs.usgs.gov/sir/2012/5273/*).

In 2015, monitoring and assessments will continue to fill in spatial and temporal information gaps in areas of natural gas exploration and production. The USGS will place additional focus on monitoring of hydraulic fracturing derived contaminants in water and sediment and assessment of impacts of energy development on channel morphology and sustainability of stream habitat and aquatic communities.

Landscape Level Understanding of Our Resources – Foundational and often long-term assessments and research were conducted through the CWP in every state in 2013 to establish relations among landscape and watershed characteristics, human activities, natural factors, and the quantity and quality of our water resources. The science helps to tease out the increasingly complex relations associated with natural and manmade factors, including climate variability and population growth that directly coincides with increased development of land for agriculture and urban use, increased demands for water, and increased use of fertilizers, pesticides, and other synthetic organic chemicals. Such studies directly support the USGS Water Census and the NAWQA.

For example, in 2013, the USGS in partnership with the Hampton Roads Sanitation District, showed that intensive groundwater withdrawals are a major cause of sinking land or "land subsidence" in the southern Chesapeake Bay region, which makes communities and coastal habitats vulnerable to increasing seawater levels and flooding and waterfowl vulnerable to the loss of coastal marsh and wetlands habitat needed for wintering in the Bay region. The report suggests that changing groundwater management practices—such as moving groundwater pumping away from high-risk areas—could slow or mitigate land subsidence and relative sea-level rise. These results are used by federal and state managers to consider adaptation strategies in their efforts to restore and protect the Chesapeake Bay (*http://pubs.usgs.gov/circ/1392/*).

In 2015, interdisciplinary monitoring and assessments will continue to assess and track physical, chemical, and biological components of watersheds to increase landscape-level understanding of the natural and manmade factors affecting our waters. Priorities will continue for studies that support NAWQA, including those that assess impacts of land use and climate on the quantity and quality of water; ecological flows; contaminants of emerging concern in drinking water; and transport of sediment, nutrients, and other contaminants to critical receiving waters. Analytical and research tools will continue to be developed that are transferrable across watersheds, such as the tools developed by the USGS in Tennessee to understand how streamflow characteristics and hydrologic alternation affect biological communities and ecosystem health.

Data Collection Activities

(2013 Actual, $34.0 million; 2014 Enacted, $34; 2015 Request, $34.1 million)

Over the past few years, the CWP has provided sole Federal support or partial support for over half the sites where the USGS collects data on surface-water levels and flow, groundwater levels, and groundwater quality. The CWP supports data collection of surface-water quality needed for State compliance with requirements of the Clean Water Act and collection of streamflow data important to water supply planners to identify the influence of climate variability and change on water availability.

These data provide resource managers with information they need to determine suitability of water for various uses, identify trends in water quantity and quality, and evaluate effects of various stresses on the Nation's groundwater and surface-water resources. Data collected at USGS monitoring sites are provided free of charge to everyone on the Internet. This includes historical data as well as real-time data. Emergency management agencies, State and municipal agencies, businesses, irrigators, and recreational users routinely employ this real-time data.

Most USGS data-collection stations serve multiple purposes and many receive funding, wholly or in part, through joint-funding agreements with one or more partners. Normally, these stations, though funded by various organizations, operate as part of an integrated network that provides benefits to a broad community of users and comprise the majority of the USGS national hydrologic data network.

Interpretive Studies and Technical Development

(2013 Actual, $25.5 million; 2014 Enacted $25.5 million; 2014 Request, $25.5 million)

In addition to data-collection activities, the CWP supports about 700 hydrologic studies each year. Water resource studies define, characterize, and evaluate the extent, quality, and availability of water resources. Publishing results of these investigations provides cooperating agencies that use them the basis for managing water resources for which they are responsible. These investigations follow national methodology and thereby provide information that is synthesized and applied to a variety of hydrogeologic and climatic settings across the Nation, greatly expanding the usefulness and transferability of USGS study results nationwide. Advancements in innovative tools, technology and statistical modeling also transfer among Water Science Centers and help to solve similar issues across the Nation.

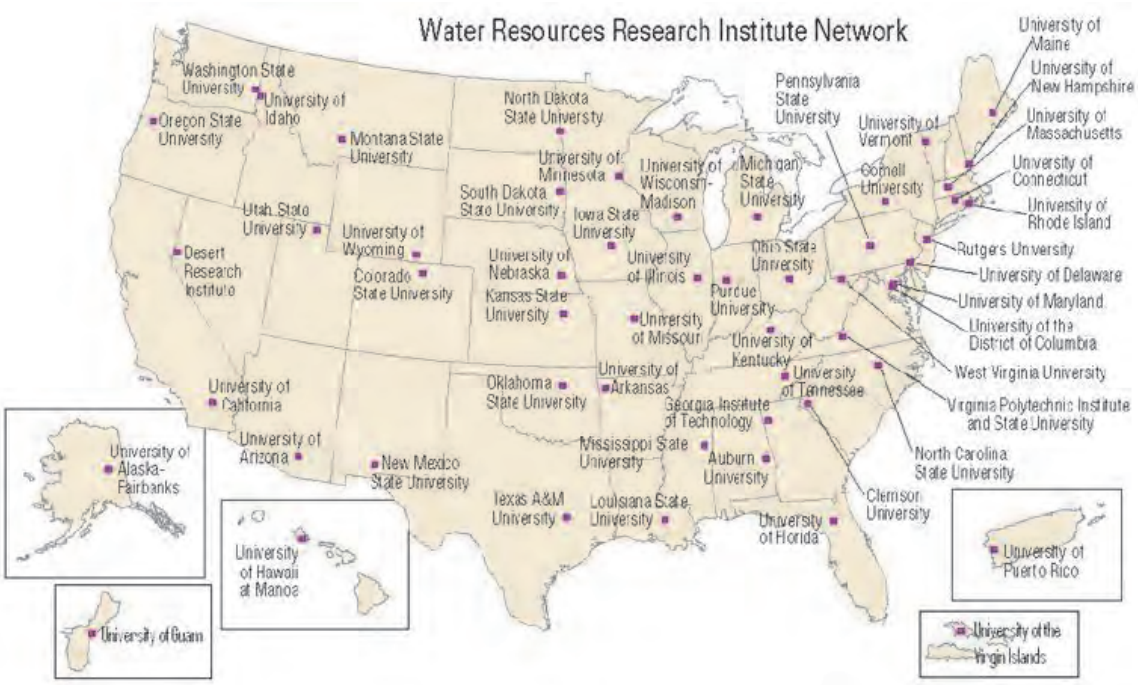
Activity: Water Resources

Subactivity: Water Resources Research Act Program

2013 Actual: $3.3 million (2 FTE)
2014 Enacted: $6.5 million (2 FTE)
2015 Request: $3.5 million (2 FTE)

Budget Realignment

The Water Resources Research Act (WRRA), of 1984, established a Federal-State partnership in water resources research, education, and information transfer through a matching grant program that authorizes State Water Resources Research Institutes at land grant universities across the Nation. There are 54 Institutes: one in each State, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. The Guam institute also serves as the Federated States of Micronesia and the Commonwealth of the Northern Mariana Islands.



Overview

The 54 Water Institutes provide new opportunities for young people through research and education efforts. Student internships supported by the Institutes provide practical training experience for the next

generation of hydrologic scientists and engineers and afford students the opportunity to participate in research projects while encouraging them to pursue careers in water resources.

The WRRA Program provides an institutional mechanism for promoting State, regional, and national coordination of water resources research, training and information and technology transfer. In 2013, through Federal appropriations, the program provided training and support to more than 100 undergraduate and graduate students by involving them in institute-sponsored research activities. With its matching requirements, the program is also a key mechanism for promoting State investments in research and training. In fact, the Water Institutes have developed a constituency and a program that far exceeds that supported by their direct Federal appropriation.

Program Performance

Though the program contributes to the Interior goal and the USGS Science Strategy focus of providing scientific information on water availability and quality of the United States, there is no performance measures specifically linked to this program. Historically, the Institutes support training for more than 300 students and production of about 500 publications annually. The proposed budget reduction would reduce funding of the annual base grants. The competitively awarded portion of the program would continue at the current level. In 2014 and 2015, the WRRA Program will develop more-rigorous oversight of the program and ensure that Federal investments at each of the Institutes effectively and consistently maximize national science goals and leverage all available resources, particularly in the areas of water availability, quality, and climate change.

Activity: Core Science Systems

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Science Synthesis, Analysis, and Research ($000)		23,914	24,314	140	0	-15	24,439	+125
	FTE	115	115	0	0	-4	111	-4
National Cooperative Geologic Mapping Program($000)		24,397	24,397	136	0	0	24,533	+136
	FTE	112	112	0	0	0	112	0
National Geospatial Program ($000)		59,332	60,096	388	0	-56	60,428	+332
	FTE	319	319	0	0	-39	280	-39
Total Requirements ($000)		**107,643**	**108,807**	**664**	**0**	**-71**	**109,400**	**+593**
	Total FTE	**546**	**546**	**0**	**0**	**-43**	**503**	**-43**

Summary of Program Changes

Request Component	($000)	FTE	Page
Science Synthesis, Analysis and Research Program	**-15**	**-4**	
Big Earth Data Initiative	2,000	0	B-48
Ecosystem Priority: EcoINFORMA	800	0	B-22
Hydraulic Fracturing	185	0	B-24
Bio-Science Data Synthesis	-3,000	-4	B-57
National Cooperative Geologic Mapping Program	**0**	**0**	
Hydraulic Fracturing	2,000	0	B-24
Glacial Aquifers Project	-2,000	0	B-57
National Geospatial Program	**-56**	**-39**	
3D Elevation Program	5,000	0	B-33
Alaska Mapping	236	0	B-33
Ecosystem Priorities: Columbia River	350	0	B-16
Ecosystem Priorities: Puget Sound	450	0	B-17
Land Cover Data	-422	-1	B-57
Nation's 133 Largest Urban Areas	-4,082	-25	B-58
The National Atlas	-2,674	-18	B-58
NGP Program Coordination and Partnership Development	-822	-4	B-58
The National Map Modernization	1,908	9	B-49
Total Program Change	**-71**	**-43**	

Justification of Program Changes

The 2015 Budget Request for Core Science Systems (CSS) is $109,400,000 and 503 FTE, a net program change of +$593,000 and -43 FTE from the 2014 Enacted Budget. For more information on the CSS Mission Area changes, please see Section B, Program Changes as indicated in the table.

Activity Summary

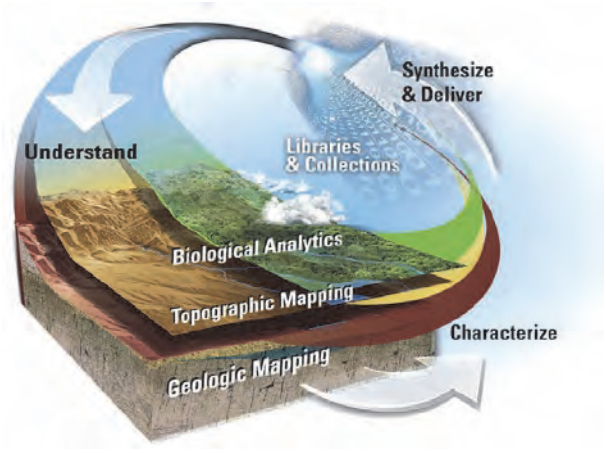
As part of the Nation's largest water, Earth, and biological science and civilian mapping agency, the CSS Mission Area conducts national-focused Earth-system science to deliver an understanding of the Earth's complex geologic structure. CSS conducts core sciences across a broad range of fields from structural geology, geomorphology and geophysics, to geography and remote sensing, evolutionary biology and biogeography. Products include interpretive studies, scientific publications, three-dimensional geologic models, geologic and topographic maps, all of which are essential for informed public policy decisionmaking and economic development.

Modern mapping includes Earth observations from many platforms (such as satellite, airborne, and unmanned aerial vehicles) and uses continuously evolving technologies that can sense and map an expanding list of features, such as gravity, magnetism, and thermal signatures using the latest technologies. Through collaborative efforts with Federal, State, tribal and local partners, CSS delivers nationally consistent, high quality geologic, topographic, and biogeographic information. Detailed, accurate information about the nature and origin of the geology of an area, portrayed through geologic maps and three-dimensional frameworks, is essential for identifying mineral, oil, and gas resources, finding and protecting groundwater, guiding earthquake damage prediction, identifying landslide and post-wildfire hazards, guiding transportation planning, and generally improving the quality of life and economic vitality of the Nation. Highly accurate elevation maps and data, for example, are essential for hazards mitigation, conservation, infrastructure development, national security, coastal shoreline erosion, and many other applications. The benefits apply to flood risk management, agriculture and precision farming, water supply, homeland security, renewable energy, aviation safety, and other activities.

CSS science supports the Department of the Interior's (Interior) 2014 – 2018 Strategic Plan Mission Area – Building a Landscape level Understanding of Natural Resources and other Administration and Interior priorities by:

- Providing foundational data layers for geology, topography, and biogeography;
- Advancing a landscape-level understanding of natural resources through the Geospatial Platform;
- Engaging the next generation of geologic mappers - more than 1,060 college geoscience students to date;
- Systematically enhancing elevation data over the conterminous United States, Hawaii, Alaska, and the territories through the 3-D Elevation Program (3DEP);
- Acquiring and enhancing foundational digital map layers such as elevation, surface water, and boundaries that will be used to produce new US Topo maps for Alaska; and,
- Managing the U.S. Node of the *Global Biodiversity Information Facility* (GBIF), which serves as an integral part of *EcoINFORMA*, the information delivery strategy in "*Sustaining Environmental Capital: Protecting Society and the Economy*," a report by the President's Council of Advisors on Science and Technology (*PCAST*).

The Critical Zone



The *Critical Zone* concept, introduced by the National Research Council in 2001, is the seamless collection of all ecosystems that sustain life on the planet and is the area where humans interact with and often compromise ecosystem functions. The figure depicts the key elements of the Core Science Systems mission.

CSS's Strategic Plan, *U.S. Geological Survey Core Science Systems Strategy – Characterizing, Synthesizing, and Understanding the Critical Zone through a Modular Science Framework*, outlines three broad goals for the coming decade:

1. Provide research and data to characterize and understand the Critical Zone;
2. Expand USGS research applications through scientific services; and,
3. Conduct scientific analysis and synthesis to improve coverage, scientific quality, usability, and timeliness of information.

The CSS Mission Area uses its information resources to create a more integrated and accessible environment for existing and new USGS data resources and participates in building global integrated science platforms.

CSS leads the USGS in the development and implementation of national standards that aid in the creation, management, and dissemination of digital Earth systems information to stakeholders. CSS includes the following subactivities and science efforts:

Science Synthesis, Analysis, and Research (SSAR) provides capabilities that support the entire science life cycle. This subactivity is comprised of the J.W. Powell Center for Analysis and Synthesis; the National Geological and Geophysical Data Preservation program; and the Core Science Analytics and Synthesis program, which includes the USGS Libraries. SSAR provides unique scientific collaborative opportunities, and preserves and makes available rock and ice core samples for scientific research. These programs maintain a comprehensive and up-to-date compilation of data about U.S. land in conservation status, enhancing CSS's ability to advance the USGS Science Strategy by developing, identifying, and implementing best practices for accessing, integrating, visualizing, and delivering USGS data and information. For more information, go to:

Core Science Analysis and Synthesis - *http://www.usgs.gov/core_science_systems/csas/*

The Libraries - *http://library.usgs.gov/*

Data Preservation Program - *http://datapreservation.usgs.gov/*

J.W Powell Center for Analysis and Synthesis - *http://powellcenter.usgs.gov/*

The National Cooperative Geologic Mapping Program (NCGMP) cooperates with State geological surveys to provide publications, digital geologic maps, and multidimensional models and visualizations that help to sustain and improve the quality of life and economic vitality of the Nation and to mitigate natural hazards. Of note, the program makes geologic mapping data from all of North America publically and freely available by way of the National Geologic Map Database. Recently the program marked the 21st anniversary of the National Geologic Mapping Act that established the NCGMP and the partnership with State geological surveys and universities. Since its inception, the program has leveraged more than $100.0 million in Federal funding matched by the State geological surveys to collaboratively produce modern geologic maps for the Nation and $8.5 million matched by universities to train the next

generation of geologic mappers—more than 1,060 college geoscience students to date. For more information, go to:

NCGMP main program page - *http://ncgmp.usgs.gov/*

The National Geologic Map Database - *http://ngmdb.usgs.gov/ngmdb/ngmdb_home.html*

FEDMAP component - *http://ncgmp.usgs.gov/about/fedmap.html*

STATEMAP component - *http://ncgmp.usgs.gov/about/statemap.html*

EDMAP component - *http://ncgmp.usgs.gov/about/edmap.html*

Federal Advisory Committee - *http://ncgmp.usgs.gov/about/evaluation/faca_intro.html*

The National Geospatial Program (NGP) publishes geospatial baseline data and maps of the Nation's topography, natural landscape, and built environment. For nearly 130 years, the USGS has been the primary producer of topographic data for the Nation, and is unveiling new and emerging geospatial products and technologies. Federal, State, and other users incorporate these data and maps into their business activities. Such applications include enhanced elevation data for understanding seismic and landslide hazards and forecasting floods; understand and mitigate coastal erosion and storm surges; improve aviation safety; hydrography data to analyze water quality, quantity, and use; and topographic maps essential for scientific fieldwork and providing a base onto which geology and other scientific data can be mapped. The program works with cooperators to consolidate funding to acquire new data through the private sector, which is an activity that provides data to all partners at lower unit costs and ensures that industry standards are followed. The program then publishes these standardized data to promote their reuse, which reduces the possible later duplication of data acquisition efforts. The baseline is *The National Map*, a set of databases of map data and information from which customers can download data and derived map products free and use Web-based map services. Through the Geospatial Liaison Network, the NGP works with cooperators to share the costs of acquiring and maintaining these geospatial data. For more information, go to:

Geospatial liaison site at *http://liaisons.usgs.gov/geospatial/*

The National Map site - *http://nationalmap.gov/*

US Topo site - *http://nationalmap.gov/ustopo/index.html*

US Board on Geographic Names site - *http://geonames.usgs.gov/index.html*

Hazards Data Distribution System site - *http://hdds.usgs.gov/hdds2/*

The National Map viewer and download platform site - *http://nationalmap.gov/viewer.html*

The National Atlas of the United States of America® site - *http://www.nationalatlas.gov/*

Historical Topographic Map Collection site - *http://nationalmap.gov/historical/index.html*

Geospatial Research - *http://cegis.usgs.gov/*

The Federal Geographic Data Committee (FGDC) promotes and endorses consistent data and metadata standards, system interoperability, and cross-government best business practices for geospatial resources, policies, standards, and technology in support of the National Spatial Data Infrastructure. The FGDC Office of the Secretariat, administered by the USGS, provides support to the FGDC Chair and Vice Chair, the 32 member agencies, and Federal geospatial initiatives and priorities that enhance information availability for decisionmaking and science, increase information delivery efficiencies, and reduce duplication of Federal Geospatial data assets through shared services to leverage economies of scale. The Geospatial Platform is an Internet-based capability that provides a suite of well-managed, highly available, and trusted geospatial data, services, and applications for use by Federal agencies and their State, local, tribal, and regional partners. The Geospatial Platform, identified this year to support the Secretary's Landscape Level Understanding priority, is the service and delivery mechanism for Federal geospatial portfolio assets, and the integration point for leveraging shared information from, and with, other State, local, tribal, and non-governmental information sources. This approach provides increased return on existing geospatial investments by promoting the reuse of data, applications, and tools. For more information, go to:

Federal Geographic Data Committee, Office of the Secretariat - http://www.fgdc.gov/

Geospatial Platform - *http://www.geoplatform.gov*

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #4: Provide Water and Land Data to Customers
Strategy #2: Generate Geologic Maps and Models for Sustaining Resources and Protecting Communities

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
U.S. Geological Survey									
National Cooperative Geologic Mapping	26,626	27,724	28,163	27,713	24,397	24,397	24,533		-9.1%

Strategic Plan Performance Measures	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Target	2013 Actual	2014 Target	2015 Target
Percent of the U.S. that is covered by at least one geologic map and is available to the public through the National Geologic Map Database (NCGMP)	USGS	47.7%	48.9%	49.4%	50.0%	50.6%	51.3%	51.9%	52.5%
		1,687,637	1,729,771	1,746,550	1,767,763	1,789,944	1,814,735	1,835,930	1,857,155
		3,537,438	3,537,438	3,537,438	3,537,438	3,537,438	3,537,438	3,537,438	3,537,438

Supporting Performance Measures

Outputs, Supporting Performance Measures and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Annual production of geologic maps for the Nation (summed and represented as a percent of U.S. land area) made available to the public through the National Geologic Map Database (NCGMP)	USGS	2.90%	2.70%	2.00%	1.80%	1.80%	2.10%	1.80%	1.80%

Mission Area 6: Building a Landscape Level Understanding of Our Resources and Providing a Scientific Foundation for Decision Making
Goal #4: Provide Water and Land Data to Customers
Strategy #1: Develop an Integrated Data Framework that is used to Guide Science- Based Stewardship of Natural Resources
Strategy #2: Generate Geologic Maps and Models for Sustaining Resources and Protecting Communities
Strategy #3: Advance the Earth Science Application of Geospatial Information

Key Funding Sources (dollars in thousands)	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Actual	2014 Enacted	2015 Request	2009 - 2015 Trend	index
U.S. Geological Survey.....	69,816	70,748	65,755	62,988	59,332	60,096	60,428		
Total.....	69,816	70,748	65,755	62,988	59,332	60,096	60,428		-8.3%

Percent of lower 48 States, Hawaii, District of Columbia and Puerto Rico published as high-resolution base geospatial databases.	USGS	26%	64%	100%	35%	67%	67%	100%	33%
		13,203	32,013	50,515	18,546	35,789	35,781	53,940	17,980
		50,414	50,414	50,414	53,684	53,684	53,684	53,940	53,940

*Note: The USGS updates all topographic maps for the conterminous States on a -year cycle. The USGS' goal is to reach 100 percent every third year, and then reset the target to zero for the next 3-year cycle of map updates.

Supporting Performance Measures

Outputs, Supporting Performance Measures, and/or Milestones	Bureau	2009 Actual	2010 Actual	2011 Actual	2012 Actual	2013 Plan	2013 Actual	2014 Plan	2015 Plan
Percent of Alaska published as high resolution geospatial databases.	USGS	N/A	N/A	N/A	N/A	N/A	31%	43%	48%
Percent of U.S. surface area published as new enhanced elevation data.	USGS	N/A	N/A	N/A	N/A	N/A	3%	5%	7%

Activity: Core Science Systems
Subactivity: Science Synthesis, Analysis, and Research

2013 Actual: 23.9 million (115 FTE)
2014 Enacted: 24.3 million (115 FTE)
2015 Request: 24.4 million (111 FTE)

Overview

Science Synthesis, Analysis, and Research (SSAR) provides analysis and synthesis of scientific data and information, and long-term preservation of scientific data and library collections. SSAR ensures that data are strategically managed, integrated, and available to decisionmakers and others as they focus on issues associated with Earth and life science processes. SSAR includes the J.W. Powell Center for Analysis and Synthesis (Powell Center); the National Geological and Geophysical Data Preservation (NGGDP) program; and the Core Science Analytics and Synthesis program (CSAS). In 2014, the USGS merged the management and operation of the USGS Libraries into CSAS to create efficiencies and better align complementary functions.

Program Performance

USGS Grants Ensure Important Data Preservation and Fund Students – In 2013, the NGGDP awarded grants to 25 States to preserve a wide array of important geoscience data. Due to this funding, many States are making great progress to preserve and provide access to fragile and one-of-a-kind materials. In many instances, the State collections provide access to information currently not available or accessible in the field due to land-use or permission changes, as well as loss of public memory of geologically important sites. These well-organized and accessible State collections ensure access to materials and data that would otherwise cost tens of thousands to millions of dollars to reproduce or collect. For example, funding is directed at assessing collections affected by the 2011 Tropical Storm Irene, which will make it possible to recombine the disparately stored collections and digitize collections for long-term preservation and easier public access. The societal benefits of the projects funded in 2013 can be separated into three major categories: science, industry/resource management, and environmental safety and health. Nationwide, including matching State funds, $1.27 million was contributed to these efforts. This includes approximately 10,000 student hours. It is estimated that $0.6 million will be awarded to 25–30 States in 2014 and 2015 to inventory collections of geological and geophysical data, create metadata for individual items in those data collections, create or update digital infrastructure, and rescue data at risk.

USGS Library System Reduces Footprint, Increases Efficiency – The USGS Clarence King Library in Reston returned over 16,000 square feet of floor space through increasing the number of books per shelf, shelf reduction, and reduction of duplicate holdings. To achieve this, over 500,000 books, reports, and other items were relocated and about 4.5 miles of linear shelving were reduced, reconfigured, or

relocated. While access to the Reston stacks was closed during the consolidation activities, all other library services including digital library functions and librarian assistance to scientists, continued in full operation. This completes the first phase of the planned space consolidation in support of the bureau's efficiency initiative; the Denver and Menlo Park branch consolidations are in the planning stages now. When completed, this effort will result in a total space reduction of about 30 percent for the entire system.

Scientific Community Validates Importance of Powell Center Research – The John Wesley Powell Center for Analysis and Synthesis brings together leading minds across the scientific community to address complex, high impact societal challenges. In 2013, Powell Center working groups concluded work leading to over 30 publications now in print or in press. These publications, many in high profile scientific journals, are quickly garnering a high number of citations and driving debate in their respective fields. These publications document studies related to significant scientific challenges. Examples include—

- A study to validate and resolve discrepancies among the climate models used as the basis for international climate reports, and to compare current and past climate conditions – this work informs ongoing attempts to understand the Earth's climate, and the impact of human and natural changes to the planet and its atmosphere;
- An examination of drought impacts on agriculture in food-insecure areas of the world – this study assessed risks and impacts of potential future famines, as well as targeting aid and development needs; and
- A study of the induced seismicity caused by hydraulic fracturing – This brings together very recent data from the Nation's ongoing "hydrofracking" growth to create the first comprehensive picture of the effects of these techniques on earthquakes and seismicity in their local areas.

The impressively high number of citations for these and other published Powell work signify the importance of and high regard for Powell Center science, aimed at discrete societal impacts, and serves as a primary example of the strengthening interdisciplinary focus of USGS science.

USGS Community for Data Integration (CDI) Provides a Foundation for Efficient Data Sharing – The CDI is a multi-Federal, State, and non-government community of practice dedicated to advancing data and information management and integration capabilities for scientific data. Through synergistic collaboration, this community expands the expertise available in any single organization to create new tools, incorporate new data, and implement best practices for more efficient and effective application of scientific data to Earth system challenges. In 2013, the CDI's successes included—

- myScience (*txpub.usgs.gov/myscience/Default.aspx*) – a USGS citizen science project discovery and public engagement Web application;
- Metadata Wizard (*www.sciencebase.gov/metadatawizard*) – a tool to assist GIS users in creating better metadata to document key science data and research;
- Data Management Web site in support of USGS Fundamental Science Practices that assists researchers and others in complying with Open Data and other Federal data management initiatives by providing guidance, processes, tools, and best practices. The site also includes

training modules to promote understanding of the value of good data management (*http://www.usgs.gov/datamanagement*); and

- Visualization tools and data portal applications that allow scientists and the public to easily access and view USGS land cover and high value, large climate datasets within the GeoDataPortal and without the need for proprietary software.

The John Wesley Powell Center for Analysis and Synthesis

(2013 Actual, $0.1 million; 2014 Enacted, $0.1 million; 2015 Request, $0.3 million)

The Powell Center serves as a catalyst for innovative thinking in Earth system science research focusing on multi-faceted issues. The scientist-driven center, which provides unique opportunities for scientific collaboration among government, academic, and industry scientists, completed its third full year of operation in 2013. In 2013, six new Working Groups were selected through peer-review by the Science Advisory Board, and hosted at the Powell Center along with the eight continuing Working Groups, for a total of 14 active Groups. These Working Groups focused on major ecosystem challenges including specific impacts of climate change, water quality and availability, and other aspects of natural resources sustainability and environmental health. In September 2013, the Powell Center signed a new Memorandum of Agreement (MOA) with the National Science Foundation (NSF), which greatly expands the opportunity for NSF-supported interdisciplinary Earth science research at the center. At the end of 2013, publications from Powell Working Groups grew to a total of 30, including publications in the highly regarded *Nature Climate Change* and *Science*. Five Working Groups that have successfully completed their USGS-supported work at the Powell Center have secured funding from sources outside the USGS to continue their scientific endeavors. Six new Working Groups have been selected for initial meetings in 2014, out of 18 total proposals submitted. In 2015, the Powell Center would continue to provide opportunities of scientific collaboration through the Working Groups.

Data Preservation

((2013 Actual, $1.7 million; 2014 Enacted, $2.1 million; 2015 Request, $2.1 million)

National Geological and Geophysical Data Preservation (NGGDP) program efforts are dedicated to the preservation of physical geoscience samples, and analog and digital geoscience data including rock and ice cores, fossils, fluid samples of oil, gas, and water, and geochemical samples. This information populates the National Digital Catalog of archived materials to include inventories of geological and geophysical data collections and metadata on individual items within those collections. To accomplish this work, the USGS cooperates with State geological surveys and other Department of the Interior (Interior) bureaus.

Preserving endangered geological and geophysical collections is more cost effective than recollecting this information, while also ensuring that research data collected in the past can be reused, and integrated into new research in the future. Typically, materials and data reside in inadequately cataloged, overfilled, and disorganized storage areas not designed as data repositories. Many Federal and State geological repositories are at or near capacity and unable to accept additional materials. The NGGDP supports the development of national standards, procedures, and protocols for preserving collections and improving their accessibility for current and future researchers. By working together to manage and make accessible

these research inputs, the USGS and its partners can leverage the work of their colleagues and provide new insights in context with the scientific record.

In 2014, Congress appropriated an additional $0.4 million to the NGGDP. With these funds, the NGGDP is able to provide more States with funds to inventory and preserve physical collections, such as core samples, fossil and fluid samples, and derived and indirect data, such as geochemical and seismic data, maps, or field notebooks. These efforts improve the National Digital Catalog that makes it possible to find, get and use preserved geoscience data comprising over 750 collections, representing 2,759,456 geoscience data points, provided by 44 States and USGS collections. These resources also allow for expanding the digitization, description, and accessibility of scientific research products in the possession of the USGS and its partners for the broader availability of this content for integration and discovery.

Included in Data Preservation are two essential repositories:

Core Research Center (CRC) – The CRC, established in 1974, preserves valuable rock cores for use by scientists and educators from government, industry, and academia. Rock cores and drill core cuttings are permanently stored and available for examination and testing at the CRC in Denver, CO. The CRC is currently one of the largest and most heavily used public core repositories in the United States. The CRC also houses, in volume, the second largest Federal fossil collection in the United States. The fossil curation staff has conducted digital georeferencing on over 30,000 fossil localities, thus making these portions of the databases projectable in mapping and commercial software. In addition, the CRC provides technical assistance as, for example, it did when CRC staff slabbed (cutting the core lengthwise) and wrapped 1,500 linear feet of USGS cores drilled at Wolcott, CO. The USGS Central Energy Resources Science Center for USGS Oil and Natural Gas assessments is studying this core. In 2013, CRC staff members participated in the Energy Governance and Capacity Initiative (led by the U.S. Department of State) by putting on a three-day workshop in Uganda to train geologists in the best practices of a rock core facility and repository management. This effort is a U.S. interagency effort to provide a wide range of technical and capacity building assistance to the host governments of select countries that are on the verge of becoming the world's next generation of oil and gas producers. In 2014, the CRC is meeting the high demand from industry, academia and USGS scientists for access to these collections, and will continue this in 2015.

National Ice Core Laboratory (NICL) – The NICL is the Nation's repository for storing, curating, and studying ice cores recovered from ice sheets, ice caps, and glaciers of the world, predominately from Antarctica and Greenland. The NICL facility provides the ice core research community with the capability to conduct examinations and measurements on the working scientific collections of ice cores while preserving the integrity of these cores in a safeguarded, temperature-controlled environment for current and future investigations. The NICL is a National Science Foundation (NSF) funded facility operated and maintained by the USGS through an interagency agreement. Research on the ice cores supports the scientific goals of the National Science Foundation, Division of Polar Programs in the fields of paleoclimate reconstruction, and atmospheric change and history of the Earth.

Core Science Analytics and Synthesis

(2013 Actual, $22.1 million; 2014 Enacted, $22.1 million; 2015 Request, $22.0 million)

CSAS drives innovation in biodiversity, computational, and data science to accelerate scientific discovery that anticipates and addresses societal challenges. In doing so, the program conducts biological occurrence data acquisition, biological taxonomic analysis and interpretation, computational analytics and synthesis, and provides access to broad collections of scientific information (including USGS publications) in paper and digital forms. CSAS leads the USGS in expanding the capacity for mobilizing data and creating innovative tools and technologies, allowing scientists to collect, access, analyze, integrate, synthesize, and model scientific data.

The USGS Science Strategy emphasizes applied Earth systems information research with a focus on data integration and new methods of investigation. In 2013, CSAS worked closely with other mission areas to leverage expertise and apply it to the computing and information needs of science research projects. To help respond to complex and sometimes perplexing science questions, CSAS collaborates with other USGS Mission Areas, and partners with institutions, programmers, modelers, application developers, and others.

CSAS continues to develop the USGS Big Earth Data implementation plans that prioritize DOI and USGS Earth science data and applies the characteristics defined by USGEO to assess the treatments needed. CSAS is initiating efforts to provide managed collections of Earth science data to Data.gov and specialized collaborative portals (e.g., Ocean.data.gov and Ecosystems.data.gov). For example, the USGS is integrating disparate bird observations data into a larger portal platform using the Biodiversity Information Serving Our Nation (BISON), which will be mostly completed in 2014, resulting in efficiencies such as fewer disparate bird databases to manage and a more central location (BISON) to access the bird observations, and supporting the Secretary of the Interior's goal of a landscape-level of understanding the Nation's natural resources.

Scientific inquiries and interpretation require timely access to scientific data. To achieve this, CSAS leads the USGS Community for Data Integration and other communities of practice (e.g., pollinators; invasive species); conducts hands-on training on metadata standards and for common methodologies, tools and applications; and contributes to the development, adoption and implementation of standards.

In 2014 and 2015, CSAS continues to play a vital role in science and continues to perform research and analysis related to conservation science, vegetation classifications, and taxonomy. In addition, beginning in 2014, the USGS has merged the management and operation of the USGS Libraries into CSAS. This alignment of complementary functions promotes sharing of expertise and creates efficiencies. The USGS Libraries maintain over 1.8 million physical items, and focus on digitizing important collections while retaining the ability to locate and acquire rare or specialized research products needed by scientists.

CSAS maintains products and capabilities that make national-level data available through interactive systems that facilitate integration, modeling, and visualization of the data. They include—

- **Biodiversity Information Serving Our Nation (BISON) –** The national integrated resource for U.S. Federal and non-Federal biological occurrence data serves more than 111 million records of

species occurrences for every State, county, and congressional district in the United States. BISON serves as the U.S. connection to the Global Biodiversity Information Facility and is the biodiversity hub of the EcoINFORMA informatics capability recommended in the July 2011 report on sustaining environmental capital by the President's Council of Advisors on Science and Technology.

- **Community for Data Integration (CDI) –** The CDI is a collaboration of USGS scientists, data managers, policy experts, and other organizations that promote data management best practices and data integration capabilities. It is an instrumental community of practice for leveraging expertise and resources to test new technologies and institutionalize best practices.
- **Gap Analysis Program National Data Layers (GAP) –** GAP builds and maintains three unique datasets: land cover, land stewardship, and species distributions. The USGS and other Federal agencies, States, local government, and others use GAP as a source for up-to-date, standardized environmental data that help to determine habitat suitability and sometimes guide land purchase decisions.
- **Integrated Taxonomic Information System (ITIS) –** With nearly 760,000 scientifically vetted entries, the ITIS is the authoritative source for scientific names of species and higher-level groups of organisms in North America and the world. The ITIS is produced in conjunction with eight other Federal partners who use it as the authority for taxonomic information. Its partnership with the European-based Species 2000 yields the global names standard: Catalogue of Life.
- **USGS Libraries** - The Libraries identify, acquire, manage, and provide access to a broad range of scientific information including USGS publications, in physical and digital forms. In response to user requirements, the Libraries are focusing on shifting the balance in favor of more digital and less physical content, allowing for a reduced footprint and increased cost efficiencies.
- **National Fish Habitat Partnership Data System (NFHP-DS) –** The NFHP-DS is a data system that provides users with geospatial data visualization, and downloadable maps, metadata, and map services capabilities. Members of the National Fish Habitat Partnership, which include Federal agencies and others, use this system to upload, interact with, and download data, reducing data processing workload and increases accessibility needed for national habitat assessments to inform decisionmakers better.
- **Ocean Biogeographic Information System of the United States (OBIS-USA) –** The OBIS-USA helps producers of marine biological data describe, provides access to, and stores their data according to internationally-sanctioned standards, supporting the U.S. Open Data Policy. The OBIS-USA provides access to more than seven million records, and is the official hub for the United Nations' Education, Science and Cultural Organization's Intergovernmental Oceanographic Commission.
- **ScienceBase –** ScienceBase is a data and information management capability that enables data upload, documentation, sharing, and dynamic data services through standards-compliant methods and technological components to provide a foundation for data stewardship, government open data, and scientific discovery.

- **Science Data Management –** This component provides bureauwide leadership in establishing and implementing science data-management practices. It provides access to standards, workflows, training, and tools to help ensure Federal data is properly maintained, described, preserved, and made accessible.

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Activity: Core Science Systems

Subactivity: National Cooperative Geologic Mapping

2013 Actual: 24.4 million (112 FTE)
2014 Enacted: 24.4 million (112 FTE)
2015 Request: 24.5 million (112 FTE)

Overview

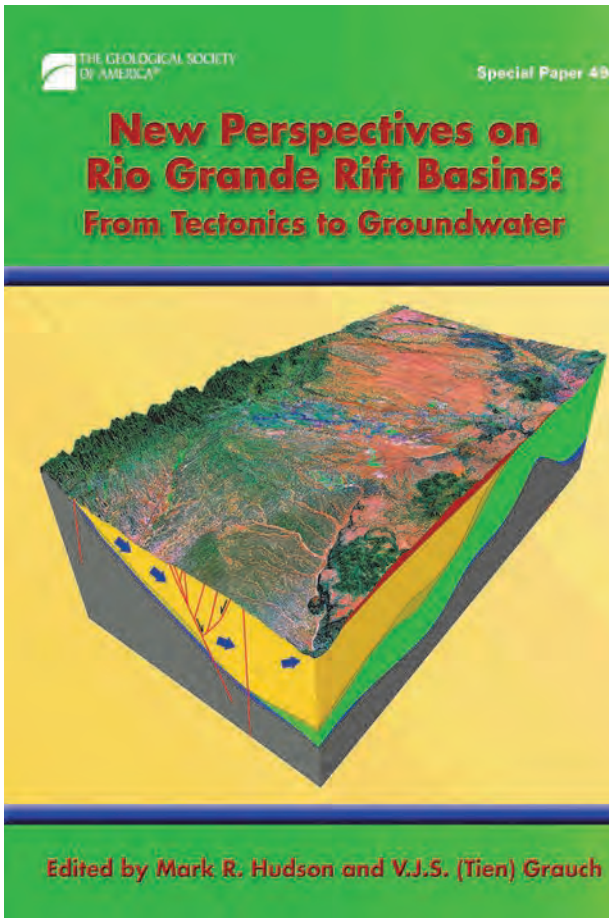
In a time when so many of the solutions to the Nation's most pressing problems lie in the ground beneath our feet, the National Cooperative Geologic Mapping Program (NCGMP) advances the understanding of the nature of the materials—rocks, energy resources, water—and processes such as characterization, containment, and flow. This nationwide program of geologic research produces about 100 peer-reviewed journal articles annually on surficial and bedrock geology, mapping, and multidimensional models that provide fundamental research and data that underpin all of the themes of the USGS Science Strategy. These primary findings and data are applied in natural hazards mitigation, water resources delineation, energy and minerals exploration, climate change studies, and ecosystem and environmental health analysis and are readily accessible through the National Geologic Mapping Database.

In 2013, the NCGMP marked the 21st anniversary of the National Geologic Mapping Act of 1992, by establishing an annual award for the Best Student Geologic Map at the Geological Society of America meeting. This award will become another tradition in training the next generation of geologic mappers. Over its history, the program has leveraged over $100 million in Federal funding matched by the State geological surveys to collaboratively produce modern geologic maps for the Nation

National Cooperative Geologic Mapping

"A foundational science program: determining the geologic framework of areas determined to be vital to the economic, social, or scientific welfare of the Nation."

National Geologic Mapping Act 2009 (P.L. 111-11)



The 18 journal articles published by USGS scientists and their partners in other Federal and State agencies, as well as academia, tell the complex geologic history of the Rio Grande rift valley and the sedimentary basins that contain the aquifers that supply water to Albuquerque, Santa Fe, and other communities. This research provides the landscape-level understanding for decisionmakers in New Mexico and southern Colorado, especially about water issues.

and $8.5 million matched by universities to train the next generation of geologic mappers—more than 1,060 college geoscience students to date.

Geologic maps and frameworks define the subsurface shape of aquifers, how much water can be stored in them, and parameters for water movement through the ground. Geologic mapping products also provide critical information for predicting and mitigating natural hazards, such as landslides, earthquakes, and volcanoes.

The NCGMP supports a major Federal geologic mapping partnership between the USGS and the National Park Service (NPS). In the past 15 years, the NCGMP has helped the NPS to inventory the geologic resources of more than 200 parks and to create digital geologic maps in many of them. Park managers require these products for making landscape-level decisions.

A hallmark of the NCGMP, the National Geologic Map Database is a major collaborative effort with the Association of American State Geologists (AASG). This national database provides rapid access for the general public, scientists, and decisionmakers to well-documented and standardized Federal and State geoscience information that can be used to support research, understanding, and decisions on a number of societal needs. Of note in 2013, a newly redesigned Map Viewer interface elicited universal praise. Through annual workshops, this project leads national-level information exchanges and the development of more efficient methods for digital mapping, cartography, geographic information system analysis, and information management.

Universal Praise from Users of the New Mapviewer for the Geologic Map Database

"As a regulator for the CA-EPA, I have extremely limited access to paper copies of geologic maps. These maps provide critical information for developing conceptual site models. Your website integrates geologic maps for different scales in one easily accessible location. The ability to download pdf copies of geologic maps, and more importantly - gis datasets if available, is an invaluable resource that will be utilized by many geologists in the future. The most important suggestion that I have is to promote this website to as many geoscientists as possible."

John K.
California Department of Toxic Substances Control
November 2012

"I just wanted to congratulate you on seeing this MapView utility become a powerful and accessible part of earth science. It was a major topic of discussion on the NRC review panel where we last talked about the infrastructure for digital mapping. The MapView is truly useful and a dream to pick up effortlessly. Besides the viewing of geological maps and topographic base maps, the retrieval of the underlying maps and publications works really well, especially when a map is available on-line."

George B.
Department of Earth and Planetary Science
University of California, Berkeley
November 2012

The NCGMP works in close collaboration with State geological surveys, such as with the Great Lakes Geologic Mapping Coalition, which is a Federal-State partnership created to produce urgently needed, detailed, three-dimensional surficial-materials maps that provide a foundation for making sound economic and environmental decisions related to ground water resources, land, and other natural resources of the Great Lakes.

Program Performance

The USGS Education Mapping Program (EDMAP) program is highly regarded throughout the Federal Government and academic communities as being one of the most effective Earth science education programs that focuses on geosciences workforce training and as a pipeline for geologic mapping professions. In satisfaction surveys of the student participants, respondents report that they have gained valuable research and mapping skills that enable them to be highly competitive in the geosciences job market upon graduation. In addition, many EDMAP alumni have pursued academic careers and are in turn educating a new generation of Earth scientists. For more information, go to *http://www.usgs.gov/core_science_systems/access/fall_2012/article-1.html*

Second Annual National Geologic Map Day – During the American Geosciences Institute (AGI)'s Earth Science Week, the USGS and the AASG partnered with the AGI to celebrate the second annual Geologic Map Day on October 18, 2013. The event concluded Earth Science Week, which boasts the participation of roughly 49 million people annually. Focused primarily on K-12 educators, Geologic Map Day is designed to inform the public, while engaging students across the Nation and to advance STEM (Science, Technology, Engineering, and Mathematics) education efforts. Teachers were provided with wide-ranging materials related to geologic mapping, reinforced by classroom visits from local scientists with geologic mapping expertise, knowledge, and field experience.

A Best Practice for Federal, State, and University Collaboration – In close cooperation with the AASG, the NCGMP has led two decades of successful cooperation among Federal, State, and university partners to deliver modern digital geologic maps to the communities that need them. Three outstanding efforts of the past year typify this strong partnership: release of the major publication *New Perspectives on Rio Grande Rift Basins—From Tectonics to Water*; the publication of two important journal articles that provide an important link between geologic mapping, past climate change and sea level change in the southeastern Atlantic Coastal Plain; and the completion of over 10 years of geologic mapping in the Ozarks National Scenic Riverways.

The Rio Grande papers, published in a Special Paper of the Geological Society of America, represents more than 15 years of work to understand the geologic history of a complex rift system that stretches from the Mexican border to Colorado better. The sedimentary basins that formed along the axis of the rift are the source of ground water for much of the population of New Mexico and southern Colorado, and understanding the subsurface architecture of these aquifers is a critical need so that State water managers can make informed decisions about water use.

The two journal articles on paleoclimate studies in the southern Atlantic Coastal Plain show that significant warming in Paleocene-Eocene times had a major impact on climate and sea-level rise, and this information is useful in understanding how present-day warming will impact coastal communities in the Southeastern United States.

The completion of geologic mapping in the Ozarks has provided information needed for competing land-use decisions by park, forest and mining mangers. All of the stakeholders in the debates on future land-use will likely use the scientifically unbiased geologic mapping of the USGS.

In 2014, review panels that include scientists and representatives from Federal and State governments, the private sector, and academia critically reviewed work plans for the three main program components: Federal Mapping program, (FEDMAP), State Mapping program, (STATEMAP), and EDMAP. Review panels will continue this effort in 2015.

FEDMAP – Federal Geologic Mapping Science and Applications

(2013 Actual, $17.0 million; 2014 Estimates, $17.0 million; 2015 Request, $17.1 million)

The FEDMAP component of the NCGMP supports about 25 regional geologic mapping and synthesis projects that cross jurisdictional-boundaries. New and ongoing geologic mapping work plans are evaluated annually by a FEDMAP Review Panel, which includes representatives from State geological surveys, the NPS, and USGS researchers that have diverse scientific backgrounds. Examples of NCGMP interdisciplinary geologic mapping 2013 accomplishments that contribute to answering a breadth of the Nation's natural resource issues include—

- Groundwater availability, movement, and contamination across the United States, such as in Texas, Oklahoma, New Mexico, and Colorado, Arizona, and New England;
- Earthquake and other hazards mitigation in the Seattle-Portland urban corridor, California, the Central United States, and Virginia;
- Ecosystem health in the Platte River Basin, in national parks, the Appalachian Blue Ridge Mountains, on Native lands in cooperation with tribal nations, and along the U.S.-Mexico border;
- Climate change understanding in the mid-Atlantic, California, and the Greater Platte River Basin, and Mojave Desert; and
- Energy and mineral resource occurrence in Nevada, Arizona, Colorado, Wyoming, Pennsylvania, and Texas. Some of this work will provide subsurface framework in areas under development for hydraulic fracturing.
- In 2014, the National Karst Map will be published which will be useful in identifying areas with potential for sinkholes. In 2015, the FEDMAP program will publish a new map of the greater Portland, Oregon area, which highlights major earthquake faults landslides providing another valuable tool for hazard and emergency response.

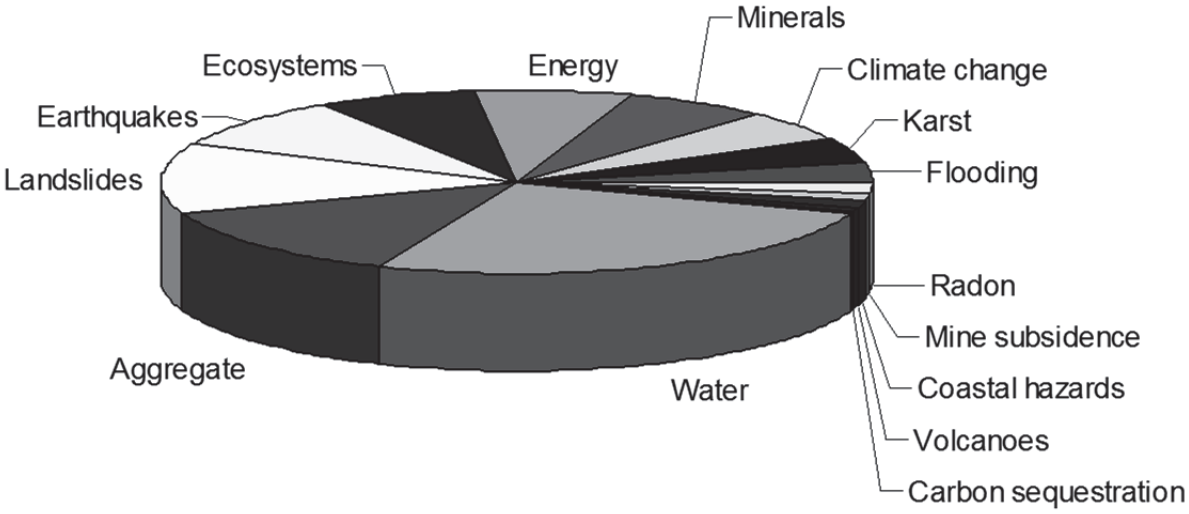
STATEMAP – Serving State Priorities for National Needs

(2013 Actual, $6.9 million; 2014 Enacted, $6.9 million; 2015 Request, $6.9 million)

The STATEMAP component of the NCGMP currently supports geologic mapping studies conducted by 43 State geological surveys through a competitive cooperative agreement program that matches every Federal dollar with a State dollar. Since STATEMAP's inception in 1993, 48 States have matched more than $100 million. In each State, geologic mapping priorities are determined with the help of State Mapping Advisory Committees that include representatives from all levels of government, the private sector, academia, and industry. Currently, more than 500 individuals offer their time on these committees to prioritize geologic mapping needs. This important group of people acts as "grass roots" allowing the

program to stay in touch with citizens' greatest needs. States propose mapping projects based on their highest priority societal, economic, and scientific issues.

Societal Applications of Federal and State Geologic Mapping



Many STATEMAP geologic mapping projects provide vital information needed by States and industry. Program outcomes from geologic mapping for the 2013 proposal cycle include mapping that provides information primarily for groundwater quantity and quality projects across the United States. STATEMAP geologic maps may aid in understanding hydraulic fracturing in the development of unconventional gas production.

EDMAP – Training the Next Generation of Geoscientists

(2013 Actual, $0.5 million; 2014 Enacted, $0.5 million; 2015 Request, $0.5 million)

The EDMAP component of the NCGMP supports the training of a new generation of geoscientists in universities and colleges through a competitive matching-fund cooperative agreement program. Through the EDMAP program, students learn the fundamental principles of geologic mapping and field techniques. Since EDMAP's inception in 1996, more than $8.0 million from the NCGMP has supported geologic mapping efforts of more than 1,060 students working with more than 230 professors at 152 universities in 45 States, the District of Columbia, and Puerto Rico. Sponsoring universities match, dollar-for-dollar, the Federal EDMAP funding they are awarded. This commitment to STEM education, engaging young scientists in important societal problems and into the field, is one of the program's highest priorities.

The Federal Advisory Committee for the NCGMP conducts an annual review of the program. In response to the most recent committee recommendations, the USGS is increasing cooperative research among Federal, State, and academic organizations across the country, working to increase numbers and the diversity of students entering geoscience education, engaging a broad stakeholder base in the development of mid-range program plans, and enhancing outreach and program visibility. The USGS will continue these efforts in 2015.

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Activity: Core Science Systems
Subactivity: National Geospatial Program

2013 Actual: 59.3 million (319 FTE)
2014 Enacted: 60.1 million (319 FTE)
2015 Request: 60.4 million (280 FTE)

Overview

The National Geospatial Program (NGP) organizes, updates, and publishes the geospatial baseline of the Nation's topography, natural landscape, and built environment through *The National Map*; and conducts geospatial research to discover new approaches for updating and using geospatial data and for reducing costs of these activities. The National Atlas of the United States has transitioned into The National Map to provide an integrated single source for geospatial and cartographic information. Users throughout the Federal Government, including those in Interior, the Department[s] of Agriculture (USDA), Commerce, and Defense; the Environmental Protection Agency (EPA), the Federal Emergency Management Agency, National Guard Bureau; and States, tribes and other organizations employ NGP geospatial data and Web services to support their decisionmaking and operational activities. The NGP devotes most of its attention to users in the areas of water resource and flood risk management, geologic mapping, geologic hazards, and natural resource management. NGP-sponsored cooperative data acquisition projects reduce duplication of expenditures among Federal agencies and with State and local governments, and result in millions of dollars in contracts for America's geospatial industry. The NGP supports the Interior's responsibilities for national geospatial coordination, and carries out the USGS's governmentwide leadership responsibilities for elevation, hydrography and watershed boundaries, geographic names, and orthoimagery.

The Federal Geographic Data Committee Office of the Secretariat (FGDC OS) coordinates geospatial activities across Federal agencies and with non-Federal organizations as required by the Office of Management and Budget (OMB) Circular A-16 and Executive Order 12906. The FGDC OS provides support for key Federal geospatial initiatives and priorities, including the Geospatial Platform, the National Spatial Data Infrastructure (NSDI) Strategic Plan, and the OMB Circular A-16 Supplemental Guidance Implementation Plan. These activities support and enhance information availability for decisionmaking and science, increase information delivery efficiencies, and reduce duplication of Federal geospatial-data assets through shared services that leverage economies of scale.

Program Performance

3D Elevation Program (3DEP) – Enhanced Elevation for the Nation Initiative – The 3DEP initiative is a plan for several Federal agencies to systematically collect improved, high resolution elevation data for the 50 States and the U.S. territories over an eight-year period. The 3DEP employs advanced laser technology, known as lidar (light detection and ranging), to build the most detailed and complete

elevation maps ever produced on a nationwide scale. In February 2013, the USGS initiated and facilitated an interagency 3DEP Executive Forum and conducted quarterly meetings of participants including executives from 12 Federal agencies. Key stakeholder groups, including the 3DEP Executive Forum, the multi-agency Digital Elevation Program (NDEP) and others, reviewed the 2014 3DEP implementation plan. By January 2015, the NGP will implement an operational 3DEP.

Remapping Alaska – The NGP is working with the State of Alaska and Federal partners to replace the more than half-century-old topographic maps for Alaska; using new and accurate geospatial data to improve aviation safety, understand and mitigate the effects of coastal erosion and storm surges, provide infrastructure for Arctic shipping and resource extraction, and protect biodiversity and habitats. The NGP and its partners have developed a five-year plan (2013-2018) to acquire data to remap the State, with an emphasis on replacing elevation data for the State using ifsar (interferometric synthetic aperture radar) technology. Unlike conventional technology, ifsar allows for elevation data collection in challenging conditions including cloud cover, which is common in Alaska. The Alaska Mapping initiative is a combined Federal, State, local and tribal program to support and improve maps and digital map data for Alaska, bringing Alaska topographic map and digital map data quality in line with the conterminous United States. The topographic maps generated from the data would be completed in 2019.

In 2013, the Alaska Mapping Executive Committee established an interagency plan with Federal partners and the State of Alaska and pooled resources to begin remapping the State. Statewide coverage improved from 15 percent to 43.5 percent. As part of this effort, the NGP continued to work with cooperators to acquire elevation data (with emphasis in the northern third of the State) and update hydrography and will continue these efforts in 2014. In 2013, the NGP exceeded their original goal by 18 percent and produced 412 topographic maps and made them available online free to the public. In 2014, the NGP is acquiring up to three—one degree by one degree—cells of new ifsar elevation data each year or approximately 5,000 square miles (about enough to cover 100 USGS topographic quadrangles).

Geospatial Platform – The FGDC OS, in support of the FGDC Chair (Interior) and Vice-Chair (OMB), the 32 Federal member agencies, and the Geospatial Platform Managing Partner (Interior, Office of the Chief Information Officer), is supporting the implementation of the Geospatial Platform to support problem solving and policy formulation for complex issues facing the Nation. The Geospatial Platform provides a suite of well-managed, highly available, and trusted geospatial data, services, and applications for use by Federal agencies and their State, local, tribal, and regional partners and includes the release of collaborative online communities for shared geospatial data investment planning and service acquisition to reduce duplicative investment and increase return on investment.

The 2013 release of the Geospatial Platform Version 2.0 included a complete redesign deploying robust Web portal functionality coordinating access to distributed geospatial resources. To leverage the capability, a shared catalog management system with Data.gov was developed.

Cooperative Data Acquisition and User Engagement
(Estimates for 2013, $13.2 million; 2014, $15.4 million; 2015, $20.6 million)

The Cooperative Data Acquisition and User Engagement (Engagement) budget component funds cooperative data acquisition projects with other Federal, State, local, and tribal government organizations. Most funding is applied to acquire new enhanced elevation and hydrography data, and to partner with the Department of Agriculture's National Agriculture Imagery Program (NAIP) for multi-year imagery data acquisition. In 2013, the NGP matched $7.2 million of program funds with $55.7 million of cooperator resources to acquire $62.9 million of elevation, hydrography, imagery, and other geospatial data. The program is pursuing similar projects in 2014; although, it is ramping down lower-priority orthoimagery partnerships with the National Geospatial Intelligence Agency (NGA) (which also is tapering off its orthoimagery focus) in order to emphasize the acquisition higher-priority enhanced elevation and hydrography data.

The Engagement component also funds a systematic, targeted approach for engaging users to identify needs best met by the program. Such engagement activities ensure the relevance of NGP products and services to users. The program focused on four priority "communities of use" that closely align with the USGS Science Strategy and the Administration's and Secretarial priorities: water resource and flood risk management, geologic mapping, geologic hazards, and natural resource management. The program planning process for 2014 activities will incorporate needs identified by the communities of use in 2013. Results from interactions with users in 2014 will inform program actions in 2015 and beyond.

The National Map Program Development
(Estimates for 2013, $30.0 million; 2014, $30.0 million; 2015, $27.5 million)

The National Map Program Development (Development) component funds quality assurance and processing of acquired geospatial data, and integration of the data into national databases. Most resources are devoted to elevation, hydrography, and geographic names geospatial data. Geospatial imagery, transportation, structures, boundaries, and land-cover data are managed as maintenance themes and rely on partners to be stewards of the data. The Development component also funds cartographic products and other associated geospatial services generated from the databases, such as the US Topo electronic topographic maps and cached base map (pre-staged combinations of frequently used base map layers).

Through the Development component and the Geographic Research component (described below), the NGP supports the Administration's research and development priorities by systematically applying knowledge and understanding to design, develop, and generate prototype and final geospatial data, products, and services that respond to the requirements of users.

The National Map's future plans include modernization and data innovation that will address data integration and quality improvements needed to support Presidential and Secretarial priorities for Building a Landscape Level Understanding of our Resources. To address landscape level understanding requirements the NGP proposes to enhance existing data with new three-dimensional elevation data and will upgrade other National Map databases to incorporate changes in the geodetic base being developed by the National Oceanic and Atmospheric Administration. These changes will enable three-dimensional

perspective landscape-level assessments and planning, and provide for easier integration of other landscape level data developed by Interior and other agencies.

Elevation: In 2013, the NGP began laying the foundation for the 3DEP initiative to acquire lidar data coverage nationally and ifsar data for Alaska; this work will continue in 2014. Key stakeholder groups, including the 3DEP Executive Forum, the multi-agency National Digital Elevation Program (NDEP) and others, reviewed the 2014 3DEP implementation. Consolidation and modernization of operations are underway, and a unified data acquisition plan is being prepared for implementation in 2015. The program will continue to transition data acquisition toward higher quality levels and larger project areas to address a greater number of user needs and to meet national 3DEP goals. The program will receive, quality assure, and integrate three-dimensional elevation data across the Nation, including areas impacted by Hurricane Sandy and the 2013 Colorado Front Range floods. Through partnerships coordinated in the Alaska Mapping Executive Committee, the ifsar coverage for the State increased from 15 percent in June 2012, to 43.5 percent at the end of 2013.

Using Disaster Relief Act supplemental funding in 2013, the NGP awarded $3.1 million to acquire lidar data within the Hurricane Sandy impact area. An additional $4.1 million for lidar is planned for spring 2014 acquisitions.

Hydrography and Watershed Boundaries: NGP assures the quality and integrates detailed hydrography data updates submitted by Federal and State data maintenance stewards. In 2013, the NGP investigated the best way to update surface water data for Alaska and will implement the new approach in 2014. In 2014, the program will pursue the integration of storm water drainage for large urban areas where information about the flow of water is lacking in the program's databases. To better support the WaterSMART activities and others interested in water use, the NGP is adding locations where water is diverted by manmade changes, such as pumping stations from natural flows. This work will continue through 2014. In 2013, the program began improving the quality of the drainage network to give users additional information about the behavior of drainage networks. In 2015, the NGP expects to complete a Water Data Requirements and Benefits Study to document user needs and return on investment for water data, to help define the next generation of hydrography data.

Geographic Names: The NGP maintains geographic names data and staffs the Board on Geographic Names (BGN), authorized by P.L. 80-242. In 2014, the NGP will continue to house and provide access to all of the Geographic Names information that has been collected over the years, but will provide consistent updates only to the base cartographic features necessary to support the USGS topographic mapping mission.

Orthoimagery: During 2013 and 2014, the Development component funded and will fund half of Interior's contribution to the USDA National Agriculture Imagery Program (NAIP), which acquires imagery of the conterminous United States over a three-year period. The program will participate in the renegotiation of the agreement with the USDA for the period 2015-2017. The NGP works with the NGA to quality assure and integrate detailed imagery over the NGA's 133 urban areas. In 2013, the NGP acquired data for 46 urban area projects using NGA and NGP resources to match cooperators' funds. In 2014, another 18 urban area projects are anticipated. This decreased number of projects results from a

refocusing of USGS resources on higher priority elevation and hydrography projects and the NGA scaling back its 133 urban areas program.

US Topo: To keep pace with an increasing demand for updated map products and data and technological advances, the USGS continues to revise each US Topo map every three years (70 maps each day) and to post new digital topographic maps for download. The quadrangles of US Topo maps are created from geographic datasets in The National Map and allow the user to select among data layers to be displayed; a technology advancement not available on older paper-based topographic maps. The new US Topo maps provide other modern technological advantages that support wider and faster public distribution, and on-screen geographic analysis tools for users. US Topo maps have a new crisper and cleaner design that enhances the readability of maps when viewed online and printed.

In 2013, the NGP began to remap the conterminous United States for the 2013-2015 cycle. The program also mapped Hawaii, Puerto Rico, and the Virgin Islands, and began mapping Alaska. Completion of the Alaska Mapping Initiative is scheduled for 2019.

Historical Topographic Map Collection: In conjunction with the US Topos, the USGS released more than 188,000 high-resolution scans of historical topographic maps of the United States dating back to 1884 (founding of the USGS mapping program). The program is now adding maps identified since the main production effort completed. This Historical Topographic Map Collection has accurately cataloged and created metadata to accompany the high-resolution, georeferenced digital files that make available the Nation's legacy of printed lithographic maps.

Natural Hazards Response and Geospatial Data Delivery

(2013 Actual, $6.2 million; 2014 Enacted, $6.2 million; 2015 Request, $3.6 million)

The Natural Hazards Response and Geospatial Data Delivery (Delivery) component delivers Web access to event-based geospatial data for emergency responders, and NGP products and services to users. It also funds The National Atlas of the United States®.

The Delivery component provides the emergency response community with vital geospatial data. In 2013, the program updated the data access system's user interface to provide stakeholders with an effortless search capability to find science data collections through a single point of entry. These efforts support the Secretary's priority goal of providing shared landscape-level management and planning tools to address their decisions.

In 2013, the NGP Delivery component acquired and posted nearly 7,100 satellite and aerial images over the September 2013 Colorado floods for emergency responders to view and use. The NGP Delivery is unique in providing programmatic acquisition and distribution of satellite and aerial imagery to responders. The NGP also supported response efforts for 38 lesser domestic emergency events, including tornadoes, snowstorms, wildland fires, explosions, and debris flows.

The NGP publishes its digital geospatial data and maps through data downloads, Web-based map services, and a robust map viewer. The NGP investigated a new technique for faster display of online

maps using cached basemap images, began implementing the approach in 2013, and will complete the effort in 2014. In 2013, the program also began transitioning data made available for download to a commercial cloud-computing capability and will continue this effort in 2014. In 2013, the program made its 178,808 historical topographic maps available to the public through the Geospatial Platform and Data.gov. During 2013, users downloaded 1.7 million US Topo maps and 2.7 million historical topographic maps.

New users have noticed the NGP's continued improvements to data access through Web services. The availability of National Map cached basemap services encouraged use by mobile application developers worldwide that specialize in geospatial data. Several developers adopted the services for use immediately and National Map data are now available in several recreational use mobile applications supporting hiking, biking, and touring that run on cell phones and tablets. The usage statistics for National Map basemaps for 2013 show a significant jump in data access with mobile access accounting for at least 50 percent of the traffic. US Topo downloads in March 2013 exceeded 1,900,000 and increased to over 4,400,000 in December 2013.

The National Atlas delivers authoritative Federal geographic information carefully integrated to present a coherent look at America through maps and data services. In 2013, the program introduced a new interactive Web application named "Streamer" that allows users to trace upstream and downstream among America's major streams and rivers. "Streamer" maps the route a stream or river follows and can generate detailed reports about the hydrographic and political features encountered along each trace (including counties, cities, and USGS streamflow gaging stations). In 2014, the small- and intermediate-scale basemap products of The National Atlas, including the "Streamer" application, will be incorporated into The National Map; the USGS will discontinue the remainder of the National Atlas data, products, and services.

Geospatial Research

(2013 Actual, $4.7 million; 2014 Enacted, $4.7 million; 2015 Request, $4.8 million)

The Geospatial Research component funds applied research that improves the efficiency and effectiveness of NGP operations, products, and services, and contributes to the Nation's understanding of geospatial science. Components of a digital topographic map design and map generalization research project have been completed, and the NGP is using the results to improve the design of the US Topo maps and to take advantage of detailed hydrography data for maps at regional and national scales. In 2013, the program tested working with public volunteers to capture updated information for manmade structures in Colorado, and is expanding the effort nationally in 2014. In 2014, the NGP will initiate a new round of research projects with universities. Candidate topics include additional research on the generalization of large-scale cartographic data, lidar research to support 3DEP data processing and applications, and high-performance computing applications of geospatial data.

An example of the NGP's research investment is the redesign of the US Topo map product. Funded by the NGP's Center of Excellence for Geospatial Information Science, a Penn State University researcher developed a crisper, cleaner design that greatly enhances the readability of the maps for online and printed use. The new design includes easier-to-read symbols (e.g., police and fire stations, State capitols,

etc.), a revised order for image layers, and adjustable transparency for viewing multiple layers of data at the same time. The NGP implemented this new look for the US Topo in mid-2013.

Federal Geographic Data Committee – Office of the Secretariat

(2013 Actual, $5.2 million; 2014 Enacted, $3.8 million; 2015 Request, $3.9 million)

The FGDC is an interagency committee that coordinates the collection, use, and dissemination of geospatial data and information to develop the National Spatial Data Infrastructure. It promulgates standards, system interoperability, geospatial shared services, and best business practices, policies, technology, and partnerships. The Secretary of the Interior chairs the FGDC, and the Deputy Director for Management, OMB serves as the Vice-Chair. The FGDC OS provides executive, administrative, and technical support to the FGDC.

In 2013, the FGDC released Version 2.0 of the Geospatial Platform, an Internet-based capability providing shared and trusted geospatial data, services, and applications for use by government agencies, their partners and the public. The Geospatial Platform was also identified as a tool to support the Secretary of the Interior's Landscape Level of Understanding goal. Geoplatform.gov version 2.0 included a complete redesign deploying robust Web portal functionality coordinating access to distributed geospatial resources; incorporated cross-agency collaboration tools; and enabled the release of three inaugural collaboration communities. These communities focus on national priority issues, increased accountability in the development of National Geospatial Data Assets, and consolidated agency-level service delivery. The initial capability of the planned geospatial investments "Marketplace" was released, for consolidated data buys that leverage shared contracting and increased economies of scale. The FGDC OS led and completed the development of a shared catalog management system for joint use by Data.gov and the Geospatial Platform. The FGDC continued to execute the geospatial cloud computing testbed collaboratively developing cloud-based, geospatial-computing environments that are preapproved for deployment across agencies, reducing individual deployment costs. The Secretariat supported all FGDC activities, including the FGDC committees, the National Geospatial Advisory Committee, development of geospatial standards, establishment of the Geospatial Platform as a Shared Service, and the close out of the Cooperative Agreements Program (CAP).

In 2014, the FGDC OS continues to support FGDC activities focusing support on development and expansion of the operational phase of the Geospatial Platform, working with numerous agencies to establish new collaborative communities, implementing NSDI Strategic Plan actions, and working with FGDC agencies to develop their A-16 Supplemental Implementation strategy and supporting reporting tools. The implementation of the Geospatial Platform's shared, cloud-based, data hosting environment will begin, leveraging the best practices from the geospatial cloud computing testbed. In 2015, the Geospatial Platform will begin implementing services supporting its role in the Federal reference architecture as a technology and collaboration environment for unclassified geospatial information sharing and continue to mature its shared services with guidance from the *Business Plan* and Geospatial Platform Oversight Body. The Secretariat will continue to support the FGDC agencies in implementing the actions of the NSDI Strategic Plan and their A-16 Supplemental Implementation strategy.

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Activity: Science Support

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Administration and Management ($000)		86,985	86,985	-593	0	0	86,392	-593
	FTE	454	454	0	0	-11	443	-11
Information Services ($000)		23,719	23,719	456	0	-2,300	21,875	-1,844
	FTE	73	73	0	0	-2	71	-2
Total Requirements ($000)		**110,704**	**110,704**	**-137**	**0**	**-2,300**	**108,267**	**-2,437**
	Total FTE	**527**	**527**	**0**	**0**	**-13**	**514**	**-13**

Summary of Program Changes

Request Component	($000)	FTE	Page
Administration and Management	**0**	**-11**	
Reduction to Administrative Services	-2,200	-14	B-59
Youth and Education in Science	1,000	1	B-37
DOI Science Coordination	200	1	B-49
Outreach to Underserved Communities	200	0	B-38
Mendenhall Program Postdocs	500	1	B-38
Tribal Science Coordination	300	0	B-50
Information Services	**-2,300**	**-2**	
Reduction to Administrative Services	-2,300	-2	B-59
Total Program Change	**-2,300**	**-13**	

Justification of Program Changes

The 2015 budget request for Science Support is $108,267,000 and 514 FTE, a net program change of -$2,437,000 and -13 FTE from the 2014 Enacted Budget. For more information on the Science Support changes, please see Section B, Program Changes as indicated in the table.

Activity Summary

The Science Support Activity provides the functions that make conducting the science done at the USGS possible; it is the framework for the USGS. This Activity provides business and information systems including: acquisitions and grants, finances, internal controls, communications, budget, monitoring and evaluation of science quality and integrity, education, technology services and human capital, each of which are crucial to the functioning of good science. Science Support includes the executive leadership and management that provide guidance, direction and oversight of all USGS science activities.

The Science Support Activity is comprised of two subactivities: Administration and Management and Information Services.

The he USGS proposes a name change in 2015 to the budget activity and the two subactivities within it. Please see the key below:

	Old Name	**New Name**
Budget Activity	Administration & Enterprise Information	Science Support
Subactivity	Science Support	Administration and Management
Subactivity	Security and Technology	Information Services

Activity: Science Support
Subactivity: Administration and Management

2013 Actual: $87.0 million (454 FTE)
2014 Enacted: $87.0 million (454 FTE)
2015 Request: $86.4 million (443 FTE)

Overview

The Administration and Management subactivity provides bureauwide leadership and direction; establishes organizational vision, mission, goals and scientific priorities; develops and enforces standards for scientific rigor and integrity; plans, obtains and manages necessary resources including people, budget authority, facilities and equipment; provides resource management systems; implements statutory and regulatory requirements and monitors and enforces compliance; and communicates our mission and science to Congress and the Public. Administration and Management is comprised of the following areas:

The USGS **Office of the Director** performs chief executive officer and chief operating officer responsibilities.

The science mission area **Associate Directors** establish program direction and goals, and serve as science advisors to the Director in their respective program areas.

The **Regional Directors** exercise line management responsibility for the science centers and implement science projects on the landscape.

The **Office of Budget, Planning, and Integration (BPI)** secures funding resources needed for the USGS to perform its mission goals, facilitates information sharing internally and externally, provides oversight of the internal controls process and the USGS Working Capital Fund, and provides in-depth analysis of budget and performance data for the USGS to understand, anticipate, and respond to the changing demands resulting from public policy decisions and science needs.

The **Office of Communications and Publishing (OCAP)** guides and conducts external and internal communications and provides publishing and Web development services. The Science Publishing Network (SPN) prepares science reports and maps for publication, and provides services including technical writing, editing and graphical displays. This information is widely used across the Nation by members of Congress and their staff, other natural resource planners and managers, recreational hunters and hikers, emergency response officials, and the media.

The **Office of Science Quality and Integrity (OSQI)** establishes and implements standards for scientific integrity and excellence and administers programs for ethics, education, development, and collaboration including the USGS Office of Ethics, the National Youth program, the Mendenhall Postdoctoral Fellowships, bureauwide education activities, and the Office of Tribal Relations.

The **Office of International Programs (OIP)** enhances the USGS scientific mission by providing opportunities for USGS scientists to interact with scientific partners abroad and extend research and investigations to other countries. The OIP supports the development and conduct of a broad spectrum of international activities involving scientific cooperation and assistance in geological, hydrological, biological, and geospatial research and scientific investigations. The OIP provides guidance and representation to domestic and international agencies and organizations in matters pertaining to international scientific activities of the USGS.

The **Office of Diversity and Equal Opportunity (DEO)** develops policies, programs, and guidelines to assure proper implementation of Equal Opportunity laws and regulations and provides leadership and oversight for the USGS Diversity and Inclusion Plan.

The **Office of Administration and Enterprise Information (OAEI)** establishes policies, coordinates and conducts activities in the areas of accounting and fiscal service, general services, security, safety and occupational health, acquisitions and grants, internal controls, technology transfer, facilities and property, environmental protection, business systems and human capital programs, including human resources and employee development The Associate Director is the Chief Financial Officer (CFO), Assistant Director for Information Resources (ADIR), and Designated Agency Safety and Health Official (DASCHO).

Program Performance

Youth and Education in Science – Investments in USGS Youth programs are critical to achieving current Federal, departmental, and bureau mission goals to ensure that we have a workforce that is ready to tackle future challenges. In 2013, the Youth Office collaborated with the Human Resources Office, the Diversity and Equal Opportunity Office, and Science Centers across the country to hire youth and leverage assets with the strategic partners of the 21st Century Conservation Service Corps (21CSC). The USGS efforts in this creative collaboration resulted in 1,160 youth employed and youth hired by partners. While this number is just short of our Agency Priority Goal of 1,287, the USGS considers it an accomplishment in light of the challenges of sequestration and the hiring freeze. New efficiencies established because of these challenges, such as a streamlined hiring waiver process and an automated funding application process will enable the USGS to increase youth hires in 2014 and 2015. In 2015, OSQI is seeking to combine the Youth and Education Offices to achieve efficiency, a consistent program and process methodology, and increase strategic vision. In 2015, the USGS plans to expand its education and internship programs for students underrepresented in Science, Technology, Engineering and Mathematics (STEM), tribal colleges, and veterans, as well as expanding partnerships in support of the 21st Century Conservation Service Corps. The development of the Youth and Education in Science (YES) Council in 2014, which is comprised of representatives from across the USGS landscape, has the purpose of identifying new and ongoing strategic efforts to engage youth and develop our future workforce. In 2015, the Council will actively engage in identifying how youth programs can enhance the USGS mission.

The USGS took the major role in advancing the critical component of engagement in the Federal STEM Education five-year Strategic Plan (National Science Technology Council, OSTP) that was transmitted to Congress in May 2013. Not only were the valuable research and the laboratory assets of the USGS

acknowledged, but the unique natural laboratory holdings of sister Interior bureaus were recognized as allowing unprecedented integration of research and education. OSQI's Education component published the 2013 USGS Shoemaker Award winning Fact Sheet, "Famous Building Stones of Our Nation's Capital" (*http://pubs.usgs.gov/fs/2012/3044/*).

As the Federal sector is placing much attention on STEM workforce development, the National Association of Geoscience Teachers/USGS Internship Program (NAGT) stands out as a model of research education excellence and cost effectiveness. The USGS breathed new life into this historic program nine years ago, and increased the number of USGS NAGT interns to numbers that are consistent with its near 50-year historical average, despite the sequestration hiring challenges of 2013. Annual program evaluations of both interns and scientists consistently illustrate highly rated contributions to the essential research mission of the bureau. Other programs, such as GeoFORCE, the USGS and Mayor's Office collaborative employment partnership , and the Hydrologic Technician Internship programs, provide investment in youth, opportunities for underrepresented communities, pathways that lead youth to geoscience and other STEM professions, and help the USGS in succession planning efforts. The USGS Education Web site continued expansion of content material and ease of access. It now contains content and grade level holdings with downloadable videos and animations, citizen science lectures, "Special Interest" topics, and "What's New, What's Happening" categories.

The USGS partners with the Alaska Native Science and Engineering Program (ANSEP) to increase the number of indigenous American students in STEM degrees. This partnership received Interior's 2013 Partnership in Conservation Award for these efforts to create a systemic change in the number of Indigenous American students in STEM career paths, which are essential to the science, stewardship, and conservation missions of the USGS and Interior. ANSEP follows a longitudinal approach, providing inspiration, guidance and opportunity ranging from middle school through the PhD. This is essential for creating a cadre of future scientists that are highly prepared and trained with the required skills critical for the USGS workforce.

Through presentations, demonstrations, and hands-on activities, the USGS has encouraged, mentored, and taught children the importance of appreciating their environment and understanding that they are the future stewards of the Earth. Every USGS office in each State reaches out to their community, providing education and outreach programs. The USGS organizes, participates, and partners on hundreds of events every year that reach over 30,000 children and families. These Let's Move Outside! activities have a key educational component that increases the child's knowledge of the environment through physical activity. The USGS encourages youth across the landscape to engage in the outdoors and to reconnect with nature, through collaborative fishing derbies, field trips, science camps, and family workshops.

Linking Science Quality Best Practices Together – OSQI provides internal controls to OMB based on FSP and IPDS, which demonstrates the evidentiary process for maintaining the quality of USGS science. Linkages are in in place for ensuring science quality best practices are followed for approving and releasing publications; helping the bureau grow the next general of Federal scientists through Mendenhall postdoc high school and college internships; evaluating USGS research, development, and senior scientists; and maintaining scientific knowledge base associations through scientist emeritus. In 2013, Bureau Approving Officials in OSQI reviewed and approved 3,128 publications containing new

interpretive information and 3,892 publications without new interpretative information were approved at the USGS Science Center level, all tracked through the IPDS. Additionally, 17 postdoctoral fellows were added in 2013.

Fundamental Science Practices (FSP) – These vital policies govern the integrity of the scientific process including the development, review, and release of scientific information. One FSP policy updated in 2013, details requirements to ensure stronger safeguarding of unpublished USGS data and information. In 2014, the USGS plans to further expand FSP policies. Some of these additional policies directly respond to the Office of Science Technology and Policy requirements for increasing access to federally-funded scientific research and the Office of Management and Budget (OMB) open data directives. In June 2013, the USGS launched the reengineered Information Product Data System (IPDS), which provides the official record of adherence to the FSP during development, peer review, and final approval of USGS scientific publications. The new IPDS provides improvements in user interface and streamlined routing, more efficient and accurate tracking of the review and approval process, and easier identification of the funding source of USGS information products, which results in time savings for USGS Science Centers and improves data quality for decision support throughout the bureau. More than 1,820 unique USGS users have accessed the new system since its launch showing significantly increased participation in using the system, resulting in improved FSP compliance. In 2013, OSQI handled five Information Quality Act requests for corrections in collaboration with the USGS Water, Ecosystems, and Core Science Systems mission areas, and coordinated postings to the USGS Peer Review Agenda Web site of 10 peer review related documents for influential USGS products.

The USGS Leads Efforts to Update the Department's Science Integrity Policy and Develop Training – In 2013, OSQI led efforts to update Interior's Scientific Integrity and Scholarly Activities policy and developed a draft DOI Learn Scientific Integrity training module, planned for release in 2014.

Supporting Native American Needs – In 2014, the USGS's Office of Tribal Relations (OTR) designed and provided support for the second year of the *Native Youth in Science – Protecting Our Homelands* summer science camp. The USGS partnered with the Mashpee Wampanoag Tribe on this unique pilot project that paired USGS scientists with tribal culture keepers to ensure that course material was presented to tribal youth (grades 6-8) in a context that interwove Western science and traditional ecological knowledge (TEK). The OTR also funded the first ever workshop on Native Hawaiian TEK and Western science as they relate to Kilauea Volcano, and supported a study of Native Alaskan use of berries as a vital subsistence food. The OTR sponsored USGS scientists to work with Salish Kotenai College (SKC) to integrate USGS training in to SKC's Hydrology program. The OTR also funded USGS tribal outreach in New Mexico, the Great Lakes region, and the Pacific Northwest, as well as funding studies on Laurel Wilt impacts to the Everglades tree islands (sacred to Florida tribes). The OTR provides yearly funding for tribal capacity building training in a variety of disciplines, as well as internships on USGS research projects on tribal lands. In 2014 and 2015, the OTR will continue to maintain and strengthen partnerships with Native American tribes and communities and tribal colleges and universities (TCUs) on cross cutting initiatives in areas such as tribal uses for remote sensing technology, climate change, and Hurricane Sandy research.

USGS Ethics Office Recognized for Having a Model Program – At the "Ethics Summit," held in July 2013, the USGS Ethics Office was recognized as a model ethics program and the Director of OSQI actively participated in an ethics roundtable with leadership from other Interior bureaus. With over 100 scientists serving as officers and board members of professional scientific organizations in their official capacities, the USGS continues to be a leader among all other Federal departments and agencies in enabling official service through formal authorizations of assignment. The Deputy Ethics Counselor updated and edited a smartphone application of the Ethics Guide for DOI Employees (2013), which will be provided to political appointees and bureau leaders in 2014. The Ethics Office held four Ethics Forums (for the Natural Hazards Mission Area, the Climate and Land Use Mission Area, new Climate Science Center Directors and the Earth Remote Observation Systems [EROS] Data Center) and provided training to two new Federal Advisory Committees (the National Geospatial Advisory Committee and the Advisory Committee on Climate Change and Natural Resources Science). The Ethics Office successfully implemented an electronic financial disclosure report system, which maintains documentation from previous filing cycles, and will reduce the paperwork burden for over 800 filers.

Technology Transfer – The Federal Technology Transfer Act, 15 USC 3710 as amended, requires each Federal laboratory having 200 or more full-time scientific, engineering and related technical positions to establish a research and technology application function. Within the USGS, this function is housed in the Office of Policy and Analysis where staff service USGS Science Centers and offices throughout the country. In 2015, the USGS will continue negotiating and drafting Cooperative Research and Development Agreements (CRADAs), Technical Assistance Agreements (TAA), Facility Service/Use Agreements (FSUA), Material Transfer Agreements (MTA), and Patent Licenses. This office also manages the USGS intellectual property and inventions program; markets USGS technology opportunities and assistance to industry, non-profits, academic institutions, and State agencies; and provides training to USGS personnel on technology transfer and intellectual property protection.

At the end of 2013, the USGS had 14 active patent licenses. The USGS had 41 active patents in its portfolio and an additional 20 patent applications filed with the U.S. Patent and Trademark Office. During 2013, the U.S. Patent and Trademark Office issued four new patents and accepted filings for seven new USGS inventions.

USGS science and research contributes to a broad range of valuable collaborative projects in the private and academic sector. During 2013, the USGS increased its technology transfer activity in terms of number of collaborations and projects. The USGS had more than 30 specialty analytical laboratory services providing unique capabilities to the United States, private sector partners, and academia. New facility use agreements executed during 2013 totaled more than 240. The total partner contributions from these various types of technology transfer agreements totaled more than $7 million.

The table below page summarizes the number of technology transfer projects in 2013.

Active	Total Number	Private	Non-Profits	Academic Institutions	Government Entities	International Entities	Partner Contributions	USGS In-Kind Contributions
CRADAs	14	10	1	0	1	2	1,271	65
TAA	118	46	24	14	16	18	6,242	2,342
Patent Licenses	14	11	0	3	0	0	45	0

Facilitating the Advancement of Global Scientific Priorities – In 2013 the USGS served as the Secretariat for the International Union of Geological Sciences (IUGS). With 121 member nations, the IUGS is one of the largest and most active non-governmental scientific organizations. Serving as the Secretariat helped the USGS guide and shape global scientific priorities and, since all member nations share planet Earth, serving as the Secretariat ultimately helps the USGS achieve its mission of describing and understanding the Earth, minimizing loss of life and property from natural disasters, managing water, biological, energy and mineral resources and enhancing and protecting our quality of life.

Enhancing Discoverability of USGS Science – The USGS is working to increase the discoverability and use of USGS science information within the science community and for the public. Through new publishing technologies and methods, USGS research results are more likely to be accessed, providing a foundation upon which others can advance science and develop new applications. In 2013, the USGS worked on the planning and programming necessary to implement digital object identifiers for all USGS series publications and maps in order to increase access to the results of federally-funded scientific research. Digital object identifiers are crucial to enhancing discoverability of information and data by users and this feature will open USGS science to a much wider audience through the CrossRef registry that resolves publication digital object identifiers to the USGS's Publications Warehouse, a resource not currently searched by scholarly bibliographic indexers like Scopus and Google Scholar. The digital object identifiers were implemented into all new publications beginning October 1, 2013. During 2015, the USGS will begin plans to implement the digital object identifiers on approximately 400,000 legacy publications as well.

Work on enhancing public access to Federal research will continue in 2014 and 2015**.** In accordance with OMB's Memorandum 13-13: Open Data Policy Managing Information as an Asset and the White House's Office of Science and Technology Policy, Policy 2.22.13—Increasing Access to the Results of Federally Funded Scientific Research, the USGS will provide metrics on the digital object identifiers resolutions for USGS reports, which are useful to scientists in preparing for Research Grade Evaluations.

In 2014, the USGS will implement the use of International Standard Series Numbers (ISSNs) on all USGS series publications. ISSNs help libraries and individual users locate and obtain USGS series publications.

In 2014, the USGS will also undertake the development of dynamic index pages for all USGS series publications. This process, which is currently manual, can result in errors that limit the online

discoverability of a publication. The automated system will eliminate these errors; allow global changes if needed, and reduce the number of broken link errors on the Publications Warehouse server.

In 2014 and 2015, the USGS will begin transitioning from a PDF based to an XML-based publishing process. XML has recently become the industry-standard method for science publishing and it fully supports Executive Order 13642, Making Open and Machine Readable the New Default for Government Information. XML will allow development of derivative products, including print, PDF, HTML, mobile formats and various e-book formats from one master file. XML also aids in discoverability of USGS information and the transportability of USGS information into other user-created products.

Communications and Public Outreach – In 2013, the USGS embarked on a Web Reengineering effort to create a more effective and manageable Web presence. Web-enabled technology, real-time access, social and collaborative cloud-based tools, and extensive use of mobile and tablet devices are just a few of the many shifts transforming the Web and changing the government's digital landscape. Along with these technological trends, consumer behaviors are also evolving quickly and making new demands on information. Web users want content to be, more concise, personalized, and delivered faster. The USGS is answering this call and is making our science more accessible and useful for customers and partners. Activities and accomplishments support the White House Digital Strategy goal to enable the American people and an increasingly mobile workforce to access high-quality digital government information and services anywhere, anytime, on any device.

The USGS rolled out a new search technology for the bureau in June 2013. Powered by USA Search (administered by GSA), the new search capability enables visitors to the USGS Web site to have an enhanced search experience through the ability to filter results. In addition, it integrates our RSS feeds, tweets, videos and photos. A second critical step taken to improve search on USGS Web sites was the implementation of search engine optimization—making the USGS Web site and its content easy to find by search engines. The total number of search inquiries increased by 16.3 percent after migrating to the new search experience.

The USGS also developed and sought internal feedback on the prototype of the new *www.usgs.gov* external Web site. This new site is customer focused, provides science-driven content, is mobile ready, uses industry best practices, improves search, Web site functionality and navigation and complies with Federal standards. In addition, the new site incorporates insights learned through customer satisfaction data and usability testing.

In 2014, the USGS will publically launch the new *www.usgs.gov* Web site using open source content management software and hosted within Interior's cloud. The USGS will also conduct usability testing to measure effectiveness in meeting customer needs.

In 2013, the USGS also implemented systems and processes to make science products more accessible and useable in accordance with the Administration's goal to provide competent, efficient, and responsive service to the public as outlined in Executive Order 13571, Streamlining Service Delivery and Improving Customer Service, including:

- The USGS Science Information Services team responded to approximately 20,000 phone calls and 26,000 e-mail inquiries ranging from a variety of topics including hazards, water, ecosystems, mapping, and much more. Customer response rates increased inquiries from 94 to 96 percent within a 24-hour period, well above the target of 90 percent as originally outlined in Interior's Customer Service Plan.
- USGS customer service representatives are using live chat to provide real-time answers to Web-based inquiries 13 hours per day. During 2013, more than 1,457 Web chat sessions were conducted, assisting customers with a wide range of science topics in real time.
- The USGS improved readily available sources of information with 150 new and more than 400 updated existing Frequently Asked Questions are available on the USGS Web site (*http://www.usgs.gov/faq/)*, which was also adapted for use on mobile devices.

In 2014 and 2015, the USGS will continue to make improvements in customer service to the public, and will develop and begin to employ customer-service satisfaction surveys across customer service communications tools including e-mail, phones and Web chat.

Ensuring Financial Health – Innovative science center financial health tracking tools were developed in collaboration with resource managers at all levels to ensure effective management of sequestration-affected budgets. The USGS used these tools throughout the bureau, which enabled leadership to prioritize use of financial resources. These tools will continue to be used in future years to maintain increased awareness of budget management to maximize science productivity.

Financial performance improved as measured by the Interior scorecard metrics, in Prompt Pay, EFT, and Charge Cards. The USGS's Office of Accounting and Financial Management participated on a departmental workgroup that improved the presentation and use of Interior's scorecard to make it a more effective tool for improving financial accounting and compliance with policy. The USGS is upgrading its financial management tools and control processes, and is deploying a Business Process Consolidation to replace outdated financial reporting. USGS employees have coordinated on validation and verification of the software and assisted in resolving nine failed validations.

Improving Efficiency and Effectiveness of Resource Management – The USGS met all Campaign to Cut Waste spending reduction goals for 2013 through a comprehensive education and management oversight program. A dedicated SharePoint site was created to provide current-status tracking, policy, and reference tools. Resource administrators in science centers received training on spending in applicable budget object classes. The USGS developed conference-planning methods to provide data to manage conference attendance. The USGS will continue to monitor resource management performance against Campaign to Cut Waste targets.

Acquisition – The Office of Acquisition and Grants (OAG) continues to implement acquisitions reforms. Strategic sourcing initiatives will consolidate common purchases of like items and services delivering them to the field in less time and with the ability to better control costs across the bureau. In 2013, 21 potential strategic sourcing initiatives (SSI) were identified including those for visual identity wear and international liability insurance. Work will continue in 2014 and 2015 to transition existing acquisitions of these items to SSI acquisitions. Additionally, the OAG works to improve customer understanding of complex acquisition concepts. For instance, the OAG recently held a Brown Bag discussion of the new Interior policy regarding requiring a 'lease versus buy' analysis on all equipment valued at $15,000 and above. The USGS was complimented for being the first bureau to request a briefing on the required analysis tool. In addition, in 2014 the OAG will continue the development and enhancement of the Acquisition Operating Procedures (which began in late 2012 and dramatically improved in 2013) in order to enable customers to navigate acquisitions requirements efficiently and obtain required resources in a timely manner. This will consolidate, update and "make user friendly" all acquisition and financial assistance guidance.

Human Resources – A consolidated bureau workforce plan being developed in 2014 will synthesize all mission area, regional and office plans. The USGS chartered a bureau-level workforce planning group to review all of the individual plans and develop themes and strategies for a bureau-level plan.

Customer service improvements were realized by implementing a tailored Customer Service Plan. Using customer feedback groups to evaluate and finalize the plans, the USGS launched the plan via an All Employee E-mail and posted it on the Human Capital Web site.

Recruitment, hiring, and retention efforts were strategically coordinated in support of several Presidential Initiatives including the Operation Warfighter Program. A recruitment coordinator was established to partner with science centers in focusing recruiting efforts on diversity, and student and youth hiring programs and priorities. The Servicing Specialists have been providing training to the mission areas and regions on recruitment.

To provide more effective support to managers in the field, Human Resources developed a training catalog of services available along with training schedules. The catalog will be finalized in early 2014. Training sessions have been developed in order to provide briefings and training on topics of importance to managers and employees, i.e., benefits briefings, performance management, and workforce planning. Further, training on workforce management and planning tools and techniques are currently being scheduled. The HR Servicing Specialists have been providing training to the mission areas and regions on recruitment to reduce hiring times and maximize the quality of new hires.

Organizational and Employee Development – The USGS is improving the delivery of education and training to its workforce on technical skills by revising curriculum and training modalities. In 2013, the USGS coordinated detailed programmatic reviews of curriculum and delivery methods and will continue with an operational review to include National Training Center delivery strategies and associate pricing models. Planned 2014 and 2015 achievements include prioritizing organization and employee developmental activities which maximize the return on investment to the organization.

The USGS continues to make improvements in making the organization an employer of choice, as measured by the Federal Employee View Point Survey (FEVS), which helps the USGS to compete effectively for the best candidates when recruiting for its workforce. The USGS's office of Organizational and Employee Development works directly with leadership and management at all levels of the organization to build understanding on the data obtained through the FEVS and how to use it to improve organization effectiveness and quality of life. The OED provided center-specific results as well as an interpretation guide on how to work with organizational results to organizations that received generated results reports form the Office of Personnel Management. Briefings for leadership teams and staff groups were also provided.

Energy Efficiency and Environmental Management – In 2013, the USGS worked to continue to achieve the targeted energy use-reduction goals outlined in E.O. 13425 and E.O. 13514. In 2013, the USGS took steps to implement an Energy Savings Performance Contract (ESPC) to meet the requirements of the Presidential Memorandum on Energy Savings Contracts, leading the effort to meet the goals of the Department of the Interior. The ESPC estimates include over $19 million in capital investments at USGS facilities. The USGS projects a $40 million reduction in facility costs related to utility consumption, operations and maintenance during the ESPC 20-year performance period. The ESPC estimates it will enable the USGS to meet its commitment to reduce Scope 1 and 2 Green House Gas emissions by 20 percent. The USGS will continue each of these efforts in 2014. Asbestos reporting standards have been implemented and data accuracy checks are in progress. This will protect employees from inadvertent exposure.

Environmental Compliance – In 2013, the USGS declared conformance with the ISO 14001 Environmental Management System (EMS) standard and put policies and procedures in place to ensure environmental compliance for USGS activities. The USGS contracted to conduct environmental compliance audits and for new environmental compliance software to make the USGS less vulnerable to environmental non-compliance. The USGS developed Environmental & Disposal Liabilities (EDL) policy, which outlined the requirements and responsibilities for environmental liabilities and locations of concern (LOC) and developed standard operating procedures (SOPs) for asbestos-related liability reporting.

National Environmental Policy Act – The USGS designated National Environmental Policy Act (NEPA) Responsible Officials at the field level and expanded the NEPA Handbook to clarify the use of various USGS and departmental categorical exclusions. The USGS finalized the USGS Environmental Achievement Awards (EAA), which recognizes extraordinary environmental achievements within the bureau; the USGS winner went on to receive an Interior Environmental Achievement Award.

In 2014, the USGS will continue to carry out the Environmental Compliance policies and procedures put in place in 2013 in order to ensure environmental compliance for USGS activities. The USGS will also continue to expand the use of the environmental compliance software that was implemented in 2013.

Employee Safety – In 2013, the USGS continued to lead Interior with the lowest accident rates. The USGS safety team worked to train additional USGS safety personnel as serious accident investigators in order to increase response times for USGS incidents on a local level. Newly trained investigators were

provided with serious accident investigation kits, which provided them tools and techniques to conduct accident investigations in a standardized manner using best practices to obtain required information.

In 2014 and 2015, the USGS will continue efforts to lead the Interior with the lowest accident rates through employee awareness and training opportunities. The USGS will implement the use of additional safety team members, as serious accident investigators, in order to increase response times for USGS incidents on a local level.

Transportation Management – In 2013, the USGS reduced the fleet size by seven percent and saved over $2 million in acquisition costs to meet the goals of the Campaign to Cut Waste and the Presidential Memorandum on Federal Fleet Performance.

In 2014 and 2015, the USGS will work to reduce the fleet size by an additional three percent, meeting the final goals of the Presidential Memorandum on Federal Fleet Performance and achieving an overall reduction of 10 percent in fleet size.

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Activity: Science Support
Subactivity: Information Services

2013 Actual: $23.7 million (73 FTE)
2014 Enacted: $23.7 million (73 FTE)
2015 Request: $21.9 million (71 FTE)

Overview

The Information Services subactivity provides the critical information technology (IT) foundation for the USGS science mission by implementing advances in IT and computing capability and using them to facilitate research, data gathering, analysis and modeling, scientific collaboration, knowledge management and work processes. Additionally, this subactivity funds the USGS information security program, Capital Planning and Investment Control (CPIC), as well as federally mandated information activities such as Records Management (to include the Data Rescue Program), the Freedom of Information Act (FOIA), Information Collections, Section 508 Amendment to the Rehabilitation Act of 1973, and the Federal Advisory committee Act (FACA) program. This subactivity also supports the Department of the Interior (Interior) information technology transformation.

Information Assurance protects infrastructure and data from improper or malicious access or manipulation, protects the integrity and availability of science information, and preserves the confidentiality of privacy and other sensitive information. Oversight is applied to IT security control implementation to ensure well-rounded information system management is used to increase the reliability of the technology supporting science information delivery. The Information Assurance office provides specialized security training to 10 major systems and over 100 subcomponents in the appropriate remediation of vulnerabilities, planning, and internal control implementation to ensure risks are managed commensurate with data sensitivity and mission requirements.

Telecommunications support timely transmission and sharing of emergency and routine data such as from earthquakes, flooding, and volcanic eruptions. This complex architecture is used to provide timely access to global environmental data to promote, protect, and enhance the Nation's economy, security, environment, and quality of life. To fulfill its responsibilities, the Telecommunications Program acquires and manages the investments for voice, data, video, and radio/wireless subsystems within the USGS, including working capital funds (WCF), to assist with capital investment funding. This component also provides regular voice and computer network services.

The USGS Video Program provides for the management and hosting of $1.3 million in video teleconferencing (VTC) infrastructure, which supports video and audio communications between scientists and their constituents as a complement to standard voice communications. With over 40 VTC endpoints throughout the Nation, the USGS has been increasingly exploiting its use to save on travel costs, enhance communications, and enable cost-saving telework initiatives.

The USGS Radio Program provides strategic and operational support to the science mission including radio frequency spectrum management for almost 1,000 radio frequency assignments and risk management for over $85 million of radio-enabled assets including maritime mobile, hydrological, ground penetrating radio, weather radar, satellite communications, water metering systems, underwater communications systems, aeronautical mobile and wildlife tracking systems.

The USGS Voice Program encompasses a wide range of services consisting of a system of highly reliable, dedicated voice circuits working in conjunction with a switching and conferencing system to create voice loops. These voice loops interconnect the 127 different voice distribution systems and additional landlines that support the diverse scientific mission centers. A heavily leveraged WCF provides for voice equipment upgrades and replacements and assistance to bureau sites in PBX upgrades. A Blanket Purchase Agreement (BPA) was established to allow for standardization on a single, consistent voice platform, thus reducing the cost for equipment and support.

The USGS Data Network Program provides the necessary tools for scientists to share substantial amounts of information and data across the network. It supports critical hazards programs that monitor earthquakes, floods, and volcanoes across the Nation and around the world. The Telecommunications Program manages the wireless local area networks (WLAN) that enable users to connect to the USGS network via laptop, smartphone and tablet, and move freely about without losing connectivity. The USGS is moving toward an increasingly untethered workplace; this goal will be significantly enabled by the finalization of an enterprise WLAN contract which will help to reduce overall costs. WLAN boosts the efficiency of employees, saves on cabling costs, and makes the network more accessible.

Computing Infrastructure provides data storage and Web-based collaboration tools, directory services, Internet and Intranet services (EWeb), GIS support, and a “one-stop shop” service desk. The primary services include secure authentication, group policy management, directory services, naming services, IT asset management, and security compliance monitoring. E-mail is the primary avenue of delivering information quickly throughout the USGS, as well as to cooperators and colleagues throughout the world. It allows scientists to receive notifications quickly from automated systems that send information on earthquakes, tsunami, hurricanes, and flooding around the country and sometimes the world.

Information Management conducts planning for future requirements, prevents loss of capability through investment control and supports sound investment strategies. In addition, Information Management oversees a broad suite of activities that support information discovery and delivery and ensures the collection, storage, sharing, preservation and publication of scientific data according to Federal laws and regulations. The USGS Enterprise Web (EWeb) program is a network of people and resources focused on providing access to USGS digital resources. The EWeb Program includes a secure and reliable hosting infrastructure through the National Web Server System (NatWeb). EWeb also provides policies, guidance, services, and tools to enable the effective delivery of USGS science and information products.

The Investment Management Program works to ensure that IT funds are spent in the most efficient and effective manner to support the science mission of the USGS. The program works to increase the use of enterprise contracts and other strategic sourcing approaches combined with more standardization of tools and services to optimize IT spending and support a great amount of scientific research.

Capital Planning and Investment Control (CPIC) is a decisionmaking process designed to help ensure that IT investments integrate strategic planning, budgeting, procurement, and the management of IT in support of the USGS mission. The USGS Investment Portfolio is projected to be $142 million in 2015; this total includes working capital fund charges at the current levels.

The **USGS DOI Enterprise Services** supports the Interior's IT Transformation, technology streamlining and cost and service efficiency initiatives through contributions to Interior's IT Working Capital Fund.

Program Performance

Even though Information Services was confronted with competing mission challenges resulting from natural disasters and austere budgets, Information Services continues to meet the increasing demand for mobile science information delivery services. In meeting these challenges, the Information Services, working in collaboration with bureau executives, has instituted strategic adjustments to mission priorities and activities allowing the organization to remain resilient, adaptable, and agile while maintaining core services and delivering the expected level of customer service. Across the organization, Information Services has undertaken prudent workforce shaping and realignment to not only meet current budgetary realities, but also define the outline of a 21st Century comprehensive workforce that is and will continue to be responsive to mission needs. Information Services focuses its service delivery on four key priorities: enhance science information delivery; protect science data and assets; maintain operations; and support the IT Transformation initiatives.

Science Information Delivery – To enhance public access to USGS data, Information Services established collaborative partnerships with the USGS mission areas in order to achieve the Administration's digital strategy goals of increasing cross-agency and public access to government data. Through these collaborative relationships, USGS total high value datasets submitted to data.gov now exceed 265,381 and have been routinely ranked number one for dataset and tools views and usage in 2013.

The USGS is leveraging Web-enabled technology, real-time access, social and collaborative cloud-based tools, and extensive use of mobile and tablet devices. Information Services, in partnership with the USGS's OCAP, embarked on a USGS Web reengineering effort in 2013, to create a more effective and manageable Web presence. The goal of this effort was to make USGS science more accessible and useful for customers and partners. These activities and accomplishments also support the White House Digital Strategy goal to enable the American people and an increasingly mobile workforce to access high quality digital government information and services anywhere, anytime, on any device.

The USGS prototyped the customer focused, externally facing Web site *www.usgs.gov*. This prototype provides enhanced access to science-driven content including, RSS feeds, tweets, videos and photos. It is mobile ready, uses industry best practices, improves search (as described below), and Web site functionality and navigation. Additionally, the prototype site incorporates customer driven improvement garnered from satisfaction data and usability testing.

An enterprisewide search technology leveraging USA Search (administered by GSA) was also implemented. This new search capability enhances a Web site visitor's search experience through enhanced search result filters and implementation of search engine optimization. The www.usgs.gov Web site has experienced a 16.3 percent increase in search inquiries since migrating to the new search experience.

The USGS plans to aggressively leverage the IT Transformation Cloud services (public cloud) integrated with internal USGS private cloud capabilities for the transition of digital and paper science products. In 2013, the USGS established a team consisting of technical, acquisition, and policy experts that developed a strategy to move the USGS Online Store to a cloud-like service provider. When the strategy is fully implemented in 2015, it will increase USGS product visibility significantly. Placing these maps and science products in the "cloud" will improve customer access to these products. This strategy will allow the Government to establish effective commercial partnerships while focusing more on science community service, product trends, and creative ways for reaching various market places that more often than not have limited access to quality scientific and public safety information.

Preserving Science Data for Future Generations – The USGS is protecting science data and assets by leveraging the concepts and best practices of a "Service on Demand" delivery solution. Information Services transitioned the organization from analog to digital for the USGS Freedom of Information Act (FOIA), Information Collections (IC), Records, Information Quality (IC), and Information Delivery programs. These programs worked with stakeholders to update guidance, improve data quality, automate processes, migrate paper products to digital, and utilize modern technologies to extend access to the public for current holdings.

The USGS continued its focus on preserving science for future generations by ensuring that data from 20 science projects were preserved as one-of-a-kind, high-value datasets, documents, reports, maps, imagery and other information. The Records Program analog to digital preservation activity is the culmination of a 6-year effort that has successfully "saved" data from 113 science projects that span more than 100 years of research in energy resource availability, water, ecosystems, climate, hazards, and geography. Now preserved and digitally accessible, these data are being made available to the science community, stakeholders, and the public for the first time, serving diverse scientific and marketplace needs today and for future generations. In 2015, data from an additional 18 science projects are scheduled for preservation.

Improving the Operational Infrastructure to Ensure Science Success – Information Services spearheaded strategic sourcing initiatives targeting the $106 million in IT acquisition spending for administrative and cost efficiencies. Three multi-year strategic sourcing initiatives were successfully awarded. These strategic sourcing initiatives consolidate hundreds of separate procurement actions, standardize technology, streamline procurements, lower costs by 20 to 75 percent, and reduce administrative overhead.

Improvements in the bureau's computing infrastructure includes improving efficiencies through the optimization data center services with external parties, acceleration of virtualization efforts, and replacement of outdated equipment with more energy efficient devices, retirement of legacy services, and

the consolidation/closure of data centers. Virtualizing applications allows the USGS to reduce operating costs for software, power, equipment cooling and labor. Within the Information Services operating unit, 85 percent of the physical servers have been virtualized and consolidated. Across the USGS, the virtualization status is now at 30 percent and projected to be at 50 percent by 2015.

Information Services has also been closely coordinating with personnel across the bureau in the identification, planning, and execution of targeted data center closures. Closures have been accommodated through consolidation of functionality to sister data centers within the bureau. As Interior implements their planned shared service centers, consolidation to these facilities will also be considered. Five data centers were closed in 2013, with plans to close an additional three in 2014. The USGS plans to consolidate up to 14 additional centers in 2015, depending upon final evaluations and available implementation funding.

On the telecommunications front, the USGS is leveraging emerging wireless communications and mobile devices to create an untethered environment for science investigations and discovery. USGS Mobile Science resources will allow scientist, technicians, support staff and stakeholders to more efficiently capture, analyze and transmit data and information in the office and while conducting studies in the field. The USGS Mobile Science initiative includes mobile office and mobile applications strategies.

In 2013, the Radio Program Management Office developed a strategic plan and preliminary budget for planned radio frequency spectrum relocation initiatives involving the 1755-1850 MHz, 2200-2290 MHz, and 410-420 MHz radio frequency bands. In the years 2015–2020, the USGS plans to vacate or share these frequencies with the public sector in accordance with the Commercial Spectrum Enhancement Act (CSEA).

The USGS streamlined and continues to monitor and enhance the USGS Wide Area Network Architecture resulting in faster and more efficient network connections between offices; reductions in the number of firewalls between the USGS and Interior IT resources; migration of 50 percent of USGS offices and locations to the next generation Interior network; increased bandwidth at 30 locations (including the Seismic, Volcano, Flooding, and Federal Aviation Public Safety and Early Warning monitoring requirements in the States of Alaska and Hawaii); completion of the implementation of wireless network with 75 percent coverage on the major campus locations; and enhanced security monitoring resulting in a significant decrease in vulnerability across the USGS.

In 2013, next generation improvements were made to telecommunication services including implementing wireless services, upgrading circuits and modernizing wide area network infrastructure resources. These “untethered high-speed” foundational upgrades enhance the agency’s ability to collect, process, synthesize and disseminate information at near real-time basis. These strategic efforts lay the foundation for anticipated out-year cost avoidance of roughly 15 percent annually for voice services, 80 percent reductions from wireless networks versus wired networks, and ongoing 30 percent reductions in circuit cost for data services.

In 2013, the USGS undertook a major architectural initiative to improve collaboration and workforce capabilities with the implementation of a greatly enhanced SharePoint platform. This new, enhanced

platform is the underpinning infrastructure supporting the bureau's need for an integrated collaboration tool that meets science and administrative demands for information capture, processing, synthesis and dissemination efforts. As a result of the capabilities this enhanced platform provides, the USGS transitioned over 100 key tools and developed new forms and applications for furlough notification, hiring waivers, classifieds and other resources that support science research, human resources, budget, finance, internal controls, property, facilities, safety and other compliance activities. Additionally, the USGS's Office of Science Quality and Integrity selected the USGS's SharePoint solution for the modernization of the flagship Information Product Data System (IPDS). The IPDS serves as the foundational science lifecycle-management resource in publishing USGS science. Today, over 6,800 real-time workflows are executing in the re-architected IPDS.

In addition, the USGS commenced the introduction of a technology collaborative, shared tools and methodologies allowing for improved science data collaboration between USGS scientists and Federal science partners such as National Oceanic and Atmospheric Administration, National Aeronautics and Space Administration , etc., in a manner that promotes government efficiencies throughout the research community in the public sector.

The USGS also enhanced their information security by augmenting Continuous Monitoring Capabilities. The bureauwide implementation of IBM Endpoint Manager (IEM) solution allowed all assets to be accounted for and improved monitoring of all systems. IEM improved the USGS's ability to develop security dashboards and convey the security posture to appropriate levels and affect corrective action.

Consistent with the plan as a roadmap in 2013 and 2014, the organization improved and continued the implementation of consistent and measurable information security processes and controls; provided over 53 training courses; migrated five systems under the new Assessment and Accreditation (A&A) model; maintained A&A for 100 percent of all reported IT systems/enclaves; increased the number of common security controls; and developed updated standard operating procedures. Because of these activities, the bureau improved its Federal Information Security Management Act (FISMA) ratings; improved staff knowledge, skills and abilities; improved internal controls; improved the bureau's ability to detect and mitigate IT security risk; and completed remediation of 528 reported risks that could have significantly affected operations.

The USGS was the first Interior bureau to complete the implementation of Data Encryption software for the Data-at-Rest (DAR) initiative. Of the approximately 4,300 computers in the bureau's managed environment, 2,300 were encrypted through the centralized McAfee enterprise Policy Orchestrator (ePO) console. In addition, technical support for encryption of USB storage devices was also established through the ePO.

The USGS improved their Business Continuity Planning capabilities by integrating Information System Contingency Planning processes with the Emergency Management and Occupant Evacuation Programs. By integrating IT initiatives into the planning efforts, the USGS was able to streamline security processes, leverage new technologies and identify efficiencies for security implementation. Developing the process for security requirement evaluation in the earliest stages of IT requirements development helps ensure the system will be secure prior to granting IT approval.

Information Technology Transformation Initiative – In support of the Interior's Information and Technology Transformation Initiative (ITT), the USGS has been collaborating with the CIO for the migration of staff, equipment and other resources to the CIO, and retire existing services and support functions under a fee-for-service model. The ITT initiative is supported by USGS staff that are leading and participating on planning teams. Additionally, the USGS has either implemented or plans to implement the following CIO new services by the end of 2015: forms management system; electronic records system, content management system; mobile device management system, risk management services; endpoint implementation; migration of applications and data centers to a vendor-based cloud solution; consolidation of telecommunications infrastructure; and moving end-user support services to the CIO.

Transition to cloud based email and collaboration system was completed in 2013. Over 30-terabyte of USGS messages, collaboration tools, and hundreds of integrated applications were successfully migrated to Google Apps in eight months. This initiative represented the largest data transaction migration in USGS history. The transition and implementation costs are self-funded by the USGS, with anticipated efficiency savings occurring upon successful migration and implementation of new services by the close of 2015.

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Activity: Facilities

		2013 Actual	2014 Enacted	Fixed Costs and Related Changes (+/-)	Internal Transfer	Program Changes	2015 Request	Change from 2014 Enacted (+/-)
Rental Payments and Operations & Maintenance ($000)		93,141	93,141	911	0	5,365	99,417	+6,276
	FTE	60	60	0	0	0	60	0
Deferred Maintenance and Capital Improvements ($000)		6,899	7,280	0	0	0	7,280	0
	FTE	0	0	0	0	0	0	0
Total Requirements ($000)		**100,040**	**100,421**	**911**	**0**	**5,365**	**106,697**	**+6,276**
	Total FTE	**60**	**60**	**0**	**0**	**0**	**60**	**0**

Summary of Program Changes

Request Component	($000)	FTE	Page
Rental Payments and Operations & Maintenance	**5,365**	**0**	
Reducing the Facilities Footprint - Cost Savings and Innovation Plan (CSIP)	5,365	0	B-50
Total Program Change	**5,365**	**0**	

The 2015 Budget Request for Facilities is $106,697,000 and 60 FTE, a net program increase of +$6,276,000 and 0 FTE from the 2014 Enacted. For more information on the Facilities Mission Area change, please see Section B, Program Changes as indicated in the table.

Activity Summary

The U. S. Geological Survey (USGS) Facilities Activity provides safe, functional workspace for accomplishing the bureau's scientific mission. Funds support basic facility operations; security costs; facility maintenance in compliance with Federal, State, and local standards; and the provision of a safe working environment for USGS employees, visiting partners, and customers.

Assets include property consisting of land, buildings, or other improvements permanently attached to the land or a structure on it. The Department of the Interior (Interior) defines a facility as an individual building or structure. The USGS defines facilities to include all sites where USGS activities are housed and mission related work is conducted. Facilities typically provide space for offices, laboratories, storage, parking, and shared support for cafeterias, conference rooms, and other common space uses. The USGS also classifies its eight large (greater than 45 feet in length) research vessels as laboratory facilities. Owned assets are usually part of a campus; for example, the Leetown Science Center includes all associated land, buildings, and other structures.

The Facilities Activity is comprised of two subactivities: Rental Payments and Operations and Maintenance (RP and O&M), and Deferred Maintenance and Capital Improvements (DMCI).

This Activity supports the Interior's goal of facilities improvement by tracking outcomes such as overall condition of buildings and structures, reduction of energy intensity by three percent annually; percentage of square footage that meets Executive Order (E.O.) 13514 sustainable building goals; and cost savings initiatives through space consolidations.

The Facilities program goal is to meet bureau science needs while optimizing facilities location, distribution, and use to control or reduce costs. Objectives for meeting this goal are to—

- Coordinate facility planning with science planning to provide safe, high-quality workspace aligned with science needs.
- Develop Asset Business Plans to meet asset management goals, continue annual surveys, and cyclic condition assessments.
- Meet performance targets for improving space utilization, controlling rent and operating costs, and releasing unneeded space.
- Reduce deferred maintenance by renovating and constructing buildings and other facilities to replace assets otherwise no longer cost effective to operate.
- Establish an effective maintenance program at each owned facility to meet industry best practices.
- Increase co-location consistent with science program objectives.
- Achieve energy performance goals.

Facility Planning

The USGS completed its site-specific Asset Business Plans (ABPs) to supporting the bureau's Asset Management Plan (AMP). The ABPs are 5- to 10-year plans addressing specific needs of a field unit, campus, or region including all assets reported in the Federal Real Property Profile (FRPP). The USGS ABPs effectively address the life cycle issues and characteristics of a site's real property assets. For the local facility or program manager, the ABPs help provide a profile of their current facilities, size, staffing, and utilization rate. The plans also anticipate future needs, create an awareness of recurring and one-time space costs, plan mission operations with facilities in mind, and identify issues that may qualify for additional funding. The ABPs are also used as annual action plans to direct bureau area resources where they are most needed to support the USGS mission.

The USGS has been aggressively pursuing actions to reduce the USGS footprint and to achieve an office space utilization-rate of 180 square feet (SF) per person. The USGS scrutinizes all space actions, irrespective of how the space is acquired, to ensure we are working toward set goals in the Office of Management and Budget's (OMB) "Freeze the Footprint" policy. This broad-based approach allows the bureau to manage all the space in the portfolio holistically. To control the footprint and to administer the space policy, the USGS developed an automated, centralized Space Action Approval and Waiver (SAAW) process for all space actions. This process ensures each space does not increase the bureau's footprint, works toward the utilization standard, and keeps costs under control. These tools use alternative analyses to help manage the footprint and allow for a more informed decisionmaking process regarding facilities investments and space actions.

The USGS relies on General Services Administration (GSA) -owned and -leased buildings for about 67 percent of the space it occupies. The USGS has no ability to reduce fixed rental rates at these sites and can only offset the higher facility costs by vacating space. Therefore, the primary emphasis will be on improving space utilization; disposal of underutilized assets; consolidating operations within; and

relinquishing space to GSA provided offices, laboratories, data centers, and warehouses at major USGS centers in Reston, VA, Denver, CO, and Menlo Park, CA.

The USGS owns 285 buildings situated on approximately 2,158 acres. These buildings total 1.28 million SF and have a replacement value of approximately $325 million. Additionally, the USGS owns 287 structures with a replacement value of $103 million. The owned inventory includes 10 ecological science centers; five ecological field and research stations; one land use center—the National Center for Earth Resources Observation Science (EROS); 10 geomagnetic, seismic and volcano observatories; and 7 miscellaneous owned properties such as streamgage stations, warehouses, and a storage annex.
The USGS also owns eight large research vessels that have operations and maintenance costs that are comparable to those of a USGS building. These vessels exceed 45 feet in length and perform overnight research to support biological, water resources, and marine geology research. Five of the vessels operate on the Great Lakes; two operate in California, and one in Alaska.

USGS facilities were ranked in terms of their mission dependency using a tool called the Asset Priority Index (API). Although the largest concentrations of employees are in GSA-controlled space in Reston, VA, Denver, CO, and Menlo Park, CA, 15 of the top 20 mission-critical assets are owned assets in other locations. These owned assets have specialized capabilities positioned on the landscape to address specific science issues.

For example, the National Wildlife Health Center (NWHC), in Madison, WI, certified by the Centers for Disease Control and Prevention (CDC) to receive and work with “select” disease agents, maintains a high-security infectious disease facility that operates at the Biological Safety Level 3 (BSL-3). The U.S. Department of Agriculture (USDA) has also approved the NWHC to import, export, and transport domestic animal infectious agents. The NWHC is the only Federal institution dedicated to understanding the role of wildlife health in conservation and public health. In the case of wildlife disease emergencies, the NWHC is the lead for the Interior under the Department of Homeland Security’s National Response Plan. A seven-feet-high cyclone fence surrounds the 24-acre NWHC tract. The entrance to the science center has a high-security-card access gate. Each building has security card readers for entrance and security keypad systems. Twenty-four hour access to restricted areas is limited per CDC Select Agent requirements for BSL-3 laboratories. An additional cyclone fence further secures the Tight Isolation Research.

Another location is the EROS Data Center (EDC), centrally located in Sioux Falls, SD. When the idea of an EROS Center was conceived, it was decided that it needed to be centrally located for receiving data as Landsat satellites passed over the United States. A location was required where the EDC ground station could see the satellites as they orbited over the east coast, west coast, most of Canada and Mexico (i.e., the center of North America). The central location was a valid requirement 40- plus years ago and is a valid requirement yet today. The EDC’s location eliminates the need for locating a ground station on both the west coast and the east coast to ensure coverage of the conterminous United States—EDC does all that from a single site.

The USGS’s five-year Space Management Plan (SMP) supports the bureau's SMP and Site-Specific ABPs, providing a framework, strategic vision, and plan of action for effective bureau management of

GSA provided space, USGS direct leases, and owned property. It is used by USGS management to implement bureau space goals, including consolidation, co-location, and disposal. Information contained in the Bureau Asset Management Plan focuses on mission dependency and program requirements for space.

Cost Savings and Innovation Plan (CSIP) – Space savings are integral to rent and operations management. The USGS realizes space savings when locations are able to consolidate space or relocate to space with lower costs. The USGS is actively assisting the Interior to meet its cost savings and innovation targets by proceeding with a CSIP. The USGS's goals under the CSIP are to reduce its footprint and costs, and move toward a 180 SF per person utilization standard. In addition to implementing a centralized space action approval process to focus on meeting these goals, the USGS also established a five-year planning process for CSIP projects. Implementation included a ranking, scoring and approval process, as well as identifying funding for CSIP projects. The USGS leveraged existing software for project inventory, status updates, calculating savings and cost avoidances. The USGS is prioritizing and funding CSIP projects with the shortest payback period while significantly reducing the bureau's footprint and costs.

The USGS is utilizing the Financial and Business Management System (FBMS) to track the bureau's facilities cost at the asset level. The system allows for improved facility planning and reporting to the Department.

Maintaining America's Heritage is Interior's commitment as a steward of priceless and natural resources to preserve and maintain operational facilities and major equipment. Provided through the USGS 2015 Facilities budget this includes an estimated $35.7 million, $7.3 million for DMCI, including facilities projects, equipment maintenance, maintenance management, condition assessment and project planning; and $28.4 million for O&M at many of its unique science centers and one-of-a-kind labs such as the NWHC, the only Federal facility devoted exclusively to the diagnosis, prevention, and control of diseases of wildlife; the Denver Ice Core Lab, a premier facility for examining, sampling, and analyzing ice cores from some of the most remote places on Earth; and EROS, specifically located and equipped to collect, process and distribute remotely sensed land data and archive for users worldwide.

Activity: Facilities

Subactivity: Rental Payments and Operations and Maintenance

2013 Actual: $93.1 (60 FTE)
2014 Enacted: $93.1 (60 FTE)
2015 Request: $99.4 (60 FTE)

Overview

The Rental Payments (RP) and Operations and Maintenance (O&M) Subactivity provides the USGS with funding needed to meet asset management goals and carry out Executive Orders (E.O.) related to Federal space.

In 2015, the USGS plans to spend $139.3 million on rent and operations and maintenance. Of these costs, 71 percent ($99.4 million) are funded through this subactivity. Reimbursable partners (26 percent) and science programs (3 percent) fund the remaining costs. In 2015, the total facilities rent cost is estimated to be $100.3 million. Approximately 20 percent of rent and operations and maintenance funds are spent on USGS owned properties; these assets are unique and mission critical in the USGS portfolio.

The RP cost component provides rental payments for space occupied by the USGS to the GSA, other Federal sources, private lessors, and cooperators. The USGS has unique facility requirements for supporting science functions and relies heavily on the GSA to meet those needs, including modern laboratory space. The USGS occupies approximately 4 million square feet of rentable space in about 165 GSA buildings nationwide, making the USGS one of the largest users of GSA space within the Interior. Approximately 21 percent of USGS space is owned; the GSA, direct leases, and cooperative and interagency agreements provide the remaining 79 percent.

The O&M component provides funding for basic facility operations; security costs; facility maintenance in compliance with Federal, State, and local standards; and the provision of a safe working environment for USGS employees, visiting partners, and customers. Maintenance involves the upkeep of USGS owned facilities, structures and capitalized equipment, necessary to maintain the useful life of the asset. This includes preventive maintenance; cyclic maintenance; repairs; rehabilitation; replacement of parts, components, or items of equipment associated with the facility; adjustment, lubrication, and cleaning (non-janitorial) of equipment associated with the facility; periodic inspection; painting; reroofing; and resurfacing. Also included are special safety inspections and other activities to ensure smooth operation and to prevent breakdowns; scheduled equipment servicing (such as that for heating, ventilation, and air conditioning equipment); and maintenance for owned facility-support equipment such as snowplows and landscape-maintenance vehicles.

Operational costs at USGS owned, and some leased, facilities include electricity, water, and sewage; gasoline, propane, natural gas, diesel, and oil; janitorial services; grounds keeping; waste management and disposal; vehicles operated solely in direct support of operating the facility; annual certification for

building systems such as fire systems, fire extinguishers, backflow preventers, and fume hoods; and upkeep standards necessary to assure the anticipated useful life of the vessels, salaries and benefits of marine professionals operating the vessel, fuel, docking fees, inspections, minor repairs, cyclic maintenance, and at least one vessel haul-out per year. In addition to maintenance costs, salary costs associated with onsite staff responsible for the day-to-day operations of the facility and for maintaining it in operating order are included in the subactivity.

Program Performance

In 2013 and 2014, the CSIP provided the USGS with the ability to reduce its footprint by more than 400,000 rentable square feet (RSF). These efforts focused on its three major centers in Reston, VA, Denver, CO, and Menlo Park, CA. Each of these centers were successful in taking on major consolidation projects, reducing space requirements, actively seeking co-location opportunities and vacating more expensive space. The achieved results were the direct impact of the bureau's CSIP activity.

Through the GSA's Achievement Award Program, in October 2013, the USGS was awarded the "GSA Real Property Award for Best Adopted Practices – Real Property Process Improvements" for their CSIP accomplishments. The GSA sought entries demonstrating innovation, creativity and best practices in four categories of Federal Real Property**:** Asset Management, Sustainability, Workplace Innovation and Best Adopted Practices**.**

At the USGS National Center in Reston, VA, the USGS performs building operations under GSA delegation and has day-to-day control of most space assignments. The USGS supports Interior and other agencies, providing more than 266,648 SF of released space to other Federal partners. The most recent consolidation efforts included the USGS signing an agreement with the Interior's Business Center for their occupancy of 19,710 SF; an agreement with National Park Service (NPS) to occupy 37,284 SF of office and data center space; an agreement with the Department of Commerce (DOC) to occupy 21,482 SF; and an agreement with the Department of Defense (DOD) to occupy 12,500 SF of space at the Advanced System Center (ASC) building. In 2015, the USGS will continue to consolidate and actively seek additional Federal partners to improve the space utilization at the National Center.

The Denver Federal Center consolidation efforts included moving out of older GSA-owned buildings into newer and more suitable buildings such as Building 25, Building 95, and Building 810. Consolidations in 2013 and 2014, further reduces the USGS space requirement by an additional 210,000 SF.

In 2014, the Menlo Park Campus consolidation plan returns 36,500 SF back to the GSA by moving out of the entire first floor of Building 3 into existing USGS space on the campus such as Building 2, Building 11, and Building 15.

In 2015, the bureau will continue its progress toward accomplishing the savings targets set by Interior. The USGS will continue to fund the library consolidation projects at the Denver Federal Center and Menlo Park Campus, which will immediately reduce the space occupied by the library by 29,400 SF; a 48 percent reduction. Completing the Menlo Park library project will also speed up the overall consolidation

plan at the Menlo Park Campus, which will ultimately release the remainder of Building 3; an additional reduction of 50,100 SF. The USGS will also fund a co-location project with the Bureau of Reclamation, in Boulder City, NV. This project will significantly reduce the rent costs as well as lessen the Interior's overall footprint.

The USGS continues to reduce its energy and water use and is ahead of the "energy and water conservation goals" set forth in 2013 by E.O. 13423, "Strengthening Federal Environmental, Energy, and Transportation Management; the Energy Independence and Security Act of 2007 (EISA); and E.O. 13514, Federal Leadership in Environmental, Energy, and Economic Performance", and has implemented an energy management plan to guide programs toward meeting mandated goals. In 2013, the USGS exceeded its goals for achieving "energy and water use reduction" and "renewable energy consumption" goals set forth in E.O. 13423.

In 2014, the USGS is utilizing the Interior's Financial and Business Management System (FBMS) to track all of its utility costs and consumption. This action ensures the Interior has a consistent methodology for collecting and reporting purposes.

The USGS continues to use industry standard cost modeling to project the appropriate sustainment level for operations and maintenance funding and to identify voids in critical cyclical and preventive maintenance practices and processes.

In compliance with the December 2, 2011, Presidential Memorandum, Implementation of Energy Savings Projects and Performance-Based Contracting for Energy Savings, and the December 3, 2013, Administration's announcement to expand and extend the Federal Energy performance contracting challenge, the USGS developed a multi-million dollar alternatively financed project that will be awarded in the third quarter of 2014, and will complete construction in 2015. The project installs energy efficient upgrades at three of the USGS's largest energy consuming science centers and prioritizes Energy Conservation Measures (ECMs) with the greatest return on investment, leveraging both direct appropriations and performance contracting, consistent with guidance by the Office of Management and Budget.

The project includes—

- Boiler and chiller plant improvements
- Energy management control system installation or upgrades
- Heating, ventilation, and air-conditioning (HVAC) improvements
- Lighting upgrades and controls
- Building envelope modifications
- Electric motor and drive upgrades
- Renewable energy systems installation
- Water and sewer efficiency improvements
- Retro-commissioning
- Appliance and plug-load reductions

The USGS is working toward achieving the 2015 goal set forth by E.O. 13514, which requires ten percent of the electric energy consumed by the USGS generates from renewable energy sources. Additionally, the USGS has developed a plan to meet the 2020 goal set forth by the December 5, 2013, Presidential Memorandum, regarding Federal leadership on energy management, increasing this goal to 20 percent renewable energy sources for electrical power consumed.

In 2015, the USGS Facility Energy Program will continue to ensure that all facility managers understand the energy and water efficiency mandates and goals, and will provide guidance and assistance, as necessary. The program will promote alternative financing, renewable energy technologies, sustainable design principles in all projects, and training to ensure that field personnel have the tools necessary to meet the energy and water efficiency mandates.

In 2015, the USGS will continue to make every effort to ensure that when entering lease agreements, provisions that encourage energy and water efficiency are incorporated. Build-to-suit lease solicitations will contain criteria encouraging sustainable design and development, energy efficiency, and verification of building performance. In addition, a preference for buildings having the Energy Star building label will be included in the selection criteria for acquiring leased buildings, and leasing companies will be encouraged to apply for the Energy Star building label.

Activity: Facilities
Subactivity: Deferred Maintenance and Capital Improvements

2013 Actual: $6.9 million (0 FTE)
2014 Enacted: $7.3 million (0 FTE)
2015 Request: $7.3 million (0 FTE)

Overview

Annually, the USGS develops a Deferred Maintenance and Capital Improvements (DMCI) five-year plan. The plan provides the projects of greatest need in priority order that best support bureau missions, with focus first on critical health and safety and critical resource protection. The bureau has undertaken an extensive effort in developing this plan, identifying projects where the urgency of remediation and science program impact are most visible.

The DMCI subactivity funds address the highest priority USGS facility and equipment needs according to Interior's guidance. The current funding level addresses approximately nine percent of the facilities deferred maintenance and capital improvements backlog of $90.4 million (as reported in the 2013 FRPP). The condition assessment program includes annual surveys and a cyclic process for comprehensive onsite inspections to document deferred maintenance.

Facilities projects reflect comprehensive evaluations conducted by independent architectural and engineering firms. These installation-wide assessments help establish core data on the condition of USGS constructed assets.

Through the asset management planning process, the USGS can identify real property assets that are candidates for disposition. Any asset that is no longer critical to the mission, in poor condition, or no longer cost effective to maintain is a candidate for possible disposal.

The USGS has stewardship responsibility for unique mission equipment assets such as hazard warning networks, river cableways, and streamgaging stations, all of which require maintenance and capital investments to preserve their functionality. Projects targeting these assets are included under the Equipment Section of the DMCI five-year plan.

The USGS prioritizes critical DMCI needs according to the Interior's guidelines. Five-year plans are updated on an annual basis using the uniform, department-wide process. Plans are subject to adjustments in outyears due to funding changes and revised priorities based on comprehensive facility condition assessments, annual condition surveys, and emergency needs. The goal of the five-year planning process is to focus limited resources on projects that are both mission critical and in the most need of repair or replacement. The ranking equation is designed to accommodate many types and sizes of projects, from simple to complex and places the highest priority on facility buildings based on their Facility Condition Index (FCI) and Asset Priority Index (API) ranking. This emphasizes projects that involve mission

critical assets in unacceptable condition with less emphasis on non-mission critical assets. The average FCI for USGS owned building is 0.189 and the average FCI for USGS owned structures of 0.154. The USGS determines a 0.15 score on an asset to be in the acceptable range of condition. The Interior's newly defined criteria for 2015 and methodology also takes into account—

- Projects that are clearly aligned with Interior, bureau, office and program missions, initiatives, and strategic goals.
- Projects that clearly define a positive return on investment, leverage outside interest, and reduce operation and maintenance liabilities.
- Projects that have unacceptable risk levels should the project not be completed.

The condition assessment (CA) process identifies deferred maintenance needs and determines the current replacement value of constructed assets. Knowing the estimated cost of deferred maintenance and the replacement value of constructed assets allows the USGS to use the industry standard FCI as a method of measuring facility condition and condition changes. It is an indicator of the depleted value of capital assets. Funds are also available through the condition assessment process to identify, report, and track any asbestos, environmental, and disposal liability sites on departmental lands according to guidelines issued by the Interior's Office of Environmental Policy and Compliance.

Program Performance

DMCI funds associated with the USGS Streamgaging Network provided the ability to upgrade vital cableways that need to be restored to safe operation, and to remove abandoned cableways that present a potential hazard to public safety. In 2013, 22 major cableway projects were completed with DMCI funding. In 2014, four projects are planned to rebuild and replace large cableway systems, 16 additional projects are underway at multiple locations nationwide for renovation and removal of abandon cableways. For many decades the USGS has used cableways for the measurement of streamflow and collection of water-quality samples. In 2013, the USGS operated approximately 840 cableways. Properly constructed and maintained cableways are dependable and convenient platforms for obtaining water-resource data. The use of cableways eliminates the need for USGS personnel to work from dangerous highway bridges and also allow the selection of sites that offer optimum hydraulic characteristics for measuring stream discharge. Cableways consisting of a main cable, anchors, support structures, backstays, cablecars, and other equipment are subject to damage and deterioration from temperature changes, moisture, and vandalism. The integrity of the structure also may be threatened by erosion as a result of overland runoff or by flooding. Because of this, cableways are carefully monitored on a continuing basis and those that do not meet safety standards are removed from service until all defects are corrected and approved for use by USGS personnel. As of January 2014, 69 cableways were inactive and awaiting repair, an additional 50 cableways have been abandoned and are awaiting removal. In 2013, the USGS Water Mission Area (WMA) determined that certain cableways might possibly pose a risk to low-flying aircraft and should be retrofitted with aircraft warning markers. To minimize safety hazards, WMA policy states that intact overhead cables are to be removed from inactive cableways as soon as possible. Additional funding through DMCI provided upgrades to the Northern California Seismic Network microwave system to comply with Interior's safety requirements.

The USGS utilizes the Facility Maintenance Management System (FMMS) to develop the bureau's DMCI five-year plan. Proposed DMCI projects are entered in FMMS as deferred maintenance work orders. Selected projects become the basis of the bureau's five-year plan submission. Beginning in 2013, condition assessment results were automatically imported in FMMS, which provided an automated repository of deficiency findings and the actions taken to address them.

The Facility Maintenance Management System (FMMS) is the USGS's implementation of the commercial maintenance-management software application Maximo™. The FMMS system supports efficient operation and maintenance of USGS facilities by providing accurate maintenance information to local, regional, and national facility managers. It includes a mobile work order component, used by maintenance technicians at larger centers, to document maintenance requests and day-to-day maintenance activities in the field, and establish preventive maintenance schedules without requiring a connection to the FMMS database. The FMMS system is used in the development of the Deferred Maintenance and Capital Improvement (DMCI) five-year plan. Beginning in 2013, condition assessments results were automatically imported in FMMS, which provided an automated repository of deficiency findings and the actions taken to address them. Use of the FMMS supports the USGS's AMP by establishing an inventory and maintenance history on all constructed assets and associated equipment, standardizing maintenance business practices, facilitating maintenance reporting and data analysis, and supporting the budget and the DMCI five-year planning processes.

The USGS is playing a significant role and dedicating resources to Single Platform Maximo (SPM). The SPM is a National Park Service-led project that will upgrade and consolidate Interior bureau asset management programs to Maximo on a consolidated cloud-hosted environment, generating cost savings, allowing for the sharing of asset management best practices, and streamlining the management of IT maintenance and support contracts. The SPM project officially commenced March 29, 2013, with a planned go live date of May 2014. In 2015, the USGS will continue to strengthen the data linkage, analysis, and reporting capabilities between asset deficiencies and the work undertaken to correct them. In 2013, 17 DMCI projects were completed at a total cost of $7.5 million. Included in these projects was the replacement of Process Distribution Lines at the Great Lakes Science Center, replacement of an Emergency Generator at the Marrowstone Field Station Pumphouse, replacement and rebalancing of Laboratory Fume Hoods at the National Wetland Research Center, and the installation of Automatic Fire Sprinkler Systems at multiple locations including the Northern Prairie Wildlife Health Center (Administrative and Riverside Buildings) and at the Northern Appalachian Research Center Laboratory. The completion of these DMCI projects ensure the proper distribution of water, air and natural gas for research studies, animal safety (fish) at labs, provides fuel tank leak detection to avoid ground contamination, alarm systems for power failure, fire protection and energy reduction cost.

2015 Deferred Maintenance and Capital Improvement Plan

The following table lists, in priority order, the proposed projects and equipment to be addressed by DMCI in 2015, within available funding. ($000)

Facility or Project Name/Project Amount	Project Number/Description
Cost Savings and Innovation Plan (CSIP) $2,225	Denver Federal Center - CSIP - Reduce the Footprint Project # CSIP FY15
Earth Resources Observation and Science Data Center (EROS) $41	Install Sprinkler System in Digital Archive and Replace Sprinkler Valves Project # 1920656
Earth Resources Observation and Science Data Center (EROS) $960	Replace 200 and 300 Ton Chillers Project # 2281075
Patuxent Wildlife Research Center (PWRC) $720	Repair Heating Ventilation and Air Condition (HVAC) in Gabrielson Building Initial funding was 2014 with final funding in 2015. Project # 1967897
National Wildlife Health Center (NWHC) $524	Replace Autoclaves in Main Building Project # 1924966
National Wildlife Health Center (NWHC) $466	Replace Autoclaves in Tight Isolation Building Project # 1924966
Hammond Bay Biological Station (HBBS) $1036	Hammond Bay Phase 1 Modernization of Laboratory (partial funding 2015 remainder in 2016) Project # 1923914

2015 Equipment Projects

Project Name/Project Amount	Project Description
113 Sites Nationwide $240	Repair, Replace, or Remove Cableways (W1998A10000): 840 Cableways are Active and in Use Nationwide
Northern California Seismic Network $200	Replace Network Analog and Microwave Stations (G987160001): Replace Earthquake Network Stations providing seismic monitoring and warning for large Metropolitan areas.
Condition Assessments (CA) $210	Condition Assessments (CA)/Engineering Support: Complete CA's for the identification of maintenance and capital improvement needs, Provide engineering services support for funded projects, and Conduct Surveys to determine asbestos-related cleanup, environmental and disposal cost.
Maintenance Management System (MMS) $350	Maintenance Management System (MMS): Implement and maintain a Maintenance Management System that meets bureau reporting and oversight requirements.
Program and Project Management Support $308	Project Planning: Contract architectural, engineering, management and design services for complex projects, particularly for developing project requirements and cost estimates.

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Working Capital Fund Overview

The U.S. Geological Survey (USGS) Working Capital Fund (WCF) was established to allow for the efficient financial management of the components listed below. The WCF was made available for expenses necessary for furnishing materials, supplies, equipment, work, and services in support of USGS programs, and as authorized by law (authorization information begins on page 3 of this section), to agencies of the Federal Government and others. The WCF consists of four components:

1. The WCF **Investment** Component provides a mechanism to assist USGS managers in planning for and acquiring goods and services that are too costly to acquire in a single fiscal year or that, due to the nature of services provided must operate in a multi- as opposed to a single-year basis of funding. Investments are supported by documented investment plans that include estimated acquisition/replacement costs, a schedule of deposits, and approval of the plans, deposits and expenditures by designated USGS officials.

- **Telecommunications Investments** are used for telecommunication hardware, software, facilities, and services. Examples include replacement or expansion of automatic exchange systems and computerized network equipment such as switches, routers, and monitoring systems.
- **Equipment Investments** are used for the acquisition, replacement, and expansion of equipment for USGS programs. Equipment may include, but is not limited to, hydrologic, geologic, and cartographic instruments, laboratory equipment, and computer hardware and software.
- **Facilities Investments** support facility and space management investment expenses for USGS real property, including owned and leased space. Authorized investment expenses include nonrecurring and emergency repair, relocation of a facility, and facility modernization. The component does not include annual expenses such as rent, day-to-day operating expenses, recurring maintenance, or utilities.
- **Publications Investments** are used for the preparation and production of technical publications reporting on the results of scientific data and research. Research projects typically are three to five years in duration, and planning the medium in which to report results occurs over the life of the project. The Publications Investment Component provides a mechanism for establishing an efficient, effective, and economical means of funding publications costs over the duration of the research.

2. The WCF **Fee-for-Service** Component provides a continuous cycle of client services for fees established in a rate-setting process and, in some cases, with funding provided by appropriated funds. Fees are predicated upon both direct and indirect costs associated with providing the services, including amortization of equipment required to provide the services.

- **The National Water Quality Laboratory (NWQL)** conducts chemical and biological analyses of water, sediments, and aquatic tissue for all USGS science centers and other customers, including other USGS mission areas, other Interior Bureaus, and non-USGS customers. The NWQL also does biological classification for these customers. NWQL analysis services are provided on a reimbursable basis, with the price of services calculated to cover direct and indirect costs.
- **The USGS Hydrologic Instrumentation Facility (HIF)** provides hydrologic instrumentation on a fee-for-service basis. The facility provides its customers with hydrologic instruments that

can be rented or purchased, maintains a technical expertise on instrumentation, and tests and evaluates new technologies as they become available in the marketplace.

- **Bureau Laboratories –** There are currently three laboratories within the Water Resources Mission Area that perform gaseous dissolved chlorofluorocarbon measurements, environmental microbiology analyses and isotope-ratio measurements of water, sediments, rocks, and gases for all USGS mission areas, and for USGS customers.
- **The National Training Center** conducts USGS training programs. Examples include specialized training for USGS employees, cooperators, and international participants in many facets of earth science, as well as computer applications, management and leadership seminars, and various workshops.
- **Drilling –** There are currently two drilling units, based in Lakewood, CO, and Henderson, NV. The drilling units provide drilling services to conduct exploratory drilling for obtaining geologic samples and cores in difficult hydrogeologic environments and the emplacement of sampling devices and sub-surface sensors for hydrologic investigations.

3. The GSA **Buildings Delegation** Component is used to manage funds received under the delegated authority for the J.W. Powell Building and Advanced Systems Center in Reston, VA, as provided by 40 U.S.C. 121 (d) and (e) (formerly subsections 205 (d) and (e) of the Federal Property and Administrative Services Act of 1949, as amended, and 40 U.S.C. 486 (d) and (e), respectively). Delegated functions include building operations, maintenance, cleaning, overseeing fire and life safety, maintaining high voltage switchgear and fire alarms, recurring repairs, minor alterations, historic preservation, concessions, and energy management. Because of the size of the Reston buildings and the need to expend the facility funds in a manner corresponding to GSA's no-year funding (Federal Buildings Fund) mechanisms and the GSA National Capital Region long-range capital improvement plan, no-year funding is a prerequisite to administering the delegation. Public Law 104–208, Section 611, provides that, for the fiscal year ending September 30, 1997, and thereafter, any department or agency that has delegated authority shall retain that portion of the GSA rental payment available for operation, maintenance, and repair of the building and the funds shall remain available until expended. This WCF component was established in 2004 to provide USGS with this no-year flexibility.

4. The **Enterprise Services** Component operates in a businesslike manner, recovering fees for various consolidated services provided to USGS mission areas and other Federal agencies. By leveraging these services through a unified effort, USGS achieves cost and business efficiencies that would otherwise be lost.

The Science Publishing Network (SPN) operates within the Enterprise Services Component of the WCF. The SPN provides high quality publishing support for science information products while improving its operational effectiveness and efficiencies. The SPN offers a wide range of publishing services to authors of USGS information products and others. Services include consultation, technical editing, illustrating, layout and design, Web services, printing management and distribution, electronic publishing as well as other publishing needs.

Appropriation Language and Citations

Permanent authority:

1. Provided further, That, in fiscal year 1986, and thereafter, all amortization fees resulting from the Geological Survey providing telecommunications services shall be deposited in a special fund to be established on the books of the Treasury and be immediately available for payment of replacement or expansion of telecommunications services, to remain available until expended.

    - **43 U.S.C.50a** established the Telecommunications Amortization Fund, which was displayed as part of the Surveys, Investigations and Research appropriation from 1986 through 1990. Beginning in 1991, the Telecommunications Amortization Fund was merged into the WCF described in the next citation.

2. There is hereby established in the Treasury of the United States a working capital fund to assist in the management of certain support activities of the United States Geological Survey (hereafter referred to as the "Survey"), Department of the Interior. The fund shall be available on and after November 5, 1990, without fiscal year limitation for expenses necessary for furnishing materials, supplies, equipment, work, facilities, and services in support of Survey programs, and, as authorized by law, to agencies of the Federal Government and others. Such expenses may include laboratory modernization and equipment replacement, computer operations, maintenance, and telecommunications services; requirements definition, systems analysis, and design services; acquisition or development of software; systems support services such as implementation assistance, training, and maintenance; acquisition and replacement of computer, publications and scientific instrumentation, telecommunications, and related automatic data processing equipment; and, such other activities as may be approved by the Secretary of the Interior.

    There are authorized to be transferred to the fund, at fair and reasonable values at the time of transfer, inventories, equipment, receivables, and other assets, less liabilities, related to the functions to be financed by the fund as determined by the Secretary of the Interior. Provided, That the fund shall be credited with appropriations and other funds of the Survey, and other agencies of the Department of the Interior, other Federal agencies, and other sources, for providing materials, supplies, equipment, work, and other services as authorized by law and such payments may be made in advance or upon performance: Provided further, That charges to users will be at rates approximately equal to the costs of furnishing the materials, supplies, equipment, facilities, and services, including such items as depreciation of equipment and facilities, and accrued annual leave: Provided further, That all existing balances as of November 5, 1990, from amortization fees resulting from the Survey providing telecommunications services and deposited in a special fund established on the books of the Treasury and available for payment of replacement or expansion of telecommunications services as authorized by Public Law 99-190, are hereby transferred to and merged with the working capital fund, to be used for the same purposes as originally authorized. Provided further, That funds that are not necessary to carry out the activities to be financed by the fund, as determined by the Secretary, shall be covered into miscellaneous receipts of the Treasury.

    P.L. 101-512 Department of the Interior and Related Agencies Appropriations Act, 1991 This authority established a Working Capital Fund account in 1991. The Telecommunications Amortization Fund was included as part of the WCF and all balances of the Telecommunications Amortization Fund existing at the end of 1990 were transferred to the WCF. These balances were to be used for the same purposes as originally authorized.

P.L. 103-332 Department of the Interior and Related Agencies Appropriations Act, 1995 The amendments that were made in this appropriations act are shown in underline in the second citation shown above. This authority expanded the use of the Working Capital Fund to partially fund laboratory operations and facilities improvements and to acquire and replace publication and scientific instrumentation and laboratory equipment.

United States Geological Survey

Federal Funds

General and special funds:

WORKING CAPITAL FUND

Program and Financing

(In millions of dollars)

Identification Code 14-4556-0-4-306		2013 Actual	2014 Enacted	2015 Request
	Obligations by program activity:			
08.01	Working Capital Fund	85	86	86
	Budgetary resources:			
	Unobligated balance:			
10.00	Unobligated balance carried forward, start of year	79	75	69
10.21	Recoveries of prior year unpaid obligations	2		
10.50	Unobligated balance total	81	75	69
	Budget Authority:			
	Spending Authority from offsetting collections, disc			
17.00	Collected	79	80	81
19.30	Total budgetary resources available	160	155	150
	Memorandum (non-add) entries:			
19.41	Unexpired unobligated balance, end of year	75	69	64
	Change in obligated balances:			
	Obligated balance, start of year:			
30.00	Unpaid obligations, brought forward, Oct 1	29	33	48
30.10	Obligations incurred, unexpired accounts	85	86	86
30.20	Outlays, Gross	-79	-71	-80
30.40	Recoveries of prior year obligations	-2	0	0
	Obligated balance, end of year:			
30.50	Unpaid Obligations, end of year (gross)	33	48	54
	Budget authority and outlays, net:			
	Discretionary			
40.00	Budget authority, gross	79	80	81
	Outlays, gross:			
40.10	Outlays from new discretionary authority	46	36	36
40.11	Outlays from discretionary balances	33	35	44
40.20	Outlays, gross	79	71	80
	Offsets against gross budget authority and outlays:			
	Offsetting collections (collected) from:			
40.30	Federal Sources	-78	-80	-81
40.70	Budget authority, net (discretionary)			
40.80	Outlays, net (discretionary)		-9	-1
41.80	Budget authority, net (total)			
41.90	Outlays, net (total)		-9	-1

WORKING CAPITAL FUND

Balance Sheet

(In millions of dollars)

Identification Code 14-4556-0-4-306		2012 Actual	2013 Actual
	ASSETS:		
	Federal assets:		
1101	Fund balances with Treasury	108	108
	Investments in U.S. securities:		
1106	Receivables, net		
1803	Other Federal assets: Property, plant and equipment, net	26	26
1999	Total assets	134	134
	LIABILITIES:		
2101	Federal liabilities: Accounts payable		
2201	Non-Federal liabilities: Accounts payable	5	5
2999	Total liabilities	5	5
	NET POSITION:		
3300	Cumulative results of operations	129	129
3999	Total net position	129	129
4999	Total liabilities and net position	134	134

WORKING CAPITAL FUND

Object Classification

(In millions of dollars)

Identification Code 14-4556-0-4-306		2013 Actual	2014 Enacted	2015 Request
	Reimbursable obligations:			
	Personnel compensation:			
11.1	Full-time permanent	17	18	18
11.3	Other than full-time permanent	1	1	1
11.5	Other personnel compensation	1	1	1
11.9	Total personnel compensation	19	20	20
12.1	Civilian personnel benefits	5	6	6
21.0	Travel and transportation of persons	1	1	1
23.1	Rental payments to GSA	2	2	2
23.3	Communications, utilities, and miscellaneous charges	1	1	1
24.0	Printing and reproduction	0	1	1
25.1	Advisory and Assistance Services	1	1	1
25.2	Other services	7	10	10
25.3	Other purchases of goods and services from Government Accounts	11	6	6
25.4	Operation and maintenance of facilities	5	4	4
25.7	Operation and maintenance of equipment	2	3	3
26.0	Supplies and materials	5	5	5
31.0	Equipment	20	25	25
32.0	Land and structures	6	1	1
99.9	Total new obligations	85	86	86

WORKING CAPITAL FUND

Employment Summary

Identification Code 14-4556-0-4-306		2013 Actual	2014 Enacted	2015 Request
	Reimbursable:			
2001	Civilian full-time equivalent employment	226	226	226

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SURVEYS, INVESTIGATIONS, AND RESEARCH

Summary of Requirements by Object Class

(Millions of Dollars)

Appropriation: Surveys, Investigations, and Research		**2014 Enacted**		**Fixed Costs & Related Changes**		**Program Changes**		**2015 Request**	
Object Class		**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
	Personnel compensation								
11.1	Full-time permanent		423		4		-2		425
11.3	Other than full-time permanent		39		1		0		40
11.5	Other personnel compensation		2		0		0		2
	Total personnel compensation	5,222	464	0	5	-18	-2	5,204	467
12.1	Civilian personnel benefits		139		1		-2		138
13.0	Benefits for former personnel		1		0		0		1
21.0	Travel and transportation of persons		25		0		0		25
22.0	Transportation of things		4		0		0		4
23.1	Rental payment to GSA		53		1		0		54
23.2	Rental payments to others		4		0		0		4
23.3	Comm., utilities and misc. charges		11		0		0		11
24.0	Printing and reproduction		1		0		0		1
25.1	Advisory and assistance services		12		0		0		12
25.2	Other services from non-Fed sources		103		-1		21		117
25.3	Other goods and services from Fed sources		75		0		0		75
25.4	Operation and maintenance of facilities		15		0		0		15
25.5	Research and development contracts		3		0		0		3
25.7	Operation and maintenance of equipment		15		0		0		15
26.0	Supplies and materials		18		0		0		18
31.0	Equipment		27		0		7		34
32.0	Land and structures		1		0		0		1
41.0	Grants, subsidies, and contributions		67		0		11		78
	Total requirements		**1,038**		**6**		**35**		**1,073**

This information is displayed in budget authority (not obligations) by object class.

SURVEYS, INVESTIGATIONS, AND RESEARCH

Summary of Requirements by Object Class

(Millions of Dollars)

Appropriation: Surveys, Investigations, and Research		**2014 Enacted**		**2015 Request**		**Increase or Decrease**	
Reimbursable Obligations		**FTE**	**Amount**	**FTE**	**Amount**	**FTE**	**Amount**
	Personnel compensation						
11.1	Full-time permanent		164		164		0
11.3	Other than full-time permanent		29		29		0
11.5	Other personnel compensation		3		3		0
	Total personnel compensation	2,787	196	2,787	196	0	0
12.1	Civilian personnel benefits		59		59		0
21.0	Travel and transportation of persons		10		10		0
22.0	Transportation of things		4		4		0
23.1	Rental payments to GSA		20		20		0
23.2	Rental payments to others		1		1		0
23.3	Communications, utilities and miscellaneous Charges		6		6		0
25.1	Advisory and assistance services		3		3		0
25.2	Other services		45		45		0
25.3	Other purchases of goods and services from Government accounts		27		27		0
25.4	Operation and maintenance of facilities		5		5		0
25.7	Operation and maintenance of equipment		10		10		0
26.0	Supplies and materials		12		12		0
31.0	Equipment		18		18		0
41.0	Grants, subsidies, and contributions		28		28		0
	Total requirements		**444**		**444**		**0**

United States Geological Survey

Federal Funds

General and special funds:

SURVEYS, INVESTIGATIONS, AND RESEARCH

Program and Financing

(Millions of Dollars)

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Obligations by program activity:			
00.01	Ecosystems	147	154	162
00.02	Climate and Land Use Change	135	133	149
00.03	Energy, Minerals, and Environmental Health	89	92	99
00.04	Natural Hazards	124	130	128
00.05	Water Resources	201	207	210
00.06	Core Science Systems	106	109	110
00.07	Science Support	107	111	108
00.08	Facilities	100	102	107
07.99	Total direct obligations	1,009	1,038	1,073
08.01	Reimbursable program	444	444	444
09.00	Total new obligations	1,453	1,482	1,517
	Budgetary resources:			
	Unobligated balance:			
10.00	Unobligated balance brought forward, Oct 1	405	403	397
10.21	Recoveries of prior year unpaid obligations	9	0	0
10.50	Unobligated balance (total)	414	403	397
	Budget authority:			
	Appropriations, discretionary:			
11.00	Appropriation	1,068	1,032	1,073
11.30	Appropriations permanently reduced [ATB Reduction P.L. 113-6]	-2	0	0
11.30	Appropriations permanently reduced [Sequestration]	-54	0	0
11.60	Appropriation, discretionary (total)	1,012	1,032	1,073
	Spending authority from offsetting collections, discretionary:			
17.00	Collected	435	444	444
17.01	Change in uncollected payments, Federal sources	-4	0	0
17.50	Spending auth from offsetting collections, disc (total)	431	444	444
19.00	Budget authority (total)	1,443	1,476	1,517
19.30	Total budgetary resources available	1,857	1,879	1,914

SURVEYS, INVESTIGATIONS, AND RESEARCH

Program and Financing cont'd

(Millions of Dollars)

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Memorandum (non-add) entries:			
19.40	Unobligated balance expiring	-1	0	0
19.41	Unexpired unobligated balance, end of year	403	397	397
	Change in obligated balance:			
	Unpaid obligations:			
30.00	Unpaid obligations, brought forward, Oct 1	368	340	280
30.10	Obligations incurred, unexpired accounts	1,453	1,482	1,517
30.11	Obligations incurred, expired accounts	3	0	0
30.20	Outlays (gross)	-1,468	-1,542	-1,548
30.40	Recoveries of prior year unpaid obligations, unexpired	-9	0	0
30.41	Recoveries of prior year unpaid obligations, expired	-7	0	0
30.50	Unpaid obligations, end of year	340	280	249
	Uncollected payments:			
30.60	Uncollected payments, Fed sources, brought forward, Oct 1	-480	-455	-455
30.70	Change in uncollected payments, Fed sources, unexpired	4	0	0
30.71	Change in uncollected payments, Fed sources, expired	21	0	0
30.90	Uncollected payments, Fed sources, end of year	-455	-455	-455
	Memorandum (non-add) entries:			
31.00	Obligated balance, start of year	-112	-115	-175
32.00	Obligated balance, end of year	-115	-175	-206
	Budget authority and outlays, net:			
	Discretionary:			
40.00	Budget authority, gross	1,443	1,476	1,517
	Outlays, gross:			
40.10	Outlays from new discretionary authority	856	1,299	1,335
40.11	Outlays from discretionary balances	611	243	213
40.20	Outlays, gross (total)	1,467	1,542	1,548
	Offsets against gross budget authority and outlays:			
	Offsetting collections (collected) from:			
40.30	Federal sources	-249	-244	-244
40.33	Non-Federal sources	-207	-200	-200
40.40	Offsets against gross budget authority and outlays (total)	-456	-444	-444

SURVEYS, INVESTIGATIONS, AND RESEARCH

Program and Financing cont'd

(Millions of Dollars)

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Additional offsets against gross budget authority only:			
40.50	Change in uncollected payments, Fed sources, unexpired	4	0	0
40.52	Offsetting collections credited to expired accounts	21	0	0
40.60	Additional offsets against budget authority only (total)	25	0	0
40.70	Budget authority, net (discretionary)	1,012	1,032	1,073
40.80	Outlays, net (discretionary)	1,011	1,098	1,104
	Mandatory:			
	Outlays, gross:			
41.01	Outlays from mandatory balances	1	0	0
41.80	Budget authority, net (total)	1,012	1,032	1,073
41.90	Outlays, net (total)	1,012	1,098	1,104

SURVEYS, INVESTIGATIONS, AND RESEARCH

Object Classification

(Millions of Dollars)

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Direct obligations:			
	Personnel compensation:			
11.1	Full-time permanent	419	423	425
11.3	Other than full-time permanent	39	39	40
11.5	Other personnel compensation	2	2	2
11.9	Total personnel compensation	460	464	467
12.1	Civilian personnel benefits	136	139	138
13.0	Benefits for former personnel	1	1	1
21.0	Travel and transportation of persons	14	25	25
22.0	Transportation of things	4	4	4
23.1	Rental payments to GSA	57	53	54
23.2	Rental payment to others	4	4	4
23.3	Comm., utilities, and miscellaneous charges	11	11	11
24.0	Printing and reproduction	1	1	1
25.1	Advisory and assistance services	12	12	12
25.2	Other services from non-Fed sources	88	103	117
25.3	Other goods and services from Fed sources	75	75	75
25.4	Operation and maintenance of facilities	15	15	15
25.5	Research and development contracts	3	3	3
25.7	Operation and maintenance of equipment	15	15	15
26.0	Supplies and materials	18	18	18
31.0	Equipment	27	27	34
32.0	Land and structures	1	1	1
41.0	Grants, subsidies, and contributions	67	67	78
99.0	Direct obligations	1,009	1,038	1,073

SURVEYS, INVESTIGATIONS, AND RESEARCH

Object Classification cont'd

(Millions of Dollars)

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Reimbursable obligations:			
	Personnel compensation:			
11.1	Full-time permanent	163	164	164
11.3	Other than full-time permanent	29	29	29
11.5	Other personnel compensation	3	3	3
11.9	Total personnel compensation	195	196	196
12.1	Civilian personnel benefits	59	59	59
21.0	Travel and transportation of persons	10	10	10
22.0	Transportation of things	4	4	4
23.1	Rental payments to GSA	20	20	20
23.2	Rental payments to others	1	1	1
23.3	Comm., utilities, and miscellaneous charges	6	6	6
25.1	Advisory and assistance services	3	3	3
25.2	Other services from non-Fed sources	46	45	45
25.3	Other goods and services from Fed sources	27	27	27
25.4	Operation and maintenance of facilities	5	5	5
25.7	Operation and maintenance of equipment	10	10	10
26.0	Supplies and materials	12	12	12
31.0	Equipment	18	18	18
41.0	Grants, subsidies, and contributions	28	28	28
99.0	Reimbursable obligations	444	444	444
99.9	Total new obligations	1,453	1,482	1,517

SURVEYS, INVESTIGATIONS, AND RESEARCH

Employment Summary

Identification Code 14-0804-0-1-306		2013 Actual	2014 Enacted	2015 Estimate
	Direct:			
1001	Civilian full-time equivalent employment	5,202	5,222	5,204
	Reimbursable:			
2001	Civilian full-time equivalent employment	2,787	2,787	2,787
	Allocation account:			
3001	Civilian full-time equivalent employment	36	36	36

Funding of U.S. Geological Survey Programs (Obligations)

(Thousands of Dollars)

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Ecosystems			
Appropriated			
Multi-Year appropriation	146,488	154,040	162,025
Total (appropriated)	**146,488**	**154,040**	**162,025**
Reimbursements			
Non-Federal (Domestic) sources			
Technology Transfer	2,693	2,693	2,693
Miscellaneous	7,395	7,395	7,395
Subtotal (non-Federal domestic sources)	10,088	10,088	10,088
State and local sources			
States-Coop (matched - In-Kind Services) NON ADD	466	466	466
States-Coop (unmatched)	2,314	2,314	2,314
Subtotal (state and local sources)	2,314	2,314	2,314
Federal sources			
Department of Agriculture	1,959	1,959	1,959
Department of Commerce			
Nat'l Oceanic & Atmospheric Admin	264	264	264
Department of Defense			
Corps of Engineers	19,386	19,386	19,386
Other	4,112	4,112	4,112
Department of Energy			
Bonneville Power Administration	1,949	1,949	1,949
Other	444	444	444
Department of Homeland Security	140	140	140
Department of Interior			
Bureau of Land Management	4,609	4,609	4,609
Bureau of Ocean Energy Management	1,317	1,317	1,317
Bureau of Reclamation	11,161	11,161	11,161
Fish and Wildlife Service	9,865	9,865	9,865
National Park Service	1,569	1,569	1,569
Office of Secretary			
National Business Center	620	620	620
Office of Surface Mining	100	100	100
Department of State	252	252	252
Department of Transportation	225	225	225
Environmental Protection Agency	389	389	389
Health and Human Services	247	247	247
Housing and Urban Development	592	592	592
Subtotal (Federal sources)	59,200	59,200	59,200
Total (reimbursements)	**71,602**	**71,602**	**71,602**
Total: Ecosystems	**218,090**	**225,642**	**233,627**

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Climate and Land Use Change			
Appropriated			
Multi-Year appropriation	83,418	78,867	95,744
No-Year appropriation	51,570	53,635	53,337
Total (appropriated)	**134,988**	**132,502**	**149,081**
Reimbursements			
Non-Federal (Domestic) sources			
Technology Transfer	7	7	7
Miscellaneous	554	554	554
Subtotal (non-Federal domestic sources)	561	561	561
Non-Federal (Foreign) sources			
Corporacion Andina de Fomento	299	299	299
Miscellaneous	69	69	69
Subtotal (non-Federal Foreign sources)	368	368	368
State and local sources			
States-Coop (matched - In-Kind Services) NON ADD	6	6	6
States-Coop (unmatched)	8	8	8
Subtotal (state and local sources)	8	8	8
Federal sources			
Agency for International Development	729	729	729
Central Intelligence Agency	3,951	3,951	3,951
Department of Agriculture	531	531	531
Department of Commerce			
Nat'l Oceanic & Atmospheric Admin	100	100	100
Department of Defense			
Corps of Engineers	1,177	1,177	1,177
National Geospatial-Intelligence Agency	8	8	8
Department of Energy	30	30	30
Department of Homeland Security			
Federal Emergency Management Agency	56	56	56
Department of Interior			
Bureau of Indian Affairs	61	61	61
Bureau of Land Management	291	291	291
Bureau of Reclamation	238	238	238
Fish and Wildlife Service	589	589	589
National Park Service	394	394	394
Office of Secretary			
National Business Center	3,569	3,569	3,569
Environmental Protection Agency	1,453	1,453	1,453
Federal Aviation Administration	15	15	15
Health and Human Services	95	95	95
National Aeronautics & Space Admin	8,157	8,157	8,157
National Science Foundation	241	241	241
Sale of maps, photos, reproductions, & digital products	546	546	546
Subtotal (Federal sources)	22,231	22,231	22,231
Total (reimbursements)	**23,168**	**23,168**	**23,168**
Total: Climate and Land Use Change	**158,156**	**155,670**	**172,249**

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Energy, Minerals, and Environmental Health			
Appropriated			
Multi-Year appropriation	88,907	91,675	99,073
No-Year appropriation	328	299	0
Total (appropriated)	**89,235**	**91,974**	**99,073**
Reimbursements			
Non-Federal (Domestic) sources			
Technology Transfer	807	807	807
Miscellaneous	657	657	657
Subtotal (non-Federal domestic sources)	1,464	1,464	1,464
Non-Federal (Foreign) sources			
Islamic Republic of Mauritania	289	289	289
Miscellaneous	163	163	163
Subtotal (non-Federal Foreign sources)	452	452	452
State and local sources			
States-Coop (matched - In-Kind Services) NON ADD	105	105	105
States-Coop (unmatched)	122	122	122
Subtotal (state and local sources)	122	122	122
Federal sources			
Central Intelligence Agency	957	957	957
Department of Agriculture	125	125	125
Department of Commerce	46	46	46
Department of Defense			
Corps of Engineers	185	185	185
National Geospatial-Intelligence Agency	229	229	229
Other	6,104	6,104	6,104
Department of Energy	25	25	25
Department of Interior			
Bureau of Indian Affairs	43	43	43
Bureau of Land Management	741	741	741
Bureau of Reclamation	93	93	93
Fish and Wildlife Service	633	633	633
National Park Service	20	20	20
Office of Secretary			
National Business Center	20	20	20
Department of State	451	451	451
Environmental Protection Agency	651	651	651
National Aeronautics & Space Admin	497	497	497
National Science Foundation	30	30	30
Subtotal (Federal sources)	10,850	10,850	10,850
Total (reimbursements)	**12,888**	**12,888**	**12,888**
Total: Energy, Minerals, and Environmental Health	**102,123**	**104,862**	**111,961**

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Natural Hazards			
Appropriated			
Multi-Year appropriation	123,866	128,831	128,339
No-Year appropriation	11	0	0
Total (appropriated)	**123,877**	**128,831**	**128,339**
Reimbursements			
Non-Federal (Domestic) sources			
Technology Transfer	1,561	1,561	1,561
Miscellaneous	2,437	2,437	2,437
Subtotal (non-Federal domestic sources)	3,998	3,998	3,998
Non-Federal (Foreign) sources			
Miscellaneous	202	202	202
Subtotal (non-Federal Foreign sources)	202	202	202
State and local sources			
States-Coop (matched - In-Kind Services) NON ADD	399	399	399
States-Coop (unmatched)	366	366	366
Subtotal (state and local sources)	366	366	366
Federal sources			
Agency for International Development	3,342	3,342	3,342
Department of Agriculture	14	14	14
Department of Commerce			
Nat'l Oceanic & Atmospheric Admin	117	117	117
Department of Defense			
Corps of Engineers	418	418	418
Other	1,839	1,839	1,839
Department of Energy	1,144	1,144	1,144
Department of Homeland Security	230	230	230
Department of Interior			
Bureau of Land Management	1,053	1,053	1,053
Bureau of Ocean Energy Management	209	209	209
Bureau of Reclamation	56	56	56
Fish and Wildlife Service	127	127	127
National Park Service	279	279	279
Department of State	326	326	326
Department of Veterans Affairs	577	577	577
Federal Aviation Administration	102	102	102
General Services Administration	19	19	19
National Aeronautics & Space Admin	7,447	7,447	7,447
National Science Foundation	53	53	53
Nuclear Regulatory Commission	646	646	646
Subtotal (Federal sources)	17,998	17,998	17,998
Total (reimbursements)	**22,564**	**22,564**	**22,564**
Total: Natural Hazards *	**146,441**	**151,395**	**150,903**

*This table does not include obligations for the Spectrum Relocation Fund, since it is a mandatory fund. MAX obligations do include the Spectrum Relocation Fund. The amounts included in MAX are: FY 2013 $560K; and FY 2014 $651K.

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Water Resources			
Appropriated			
Multi-Year appropriation	200,803	207,243	210,386
Total (appropriated)	**200,803**	**207,243**	**210,386**
Reimbursements			
Non-Federal (Domestic) sources			
Permittees & licensees- Fed Energy Regulatory Commission	5,701	5,701	5,701
Technology Transfer	1,948	1,948	1,948
Miscellaneous	4,096	4,096	4,096
Subtotal (non-Federal domestic sources)	11,745	11,745	11,745
Non-Federal (Foreign) sources			
National Drilling Company	673	673	673
Miscellaneous	110	110	110
Subtotal (non-Federal Foreign sources)	783	783	783
State and local sources			
States-Coop (matched)	59,474	59,474	59,561
States-Coop (matched - In-Kind Services) NON ADD	1,158	1,158	1,158
States-Coop (unmatched)	97,730	97,730	97,643
Subtotal (state and local sources)	157,204	157,204	157,204
Federal sources			
Agency for International Development	979	979	979
Department of Agriculture	1,293	1,293	1,293
Department of Commerce			
Nat'l Oceanic & Atmospheric Admin	1,363	1,363	1,363
Department of Defense			
Corps of Engineers	32,227	32,227	32,227
National Geospatial-Intelligence Agency	437	437	437
Other	5,908	5,908	5,908
Department of Energy			
Bonneville Power Administration	684	684	684
Other	5,530	5,530	5,530
Department of Homeland Security			
Federal Emergency Management Agency	4,157	4,157	4,157
Other	2,109	2,109	2,109
Department of Interior			
Bureau of Indian Affairs	237	237	237
Bureau of Land Management	3,677	3,677	3,677
Bureau of Reclamation	18,120	18,120	18,120
Fish and Wildlife Service	2,320	2,320	2,320
National Park Service	2,043	2,043	2,043
Office of Secretary			
National Business Center	206	206	206
Office of Surface Mining	27	27	27
Department of Justice	21	21	21
Department of State	1,574	1,574	1,574
Department of Transportation	196	196	196
Environmental Protection Agency	26,821	26,821	26,821
Health and Human Services	52	52	52
National Aeronautics & Space Admin	539	539	539
National Science Foundation	50	50	50
Nuclear Regulatory Commission	142	142	142
Tennessee Valley Authority	548	548	548
Miscellaneous	22	22	22
Subtotal (Federal sources)	111,282	111,282	111,282
Total (reimbursements)	**281,014**	**281,014**	**281,014**
Total: Water Resources	**481,817**	**488,257**	**491,400**

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Core Science Systems			
Appropriated			
Multi-Year appropriation	105,621	109,176	109,400
Total (appropriated)	**105,621**	**109,176**	**109,400**
Reimbursements			
Non-Federal (Domestic) sources			
Technology Transfer	7	7	7
Miscellaneous	244	244	244
Subtotal (non-Federal domestic sources)	251	251	251
State and local sources			
States-Coop (unmatched)	4,610	4,610	4,610
Subtotal (state and local sources)	4,610	4,610	4,610
Federal sources			
Department of Agriculture	3,655	3,655	3,655
Department of Commerce			
Nat'l Oceanic & Atmospheric Admin	39	39	39
Department of Defense			
National Geospatial-Intelligence Agency	2,788	2,788	2,788
Other	1,917	1,917	1,917
Department of Homeland Security			
Federal Emergency Management Agency	565	565	565
Other	62	62	62
Department of Interior			
Bureau of Indian Affairs	14	14	14
Bureau of Land Management	72	72	72
Bureau of Ocean Energy Management	63	63	63
Bureau of Reclamation	1,126	1,126	1,126
Fish and Wildlife Service	384	384	384
National Park Service	881	881	881
Office of Secretary			
National Business Center	9	9	9
Other	15	15	15
Department of Veterans Affairs	25	25	25
Environmental Protection Agency	120	120	120
National Aeronautics & Space Admin	340	340	340
National Science Foundation	943	943	943
Tennessee Valley Authority	40	40	40
Subtotal (Federal sources)	13,058	13,058	13,058
Total (reimbursements)	**17,919**	**17,919**	**17,919**
Total: Core Science Systems *	**123,540**	**127,095**	**127,319**

* This table does not include obligations from the unobligated balance transfer from USAID, which is included in MAX. The amount for FY 2013 is $400K.

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Administration and Enterprise Information			
Appropriated			
Multi-Year appropriation	106,837	111,449	108,267
Total (appropriated)	**106,837**	**111,449**	**108,267**
Reimbursements			
Non-Federal (Domestic) sources			
Map Receipts	1,597	1,597	1,597
Sale of photos, reproductions, and digital products	734	734	734
Technology Transfer	196	196	196
Subtotal (non-Federal domestic sources)	2,527	2,527	2,527
Federal sources			
Central Intelligence Agency	343	343	343
Department of Agriculture	9	9	9
Department of Defense	1,062	1,062	1,062
Department of Homeland Security			
Federal Emergency Management Agency	54	54	54
Other	4	4	4
Department of Interior			
Bureau of Indian Affairs	141	141	141
Bureau of Safety and Environmental Enforcement	78	78	78
Fish and Wildlife Service	251	251	251
Office of Secretary			
National Business Center	7,412	7,412	7,412
Other	551	551	551
Office of Surface Mining	3	3	3
Sale of maps, photos, reproductions, & digital products	990	990	990
Miscellaneous	46	46	46
Subtotal (Federal sources)	10,944	10,944	10,944
Total (reimbursements)	**13,471**	**13,471**	**13,471**
Total: Administration and Enterprise Information	**120,308**	**124,920**	**121,738**

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Facilities			
Appropriated			
Multi-Year appropriation	91,309	93,471	99,417
No-Year appropriation	8,957	8,578	7,280
Total (appropriated)	**100,266**	**102,049**	**106,697**
Reimbursements			
Federal sources			
Department of Defense	1,177	1,177	1,177
Subtotal (Federal sources)	1,177	1,177	1,177
Total (reimbursements)	**1,177**	**1,177**	**1,177**
Total: Facilities	**101,443**	**103,226**	**107,874**

SIR Summary:

Appropriated			
Multi-Year appropriation	947,249	974,752	1,012,651
No-Year appropriation	60,866	62,512	60,617
subtotal (appropriated)	1,008,115	1,037,264	1,073,268
Reimbursements			
Non-Federal Sources			
Map Receipts	1,597	1,597	1,597
Domestic	29,037	29,037	29,037
Foreign	1,805	1,805	1,805
State and local sources	164,624	164,624	164,624
Federal Sources	246,740	246,740	246,740
subtotal (reimbursements)	443,803	443,803	443,803
Total: SIR *	**1,451,918**	**1,481,067**	**1,517,071**

* This table does not include obligations for the Spectrum Relocation Fund, since it is a mandatory fund. MAX obligations do include the Spectrum Relocation Fund. The amounts included in MAX are: FY 2013 $560K; and FY 2014 $651K. This table also does not include obligations from the unobligated balance transfer from USAID, which is included in MAX. The amount for FY 2013 is $400K.

	2013 Actual	2014 Enacted	2015 Request
Surveys, Investigations, and Research (SIR)			
Contributed Funds:			
Permanent, indefinite appropriation:			
Ecosystems	367	367	367
Climate and Land Use Change	3	3	3
Energy, Minerals, and Environmental Health	24	24	24
Natural Hazards	81	53	53
Water Resources	159	37	37
Total: Contributed Funds	**634**	**484**	**484**
Operation and Maintenance of Quarters:			
Permanent, indefinite appropriation:			
Ecosystems	12	12	12
Natural Hazards	23	23	23
Total: Operation and Maintenance of Quarters	**35**	**35**	**35**
Working Capital Fund:			
National Water Quality Lab	14,215	14,620	14,948
Hydrologic Instrumentation Facility	21,017	19,147	19,307
Other	50,102	52,526	52,123
Total: Working Capital Fund	**85,334**	**86,293**	**86,378**
Allocations from other Federal Agencies: *			
Department of the Interior: Departmental Offices			
Hurricane Sandy Supplemental	18,825	22,400	0
Natural Resource Damage Assessment	6,941	2,117	2,000
Central Hazardous Materials Fund	167	100	100
Total: Allocations	**25,933**	**24,617**	**2,100**

* Allocations are shown in the year they are received, not when they are obligated.

United States Geological Survey

Trust Funds

CONTRIBUTED FUNDS

Special and Trust Fund Receipts

(Millions of Dollars)

Identification Code 14-8562-0-7-306		2013 Actual	2014 Enacted	2015 Estimate
01.00	Balance, start of year	0	0	0
	Receipts:			
02.20	Contributed Funds, Geological Survey	1	1	1
04.00	Total: Balances and collections	1	1	1
	Appropriations:			
05.00	Contributed Funds	-1	-1	-1
07.99	Balance, end of year	0	0	0

Program and Financing

(Millions of Dollars)

Identification Code 14-8562-0-7-306		2013 Actual	2014 Enacted	2015 Estimate
	Obligations by program activity:			
08.01	Donations and contributed funds	1	1	1
09.00	Total new obligations	1	1	1
	Budgetary resources:			
	Unobligated balance:			
10.00	Unobligated balance brought forward, Oct 1	1	1	1
	Budget authority:			
	Appropriation, mandatory:			
12.01	Appropriation (trust fund)	1	1	1
12.60	Appropriation, mandatory (total)	1	1	1
19.30	Total budgetary resources available	2	2	2
	Memorandum (non-add) entries:			
19.41	Unexpired unobligated balance, end of year	1	1	1

CONTRIBUTED FUNDS

Program and Financing cont'd

(Millions of Dollars)

Identification Code 14-8562-0-7-306		2013 Actual	2014 Enacted	2015 Estimate
	Change in obligated balance:			
30.10	Obligations incurred, unexpired accounts	1	1	1
30.20	Outlays (gross)	-1	-1	-1
	Obligated balances, end of year (net):			
	Budget authority and outlays, net:			
	Mandatory:			
40.90	Budget authority, gross	1	1	1
	Outlays, gross:			
41.00	Outlays from new mandatory authority	0	1	1
41.01	Outlays from mandatory balances	1	0	0
41.10	Outlays, gross (total)	1	1	1
41.80	Budget authority, net (total)	1	1	1
41.90	Outlays, net (total)	1	1	1

Object Classification

(Millions of Dollars)

Identification Code 14-8562-0-7-306		2013 Actual	2014 Enacted	2015 Estimate
	Direct obligations:			
99.5	Below reporting threshold	1	1	1
99.9	Total new obligations	1	1	1

Employment Summary

Identification Code 14-8562-0-7-306		2013 Actual	2014 Enacted	2015 Estimate
	Direct:			
1001	Civilian full-time equivalent employment	6	6	6

Employee Count by Grade

(Total Employment)

	2013 Actual	2014 Estimate	2015 Estimate
Executive Level V	0	1	1
SES	22	22	22
Subtotal	22	23	23
SL – 00	5	7	7
ST – 00	45	47	47
Subtotal	50	54	54
GS/GM – 15	531	533	531
GS/GM – 14	770	772	770
GS/GM – 13	1,245	1,248	1,246
GS – 12	1,558	1,562	1,559
GS – 11	1,282	1,285	1,283
GS – 10	18	18	18
GS – 9	945	948	947
GS – 8	226	227	226
GS – 7	653	655	653
GS – 6	205	206	205
GS – 5	357	358	357
GS – 4	189	190	189
GS – 3	143	143	143
GS – 2	73	73	73
GS – 1	28	28	28
Subtotal	8,223	8,246	8,228
Other Pay Schedule Systems	202	202	202
Total employment (actual/estimate)	8,497	8,525	8,507

Mandatory Budget and Offsetting Collection Proposals

The USGS does not have any legislative proposals in the 2015 President's budget that impact receipts or mandatory spending levels.

Section 404 Compliance

This section describes details related to any assessments to, or within the USGS to support bureauwide services and functions. Details regarding the USGS's payments to the Department of the Interior's Working Capital Fund, and payments to other Federal Agencies are included in the External Administrative Costs subsection. Additional information on internal assessments and cost allocation methodologies can be found in the Bureau Administrative Costs subsection.

	2015 Estimate ($000)
External Administrative Costs	
The Department of the Interior's Working Capital Fund	
WCF Centralized Billings	$16,810
WCF Direct Billings	$10,912
Payments to Other Federal Agencies	
Worker's Compensation Payments	$2,361
Unemployment Compensation Payments	$641
GSA Rental Payments	$83,704
Bureau Administrative Costs	
Shared Program Costs	$9,709
Internal Bureau Overhead	$39,500

External Administrative Costs

The Department of the Interior's Working Capital Fund

The Department's Working Capital Fund was established pursuant to 43 U.S.C. 1467, to provide common administrative and support services efficiently and economically at cost. The Fund is a revolving fund, whereby capital is expended to provide services for customers who pay for the services. Customers consist of the Department's bureaus and offices, as well as other Federal agencies. Through the use of centrally provided services, the Department standardized key administrative areas such as commonly used administrative systems, support services for those located in and around the Main and South Interior building complex, and centrally managed departmental operations that are beneficial to the bureaus and offices.

Centralized billing is used whenever the product or service being provided is not severable or it is inefficient to bill for the exact amount of product or service being procured. Customers are billed each year using a pre-established basis that is adjusted annually to reflect change over time. The following table provides the actual centralized billing to the USGS for 2013 and estimates for 2014 and 2015.

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
OS Shared Services				
FBMS Infrastructure Hosting & Support	0.0	0.0	0.0	1,124.9
FBMS Hosting / Applications Management	0.0	0.0	244.2	0.0
FBMS Master Data Systems & Hosting	140.8	120.8	0.0	0.0
FBMS Master Data Systems & Hosting	0.0	0.0	120.8	0.0
FBMS Redirect - IDEAS	0.0	0.0	356.4	0.0
FBMS Redirect - FFS	0.0	0.0	1,354.6	0.0
FBMS Master Data Management	0.0	0.0	0.0	172.2
FBMS Business Integration Office	140.8	120.8	2,076.0	1,297.1
Mail and Messenger Services	16.7	6.5	5.8	0.9
Health Unit	1.3	1.0	0.0	0.0
Special Events Services	6.6	6.3	0.0	0.0
Safety, Environmental, and Health Services	2.1	1.6	3.1	0.5
Shipping/Receiving & Moving Services	1.5	1.1	1.8	0.3
Personal Property Accountability Services (formally Property)	2.8	2.1	2.6	0.4
Family Support Room	0.1	0.1	0.0	0.0
Interior Complex Management & Svcs	3.9	2.9	2.7	0.4
Departmental Library	335.5	8.3	8.4	8.5
Mail Policy	41.9	40.7	36.1	37.2
Moving Services	1.1	0.8	0.0	0.0
Conference and Special Events Services (formally Audio Visual)	5.5	4.3	4.4	0.7
Space Management Services	1.4	1.1	1.5	0.2
Office of Facilities & Administrative Services	420.3	76.8	66.4	49.2
Aviation Management	267.2	529.9	512.8	430.3
Office of Aviation Services	267.2	529.9	512.8	430.3
Subtotal OS Shared Services	828.3	727.6	2,655.3	1,776.6

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
OS Activities				
Alaska Affairs Office	12.7	15.0	10.8	10.8
Alaska Resources Library and Information Services	157.8	167.9	167.9	167.9
Departmental Museum	151.7	144.7	125.8	128.1
Secretary's Immediate Office	322.3	327.6	304.5	306.8
Document Management Unit	26.7	15.1	17.9	0.0
FOIA Tracking & Reporting System	21.0	35.2	31.2	42.8
Office of the Executive Secretariat	47.7	50.3	49.2	42.8
Departmental News and Information	89.7	87.1	106.4	108.4
Photographic Services	0.0	0.0	0.0	0.0
Office of Communications	89.7	87.1	106.4	108.4
Leadership Development Programs	86.6	90.9	109.5	111.9
Dept-Wide Training Programs (including Online Learning)	245.9	241.5	308.3	297.9
Learning & Performance Center Management	103.4	103.4	51.7	78.3
DOIU Management	82.0	92.3	77.4	78.9
DOI University	517.9	528.1	546.9	567.0
Asbestos-Related Cleanup Cost Liabilities	0.2	0.2	0.2	0.0
FedCenter	2.1	2.2	1.9	1.9
Compliance Support ESF-11/ESF-11 Website	2.3	2.3	2.3	2.3
Office of Environmental Policy and Compliance	4.5	4.7	4.4	4.3
Invasive Species Council	206.0	216.4	210.7	211.4
Invasive Species Coordinator	38.3	40.0	38.6	38.8
Office of Policy Analysis	244.4	256.5	249.3	250.2
CPIC	24.6	28.7	31.0	28.5
Office of Budget	24.6	28.7	31.0	28.5
Consolidated Financial Statement, Internal Controls & Performance	95.5	97.6	83.7	59.5
Travel Management Center	27.3	26.4	31.0	31.5
e-Travel	429.6	267.9	267.8	181.7
Office of Financial Management	552.3	391.8	382.5	272.7
Interior Collections Management System	2.1	2.1	2.1	2.1
Space Management Initiative	35.7	41.2	41.6	42.5
Renewable Energy Certificates	3.0	3.3	3.0	2.9
Facility Maintenance Management System	4.5	4.5	4.6	4.6
Interior Asset Disposal System O&M	0.0	0.0	0.0	5.1
Office of Property and Acquisition Management	45.3	51.1	51.3	57.0
Planning and Performance Management	135.3	135.5	137.9	140.7
Office of Planning and Performance Management	135.3	135.5	137.9	140.7
Department-wide Worker's Compensation Program	29.4	28.0	31.9	32.0
OPM Federal Employment Services	53.7	53.2	46.8	46.4

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
OS Activities				
Accessibility and Special Hiring Programs (Formerly ATC)	35.0	40.1	72.4	73.8
Human Resources Accountability Team	69.1	60.5	74.2	78.3
Employee and Labor Relations Tracking System	3.3	3.4	3.9	3.9
Veterans Disabilities Hiring Programs	0.0	27.3	0.0	0.0
Consolidated Employee Assistance Program	0.0	0.0	0.0	92.3
Office of Human Resources	190.6	212.5	229.2	326.8
EEO Complaints Tracking System	1.7	1.6	1.7	4.5
Special Emphasis Program	5.4	5.2	4.7	4.8
Office of Civil Rights	7.1	6.8	6.4	9.3
Occupational Safety and Health	188.9	191.3	177.9	181.3
Safety Management Information System	145.4	138.5	142.8	145.4
Office of Occupational Health and Safety	334.3	329.8	320.7	326.7
Security (Classified Information Facility)	55.1	66.5	57.2	58.3
Law Enforcement Coordination and Training	100.7	99.6	76.7	78.3
Security (MIB/SIB Complex)	30.0	23.8	22.2	3.6
Victim Witness Coordinator	19.8	20.7	21.7	22.2
Office of Law Enforcement and Security	205.6	210.6	177.8	162.3
Interior Operations Center	244.5	242.9	249.4	261.5
Emergency Preparedness (COOP)	92.3	114.8	125.5	127.6
Emergency Response	128.5	173.3	123.6	126.1
MIB Emergency Health and Safety	0.6	0.5	0.5	0.1
Federal Executive Board	33.8	34.6	30.9	31.5
Office of Emergency Management	499.7	566.0	529.9	546.8
Alternative Dispute Resolution (ADR) Training	5.9	5.9	5.9	6.0
Collaborative Action and Dispute Resolution	5.9	5.9	5.9	6.0
Conservation and Educational Partnerships	28.8	29.6	35.5	36.2
Office of Human Resources	28.8	29.6	35.5	36.2
Contingency Reserve	17.6	17.7	0.0	0.0
Cooperative Ecosystem Study Units	56.9	51.4	51.4	51.4
CFO Financial Statement Audit	552.5	546.0	545.9	728.4
Glen Canyon Adaptive Management	123.8	130.4	130.4	130.4
Department-wide Activities	750.7	745.5	727.7	910.2
Ethics	66.0	61.9	61.9	62.9
FOIA Appeals	11.4	26.0	26.0	26.0
Office of the Solicitor	77.4	87.9	87.8	88.9
Subtotal OS Activities	4,084.1	4,056.1	3,984.3	4,191.6

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
IT Shared Services				
Enterprise Directory Services (formerly Active Directory)	356.2	362.7	362.7	360.8
IT Asset Management	96.5	107.0	107.0	154.5
OCIO End User Services	450.4	472.7	472.7	461.5
IT Transformation Planning (ITT)	0.0	477.5	477.5	832.0
Office of the Chief Information Officer	0.0	477.5	477.5	832.0
IOS Collaboration	94.2	110.0	110.0	100.7
Unified Messaging	180.0	116.0	116.0	113.3
OCIO End User Services	276.5	223.0	223.0	267.8
Identity Credential Access Mgmt (formerly DOI Access & Personnel)	130.1	144.3	144.3	132.0
Threat Management	358.2	364.1	364.1	522.1
Enterprise Continuous Diagnostics and Monitoring	0.0	0.0	0.0	124.2
Enterprise Security Information and Event Management Solution (SIEM)	0.0	0.0	0.0	268.7
OCIO Information Assurance Services	488.2	508.3	508.3	1,047.1
Hosting Services (formerly Hosting/Cloud Services)	0.0	37.5	37.5	63.9
OCIO Hosting Services	0.0	37.5	37.5	63.9
Electronic Records Management	126.2	217.6	217.6	311.2
Architecture & IT Portfolio Performance Mgmt (formerly Enterprise)	356.6	395.6	395.6	451.5
Independent Verification and Validation - Risk Mgmt (formerly IT)	214.2	240.7	240.7	259.6
IT Budget Formulation & Portfolio Dev. (formerly Capital)	260.1	295.5	295.5	337.2
Privacy and Civil Liberties	46.3	93.7	93.7	101.1
IT Security - Information Assurance Division	118.6	138.5	0.0	0.0
Information Management Assurance Division Leadership	0.0	0.0	76.6	87.4
Assessment & Authorization Services	0.0	0.0	26.1	29.8
IT Security	0.0	0.0	35.8	38.7
OCIO Policy, Planning, and Compliance	1,122.0	1,381.5	1,381.5	1,616.5
Solutions, Design and Innovation (SDI) (formerly Web &)	50.0	48.6	48.6	49.4
OCIO Solutions, Design, and Innovation	50.0	48.6	48.6	49.4
Enterprise Services Network	2,495.5	2,579.0	2,579.0	1,054.2
Frequency Management Support	84.6	79.5	79.5	86.2
NTIA Spectrum Management	169.3	146.8	146.8	135.7
Radio Program Management Office	90.3	84.5	84.5	81.4
Federal Relay Service	6.3	6.0	6.0	7.1
Enterprise Services Network - Central Bill Pass Thrus	0.0	0.0	0.0	1,567.2
OCIO Telecommunications Services	2,846.1	2,895.9	2,895.9	2,931.8
Enterprise Resource Management	125.5	201.3	201.3	184.2
OCIO Office of Business Services	125.5	201.3	201.3	184.2
ITD ISSO Information Assurance Operations	0.0	373.8	373.8	373.8
ITD MIB Data Networking	0.0	1.6	1.6	1.6

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
IT Shared Services				
ITD PPCD Privacy Records	0.0	8.1	8.1	8.1
ITD Telecommunication Services	0.0	3.7	3.7	3.7
ITD Integrated Digital Voice Communications System	0.0	2.7	2.7	2.7
ITD Desktop Services	0.0	17.1	17.2	0.0
FBMS Help Desk – Customer Support Center	0.0	451.0	451.1	0.0
OCIO Former ITD/CSC Activities	0.0	858.0	858.2	389.9
e-Government Initiatives (WCF Contributions Only)	485.9	364.4	364.4	457.8
Volunteer.gov	15.1	15.1	15.1	15.1
OCIO e-Government Initiatives	500.9	379.5	379.5	472.9
Subtotal IT Shared Services	5,859.6	7,483.9	7,484.2	8,316.8

Working Capital Fund Revenue
Centralized Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
Interior Business Center				
IBC IT Security Improvement Plan	373.3	0.0	0.0	0.0
MIB Data Networking	2.0	0.0	0.0	0.0
Information Mgmt. - Records Management	8.1	0.0	0.0	0.0
Telecommunication Services	4.6	0.0	0.0	0.0
Integrated Digital Voice Communications System	2.7	0.0	0.0	0.0
Desktop Services	17.0	0.0	0.0	0.0
IBC Capital Planning	0.0	0.0	0.0	0.0
IBC Information Technology Directorate	407.7	0.0	0.0	0.0
FPPS/Employee Express - O&M	2,228.9	2,228.9	2,185.9	2,167.9
Drug Testing	10.7	6.5	8.5	8.5
IBC Human Resources Directorate	2,239.6	2,235.4	2,194.3	2,176.4
Financial Systems	1,632.0	653.2	553.6	0.0
IDEAS	75.3	31.2	26.8	0.0
Quarters Program	1.0	1.3	1.3	1.3
FBMS Master Data Management	143.2	170.3	170.3	0.0
Consolidated Financial Statement System	174.6	138.7	138.7	0.0
IBC Financial Management Directorate	2,026.1	994.7	890.7	1.3
FBMS Hosting / Applications Management	230.7	244.2	0.0	0.0
FBMS Redirect - FFS	491.3	1,354.2	0.0	0.0
FBMS Redirect - IDEAS	312.4	356.5	0.0	0.0
FBMS Help Desk - IBC Customer Support Center	429.8	0.0	0.0	0.0
FBMS Legacy System Redirect	1,464.3	1,954.3	0.0	0.0
Boise Acquisition Office	48.5	121.2	137.0	139.0
IBC Acquisitions Services Directorate	48.5	121.2	137.0	139.0
Subtotal Interior Business Center	6,186.2	5,306.1	3,222.0	2,316.7
TOTAL	16,958.2	17,573.7	17,345.7	16,601.7

Direct billing is used whenever the product or service provided is again severable, but is sold through a time and materials reimbursable support agreement or similar contractual arrangement. The following tables provide the actual direct and reimbursable collections from the USGS for 2013, and estimated billings and collections for 2014 and 2015.

Working Capital Fund Revenue
Direct Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
OS Shared Services				
Creative Communications	5.9	9.7	5.9	6.0
Administrative Operations	0.0	0.0	0.0	0.0
Ofc of Facilities & Admin Services	5.9	9.7	5.9	6.0
FBMS Change Orders	180.0	180.0	180.0	0.0
FBMS Business Integration Office	180.0	180.0	180.0	0.0
Subtotal OS Shared Services	185.9	189.8	185.9	6.0

Working Capital Fund Revenue
Direct Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
OS Activities				
Albuquerque Learning & Performance Center	8.8	8.8	8.8	8.6
Denver Learning & Performance Center	20.2	20.2	20.2	19.8
Online Learning	57.5	57.5	57.5	57.5
Washington Leadership & Performance Center	33.6	33.6	33.6	32.9
e-OPF	158.5	157.9	157.9	157.9
Federal Consulting Group	0.0	0.0	0.0	0.0
DOI University	278.6	278.0	278.0	276.8
Ocean Coastal Great Lakes Activities	52.5	52.5	40.0	40.0
Office of Policy Analysis	52.5	52.5	40.0	40.0
Single Audit Clearinghouse	0.2	0.2	1.5	1.5
Office of Financial Management	0.2	0.2	1.5	1.5
Equal Employment Opportunity (EEO) Investigations	3.0	0.0	3.0	3.0
EAP Consolidation	89.1	0.0	109.6	0.0
Worker's Comp Nurse Case Management	0.0	0.0	15.9	15.8
Office of Human Resources	92.2	0.0	128.6	18.8
Imagery for the Nation (IFTN)	950.1	950.1	950.1	950.1
Policy, Management and Budget	950.1	950.1	950.1	950.1
Federal Flexible Savings Account (FSA) Program	159.9	159.9	159.9	159.9
Department-wide Programs	159.9	159.9	159.9	159.9
Subtotal OS Activities	1,533.5	1,440.8	1,558.1	1,447.0

Working Capital Fund Revenue
Direct Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
IT Shared Services				
Architecture & IT Portfolio Performance Management (aka Enterprise)	1,042.8	0.0	0.0	0.0
OCIO Policy, Planning, and Compliance	1,042.8	0.0	0.0	0.0
Unified Messaging	1,319.6	1,869.1	1,630.3	1,630.3
Enterprise Directory Services (formerly Active Directory)	0.0	0.0	0.0	0.0
OCIO End User Services	1,319.6	1,869.1	1,630.3	1,630.3
Anti-Virus Software Licenses	299.6	308.0	308.0	308.0
ICAM (aka INFO ASSURANCE - DOI Access)	1,006.9	984.0	964.8	882.8
Data at Rest Initiative	13.3	16.9	16.9	16.9
OCIO Information Assurance Services	1,319.8	1,308.9	1,289.7	1,207.6
Hosting Services (aka HOSTING - Hosting/Cloud Services)	0.0	69.6	87.6	90.5
OCIO Hosting Services	0.0	69.6	87.6	90.5
Enterprise Services Network	2,581.9	0.0	4,141.7	4,141.7
EID Office Space	0.0	0.0	2.7	2.7
EID Rack Space	0.0	5.4	2.6	2.6
OCIO Telecommunications Services	2,581.9	5.4	4,147.1	4,147.1
ESRI Enterprise Licenses	1,098.6	0.0	894.5	1,119.4
Office of the Chief Information Officer	1,098.6	0.0	894.5	1,119.4
ITD Enterprise Technology Division	0.0	20.7	20.7	0.0
ITD ISSO Hosting Services	0.0	419.1	419.1	331.7
FBMS Help Desk - Customer Support Center	0.0	0.0	0.0	0.0
Office of the Chief Information Officer	0.0	439.7	439.7	331.7
Subtotal IT Shared Services	7,362.8	3,692.7	8,488.8	8,526.6

Working Capital Fund Revenue
Direct Billing
Geological Survey
($ in thousands)

Activity/Office	2013 Revised	2014 Pres Budget	2014 Revised	2015 Estimate
Interior Business Center				
Enterprise Technology Division	20.7	0.0	0.0	0.0
Enterprise Infrastructure Division	411.2	0.0	0.0	0.0
Denver Phone System	0.0	0.0	0.0	0.0
IBC Information Technology Directorate	431.9	0.0	0.0	0.0
Payroll & HR Systems	896.1	760.8	916.7	933.0
IBC Human Resources Directorate	896.1	760.8	916.7	933.0
Subtotal Interior Business Center	1,328.0	760.8	916.7	933.0
TOTAL	10,410.2	6,084.1	11,149.5	10,912.6

Payments to Other Federal Agencies

	2013 Actual	2014 Change	2015 Change
Worker's Compensation Payments	2,945	-241	-343
The adjustment is for the change in costs of compensating injured employees and dependents of employees who suffer accidental deaths while on duty. Costs for the BY will reimburse the Department of Labor, Federal Employees Compensation Fund, pursuant to 5 U.S.C. 8147(b) as amended by Public Law 94-273.			
Unemployment Compensation Payments	621	11	9
The adjustment is for projected changes in the costs of unemployment compensation claims to be paid to the Department of Labor, Federal Employees Compensation Account, in the Unemployment Trust Fund, pursuant to Public Law 96-499.			
GSA Rental Payments	87,069	-4,218	853
The adjustment is for changes in the costs payable to General Services Administration (GSA) and others resulting from changes in rates for office and non-office space estimated by GSA, as well as the rental costs of other currently occupied space. These costs include building security, the case of GSA space, these are paid to DHS. Costs of mandatory office relocations, i.e., relocations in cases where due to external events there is no alternative but to vacate the currently occupied space, are also included.			

* 2015 Change in Rental Payment was calculated using initial 2014 Rental amounts in the June 2012 Exhibit 54. This number is continually updated; above figures may not reflect the most up-to-date estimates, and may be understated.

Bureau Administrative Costs

Shared Program Costs

The USGS maintains less than one percent of its appropriation for other bureauwide support and science-related activities. These funds are used for initiatives, which may be unfunded mandates, are crosscutting in nature, or respond to new and emerging scientific issues.

The funding for the initiatives in the Shared Program Costs are assessed at the budget activity level, based upon one of two methodologies: proportionately, based on total appropriated funds for the mission area; or proportionately, based on total funds for the mission area, including reimbursable funding sources, and are distributed to the initiatives efficiently. The methodology used is tied to the nature of the initiative. For instance, an initiative that is crosscutting to all the mission areas, but is purely an Interior priority (one in which an external partner is not a stakeholder, nor receives direct benefit of the service) would receive its funding based upon a calculation on appropriated funds only. Conversely, an initiative where all customers of the USGS either directly or indirectly receive benefit, such as the aforementioned information technology compliance and security upgrades, would be calculated to each of the mission areas based upon all funding sources, both appropriated and reimbursable. The initiatives on the Shared Program Cost Chart are vetted each year with the Executive Leadership Team of the USGS, and are decided upon in a voting process to ensure bureauwide concurrence.

The following initiatives are currently planned for the USGS's 2015 Shared Program Costs:

2015 Shared Program Cost Chart							
Mission Area	Ecosystems	Climate & Land Use Change	Energy, Minerals & Environmental Health	Natural Hazards	Water Resources	Core Science Systems	**TOTAL**
CALFED**	123,257	106,451	73,816	103,637	167,193	87,764	**662,118**
Grand Canyon Monitoring**	187,528	161,959	112,306	157,677	254,374	133,527	**1,007,371**
Regional Science**	484,909	418,791	290,401	407,719	657,756	345,273	**2,604,849**
John Wesley Powell Center**	87,580	75,638	52,450	73,639	118,798	62,360	**470,465**
International Program**	300,422	259,459	179,916	252,599	407,508	213,911	**1,613,815**
IT Transformation*	604,313	410,298	282,836	421,757	1,293,558	337,983	**3,350,745**
Total Program Costs	**1,788,009**	**1,432,596**	**991,725**	**1,417,028**	**2,899,187**	**1,180,818**	**9,709,363**

* Proportionally spread by total funds
** Proportionally spread by appropriated funds

CALFED – The California Bay-Delta is recognized as one of the world's threatened treasures of biodiversity, which supports unique native species and their critical tidal habitats. The USGS participates in the CALFED Federal-State partnership, which coordinates the efforts of 25 State and Federal agencies to improve the quality and reliability of California's water supplies while restoring the Bay-Delta ecosystem. USGS science contributes to restoration challenges such as water supply reliability, water quality, sustainability of native species, and flood risk.

Grand Canyon Monitoring – The USGS's Grand Canyon Monitoring and Research Center (GCMRC) is the science provider for the Glen Canyon Dam Adaptive Management Program. In this role, the research center provides the public and decisionmakers with relevant scientific information about the status and trends of natural, cultural, and recreational resources found in those portions of Grand Canyon National Park and Glen Canyon National Recreation Area affected by Glen Canyon Dam operations.

Regional Science – The implementation of the USGS Science Strategy calls for the integration of the full breadth and depth of USGS capabilities; building on existing strengths and partnerships. To that end, many of the USGS's historical "single-discipline" science centers are now reflections of this science strategy, and perform research and conduct science across many USGS mission areas, and need to respond quickly to new and emerging science issues. This funding brings scientists together to work across teams and across regions, to respond to the Nation's highest and changing priorities, respond to global trends, and conduct the best possible science.

John Wesley Powell Center – The John Wesley Powell Center for Analysis and Synthesis serves as a catalyst for innovative thinking in Earth system science research. Initiated as one means of implementing the USGS Science Strategy, the Powell Center supports scientist-driven interdisciplinary analysis and synthesis of complex natural science problems. USGS scientists are encouraged to propose working

groups reflecting a mix of USGS scientists and their colleagues from government and academia focused on major earth science issues. The Powell Center work generates cutting-edge, high-visibility publications.

International Programs – The Office of International Programs is dedicated to high quality, timely, scientific study that is international in scope and that focuses on the USGS Science Strategy's themes. As one of the world's premier science agencies, the USGS has long recognized the mutual benefits resulting from interaction with scientific partners abroad and extending research and investigations to other countries. By providing reliable scientific information about the Earth and its resources from an international perspective, the USGS Office of International Programs supports U.S. foreign policy and national security; provides a basis for science diplomacy, and improves the scientific basis for managing ecosystems and natural resources.

DOI IT Transformation – This funding will be used to support Interior's efforts in IT Transformation. These funds will support the Department's activities related to data center consolidation, single-source messaging, and cloud-based electronic forms, records, documents and content management solutions.

Internal Bureau Overhead Cost Allocation Methodology

The USGS manages overhead costs at two levels—the bureau and science center. Bureau level costs include headquarters and area executive, managerial, supervisory, administrative, and financial functions and bureauwide systems. At the bureau level, funding appropriated to the Administration and Enterprise Information budget activity pays the bureauwide overhead costs in the same proportion as appropriated funding is to total funding. For this reason, bureauwide overhead costs collected on reimbursable support agreements are deposited within Administration and Enterprise Information program areas, as well.

The USGS assesses a bureau overhead rate, estimated to remain at 12 percent, on reimbursable work from non-Interior customers to recoup their share of bureau-level costs. In some cases, the USGS assesses a special or reduced rate when it can be demonstrated that indirect costs are substantially and consistently less than the norm and the amount collected covers the full costs, such as with pass-through funding where the Survey does not perform any of the actual work. The following table shows the funding available to the Administrative and Enterprise Information program, including the anticipated overhead collections to pay for bureauwide costs.

(Dollars in Thousands)

Source of Funding	2015 Budget Request	2015 Estimated Bureau Overhead Distribution	2015 Estimated Total
Science Support			
Administration and Management	86,685	30,810	117,495
Information Services	21,219	8,692	29.911
Total Funding	**107,904**	**39,500**	**147,404**

At the science center level, because there generally is not an appropriated funding source to pay the local overhead (common services) costs, both the appropriated and reimbursable funding are assessed a percentage to cover their share of science center-level costs. Science center common services costs include center costs that are not directly attributable to a specific activity or project, such as managerial, supervisory, administrative, and financial functions and related systems, as well as costs incidental to providing services and products, such as postage, training, miscellaneous supplies and materials. The cost during 2013, for the local overhead, totaled $181 million from both appropriated and reimbursable funds.

In recognition of the USGS role as the science bureau for the Department of the Interior, the USGS is continuing to give Interior bureaus and offices a "preferred" customer rate on overhead charges for a significant portion of reimbursable work, to the extent that matching funds are available within the USGS budget. The maximum rate that cost centers may charge other Interior bureaus for common services and bureau costs combined remains 15 percent net. In 2015, of the 15 percent, 7.5 percent is applied to bureau costs, and the remaining 7.5 percent is applied to common services costs. Cost centers must fund the common services costs not recovered (e.g., the difference between the cost center's standard common services costs and the 7.5 percent) from USGS appropriated funds. In this way, the USGS is partnering on the science needs of Interior from both the bureau and cost centers.

The Chief Financial Officer establishes the USGS bureau special rate for each fiscal year. The special rate for 2015 is estimated to remain at three percent. Cost centers do not charge more than the bureau special rate for facilities-related costs or their standard common services rate when funding is approved for a bureau-level special rate. Special rates are applied under the following circumstances:

- When the USGS receives funds from a non-USGS organization and awards a grant to a third-party entity.
- When the USGS receives funds from one or more non-USGS organizations to support, under USGS leadership, a strategic science objective that includes the USGS passing through funds to one or more third-party entities.
- When the USGS receives funds from a non-USGS organization for the purpose of the customer acquiring services through the Cartographic Services or the Remotely Sensed Data Contracts. The special rate helps encourage other Federal agencies to use these contracts for cartographic services and remotely sensed data, rather than establishing and managing their own contracts, and ensures greater data consistency through the use of common service providers.
- When the USGS receives funds from a non-USGS organization for the purpose of passing through the customer's funds to State and local governments for the direct purchase of geospatial data.
- Biology Cooperative Research Units (CRUs) are supported by a three-way partnership including the USGS, a State, and a university. The academic institutions where CRUs are co-located provide significant administrative support. In recognition of the direct services support received from the non-USGS partners, CRUs only recover one-half of the bureau rate (six percent) normally recovered from reimbursable customers or partners.