Invasion Impacts and Innovation in the North American Great Lakes

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Vision + Science + Technology = Solutions
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We can do this . . .
Invasive species

Problem:
Harm > Benefit

We can do this . . .
Small beginnings… great impact

We can do this . . .
Nonindigenous species in aquatic ecosystems

Cumulative number of species discovered

San Francisco Bay
Great Lakes
Baltic Sea

Annual cost of GL ship-borne invasions: $100-800M

(Cohen & Carlton, Ricciardi, Baltic Biologists)

We can do this . . .
Dreissenid mussels

We can do this . . .

photo: M. McCormick, NOAA
photo: Kim Martin, USFWS
photo: TownePost Network

1986
arrive from Eurasia
USGS data
We can do this . . .

Dreissenid mussels
Asian carps: imminent threat to Great Lakes . . .

We can do this . . .

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Aggregate costs of invasive species

- **Annual damages ($B 2015)**: US $146; Canada $31; Sweden $1; EU $19; China $14; SE Asia $34
- **Challenges**: exponential increase, apparently irreversible
- **Typical policy approach**: external costs not internalized; suffer, react, adapt;
- **Solutions**: innovative policy, science, technology
Risk-based management is common, effective, and cost effective

- Pharmaceutical safety
- Food safety
- Infectious disease

We can do this . . .
Lessons from invasive pathogen: SARS
Invasive species solutions

Problem:
Harm > Benefit

Solution:
Improve policy, use recent science and technology to improve:

- Prevention via species profiling
- Surveillance programs
- Eradication of new invasions
- Slowed invasion spread
- Control of populations

Lodge et al. 2016.
Annual Rev. Environment & Resources:

We can do this . . .
Prevention: Species profiling

Statistical modeling

Distinguish harmful from benign

Royal Plec
_Panaque nigrolineatus_

Oscar
_Astronotus ocellatus_

Silver Arowana
_Osteoglossum bicirrhosum_

Red Bellied Piranha
_Pyrhocentrus nattereri_

Zebra Tilapia
_Tilapia buttikoferi_

Arctic Grayling
_Thymallus arcticus_

Siamese Fighting Fish
_Betta splendens_

Red Shiner
_Cyprinella lutrensis_

Westslope Cutthroat Trout
_Oncorhynchus clarkii_

Florida Gar
_Lepisosteus platyrhincus_

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Surveillance: eDNA

- create a baseline for species occurrence
- monitoring imperiled species
- surveillance for invasions

- greater geographic coverage
- less time
- extract increasing information from eDNA

We can do this . . .
Eradication (not just for islands)

- Rat Island, AK
- Feral Pig, Santa Cruz Island, CA
- Caulerpa, Port-Cros Marine Park, France
- Black Striped Mussel, Darwin, Australia
- Giant African Land Snail, Miami, FL
- Pampas grass, New Zealand
- White-spotted tussock moth, New Zealand
- Witchweed, Carolinas, USA
- Feral Cat, Ascension Island
- Karroo Thorn, Western Australia
- Anopheles gambiae, Brazil
- Sandspur, Laysan

Photo: cdc.gov
Photo: C O'Neal
Photo: D Nickrent
Photo: M Newton
Photo: NT, AUS

We can do this . . .
Slow the spread

Inspection and boat washing stations

Ballast water treatment system

Electric barriers to fish invasion

We can do this . . .
Control

We can do this . . .
Invasive species solutions

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Making solutions sustainable by monetizing net benefits:
The net economic benefits delivered by solutions = business opportunity

We can do this . . .