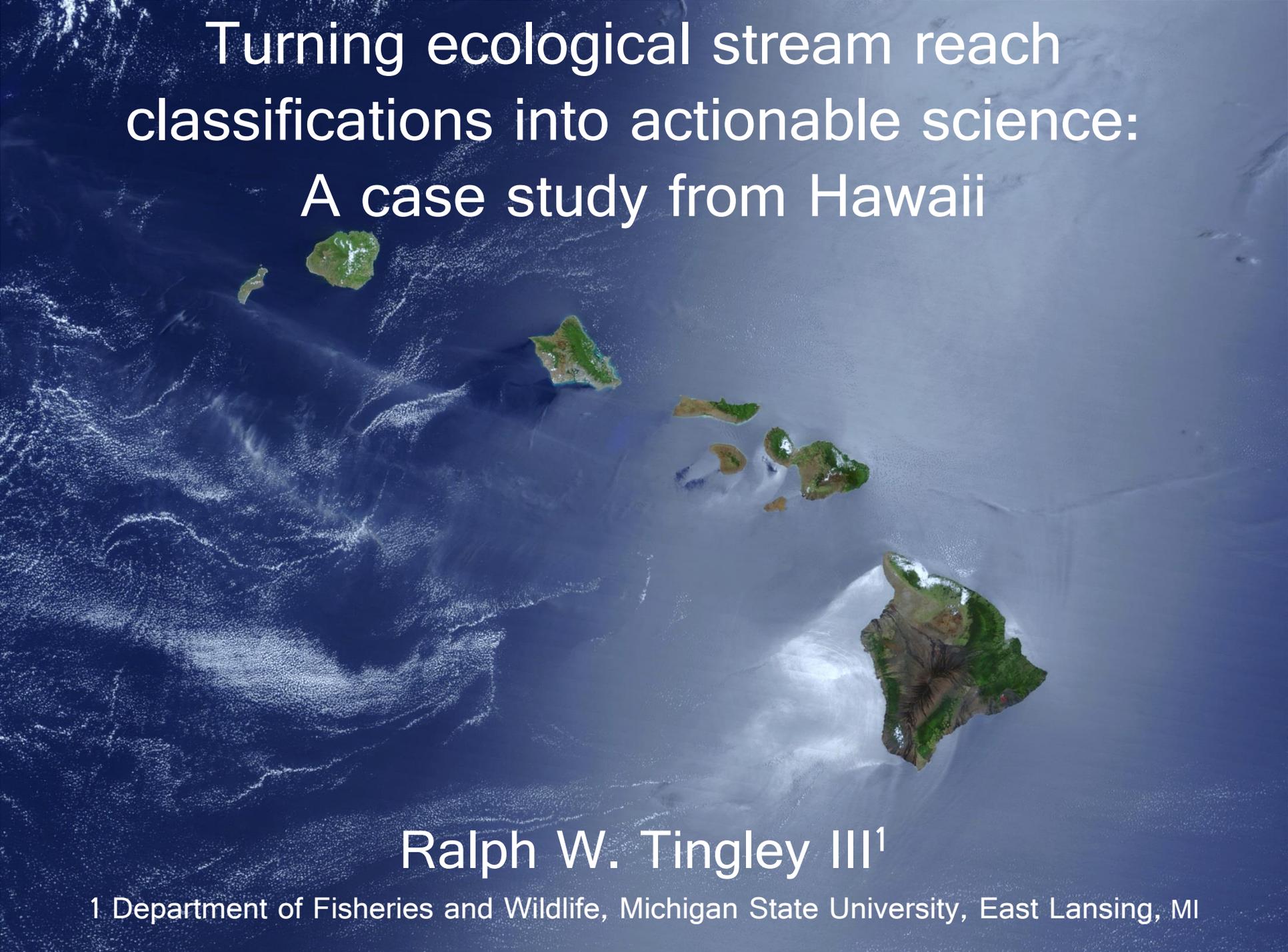


# Turning ecological stream reach classifications into actionable science: A case study from Hawaii



Ralph W. Tingley III<sup>1</sup>

<sup>1</sup> Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI

# Outline

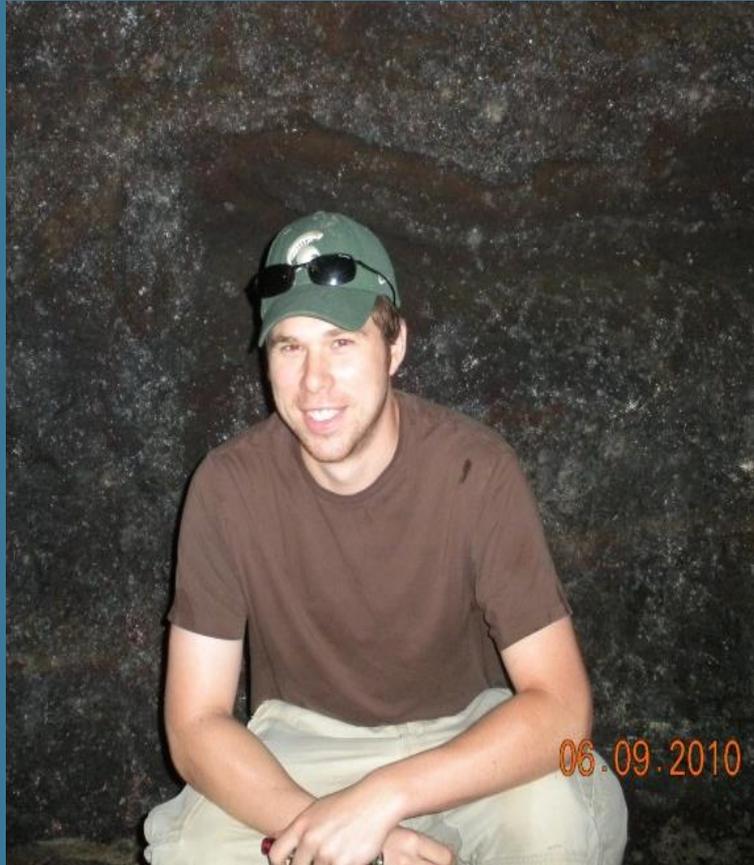
1. The USGS National Climate Change and Wildlife Science Center Science to Action Fellowship
  - My fellowship goal
2. The Hawaii stream reach classification
  - Methods and results
  - Implementation of results
3. Products
  - Product development; anticipated use

# The USGS National Climate Change and Wildlife Science Center (NCCWSC) Science to Action Fellowship

- Expose students to NCCWSC
- Pair student with an agency mentor
  - Dr. Shawn Carter
- Enhance student research by supporting development of products or tools useful for management and decision-making



# 2015 USGS NCCWSC Science to Action Fellows



Ralph Tingley  
tingleyr@msu.edu

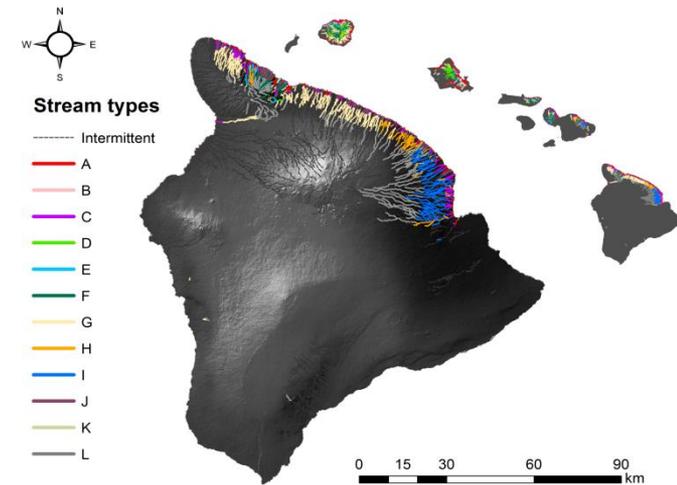
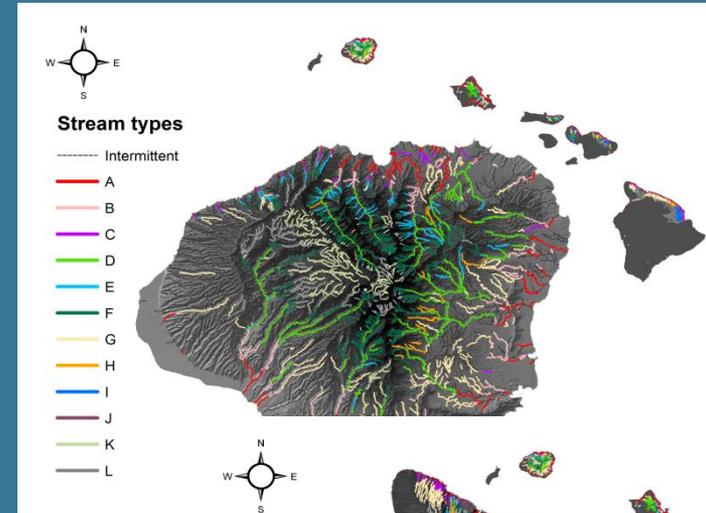
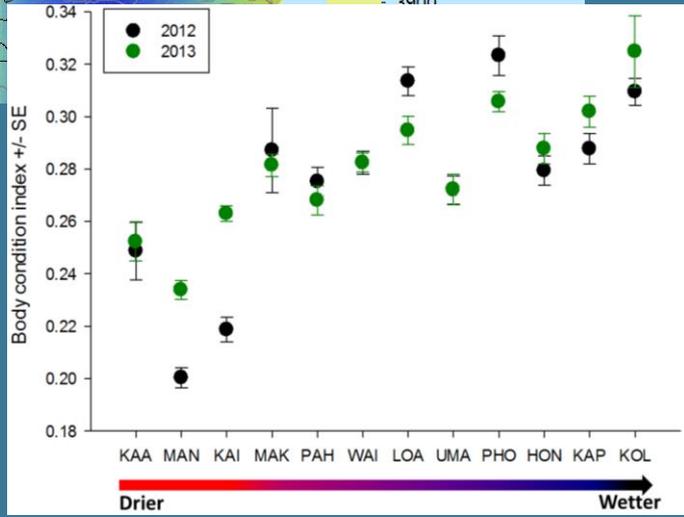
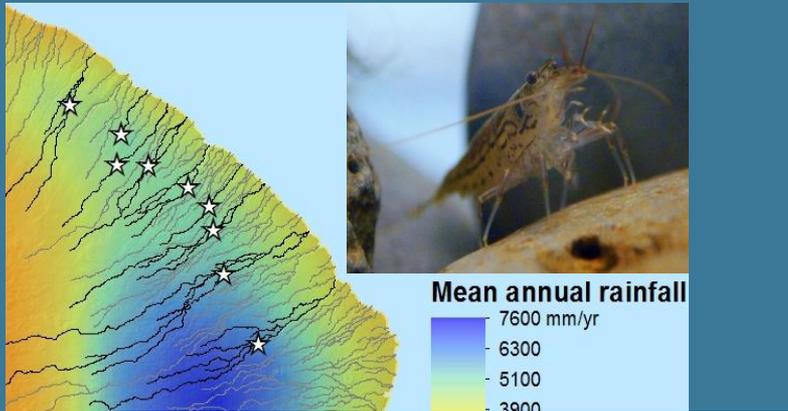


Tracy Swem  
swemtrac@msu.edu

# A little about my PhD research

Linking multiple scales of stream research in support of conservation management

- Study area: Hawaii

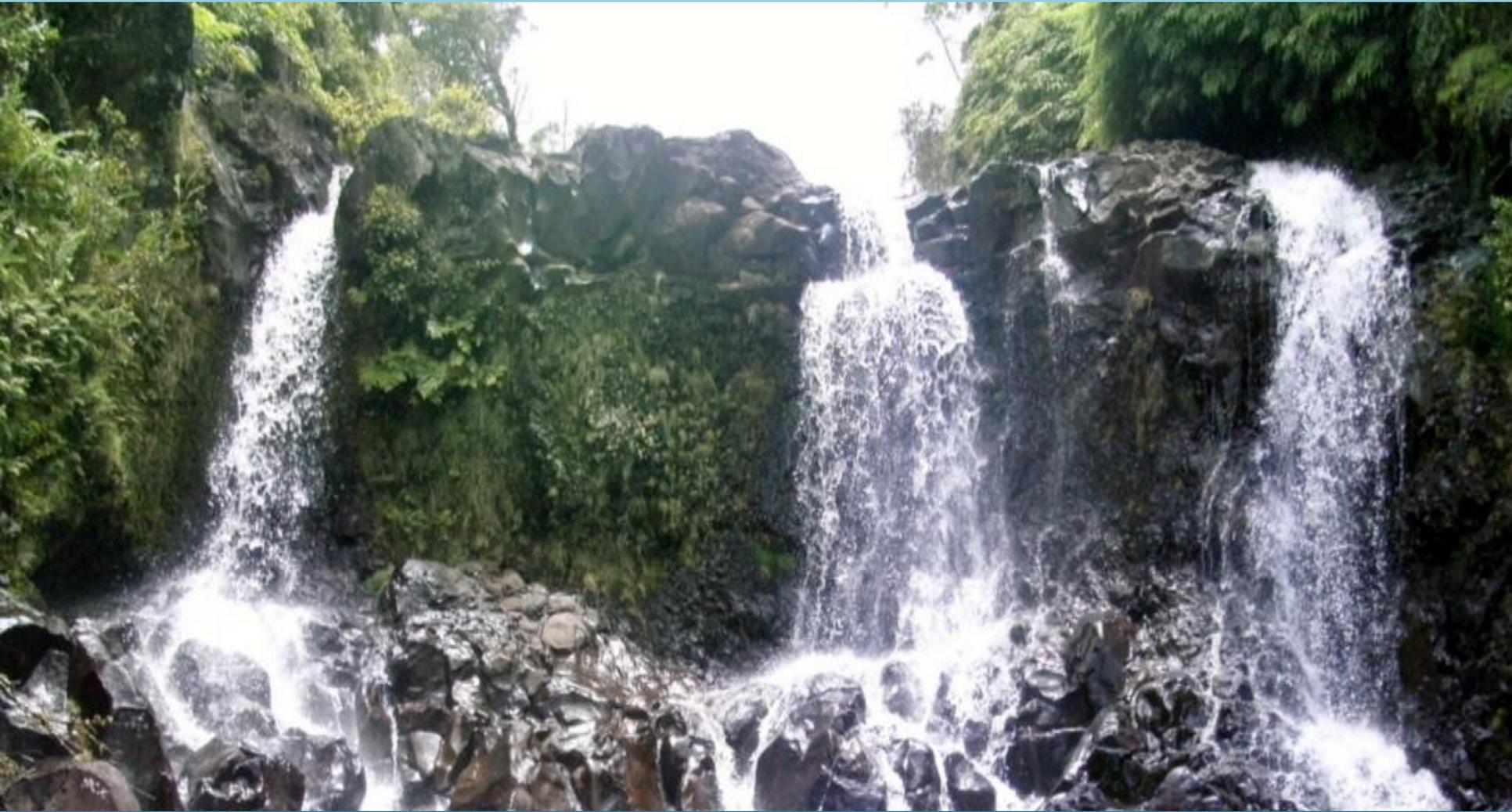


# Fellowship goal and objectives

Goal: Incorporate an ecological stream reach classification into products to help prioritize conservation initiatives

1. Present classification to stakeholders, identify needs
2. Incorporate classification into tools to aid in conservation of stream habitats

# Hawaii stream reach classification



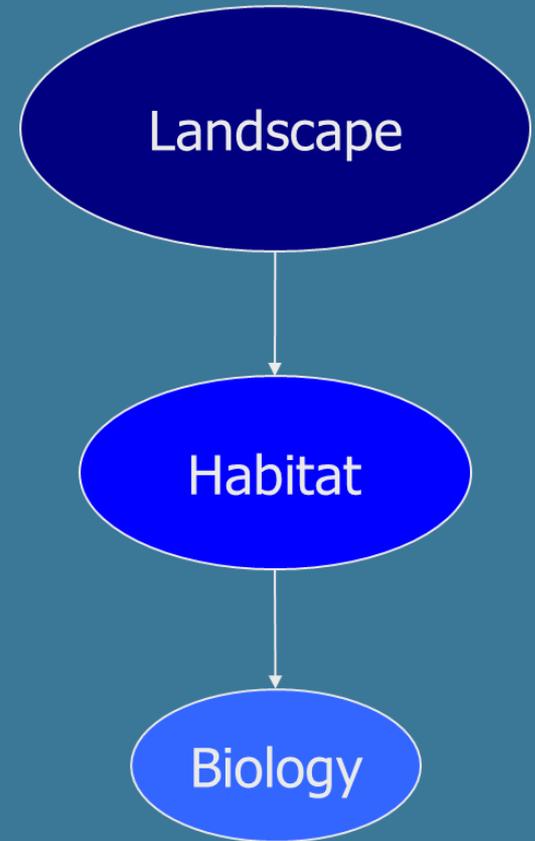
Ralph W. Tingley III<sup>1</sup>, Dana M. Infante<sup>1</sup>, Richard A. MacKenzie<sup>2</sup>, Yin-Phan Tsang<sup>3</sup>

<sup>1</sup> Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI

<sup>2</sup> Institute of Pacific Island Forestry, United States Forest Service, Hilo, HI

<sup>3</sup> University of Hawaii at Manoa, Honolulu, HI

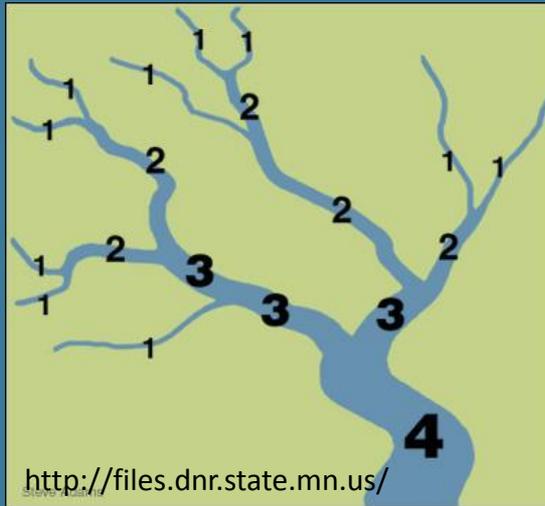
# Regional patterns and river complexity



Inventorying complexity across a region is often of interest to researchers and managers (Melles et al. 2012)

# Stream classifications

Synthesize knowledge and organize information



STREAM TYPE	A	D	B & G	F	C	E
PLAN VIEW						
CROSS-SECTION VIEW						
AVERAGE VALUES	1.5	1.1	3.7	5.3	11.4	24.2
Rosgen 1994	1-3	1-2	2-8	2-10	4-20	20-40

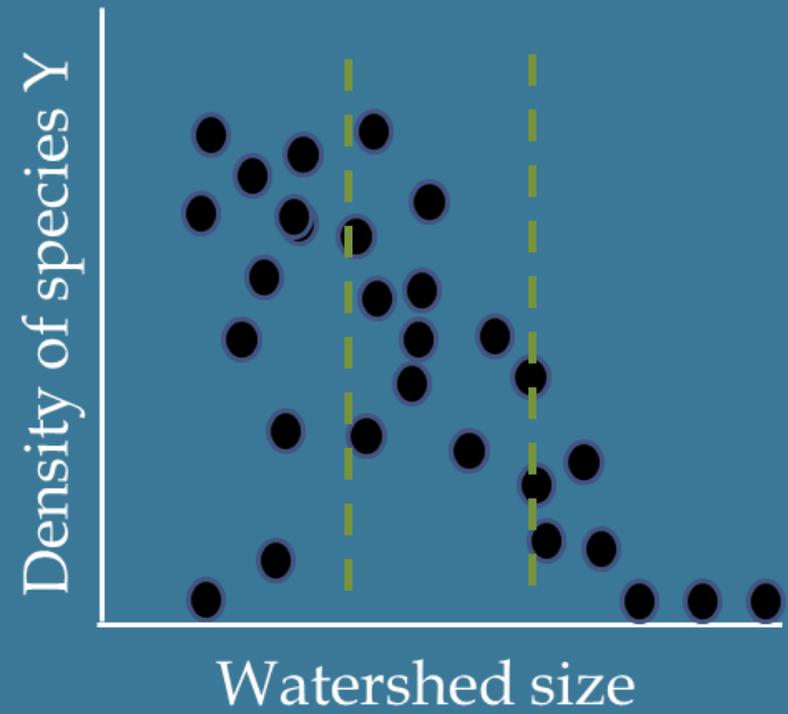
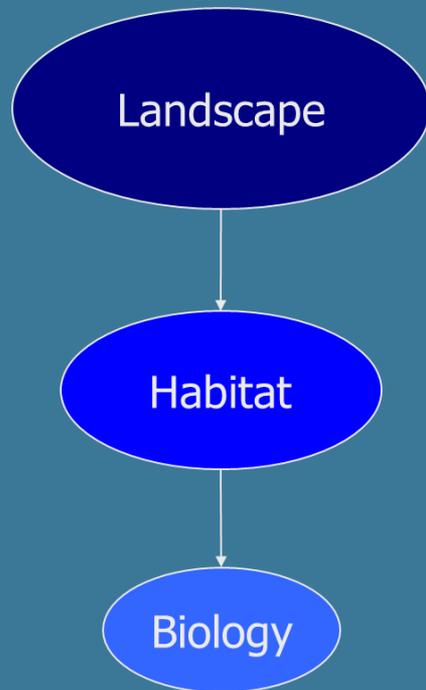
By incorporating natural landscape data, classifications can

- Account for natural variation
- Identify rare/common habitat types
- Help to prioritize management actions

# Classifications can capture ecological potential

Ideally, when the classification is based on habitat characteristics and/or landscape factors influential to organisms

- Results can indicate a stream's ability to support a given species or community



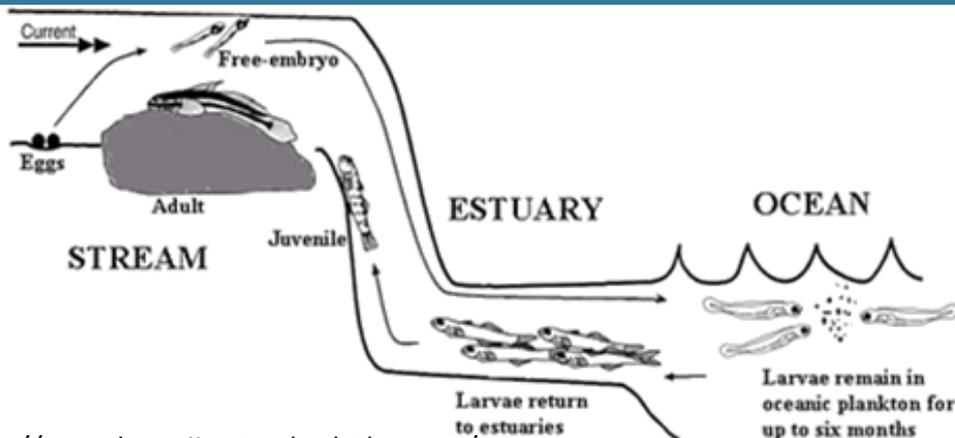
# Hawaii's stream systems

Variable conditions across and within islands

- Rainfall, geology, groundwater, slope, elevation

Native, amphidromous species

- Gobies, snails, shrimp and prawn



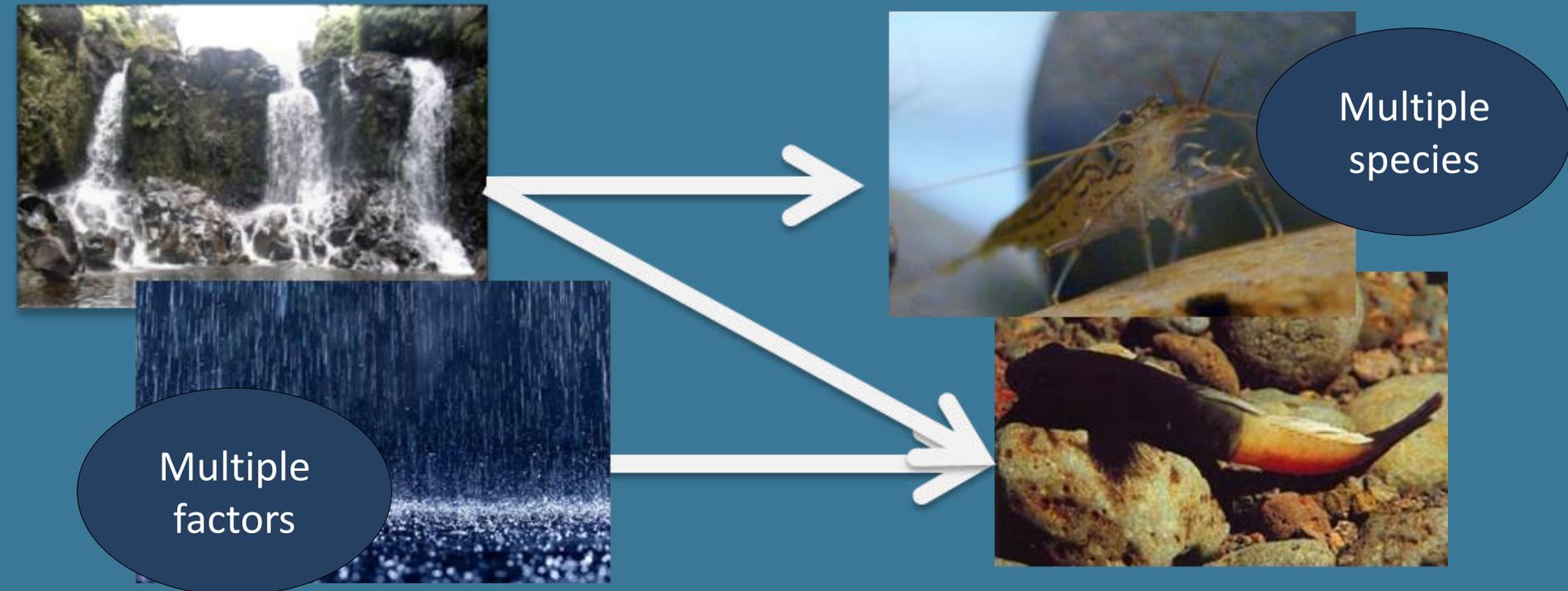
<http://www.hawaiiwatershedatlas.com/>



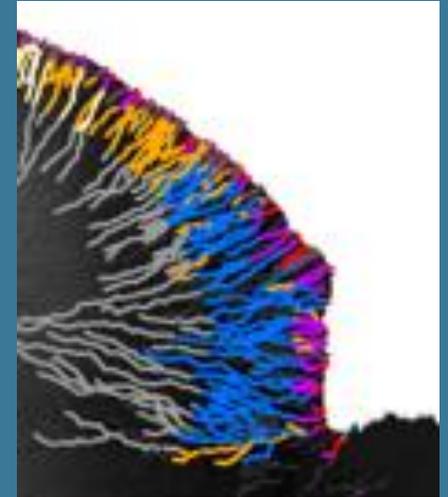
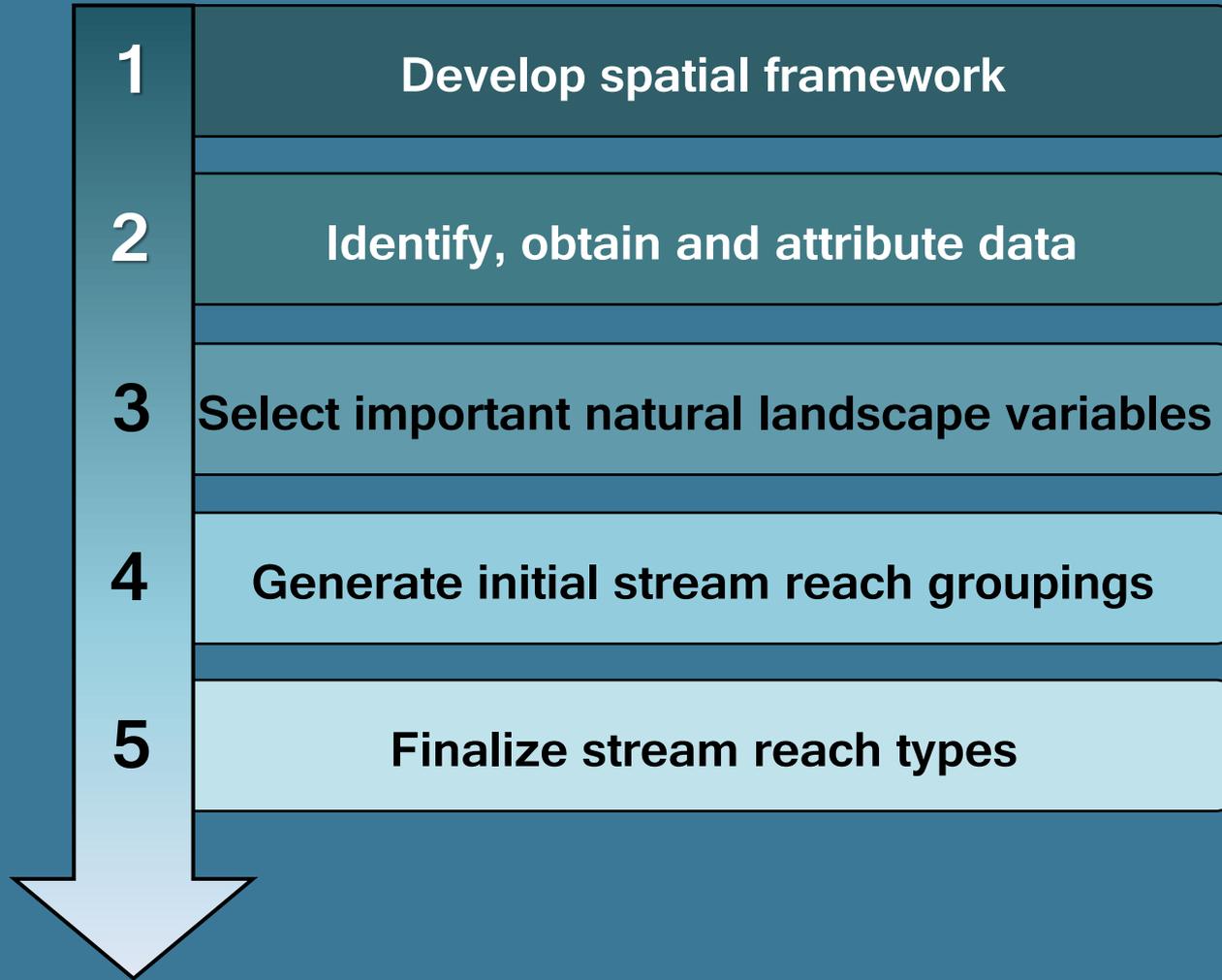
# Hawaii stream reach classification

Goal: Develop a classification that captures ecological potential of stream reaches

- Control for natural variation in stream systems
- Allow for examination of influences of disturbance

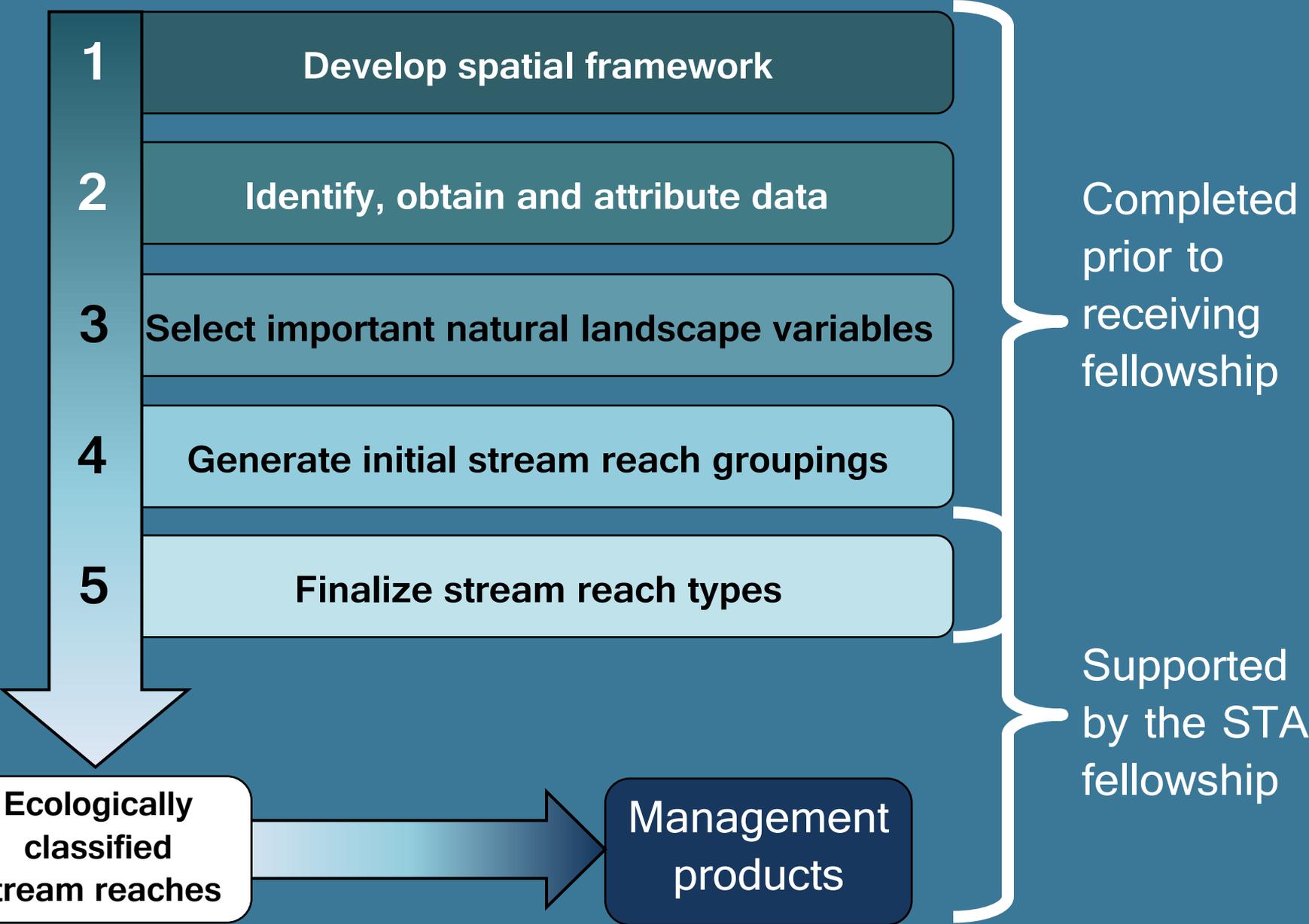


# Classification methods: Conceptual overview

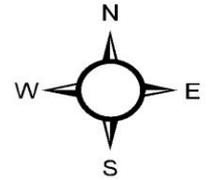
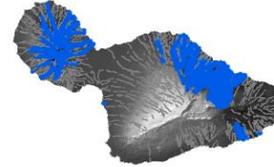
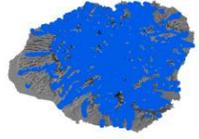


**Ecologically  
classified  
stream reaches**

# Classification methods: Conceptual overview

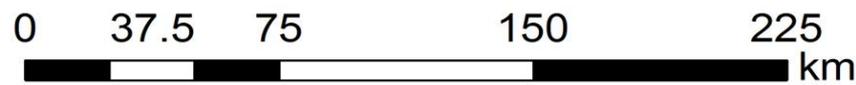
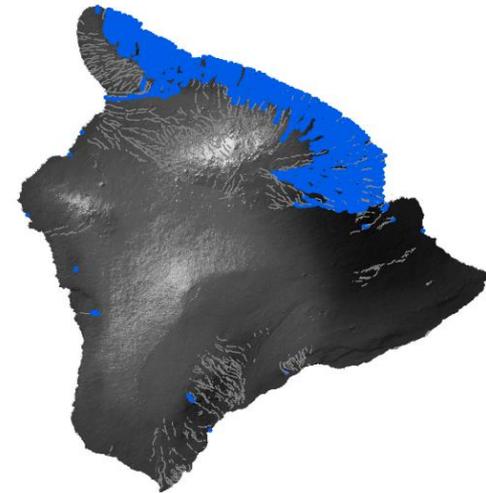


# Study region



----- Intermittent  
—— Perennial

All perennial  
streams used;  
HFHP stream layer  
(Tingley et al. in prep)

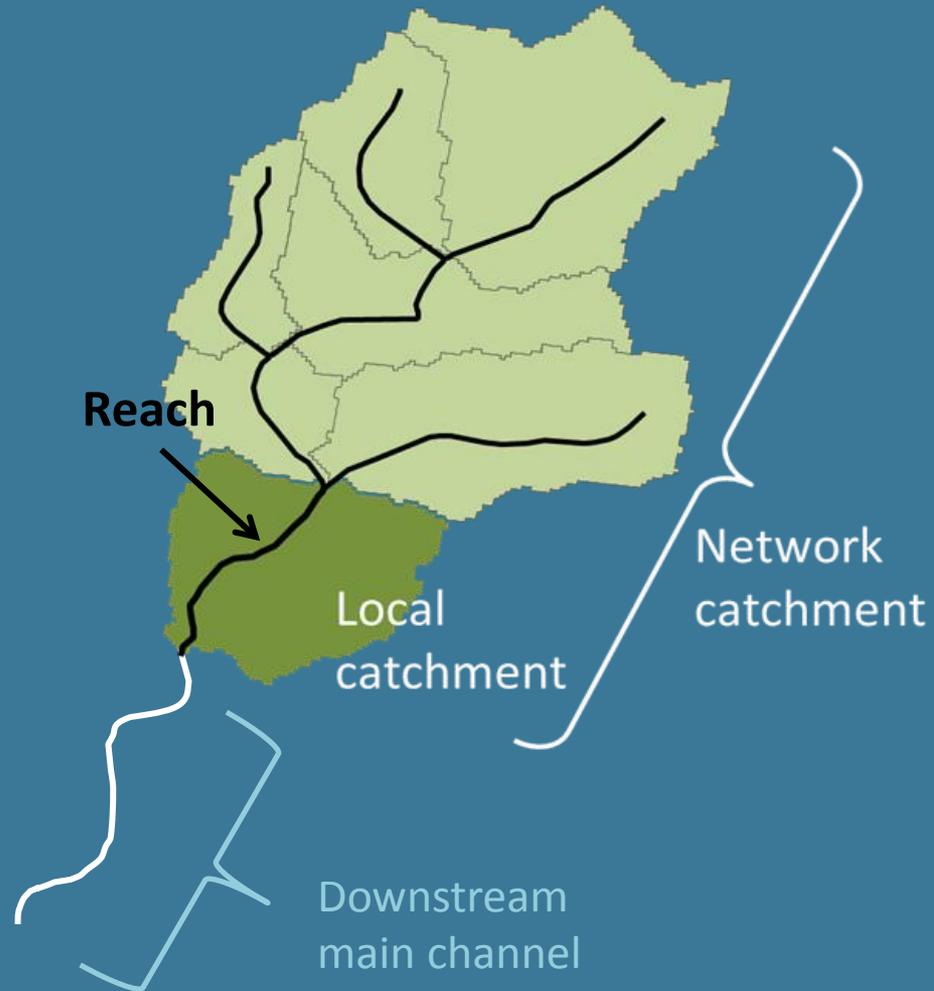


# 1. Develop spatial framework

Stream reach scale (Wang et al. 2011)

- 1:24,000
- 4,732 perennial reaches

Provides higher-resolution catchment delineation than previously available



## 2. Identify, obtain and attribute data

### Species data

- Presence/absence data (1992-2007)
- Provided by the Hawaii DAR and HFHP
- ~10% of perennial reaches



## 2. Identify, obtain and attribute data

### Natural landscape data

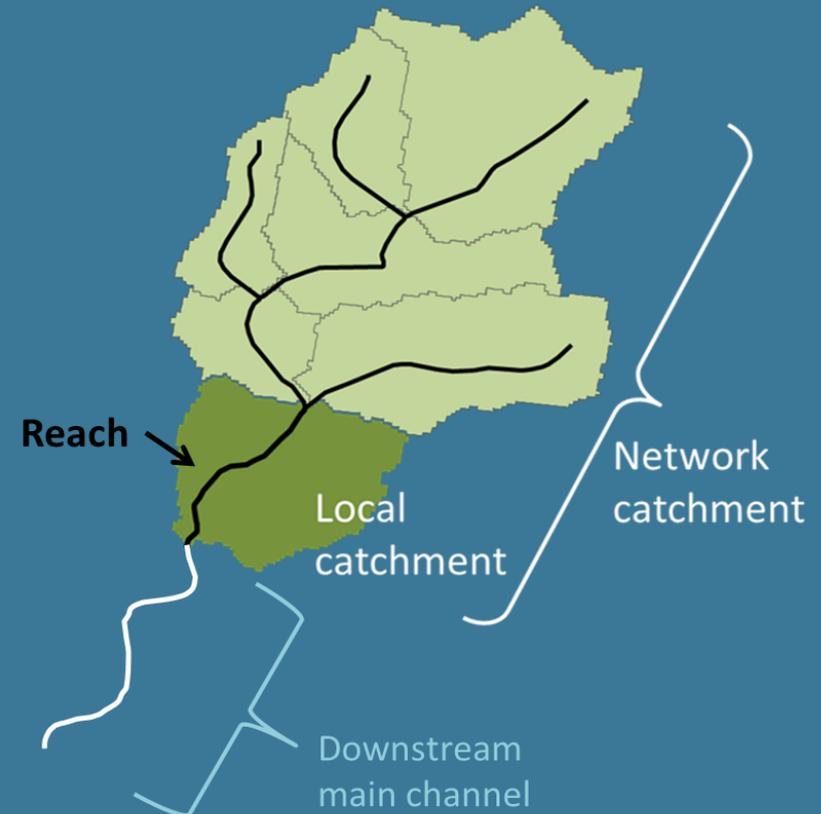
- Theorized to be important to stream species

Influences on migration

Channel size and slope

Soil and geologic characteristics

Average rainfall and variability



### Attributed landscape data to spatial framework

>70 landscape variables over spatial extents

# 3. Natural landscape data reduction

## Climate variables:

1. Calculated hydrological metrics (HIT tool, Cade et al. 2006) for gages with flow data between 1992-2007
2. Evaluated correlations between multiple flow metrics and rainfall variables

## Natural landscape variables:

- Implemented forward selection (CCA) to remove variables that explain little variance in species distributions (following Wang et al. 2003)

# 3. Natural landscape data reduction

Seven landscape variables selected for classification

Minimum elevation  
Maximum waterfall height

Upstream drainage area  
Downstream slope  
Local slope

Upstream hydrologic group

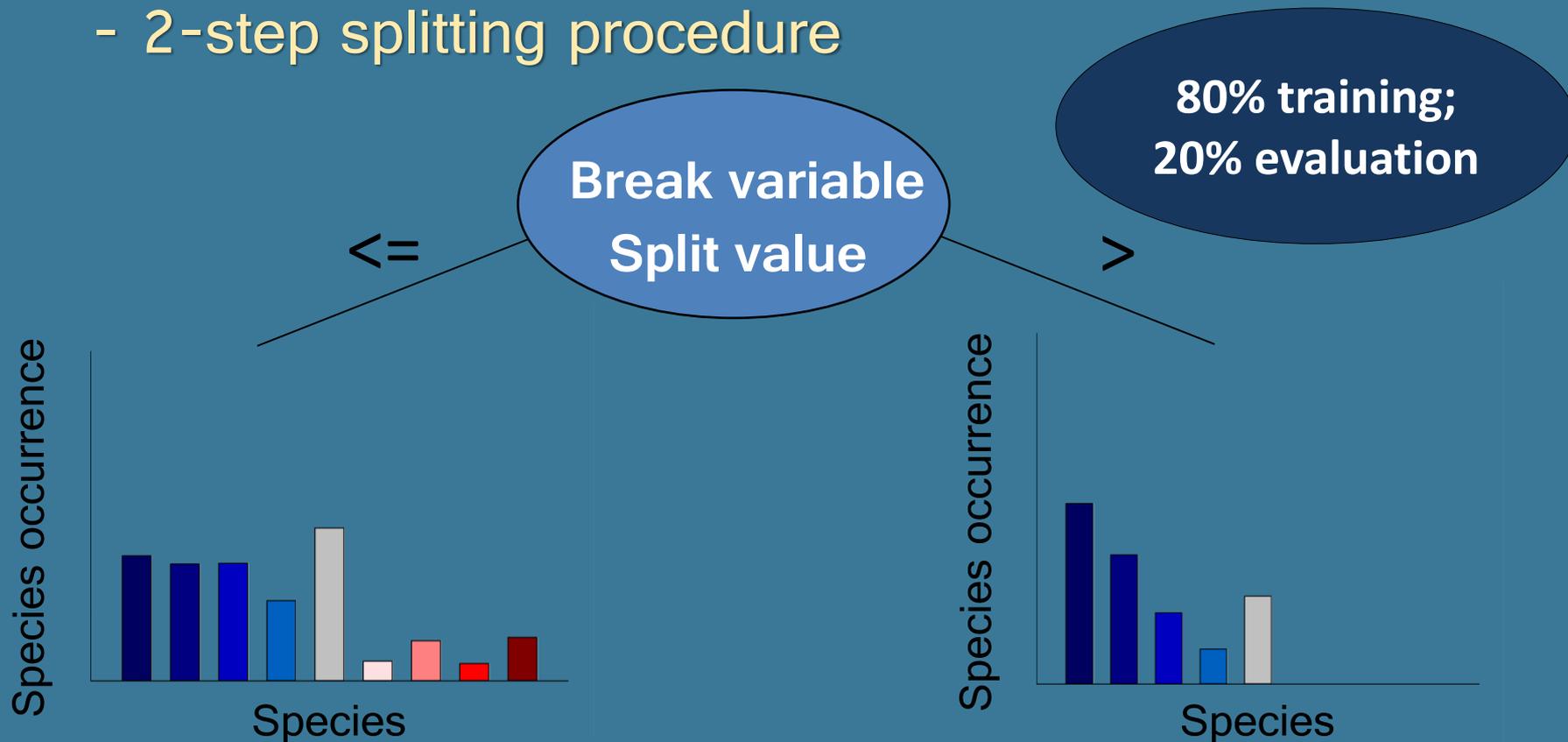
Mean annual rainfall



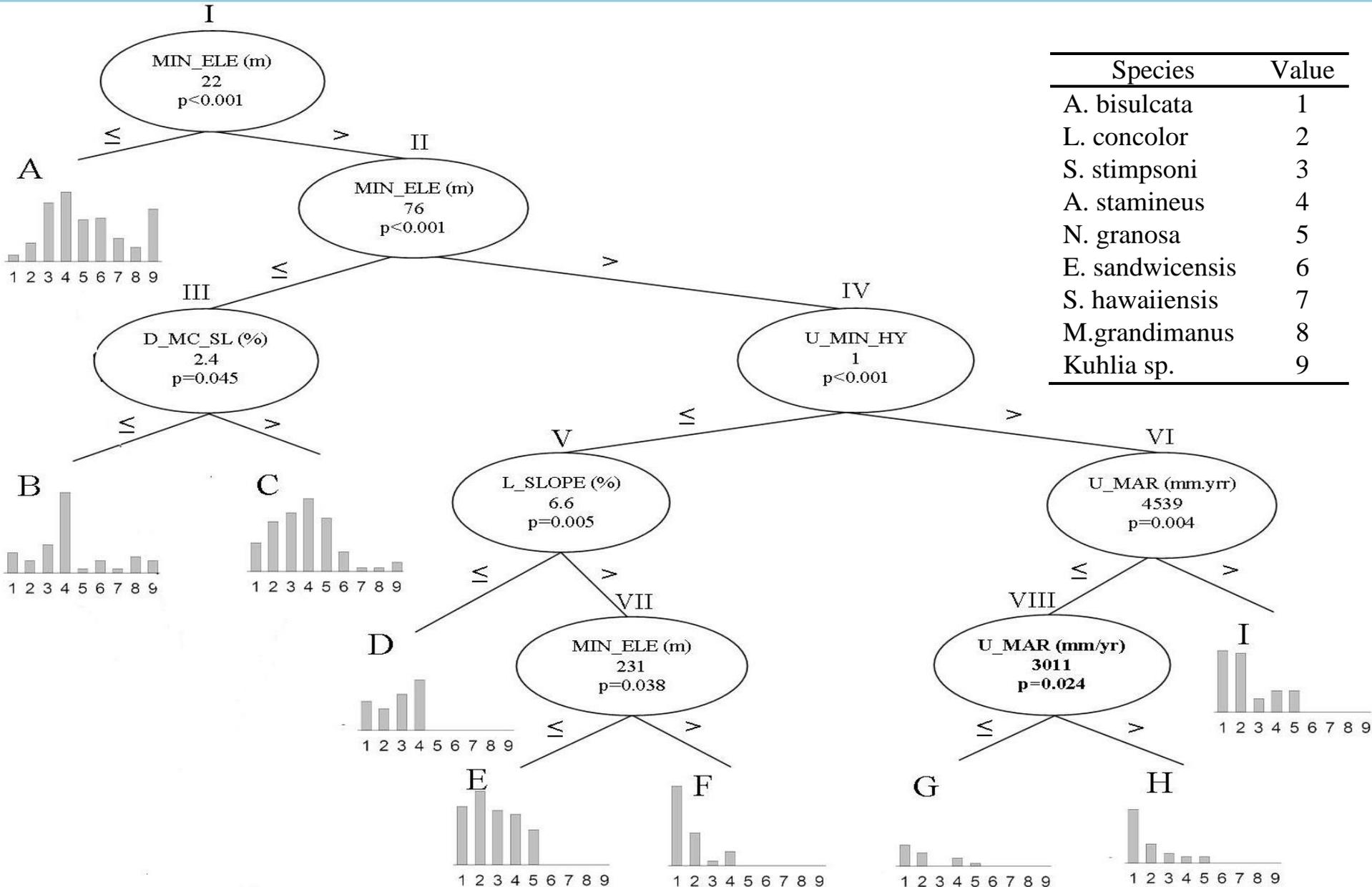
# 4. Creation of initial reach groupings

Grouped using conditional inference tree (Hothorn et al. 2006)

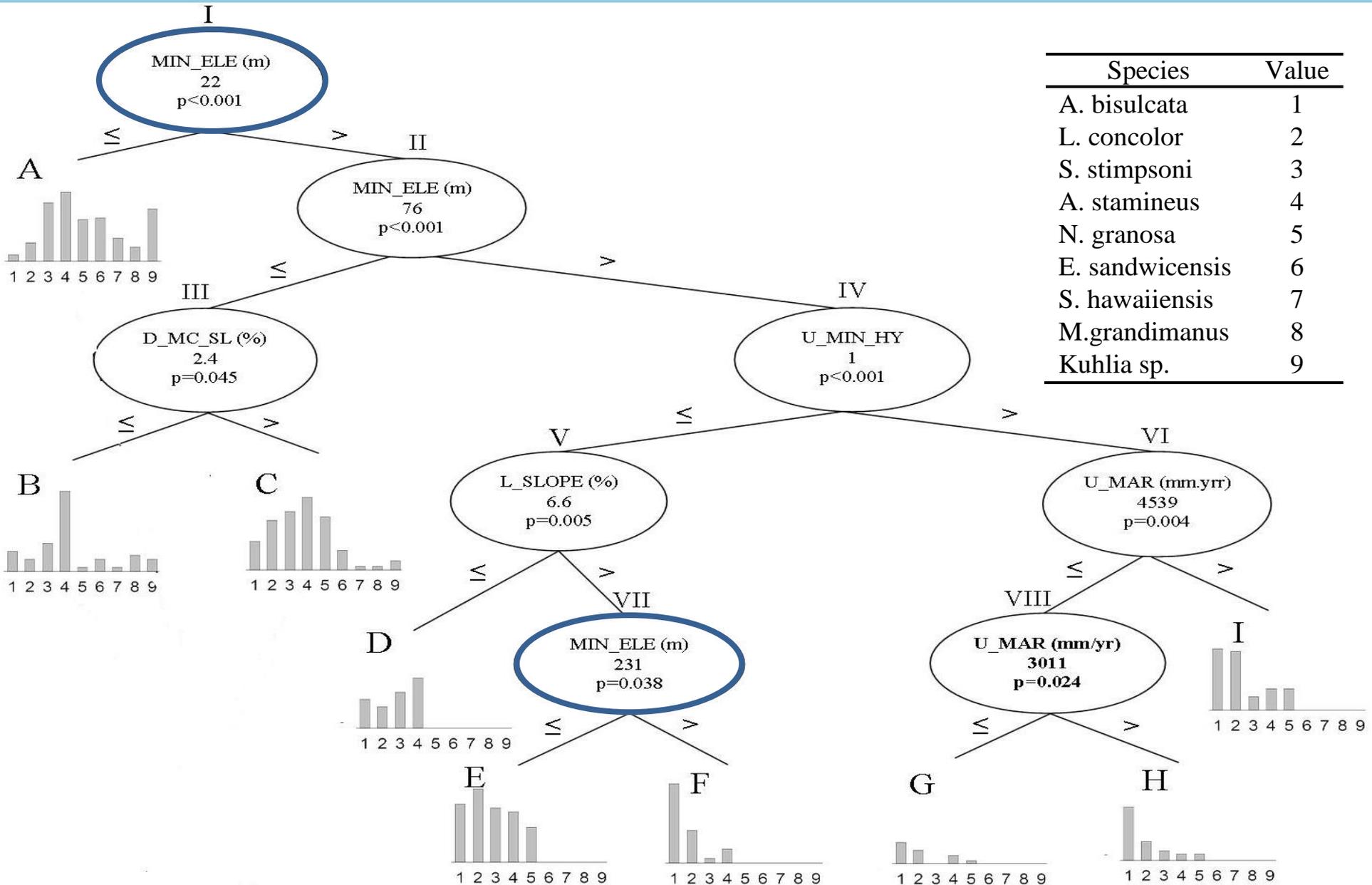
- Recursive partitioning identifies relationships between multiple predictor variables and multiple binary responses
- 2-step splitting procedure



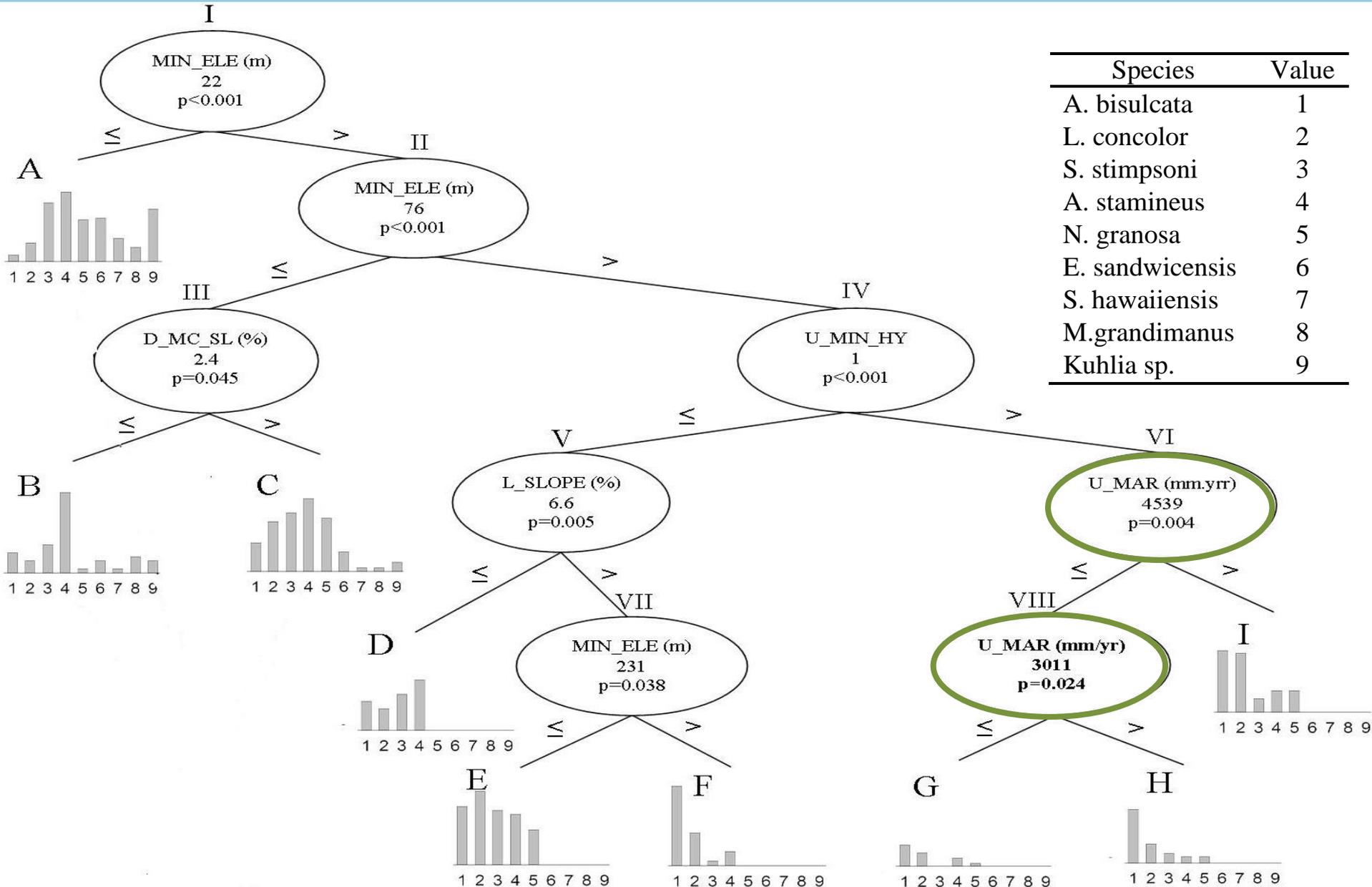
# 4. Creation of initial reach groupings



# 4. Creation of initial reach groupings



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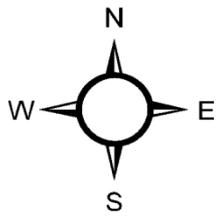
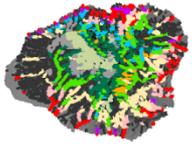


# 5. Generation of final reach types

Addition of stream types based on stakeholder input

- Reaches with terminal waterfalls to the ocean (J)
- High elevation bog streams (K)
- Headwaters (L)





## Stream types

----- Intermittent

— A

— B

— C

— D

— E

— F

— G

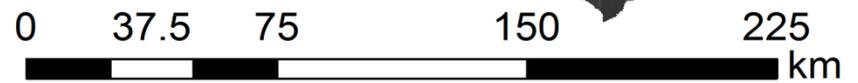
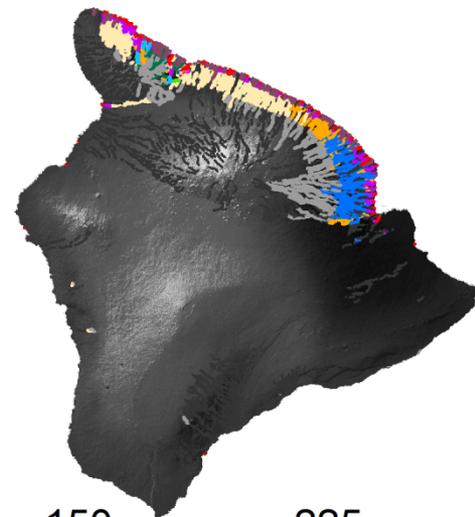
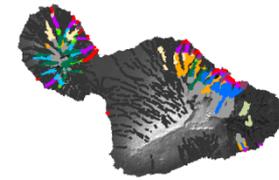
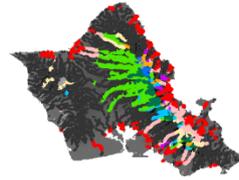
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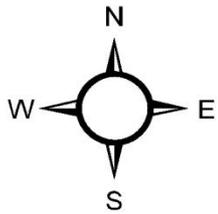
— I

— J

— K

— L





## Stream types

----- Intermittent

— A

— B

— C

— D

— E

— F

— G

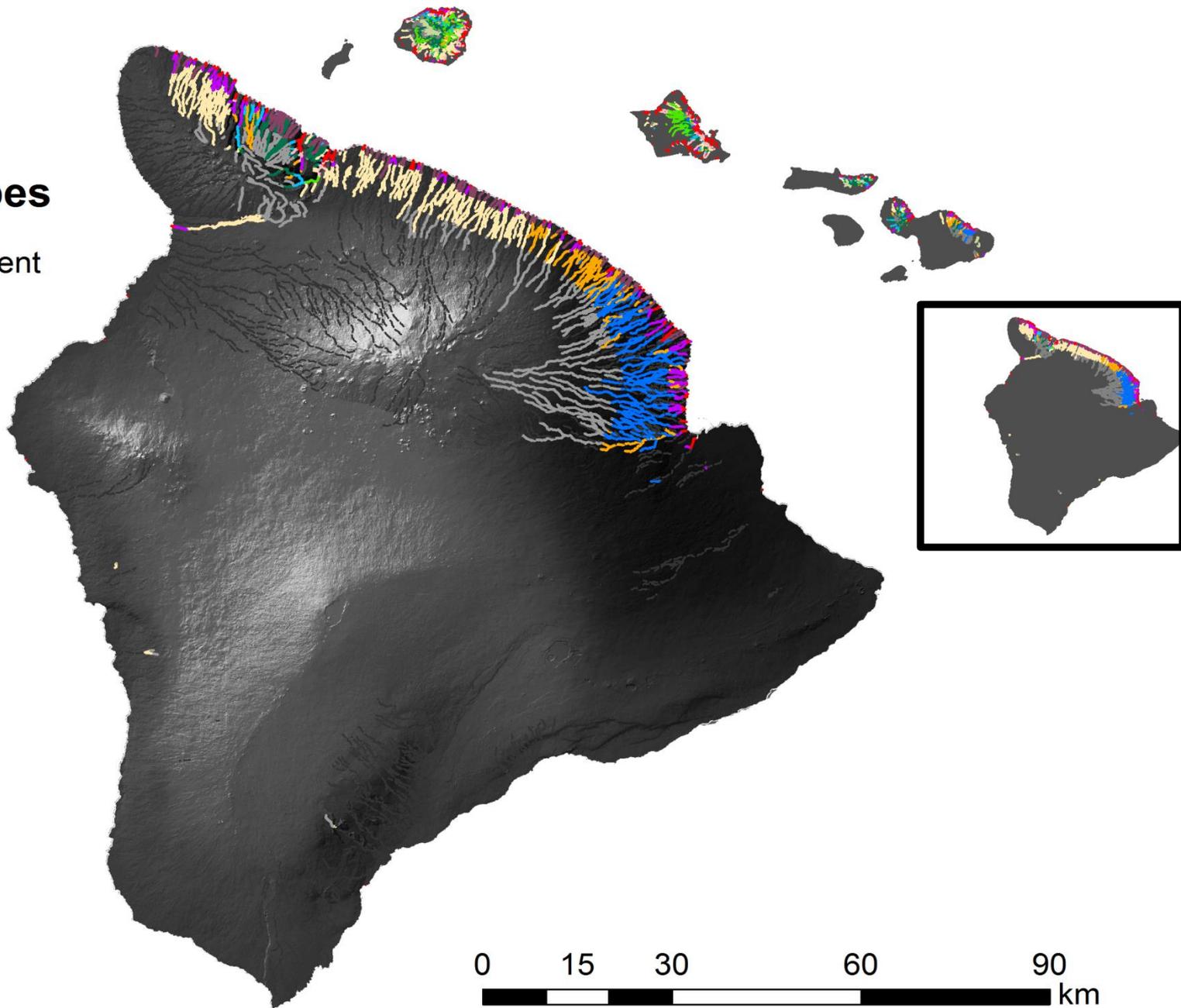
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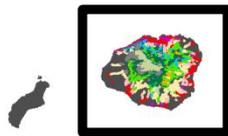
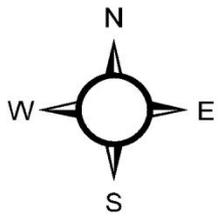
— J

— K

— L



0 15 30 60 90 km



## Stream types

----- Intermittent

— A

— B

— C

— D

— E

— F

— G

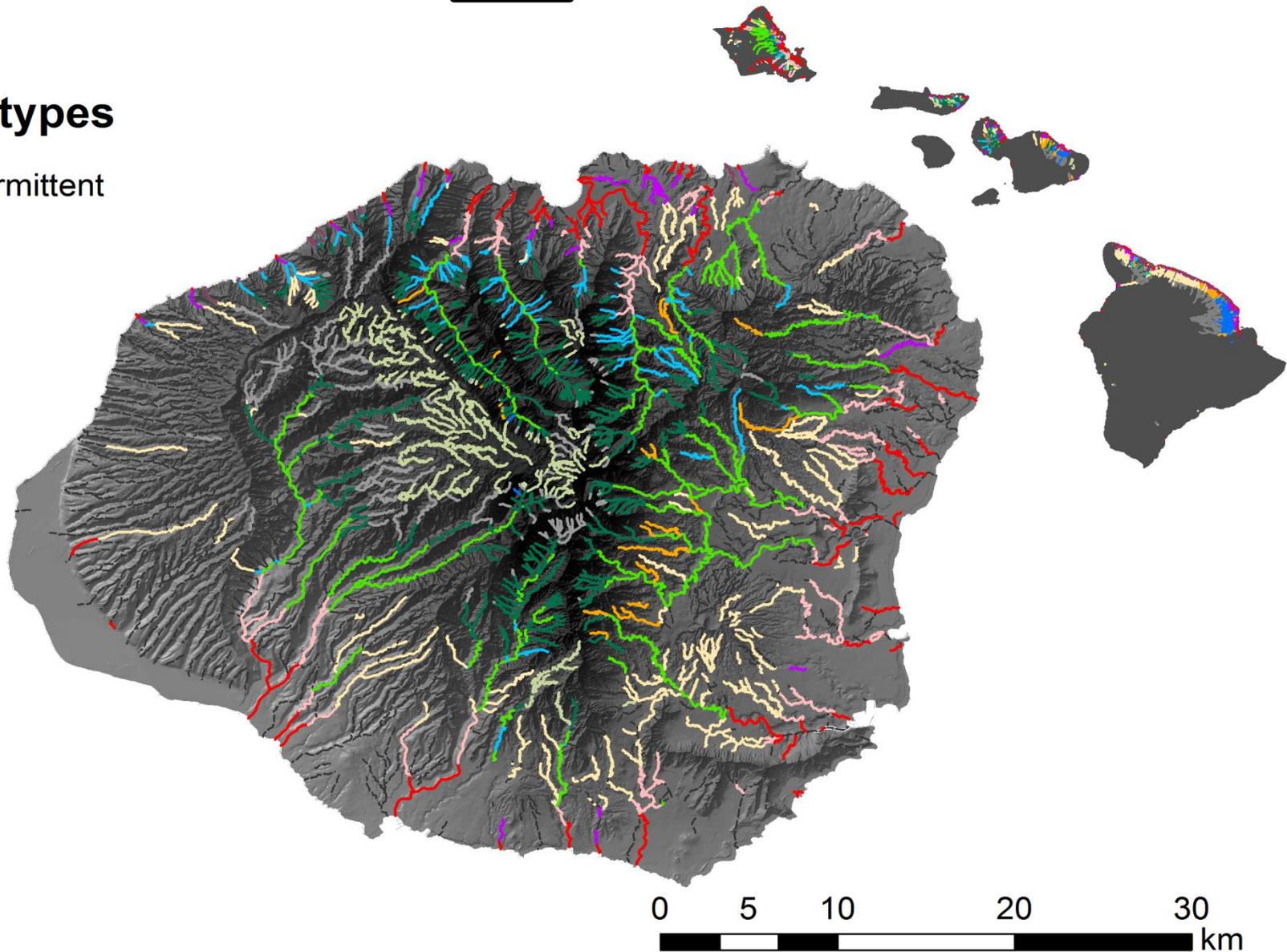
— H

— I

— J

— K

— L



# Presenting to stakeholders; identifying needs

## March: Initial webinar with stakeholders

- Discuss methods and classification results
- Discussion of STA fellowship and goals



- What are stakeholder needs related to conservation in a changing climate?
- Can the classification be used to meet current needs?
- Can the classification be integrated into new products?

# Presenting to stakeholders; identifying needs

## March: Initial webinar with stakeholders

- Discuss methods and classification results
- Discussion of STA fellowship and goals

## April-June: Follow-up discussions

- Discussion of potential products/tools
- Planning branch of the Commission of Water Resource Management; Hawaii Fish Habitat Partnership

## July: Face-to-face meetings with HFHP and CWRM

- Held in Honolulu
- Discuss initial products and new directions/ideas

# Integrating classification into products/tools

1. Classification as a region-wide reach layer depicting potential habitat available for endemics
  - Commission of Water Resource Management



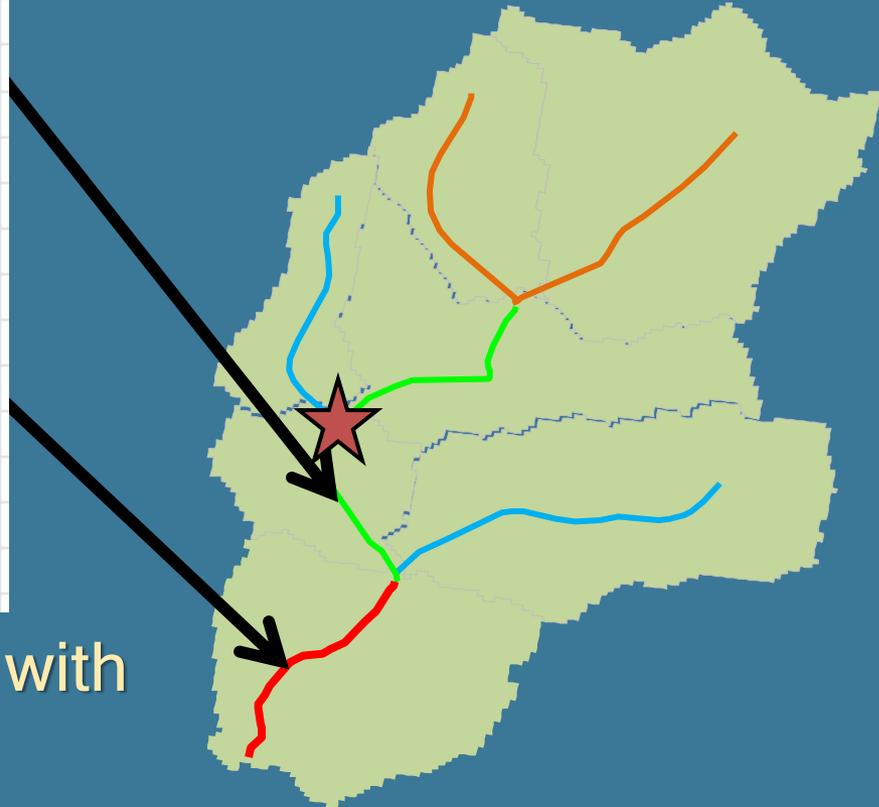
Which habitats  
would benefit  
from flow  
restoration?

How much  
habitat would  
be restored?

# Integrating classification into products/tools

1. Classification as a region-wide reach layer depicting potential habitat available for endemics

Reach_ID	Island	Type	Species1	Species2	Species3	Species4
11	Kauai	E	1	1	1	1
14	Kauai	D	0	0	1	1
<b>15</b>	<b>Kauai</b>	<b>D</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>
16	Kauai	E	1	1	1	1
18	Kauai	G	0	0	0	0
20	Kauai	G	0	0	0	0
21	Kauai	D	0	0	1	1
22	Kauai	E	1	1	1	1
33	Kauai	C	0	1	1	1
<b>34</b>	<b>Kauai</b>	<b>A</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>
35	Kauai	C	0	1	1	1
36	Kauai	A	0	0	1	1
38	Kauai	A	0	0	1	1
39	Kauai	J	1	1	0	0

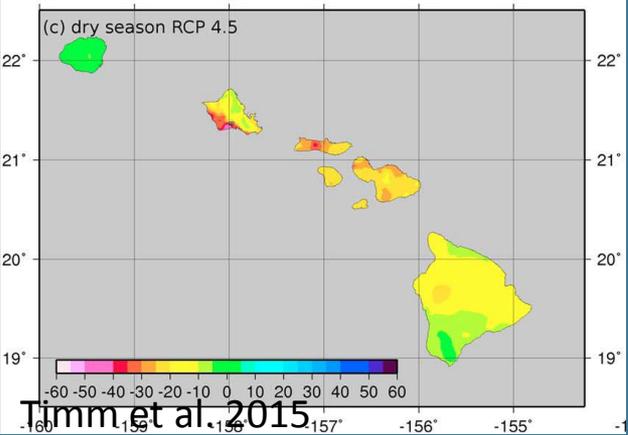
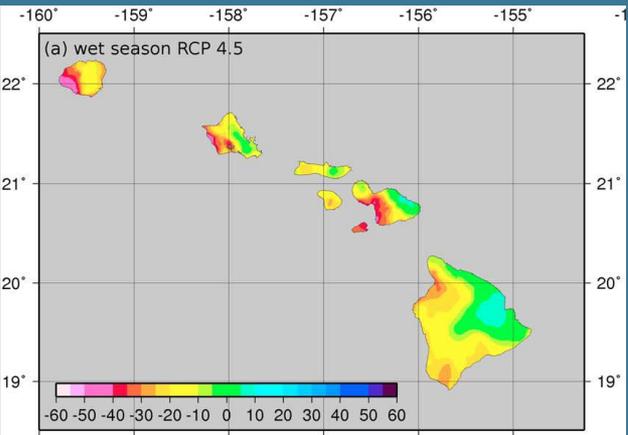


Percent occurrence compared with overall prevalence (Liu et al. 2005)

# Integrating classification into products/tools

## 2. Assessment of stream reaches that may change in the ability to support species

- Hawaii Fish Habitat Partnership

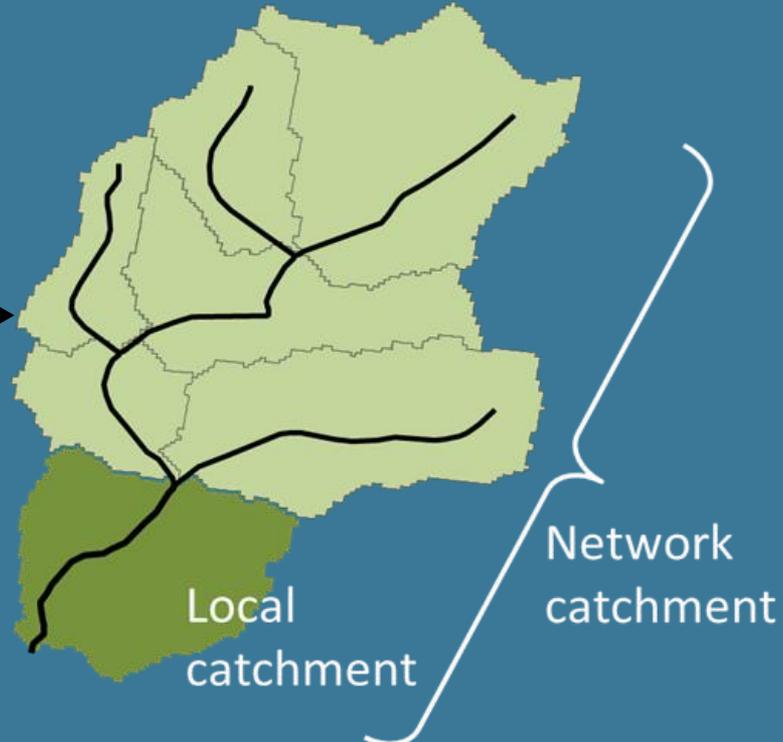
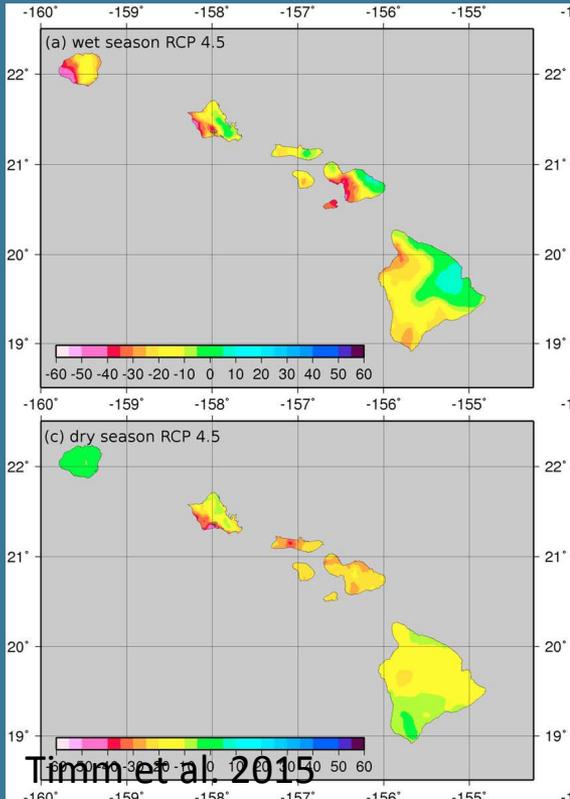


Will streams continue to support species with changes in rainfall?

Which regions have the highest conservation value under current and future conditions?

# Integrating classification into products/tools

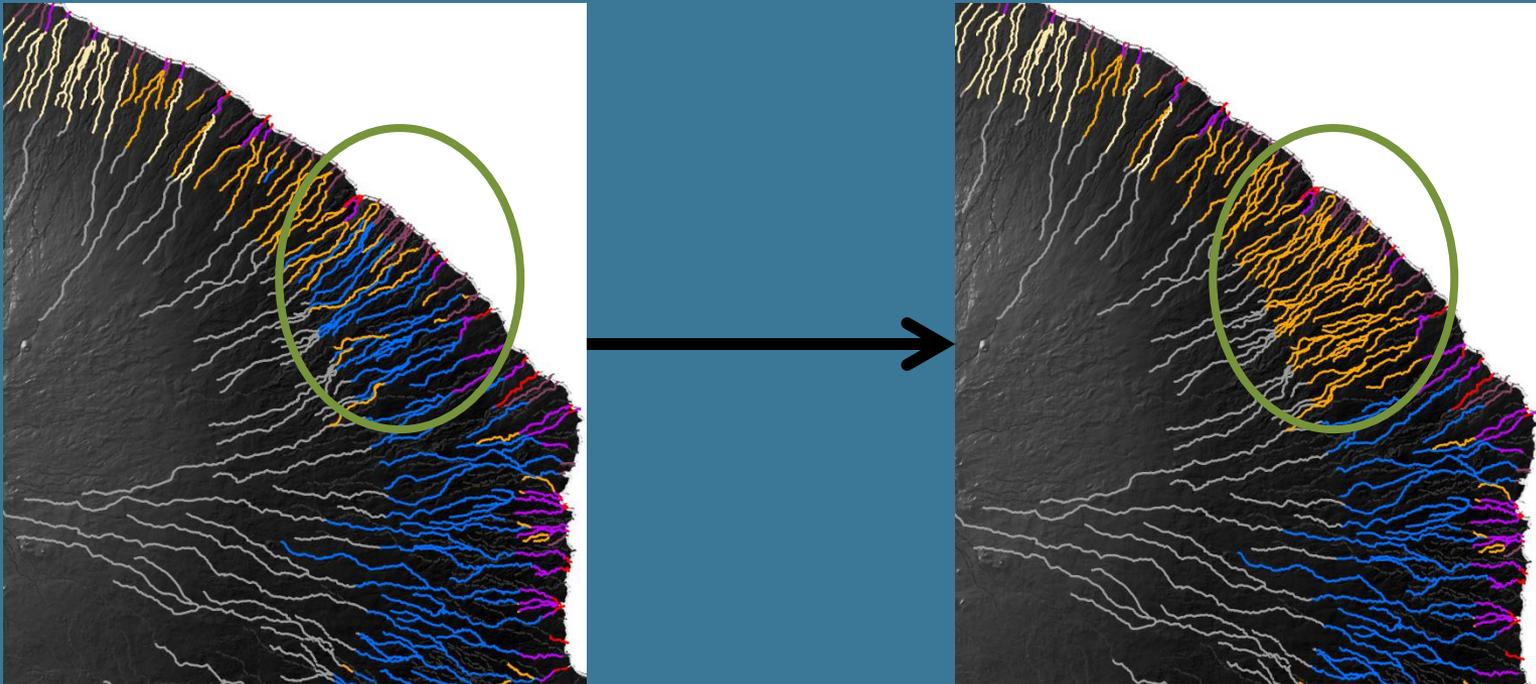
## 2. Assessment of stream reaches that may change in the ability to support species



Attribution and aggregation of multiple time steps and representative concentrations pathways (RCPs) scenarios

# Integrating classification into products/tools

## 2. Assessment of stream reaches that may change in the ability to support species



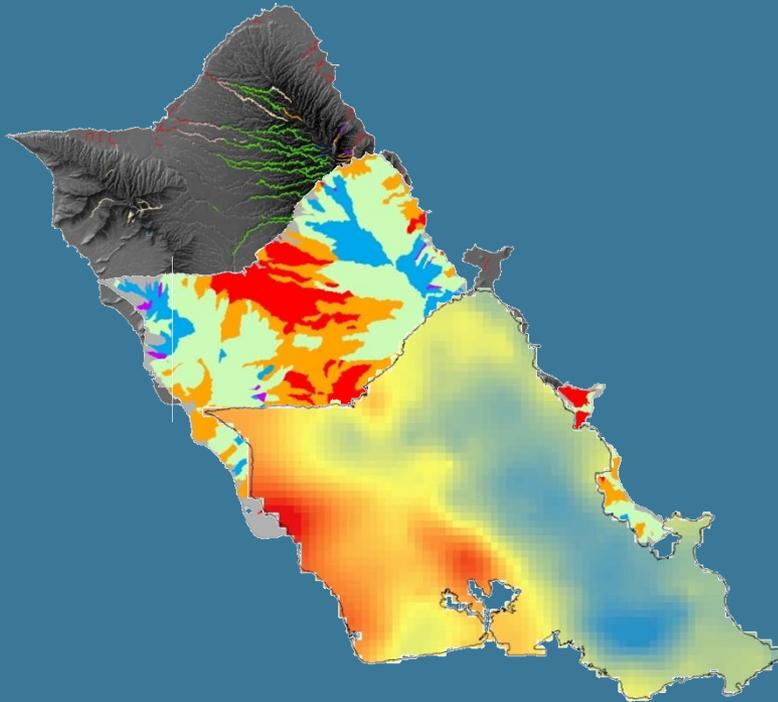
\*Hypothetical example

Calculating total length of change in reach type within catchments under multiple scenarios

# Future directions and new products

Prioritization of catchments for conservation initiatives under current and future conditions

- Hawaii Fish Habitat Partnership



Identification of  
high value  
conservation  
areas

Accounts for ecological potential, risk of degradation and projected climate data *at the reach scale*

# The Science to Action Fellowship Experience

Supported the development of management tools

Gained exposure to NCCWSC and CSC

- Setting and implementing research priorities

Shared my research and approach with a broader audience

- Attended conferences and stakeholder meetings with fellowship support
- Discovered potential applications to other regions

# Thank you!

- National Climate Change and Wildlife Science Center
- Hawaii Fish Habitat Partnership, Gordon Smith
- Hawaii Division of Aquatic Resources, Glen Higashi
- Commission of Water Resource Management
- USDA Forest Service
- Michigan State University
- National Fish Habitat Partnership
- Ayrton Strauch, Tom Giambelluca, Abby Frazier
- Shawn Carter, Doug Beard, Abigail Lynch

