# Climate Change & Climate Adaptation in Wetland Ecosystems

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& many collaborators

# Many Collaborators

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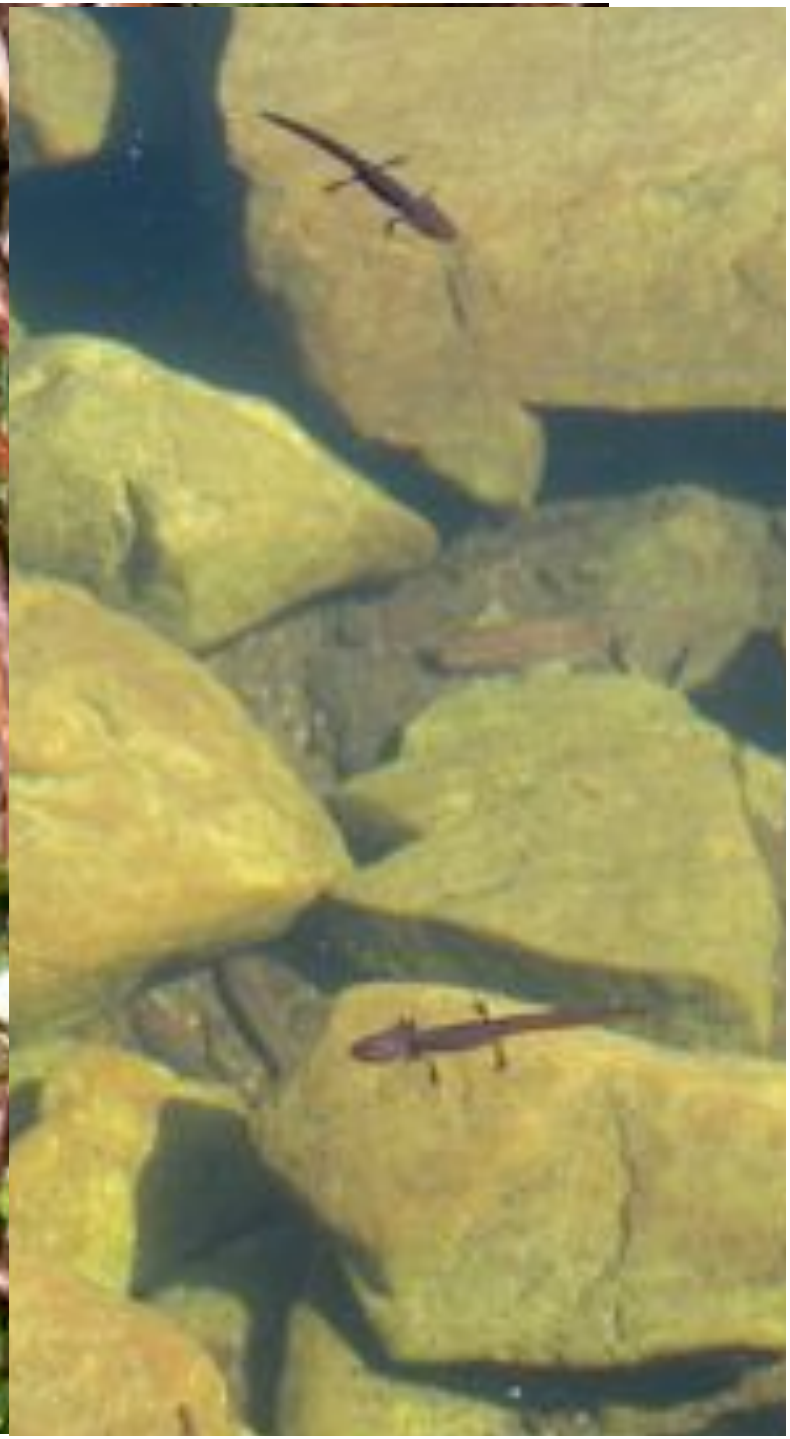
Nick Dulvy, Simon Fraser University
Mike Adams, USGS & Oregon State University
Lara Hansen, EcoAdapt
Regina Rochefort, North Cascades National Park
Reed Glesne, North Cascades National Park
Barbara Samora, Mt. Rainier National Park
Steve Fradkin, Olympic National Park
Jerry Freilich, Olympic National Park
Betsy Howell, US Forest Service
Karen Pope, US Forest Service
Justin Garwood, California Dept. of Fish & Game
Jonah Piovia- Scott, University of California Berkeley

# Important Resources

- Climate Impacts Group
- UW Remote Sensing & Geospatial Analysis Lab
- Wetland inventory data
  - National Park Service
  - USGS Amphibian Research & Monitoring Initiative
  - US Forest Service
- Demographic datasets for *Rana cascadae*
  - Wendy Palen & Mike Adams (Olympics)
  - Karen Pope & Justin Garwood (Trinity Alps)



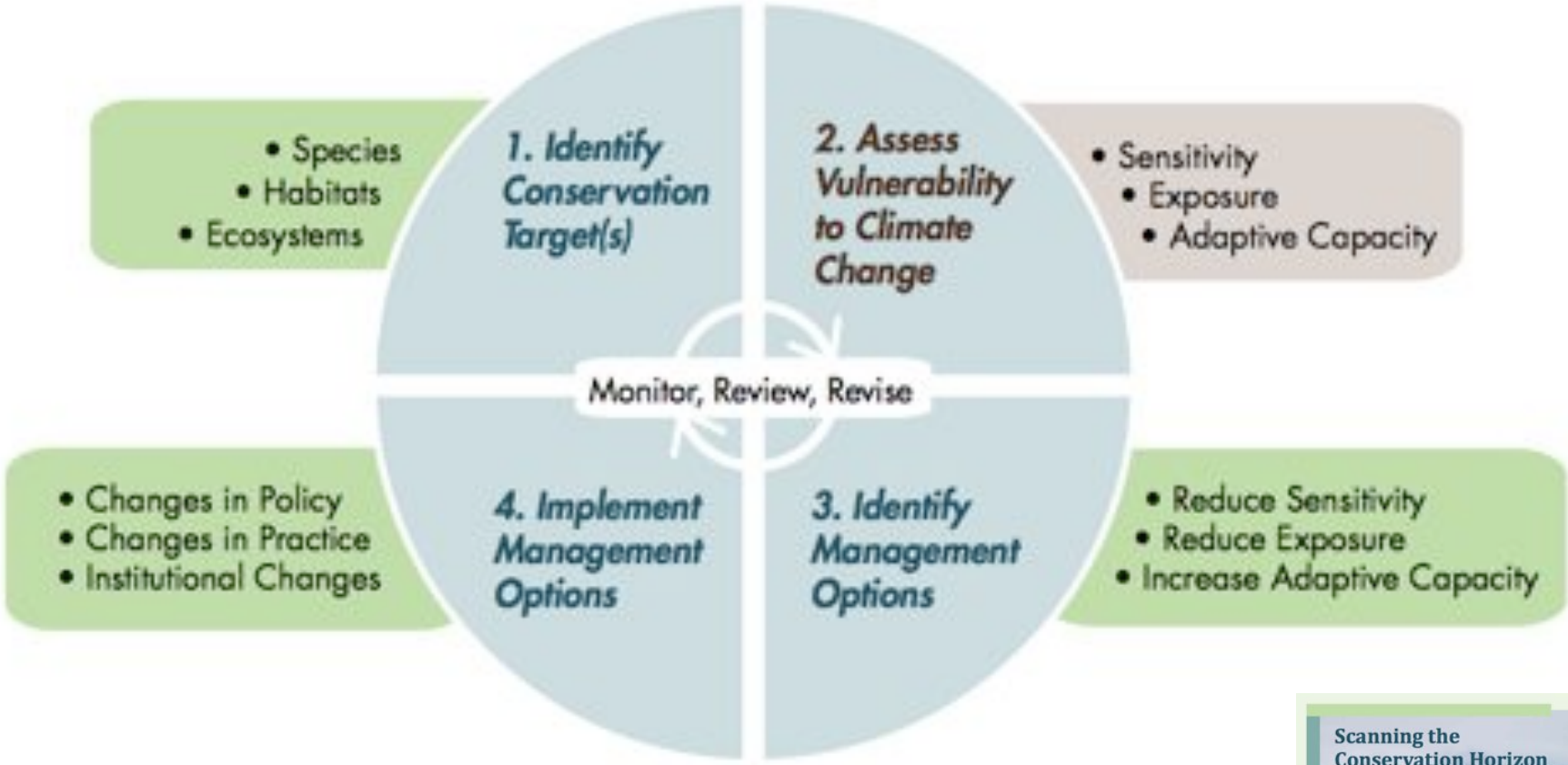
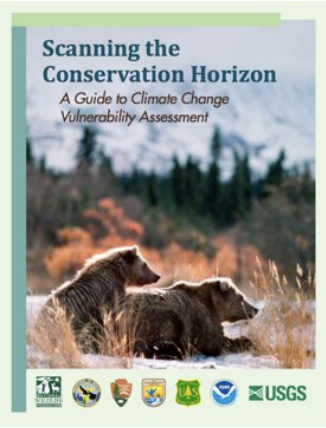
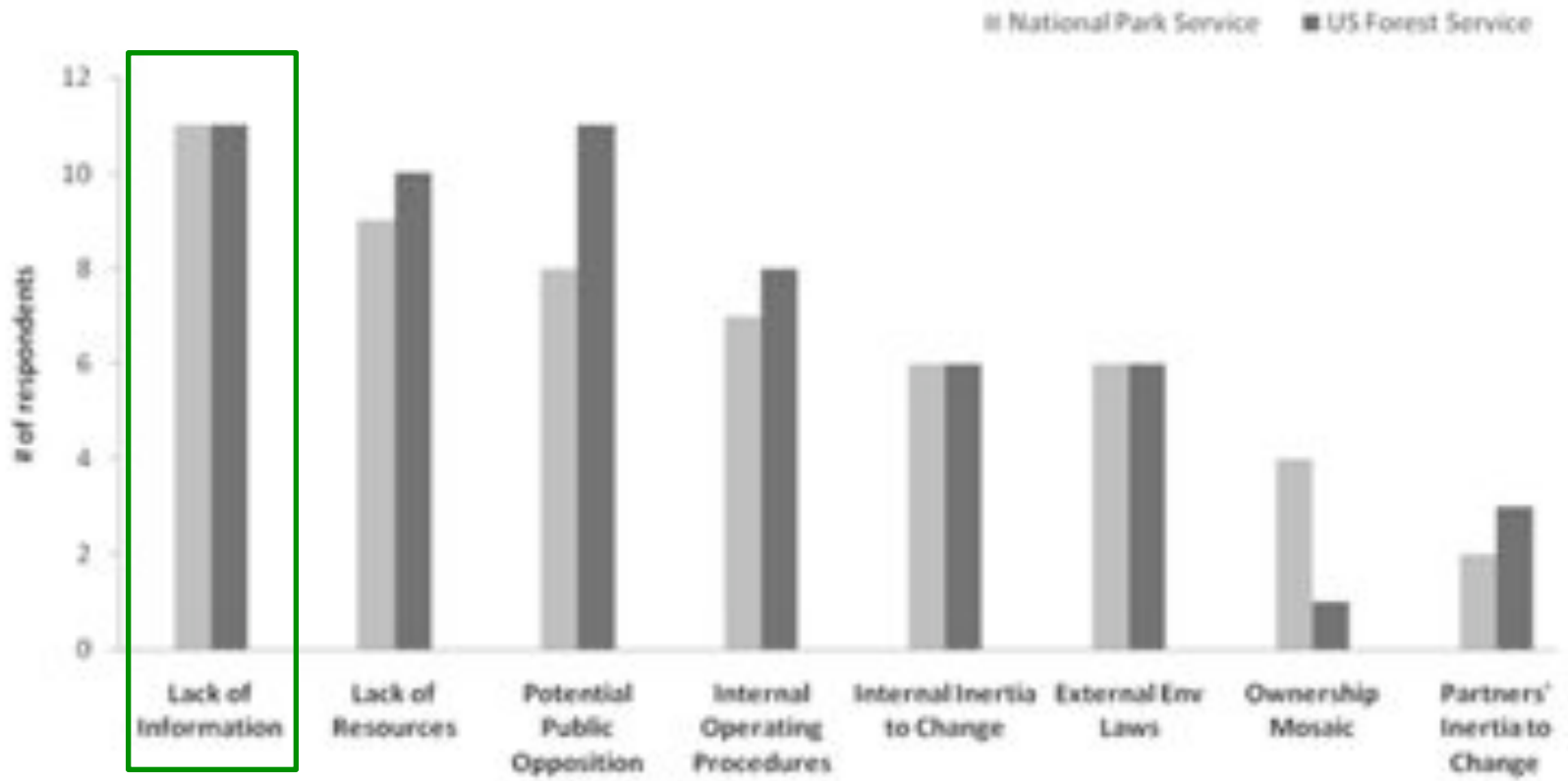



Figure 1.1. Framework for Developing Climate Change Adaptation Strategies



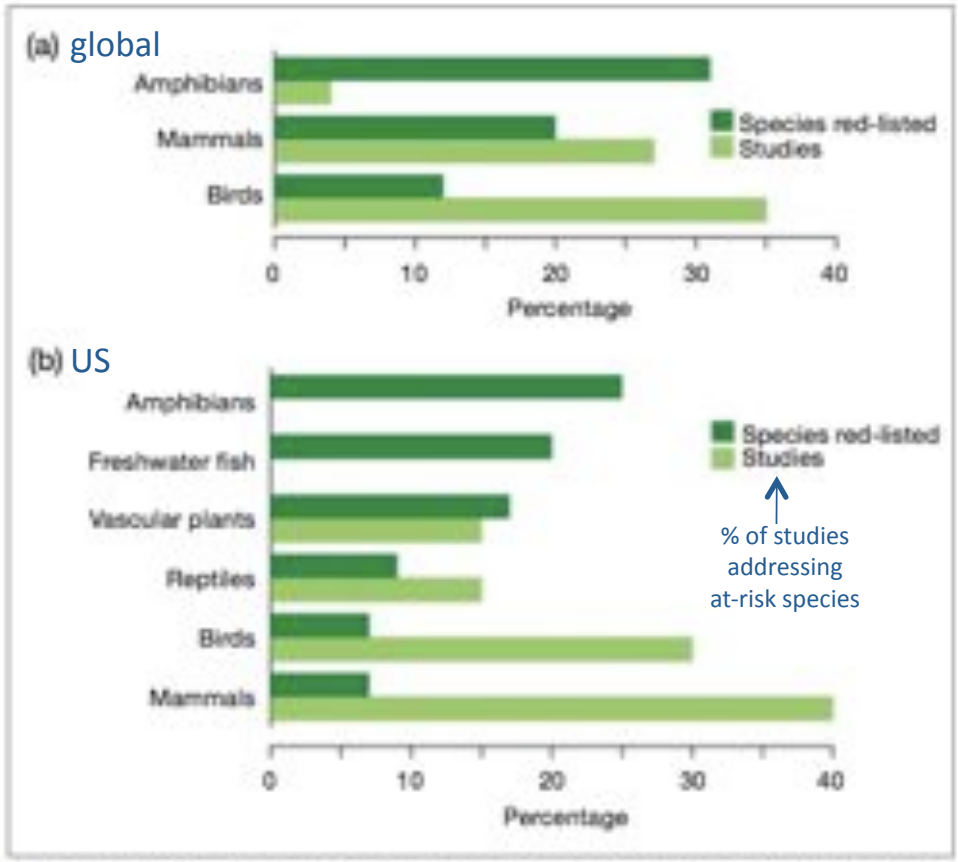
# Impediments to Climate Adaptation




Jantarasami et al. 2010. Ecology and Society15: 33.

# Declining amphibians + lack of information

- 31% at risk
- 11% of IUCN red-listed species
- Steepest rate of decline of any group
- Most understudied of all at-risk groups




Lawler et al. 2006. Frontiers in Ecology and Environment 4: 473-480.

Stuart et al. 2004. Science 306: 1783-1786.
Wake & Vredenburg. 2008. PNAS 105: 11466-11473.

# Our goals

New hydrologic products for wetlands

New methods for modeling wetland change

Wetlands symposium for scientists & managers

Wetlands vulnerability assessment (amphibian)

Identify priority landscapes for management action

# Most US Pacific Northwest mountain amphibians populations appear stable

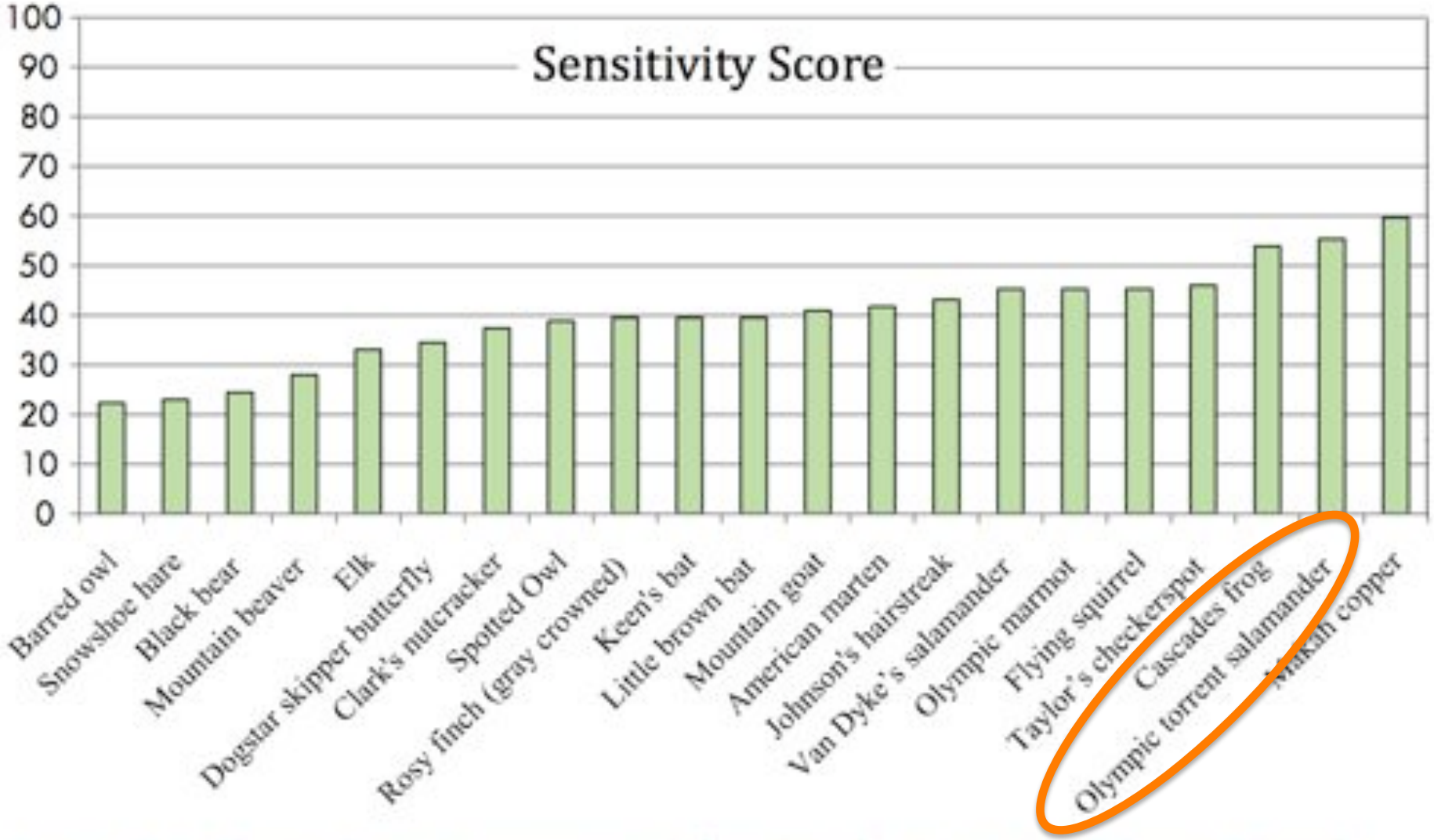
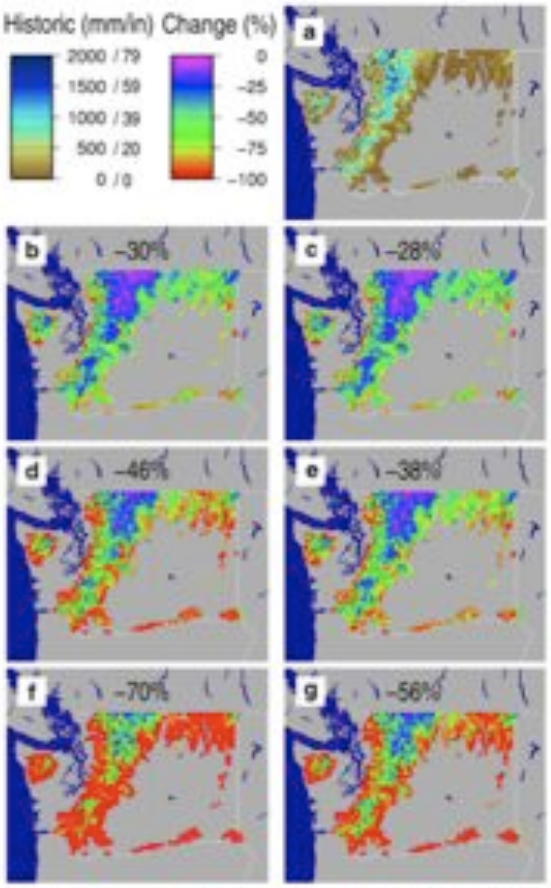
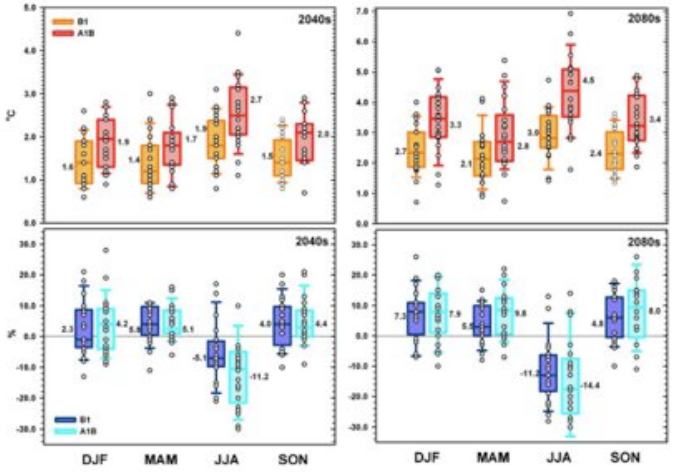
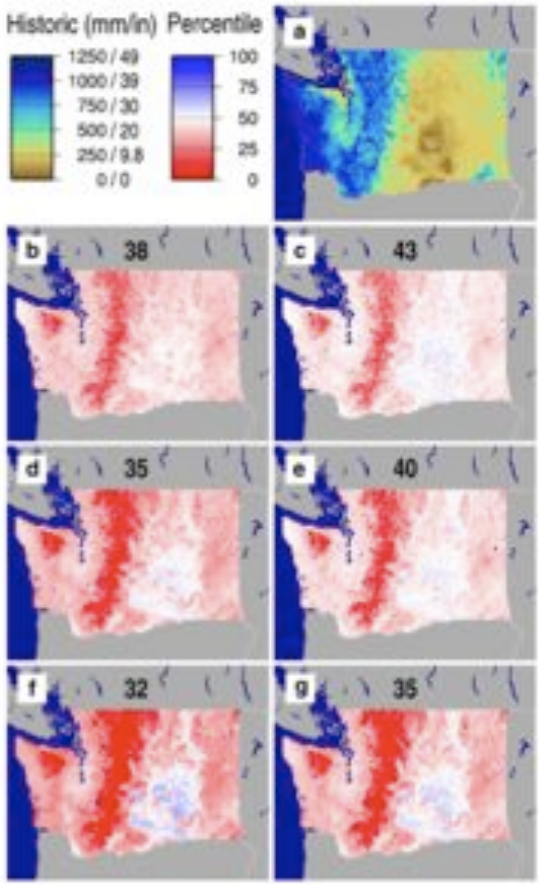



Figure C7.2. Climate change sensitivity scores for selected species on the Olympic Peninsula.




**Reduced snowpack**

**Hotter, drier summers**

**Reduced soil moisture & surface ponding**

Elsner et al. 2010. Climatic Change 102.

Changes in temperature & precipitation

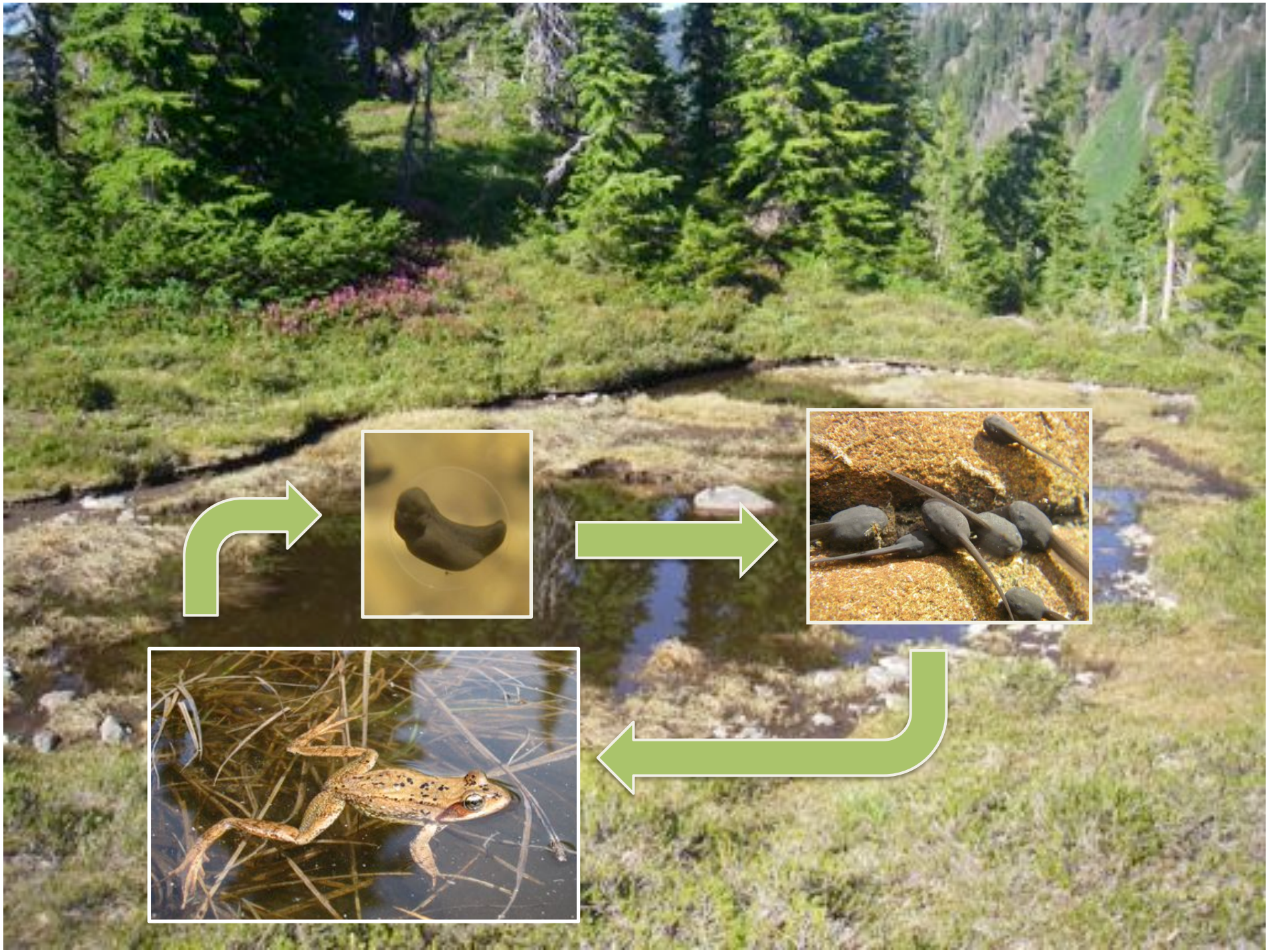
↓

Changes in snowpack & availability of pond habitats

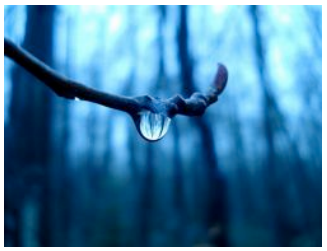
Changes in temperature & precipitation

↓

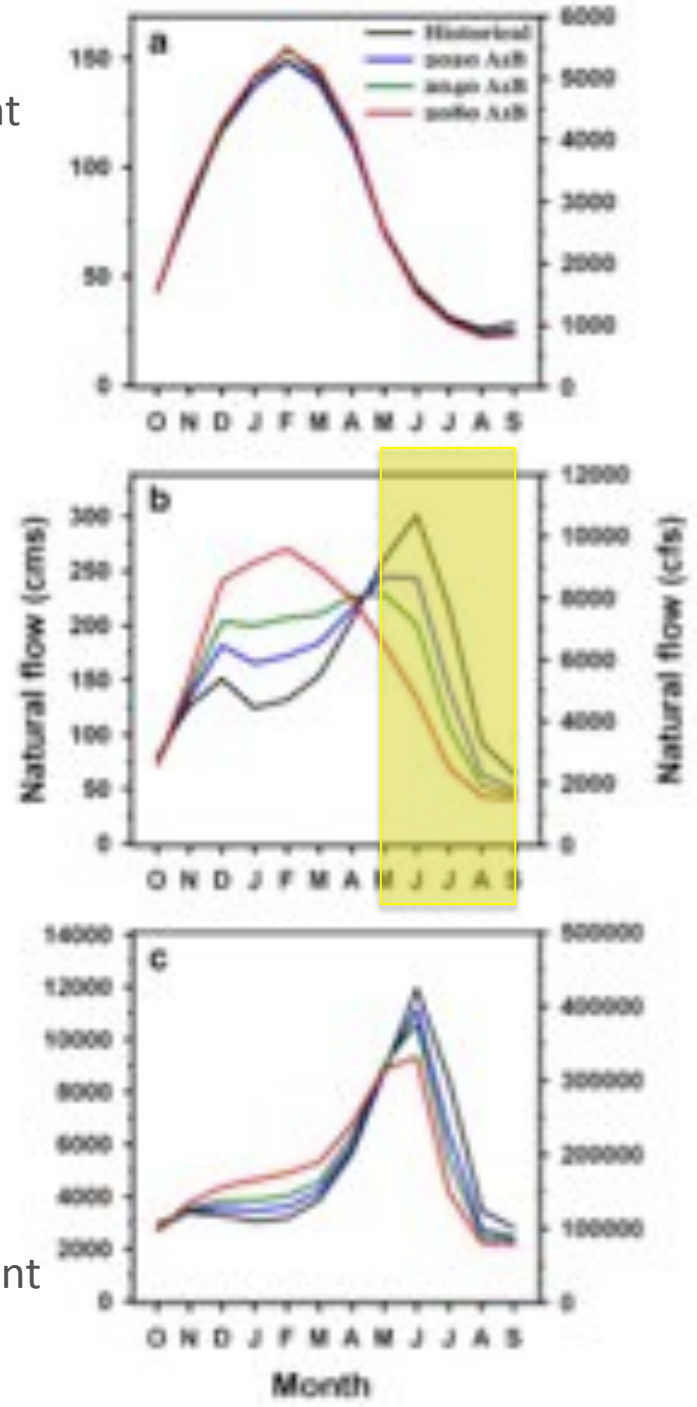
Changes in rate & timing of pond inundation & drying



Rain-dominant



Transitional regions




Snow-dominant

Elsner et al. 2010. Climatic Change 102.

# Life history requirements vary

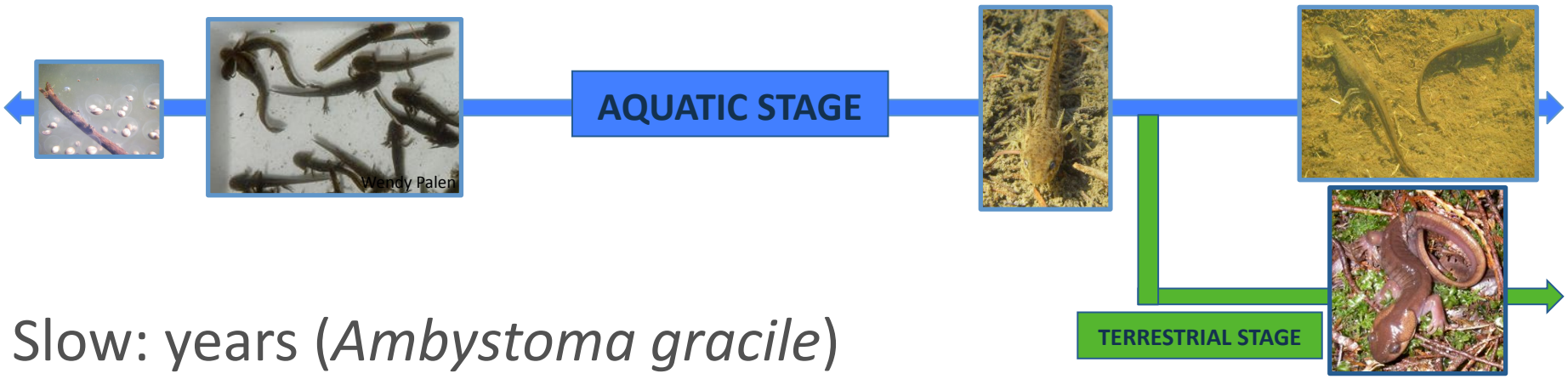
Fast developmental time

Slow developmental time

Weeks to months

Years

Fast: months (*Rana cascadae*)




Slow: years (*Ambystoma gracile*)

# Life history requirements vary

Fast developmental time

Slow developmental time

Weeks to months

Years

# Changing hydrology & amphibian demography

- Earlier ice-out, warmer temperatures
  - Beneficial?
    - Earlier breeding
    - Faster development
    - Longer season
    - Increased survival during mild winters

# Changing hydrology & amphibian demography

- Earlier ice-out, warmer temperatures
  - Beneficial?
    - Earlier breeding
    - Faster development
    - Longer season
    - Increased survival during mild winters
  - Detrimental?
    - Habitat loss (drying or shallow freezing)
    - Habitat compression = increased competition
    - Reduced developmental period
    - Altered life history selection
    - Decreased winter survival due to exposure

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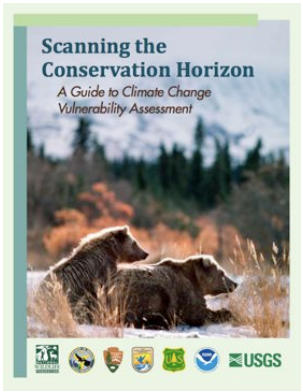



Identify synergistic threats

- Species
- Habitats
- Ecosystems

1. Identify Conservation Target(s)

2. Assess Vulnerability to Climate Change

- Sensitivity
- Exposure
- Adaptive Capacity

Monitor, Review, Revise

- Changes in Policy
- Changes in Practice
- Institutional Changes

4. Implement Management Options

3. Identify Management Options

- Reduce Sensitivity
- Reduce Exposure
- Increase Adaptive Capacity

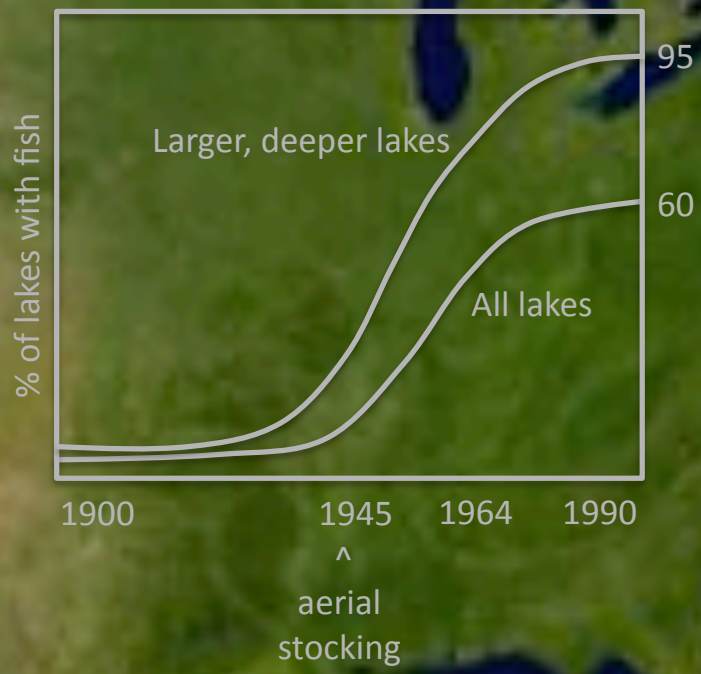
Figure 1.1. Framework for Developing Climate Change Adaptation Strategies

# Synergistic stressor: exotic fish

FIGURE 30. Airplane fish planting.

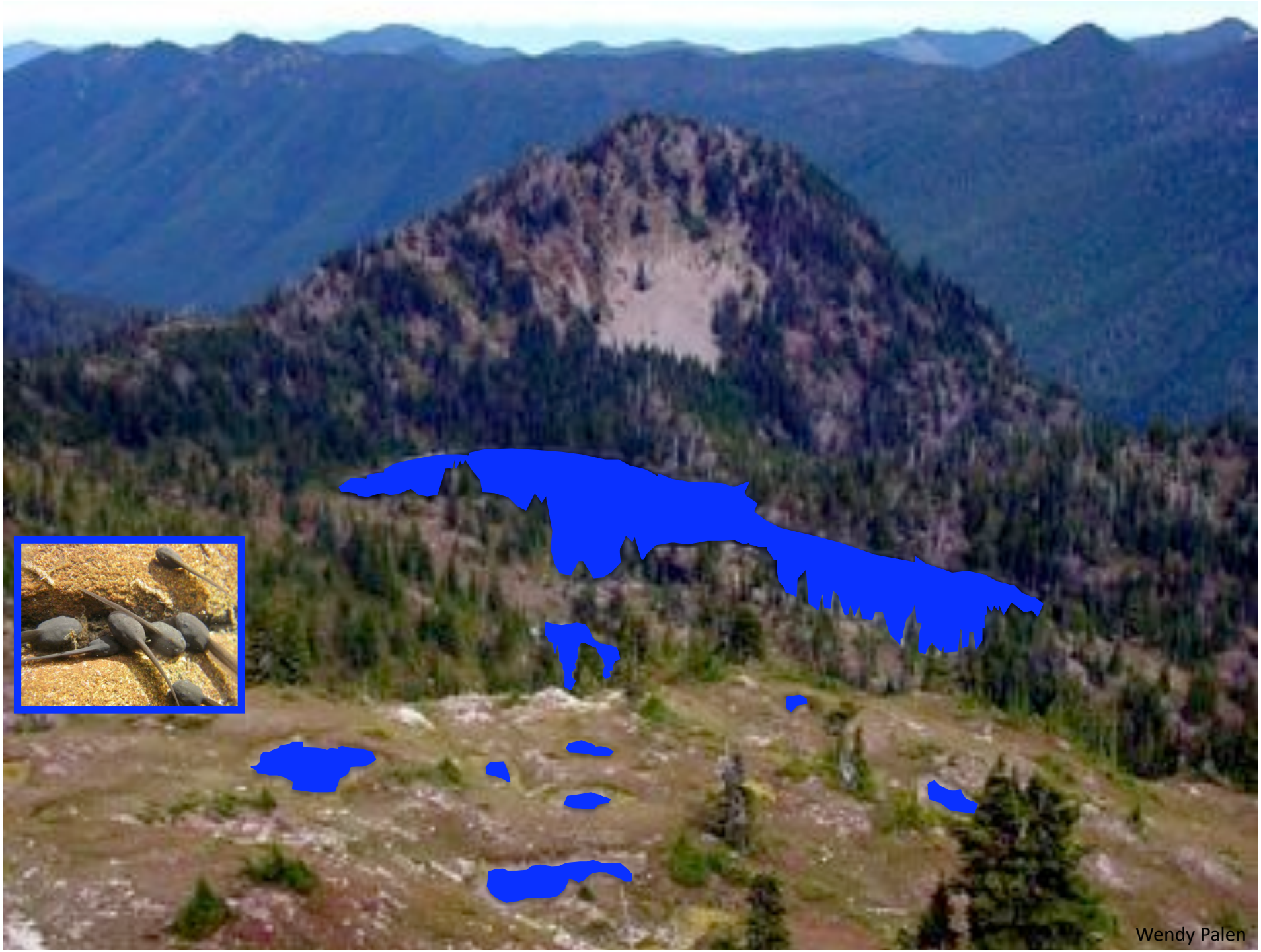
www.ediblegeography.com

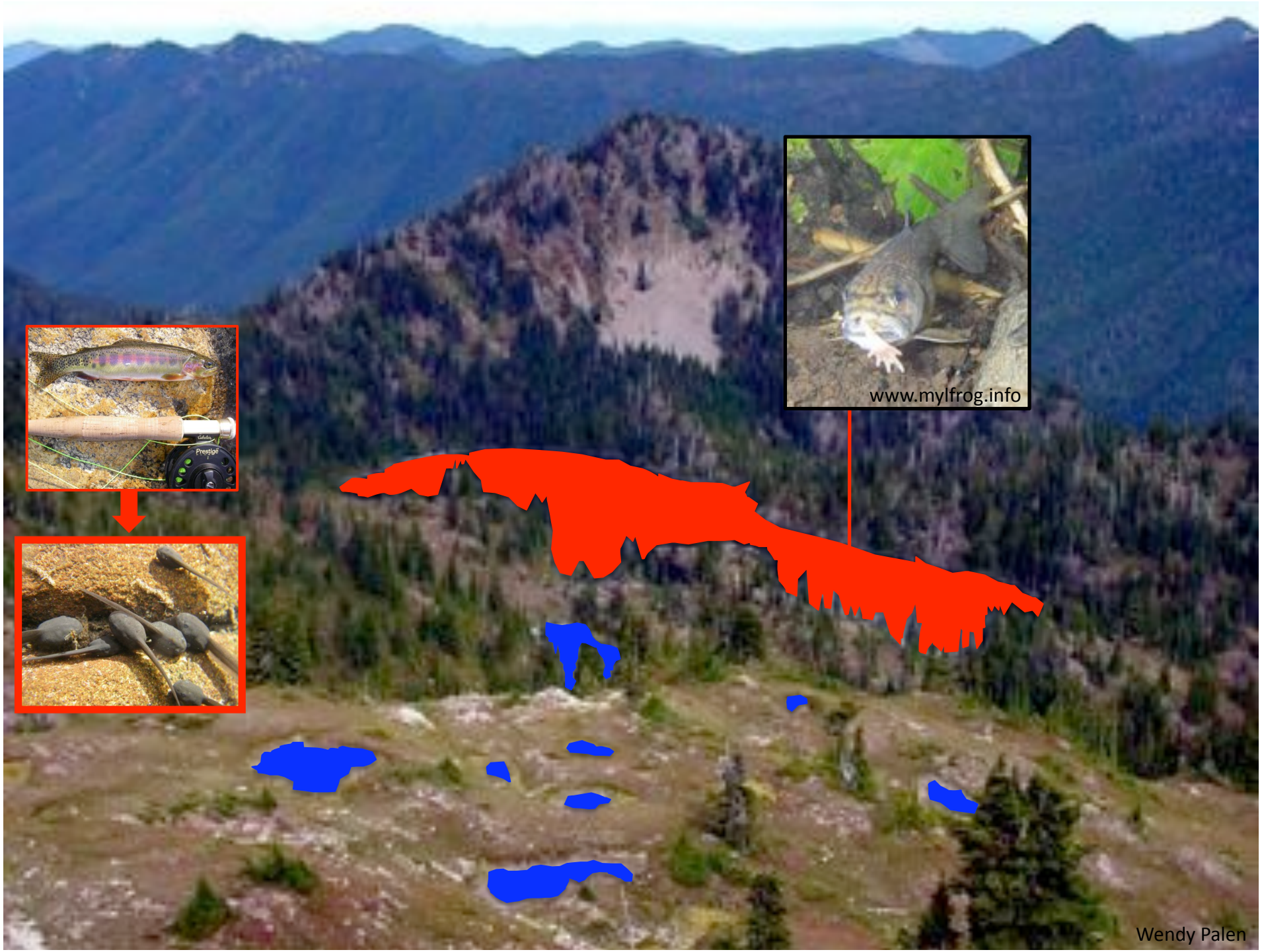
# Fish are everywhere



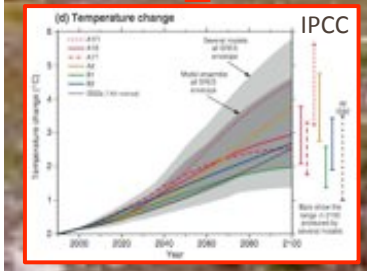

Figures from Bahls 1992

www.mylfrog.info
Wendy Palen


Wendy Palen


www.mylfrog.info
Wendy Palen

lo vulnerability hi

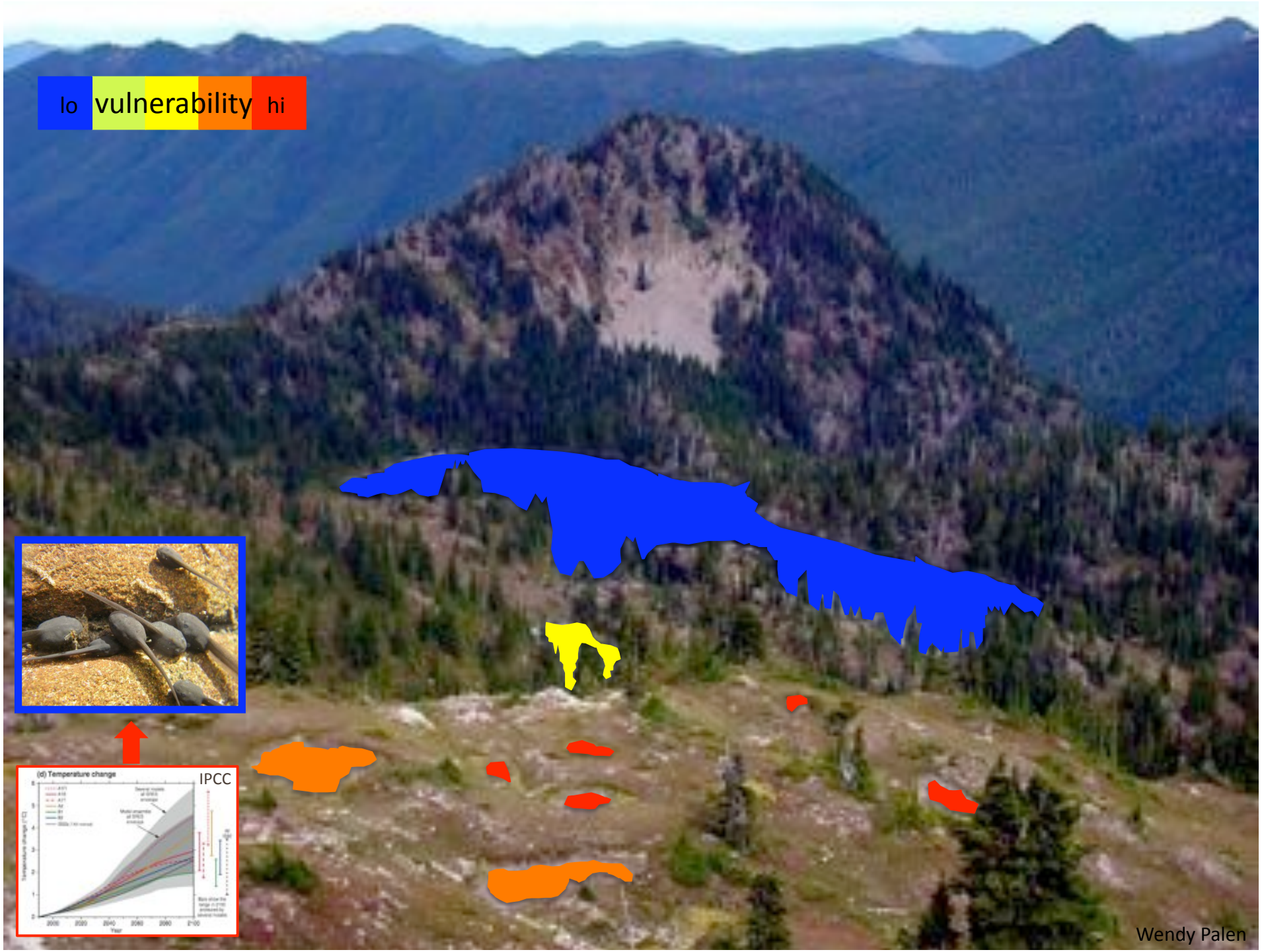


# "Amphibian squeeze"

Wendy Palen

lo vulnerability hi
www.mylfrog.info
Daszak et al. 1999
IPCC
(d) Temperature change
“Amphibian squeeze”
Wendy Palen

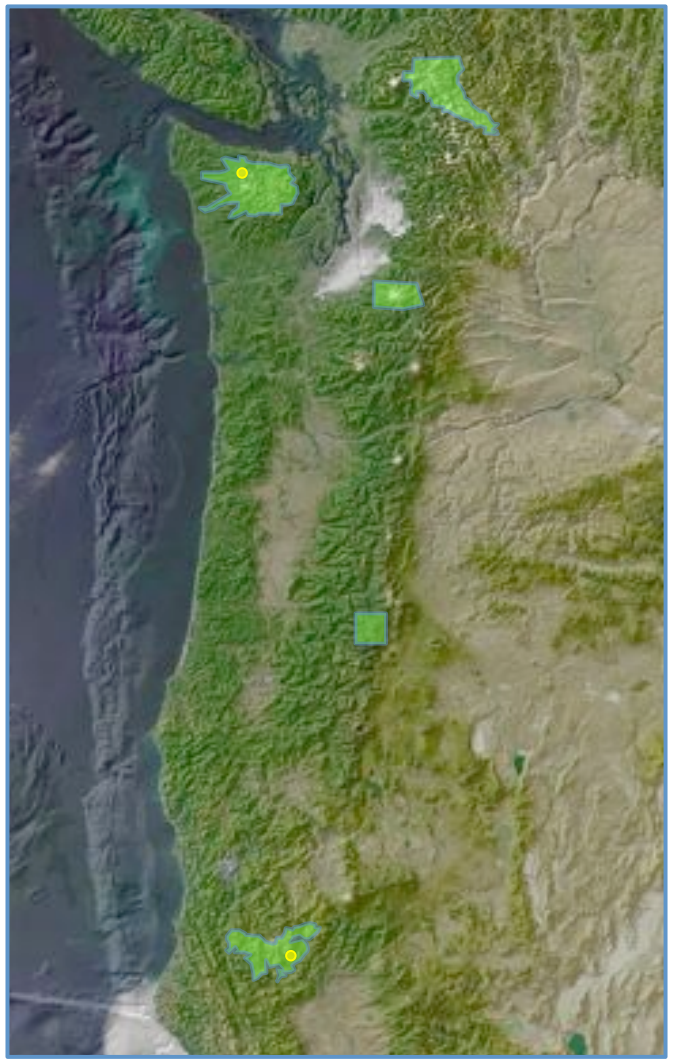
lo vulnerability hi
www.mylfrog.info
IPCC
Wendy Palen


lo vulnerability hi
IPCC
(d) Temperature change
Wendy Palen

# Focal regions & field sites

- Pacific Northwest
  - Olympic Nat'l Park & Forest
    - 7 Lakes Basin
  - North Cascades Nat'l Park
  - Mt. Rainier Nat'l Park
  - Three Sisters Wilderness
  - Trinity-Alps
    - Echo Basin

* Hope to add Nat'l Forests



# Research plan

- Step 1: develop wetland hydrologic models for 2020s, 2040s, and 2080s
  - Alan Hamlet & Se-yeun Lee, Climate Impacts Group

# Variable Infiltration Capacity Hydrologic Model

- Fully distributed, physically based hydrologic model
- Widely used in climate change studies, including ecological studies of climate impacts
- 1/16 degree resolution (~5km x 6km)

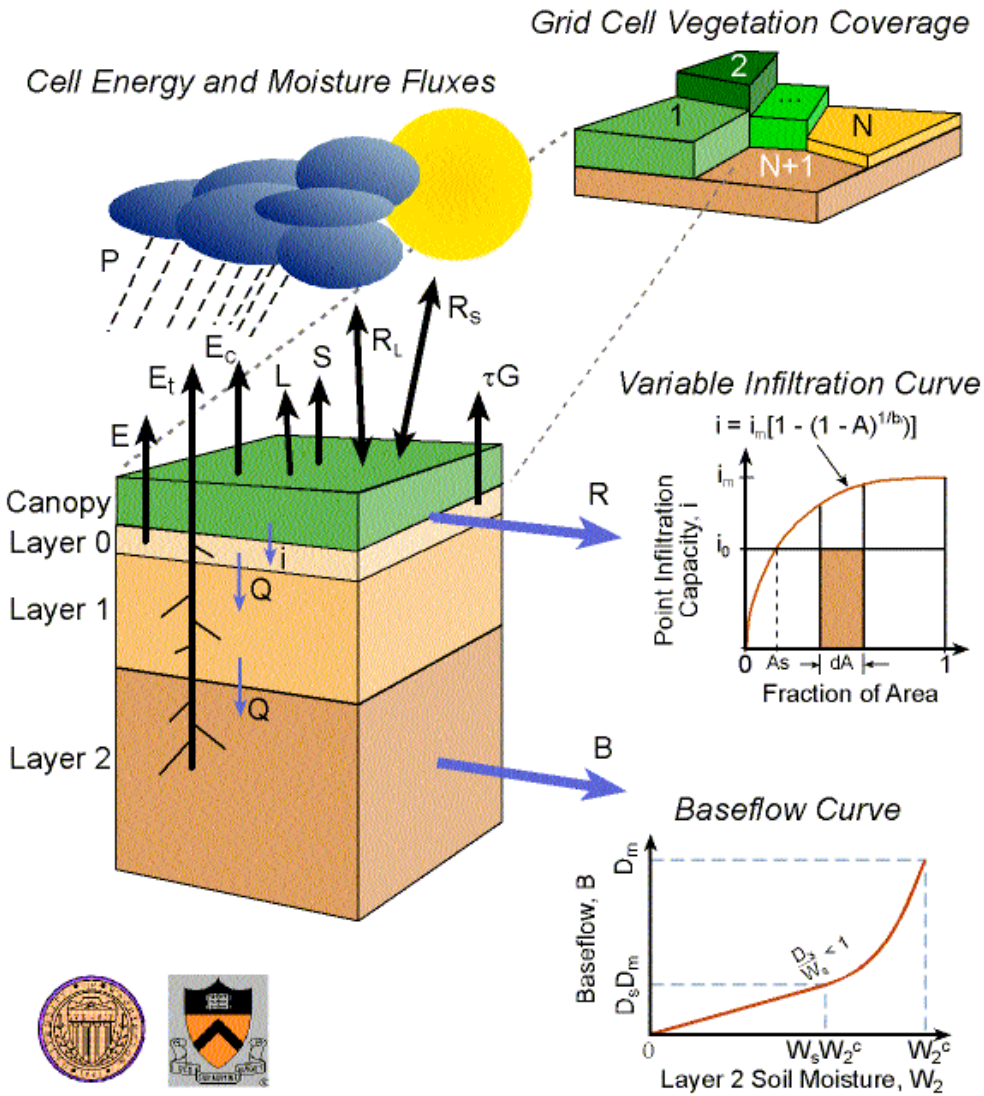



Image: Alan Hamlet

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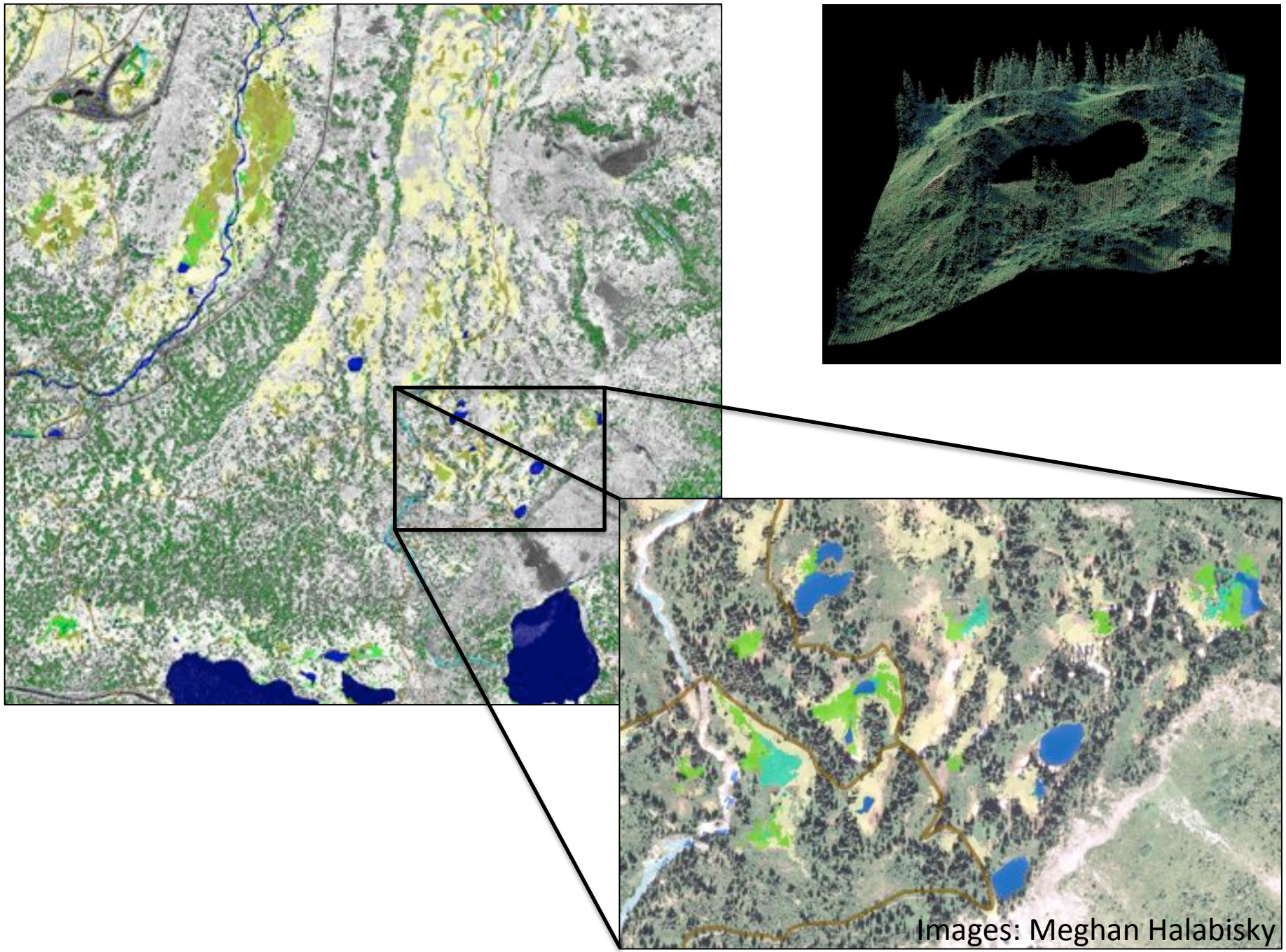
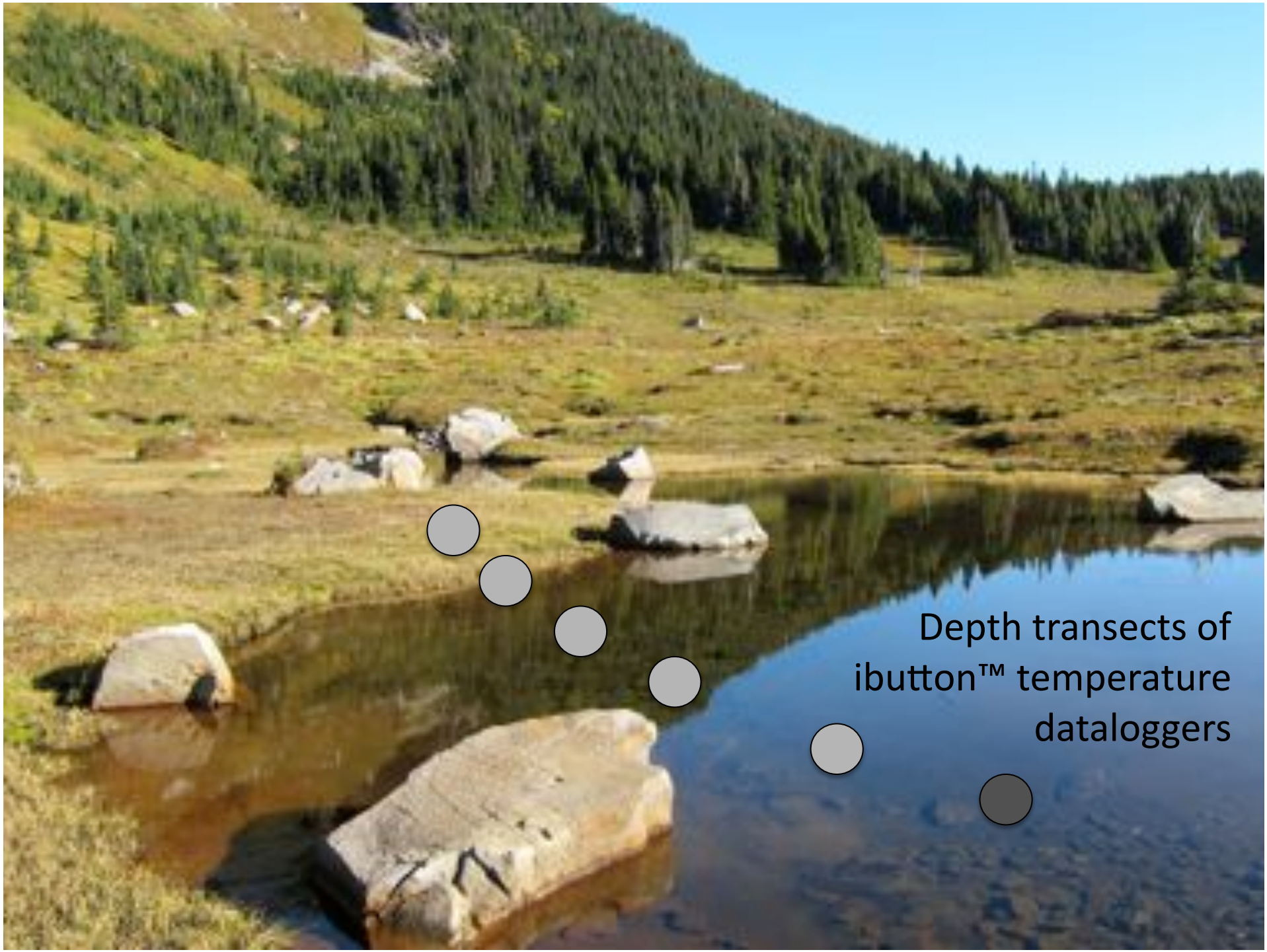
- Step 1: develop wetland hydrologic models for 2020s, 2040s, and 2080s

- Step 2: remote-sensing & empirical monitoring of wetlands
  - Meghan Halabisky & Maureen Ryan, UW


Images: Meghan Halabisky


Depth transects of
ibutton™ temperature
dataloggers

Monitor and measure
seasonal changes in pond
depth & aerial extent

USGS
science for a changing world
Amphibian Research and Monitoring Initiative
NATIONAL PARK SERVICE
FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE
Use existing data & conduct
new amphibian surveys

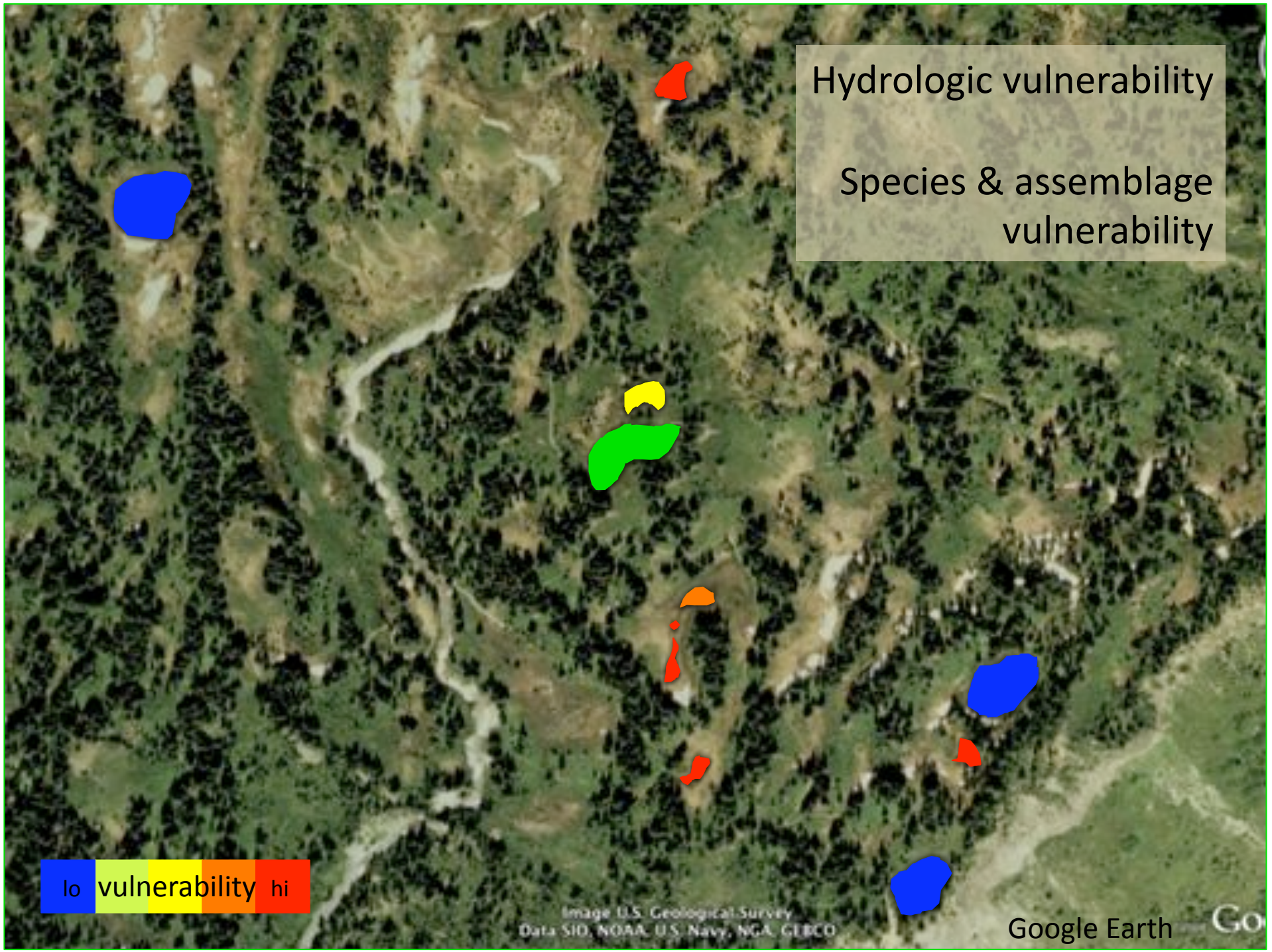
Continue long-term demographic studies

# Research plan

- Step 1: develop wetland hydrologic models for 2020s, 2040s, and 2080s
- Step 2: remote-sensing & empirical monitoring of wetlands
- Step 3: vulnerability assessment
  - Maureen Ryan & Meghan Halabisky, UW
  - Wendy Palen & Nick Dulvy, Simon Fraser University
  - Mike Adams, USGS Corvallis

Relate hydrologic attributes to species occupancy

Identify hydrologic cut-offs for fast & slow life histories


Hydrologic vulnerability
Species & assemblage vulnerability
lo
vulnerability
hi
Image U.S. Geological Survey
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google Earth

# Research plan

- Step 1: develop wetland hydrologic models for 2020s, 2040s, and 2080s
- Step 2: remote-sensing & empirical monitoring of wetlands
- Step 3: vulnerability assessment
- Step 4: identify priority landscapes for climate adaptation action
  - Research team
  - NPS & USFS managers
  - Recreational stakeholder groups

# Fall 2012 Symposium

- Exchange knowledge, ideas, and feedback
- Report on progress and new resources
- Identify needs for next steps

- Hosted by EcoAdapt
- Invitations & request for input forthcoming
- Please forward to anyone interested
- Please attend!

# Thanks

U.S. Fish & Wildlife Service
North Pacific Landscape Conservation Cooperative

Smith Fellows

USGS
science for a changing world
Amphibian Research and Monitoring Initiative

CLIMATE
IMPACTS
GROUP

NATIONAL
PARK
SERVICE

FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE