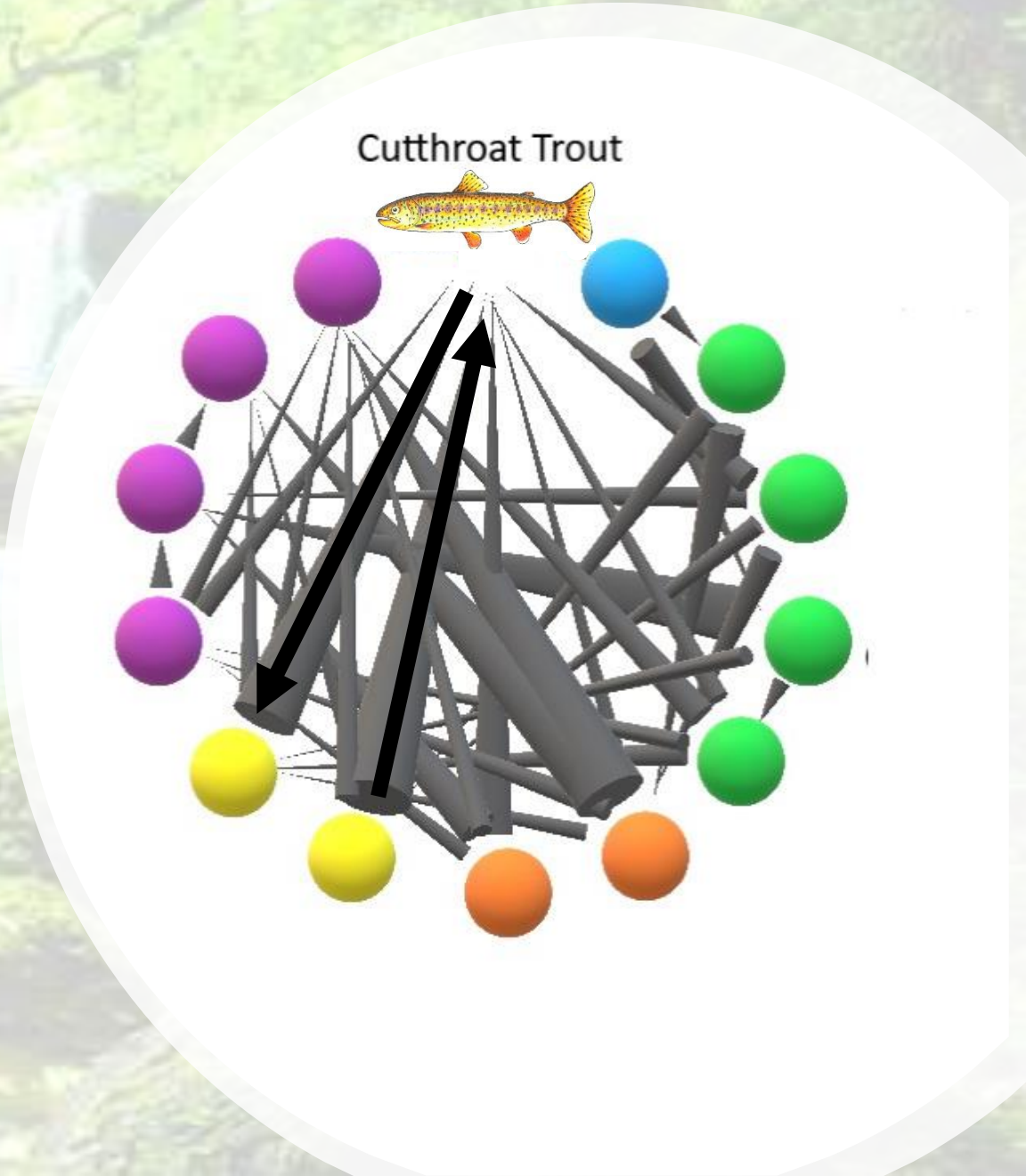
Influence of Cutthroat Trout on Food Web Topology & Community Stability in Headwater Streams

Lauren Zatkos, Ivan Arismendi, Brooke Penaluna, Sherri Johnson, & Alba Argerich

The Food Web Question…

- Aquatic ecosystems are vulnerable to climate change
- Health of headwater streams are linked to health of entire system
- Studying the topology of networks is a tool for understanding the networks robustness and resilience to disturbances
  - Predict how top predators like *Oncorhynchus clarkii clarkii* will be impacted



The Food Web Question…

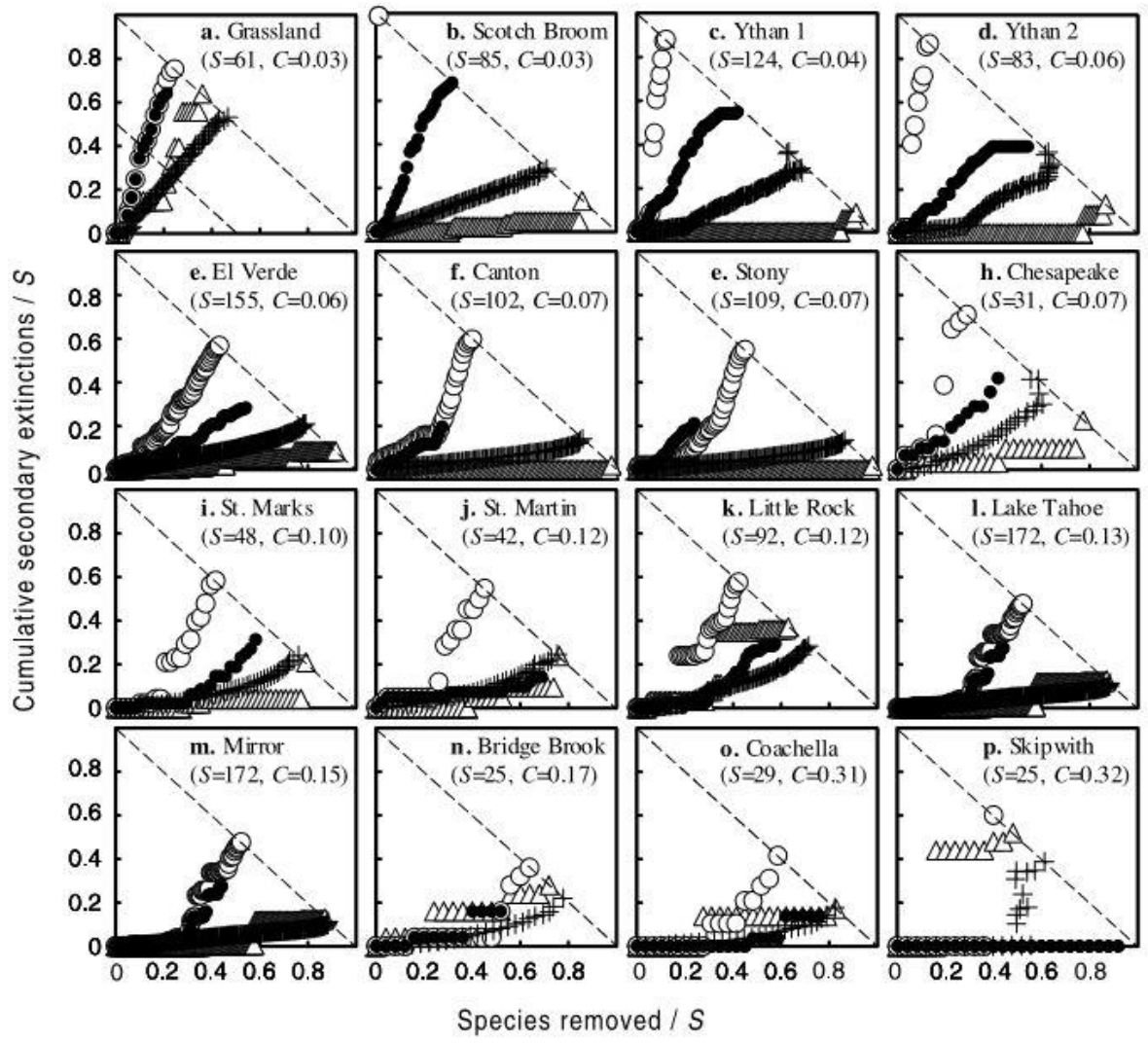
- Many attributes of a food web are quantifiable
- Allows for structure of webs to be compared
- Patterns (or lack of) in food webs allows ecologists to recognize principles that may govern *structure*, and therefore *function*
- Complexity of data → web structure models

Quantitative Network Metrics

- Wide ranging applications
  - Can be used in any system!
  - Great for large spatiotemporal scales
- Definitions:
  - Nodes (S) – taxa, or taxa richness
  - Links (L) – feeding interactions
  - Linkage Density (L/S) – average number of links per node
  - Connectance (L/S^2), or *Co* – proportion of links that actually occur compared to amount of theoretical links

Connectance

- Connectance → community stability
- Dunne *et al* (2002) found variable community responses with differing Co values among 16 food webs.
- Stability?
  - The resiliency of a community to a disturbance (species extinction)
  - Stability typically explained by the level of subsequent secondary extinctions following the primary disturbance.



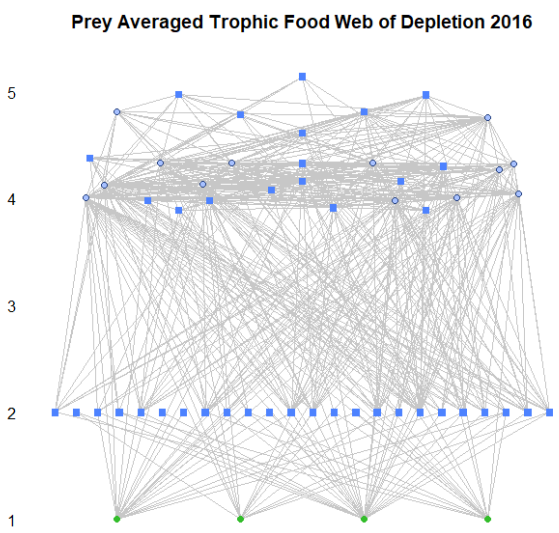
Connectance

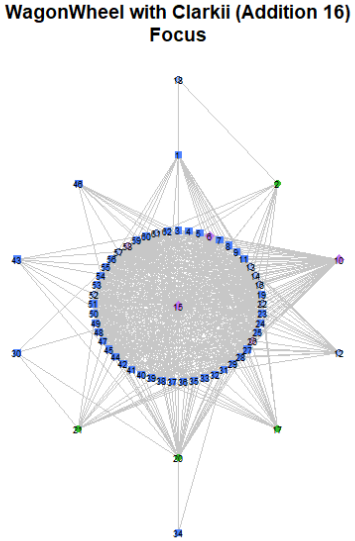
- Manipulated disturbances and monitored secondary extinctions
- Dashed line is community "threshold" – after threshold is reached, food web disappears

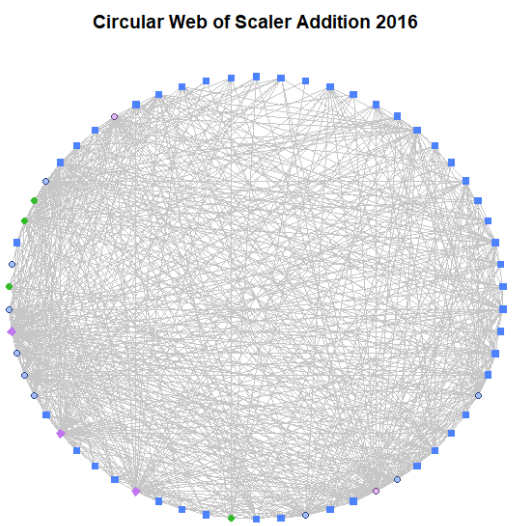
Dunne et al. (2002)

Introducing Cheddar…

- Allows for analysis and visualization of ecological food webs
- Data utilized: taxa list, abundances, body mass
- Array of visual web options, plots, and metrics



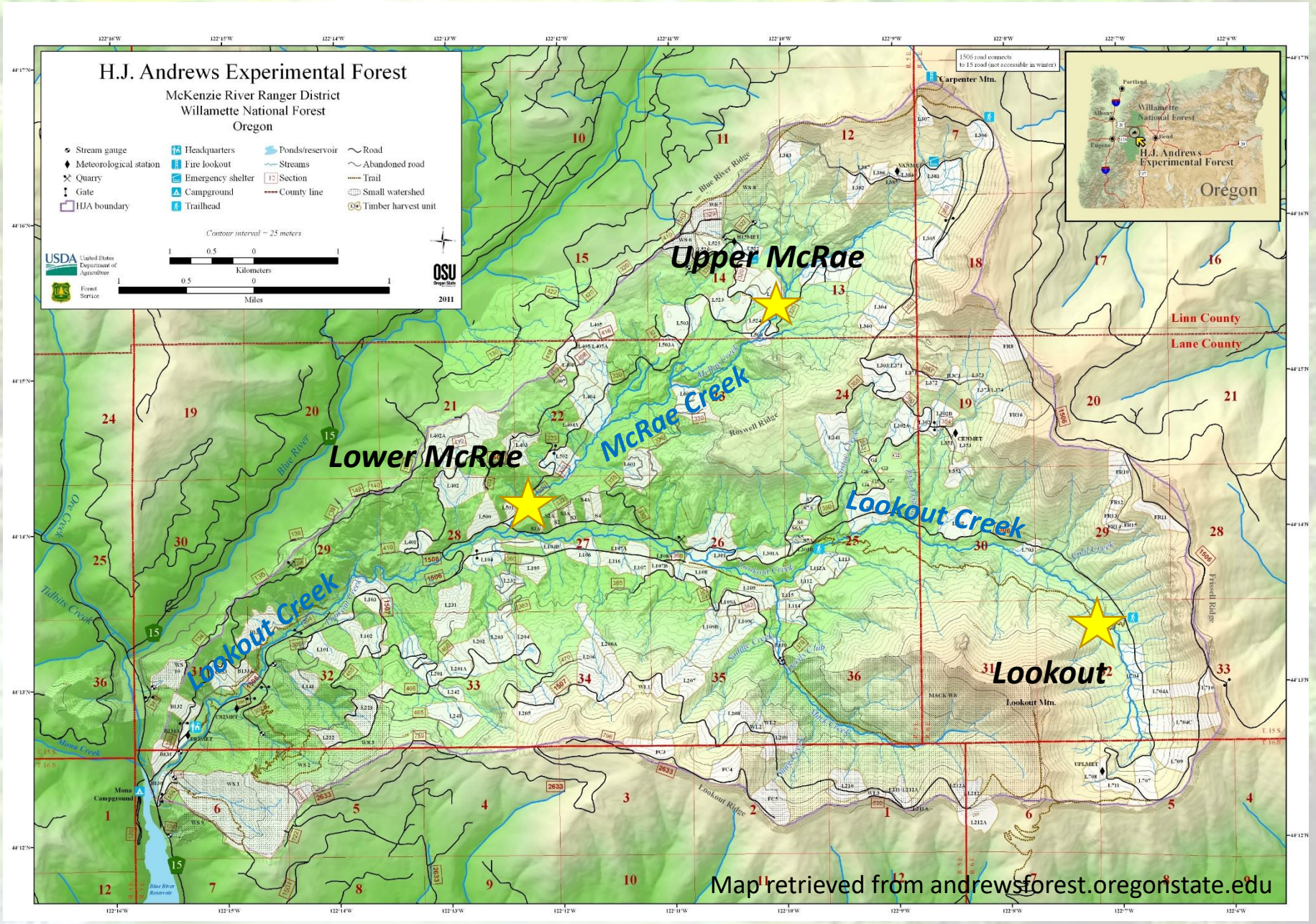




…and WebBuilder

- Assigns links between nodes based on user-defined parameters
- Data utilized: known links based on literature, minimum resource/consumer methods for each node
- Can include information from multiple studies, can include rare interactions extrapolates to build a more complete web (Gray et al. (2005))
- Example: original web with 129 interactions → 553 interactions

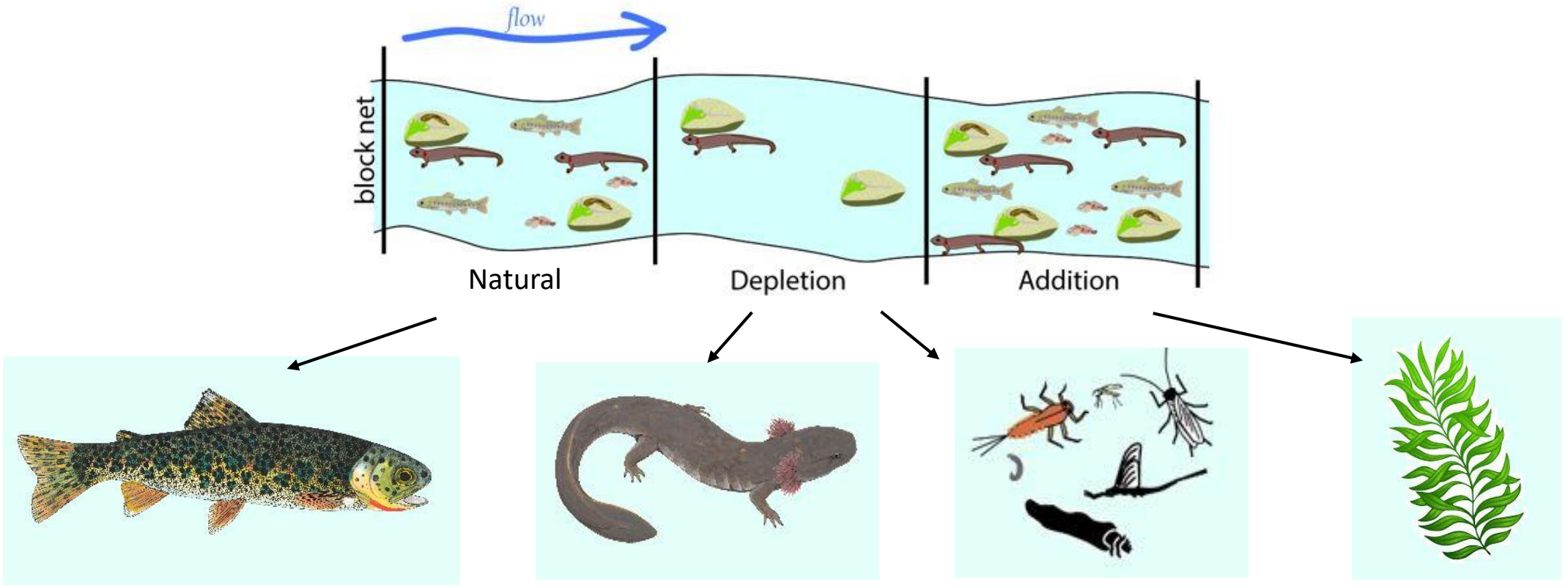
SCALER Study Sites



Map retrieved from andrewsforest.oregonstate.edu

SCALER and Food Web Data

- Lower McRae Creek – sampled from 2015-2016
- Lookout and Upper McRae – sampled in 2015



Artwork (Cutthroat and Salamander) by Azita Roshani, SCALER Study Design by Brooke Penaluna
SCALER study design by Brooke Penaluna, Alba Argerich, and Walter Dodds

Structural Metric Results - Connectance

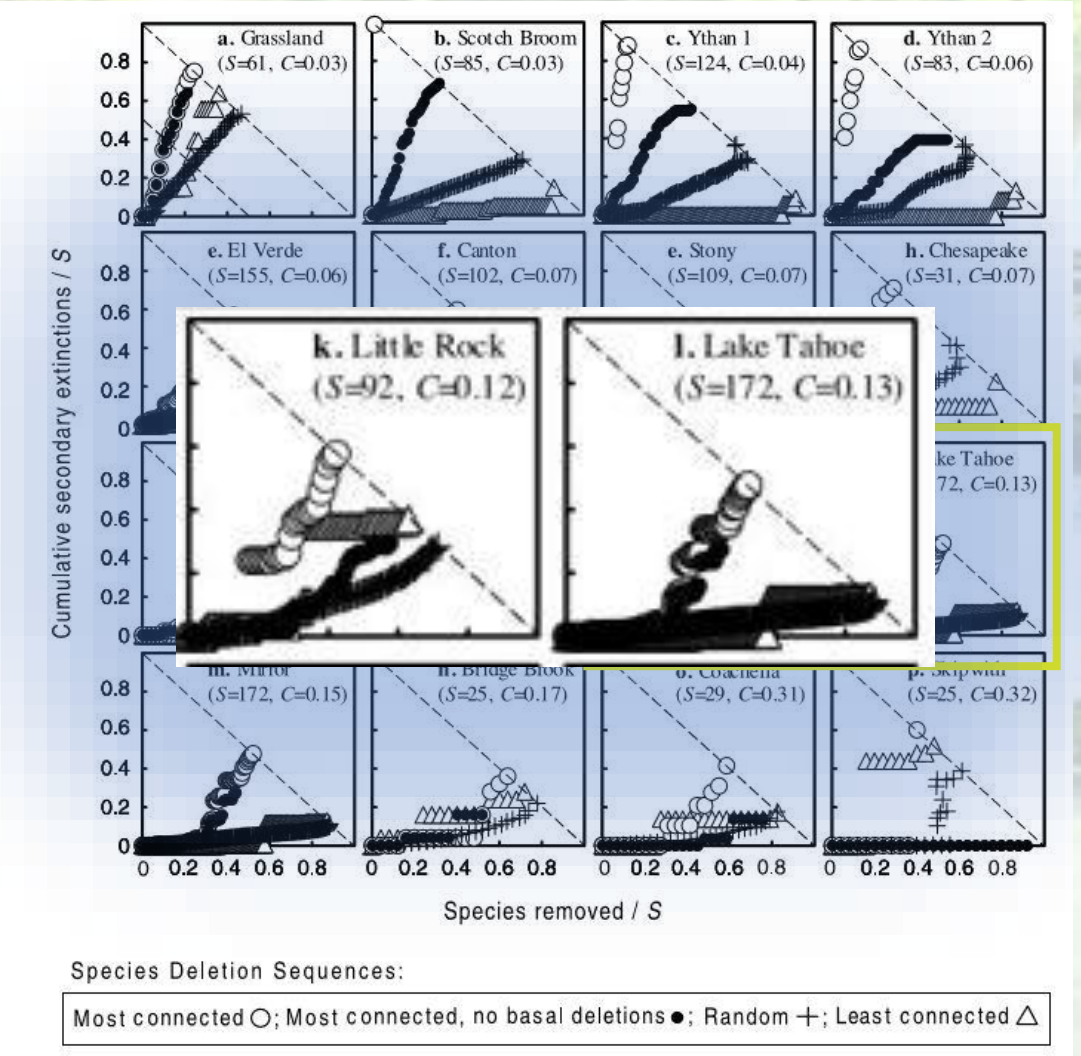
	Lookout 2015		Upper McRae 2015		Lower McRae 2015		Lower McRae 2016		
	Addition	Depletion	Addition	Depletion	Addition	Depletion	Natural	Addition	Depletion
Connectance	0.1361	0.1200	0.1517	0.1178	0.1678	0.1826	0.1611	0.1598	0.1885

Connectance values ranging from 0.12 – 0.19 fall within range of other observed *Co* values of aquatic ecosystems (0.03 – 0.32)

> 0.06 = Low *Co*

≤ 0.15 = High *Co*

Tiny changes in *Co*… what's the big deal?



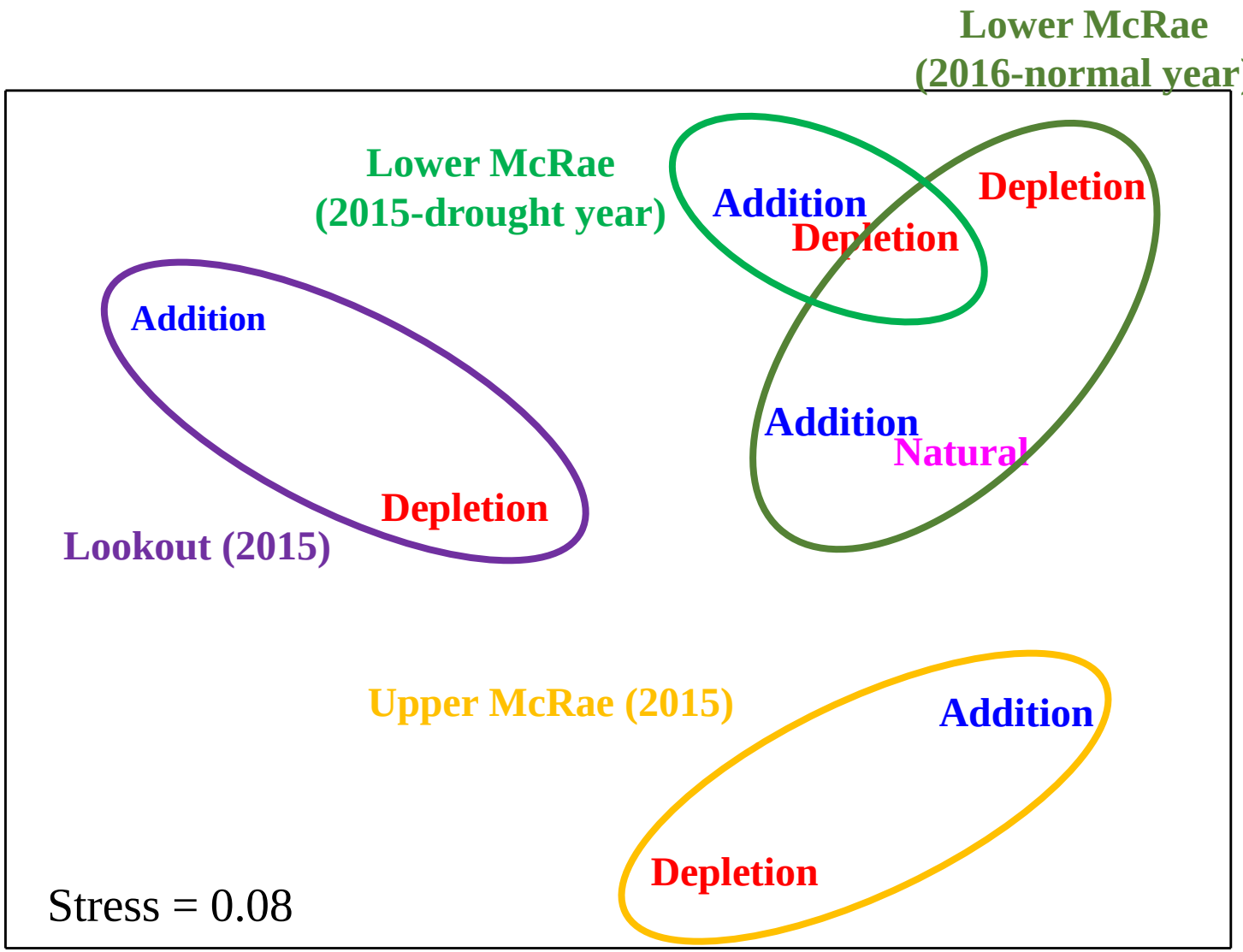
- Little Rock Lake and Lake Tahoe – only a 0.01 difference in connectance
- Three of the four categories of manipulated species deletions resulted in very different secondary extinction responses

Dunne et al. (2002)

14 Structural Metrics

- Total number of nodes
- Number of trophic links
- Fraction of omnivory
- Fraction of basal taxa
- Fraction of intermediate taxa
- Fraction of top-level taxa
- Fraction of non-top-level taxa
- Fraction of carnivory
- Characteristic path length
- Linkage density
- Connectance
- Sum of diet gaps
- Sum of consumers diet gaps
- Mean maximum trophic similarity

nMDS of Food Web Structures by Site



- Stream food webs are idiosyncratic
- Drought year (2015) had an affect on the food webs? – but still most closely resembles other webs of this site
- Top-level manipulations and environmental conditions may or may not influence structure

Conclusions from Structural Metric Comparisons

- Based on *Co,* headwater stream communities are relative stable regardless of site or top trophic level manipulation
- Headwater streams = highly resilient
- Food webs are unique to their streams and environmental conditions those sites experience, including drought
- Vertebrate manipulation and drought may have altered web topology, but webs still remained identifiable to site
- The resiliency of these webs will support trout persistence in headwater streams

Acknowledgments

- Arismendi Lab
- Bill Gerth, OSU
- Arianna Ilharreguy, OSU
- Data provided by H.J. Andrews Experimental Forest, LTER Network, & US Forest Service

Questions?