Ecosystem Services Provided by Stream Fishes

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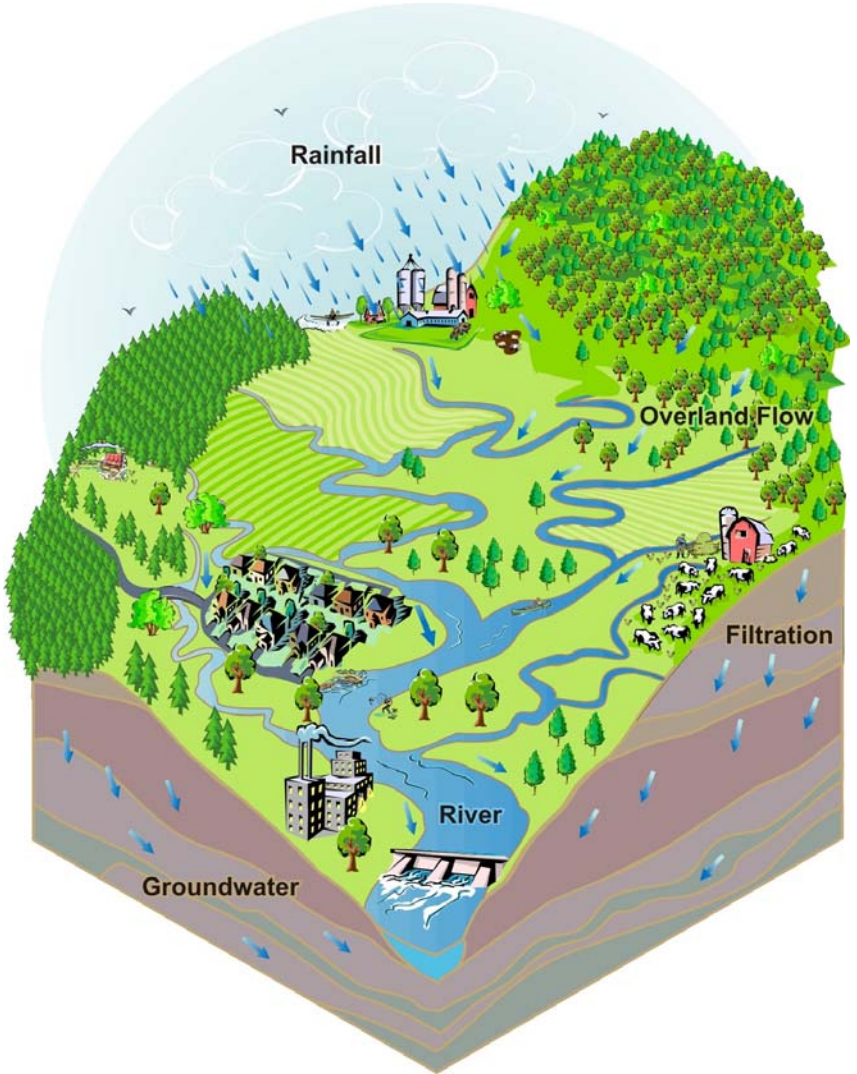
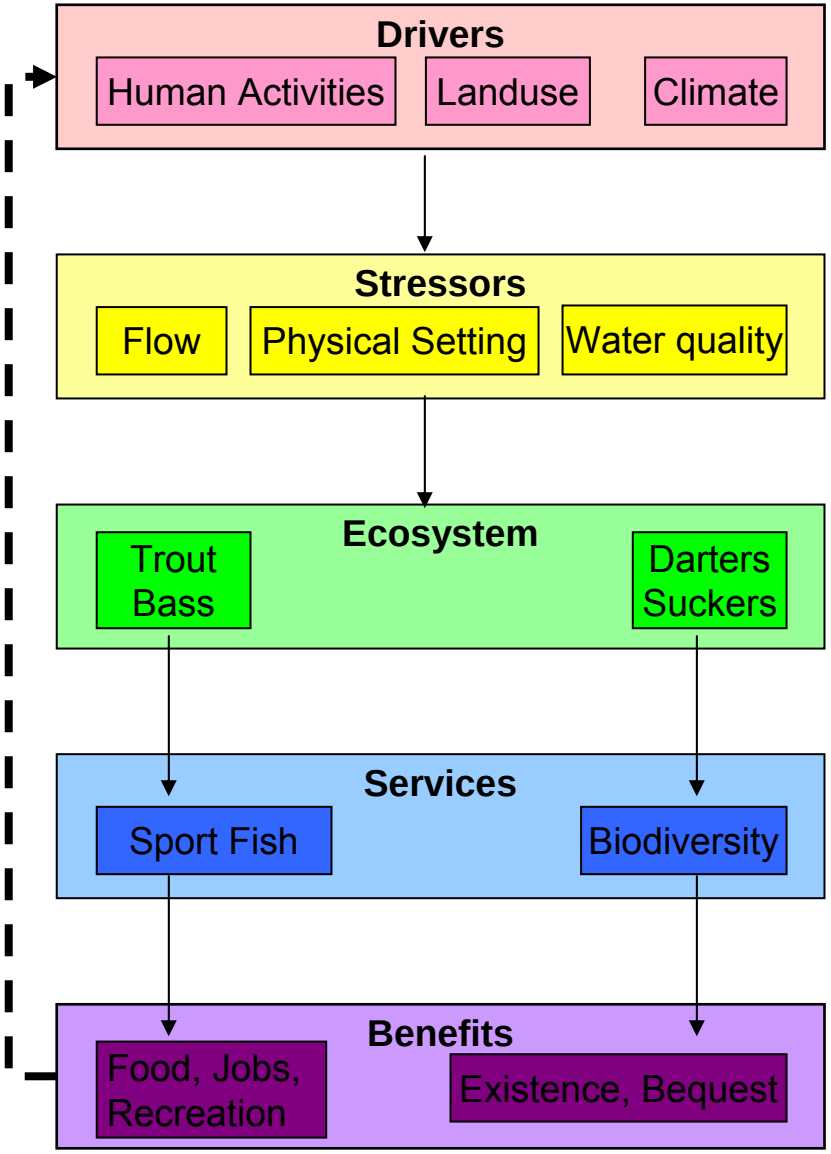
Human Activities, Landuse, and Climate Change Affect Streams

Oconee River, Athens, GA

Ecosystems Services of Streams

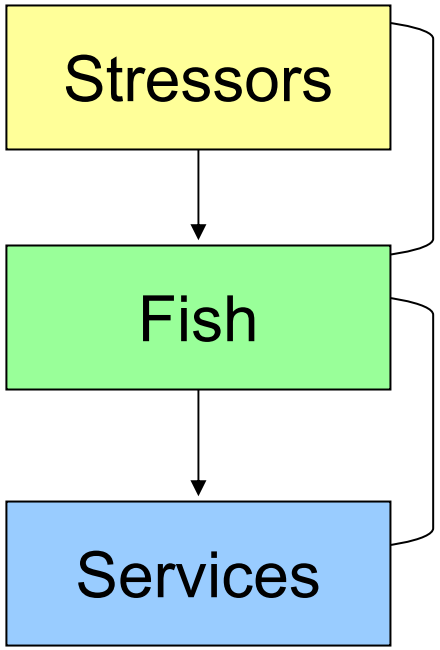
- Water for
  - Drinking
  - Agriculture
  - Industry
- Waste dilution
- Flood control
- Carbon storage
- Swimming and Boating
- Fishing
- Biodiversity



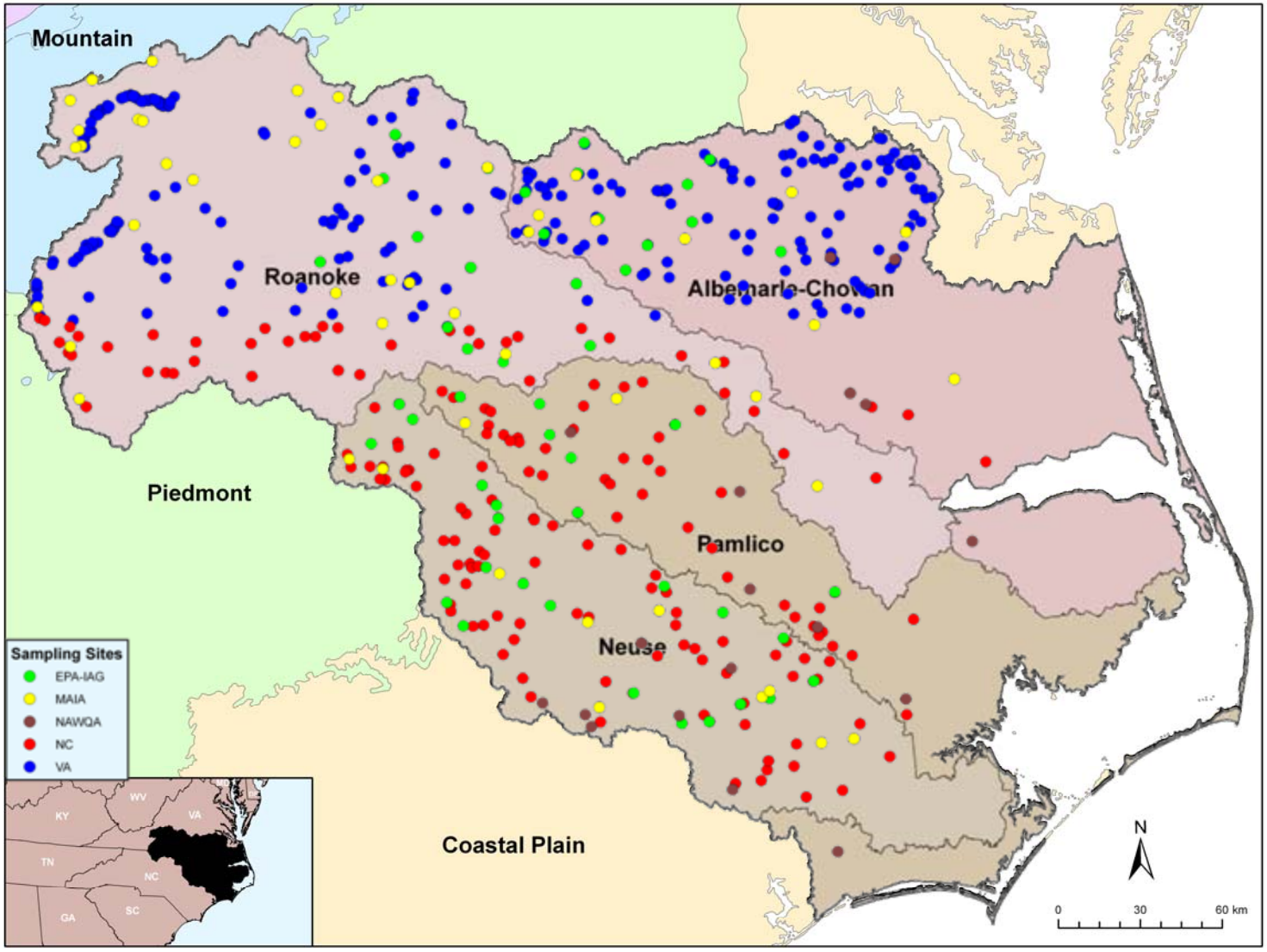

Drivers
Human Activities
Landuse
Climate
Stressors
Flow
Physical Setting
Water quality
Ecosystem
Trout
Bass
Darters
Suckers
Services
Sport Fish
Biodiversity
Benefits
Food, Jobs, Recreation
Existence, Bequest


Konrad P. Schmidt

Research Questions

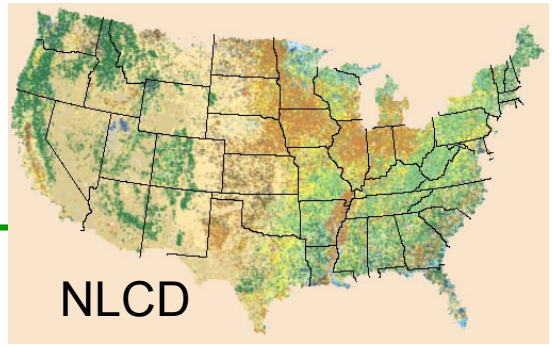


- How to relate stressors to service-relevant fish endpoints?
- How to relate fish species (guilds) to services?
- How will provisioning of services change in the future?


Mountain
Roanoke
Albemarle-Chowan
Piedmont
Pamlico
Neuse
Coastal Plain
Sampling Sites
EPA-IAG
MAIA
NAWQA
NC
VA
WV
VA
KY
TN
NC
GA
SC
N
0
30
60 km

Hierarchical Multiple Regression

$r = Intercept_{EcoregionXBasin} + c_{Forest} \cdot Forest + c_{Agriculture} \cdot Agriculture + c_{Flow} \cdot Flow + c_{Velocity} \cdot Velocity + c_{Temp} \cdot Temp + \ldots$



Habitat Suitability Index (HSI)

$= 1/(1+e^{-r})$ → 0 (Unsuitable) ≤ HSI ≤ 1 (Most suitable)

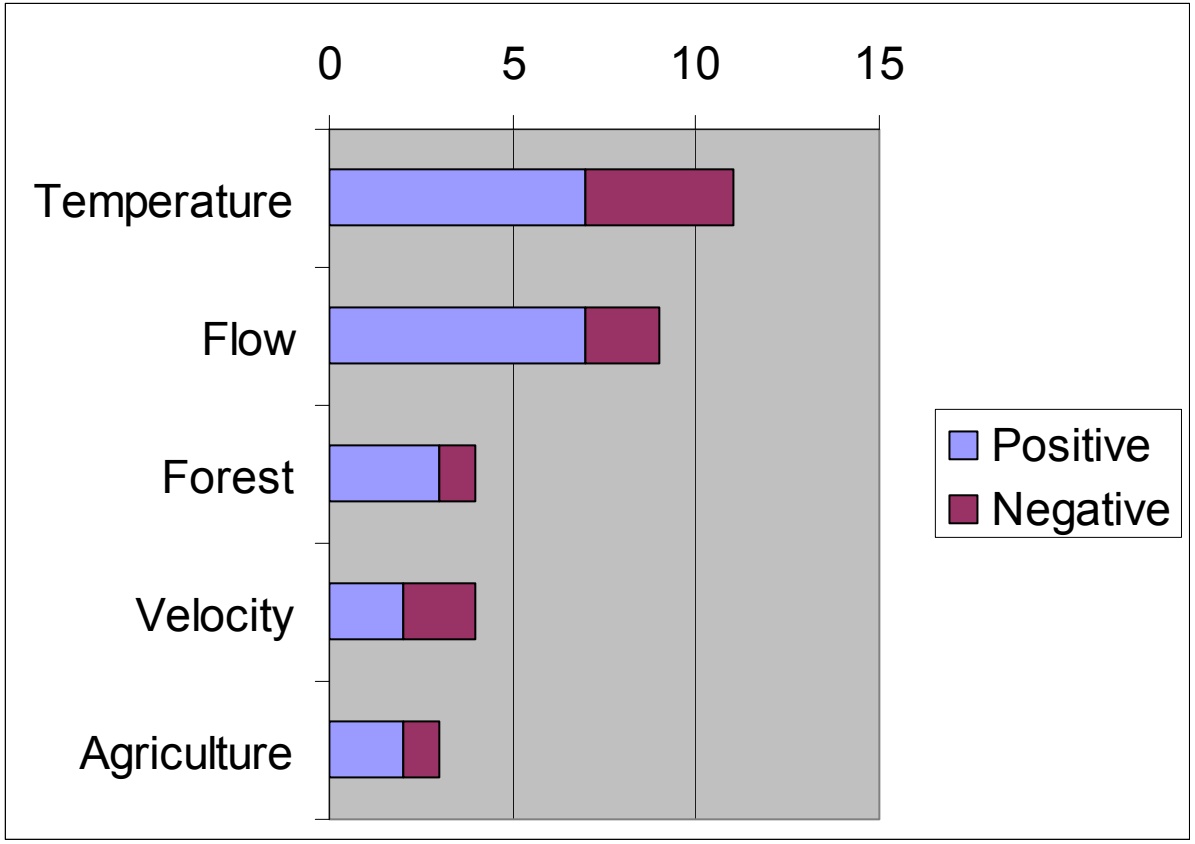
Fish Species Guilds

FISH		SERVICES
26 spp	Trout/Bass Catfish Gar/Bowfin Perch Pickerel Sunfish	Sport fish
24 spp	Darters – MT, PD, CP Suckers – MT, PD, CP	Biodiversity

Model Example

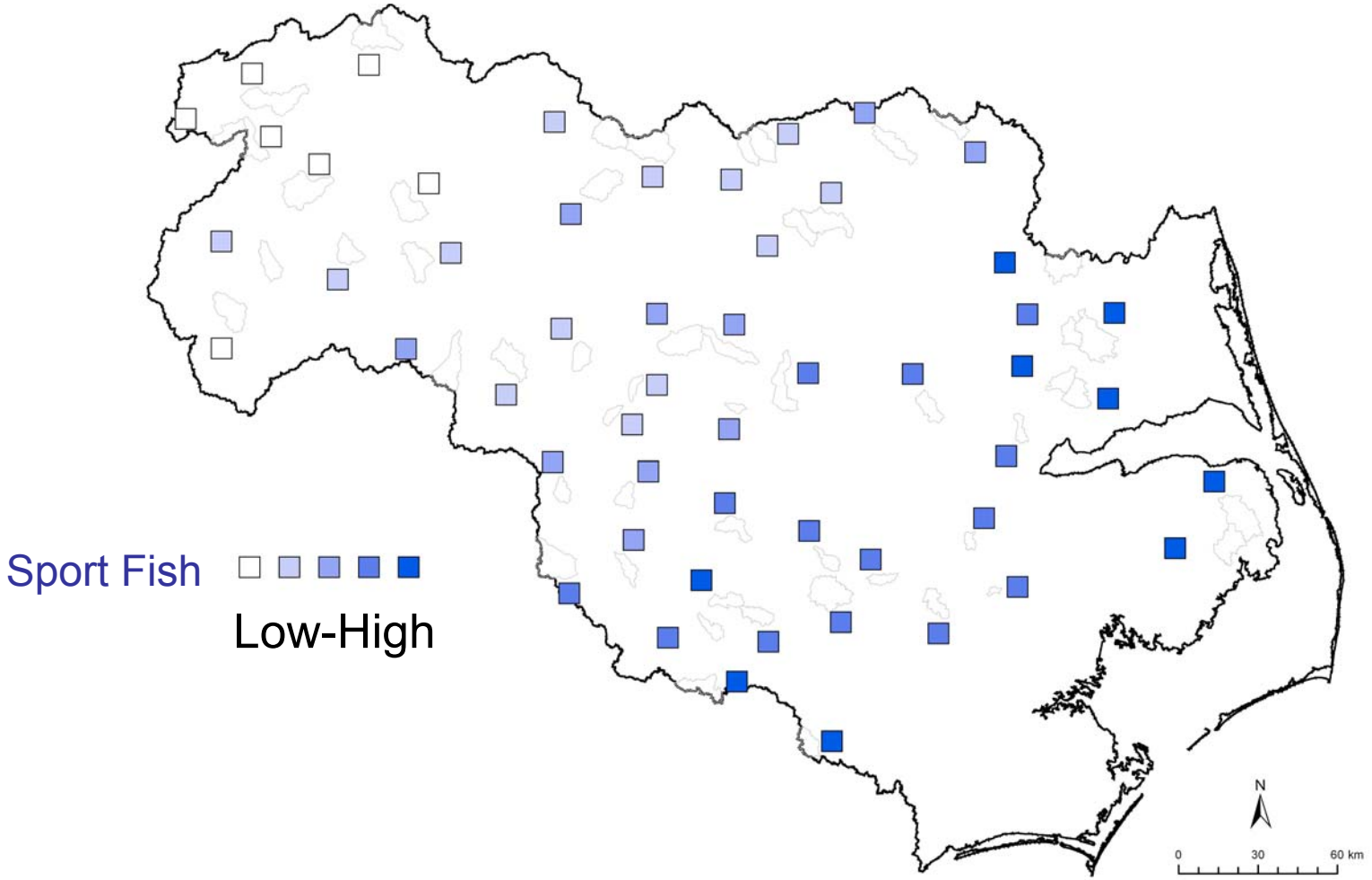
Group	HSI	Correct Classification Rate (%)		
		Absence	Presence	Overall
Darters (MT)	1/[1+ exp(-(-63.2* + 9.4·Flow + 2.5·Velocity + 8.2·Temp – 0.3·Temp^2 + 0.03·Agr – 0.5·(Flow·Temp))] * Mean intercept	86	76	81

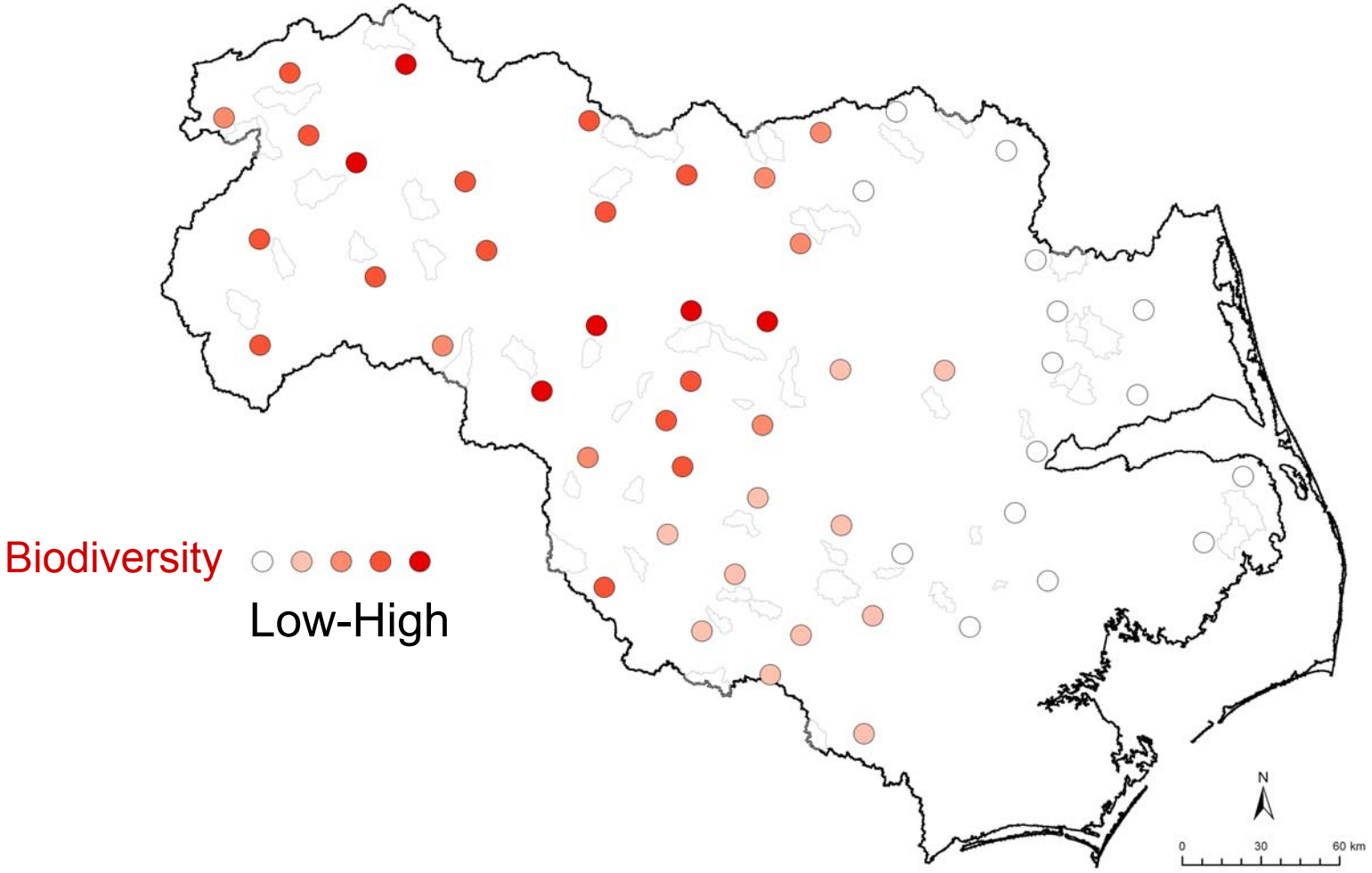
Guild Responses to Stressors

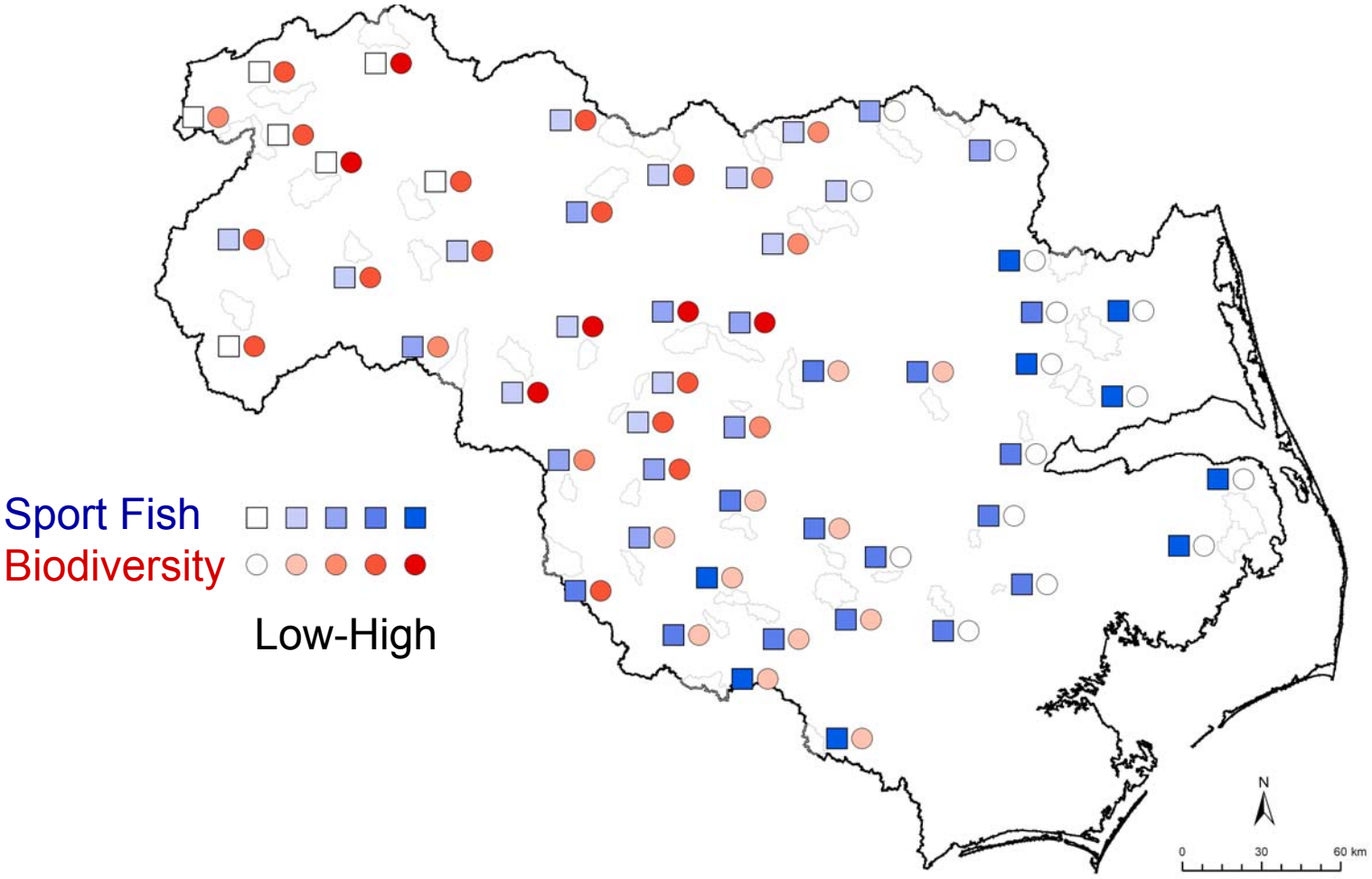


Translating Fish Species to Services

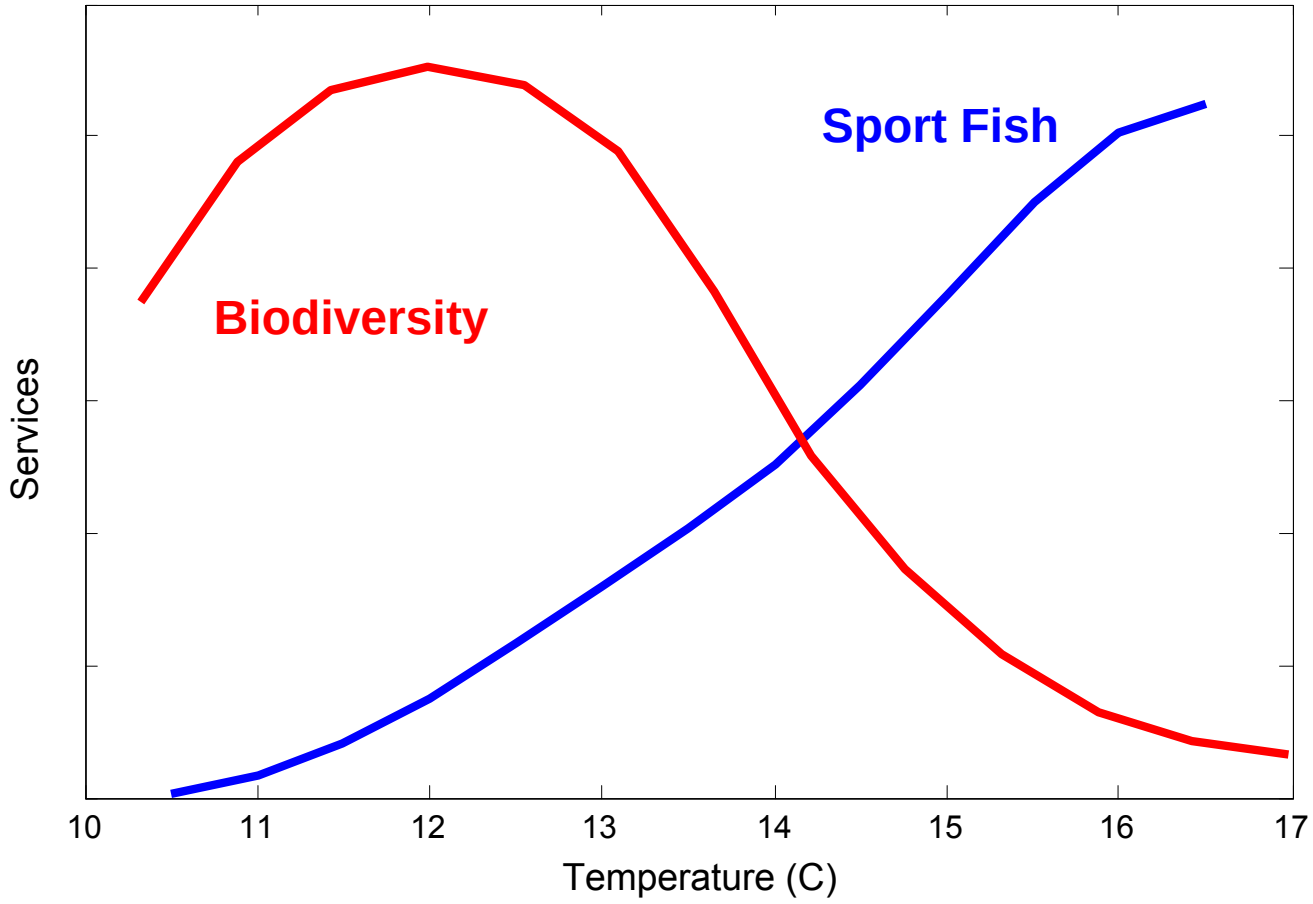
- Add scores for different groups
- Normalize to mean


Sport Fish
Low-High
N
0
30
60 km


Biodiversity
Low-High
N
0
30
60 km

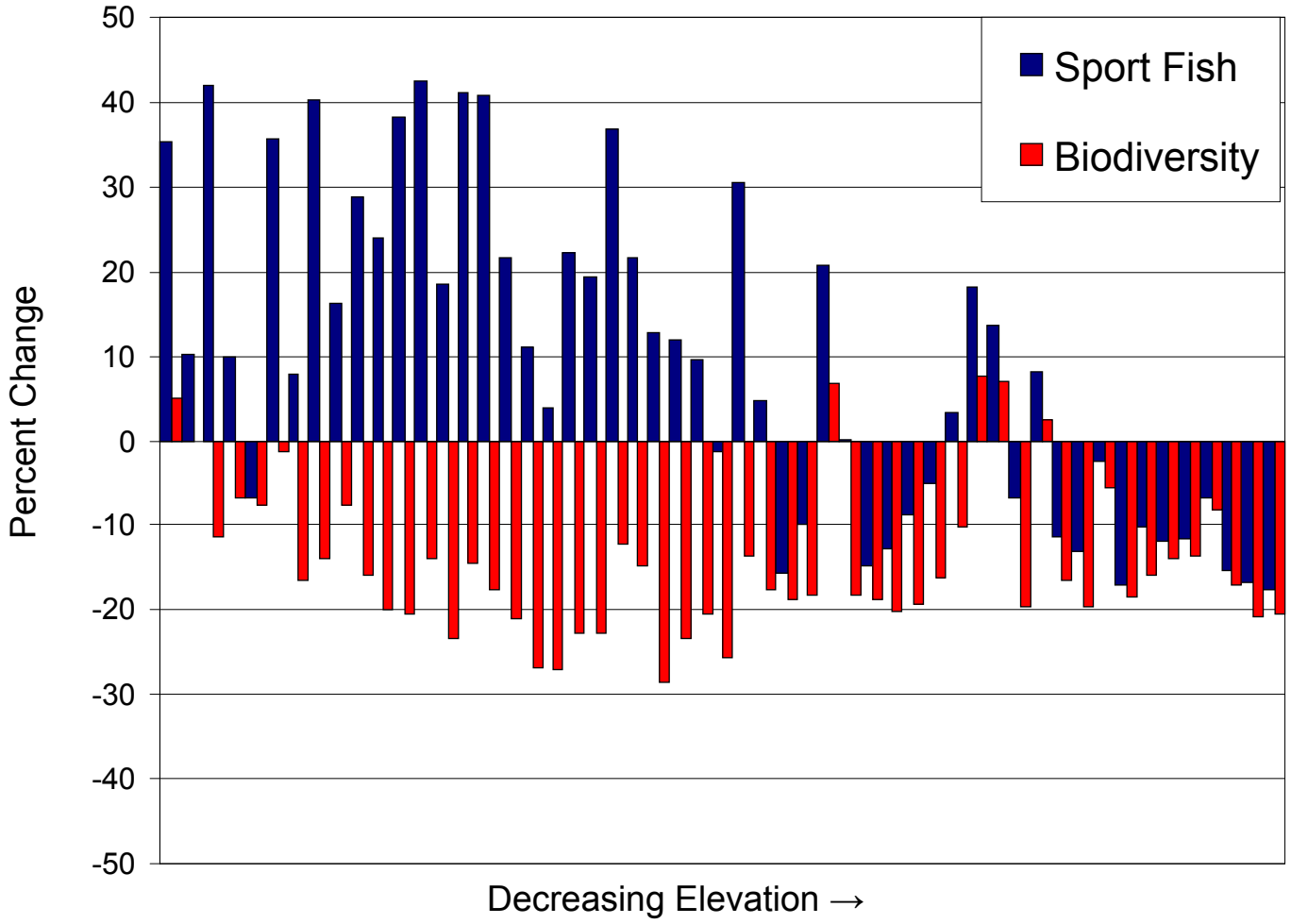

Sport Fish
Biodiversity
Low-High
N
0
30
60 km

Ecosystem Production Functions



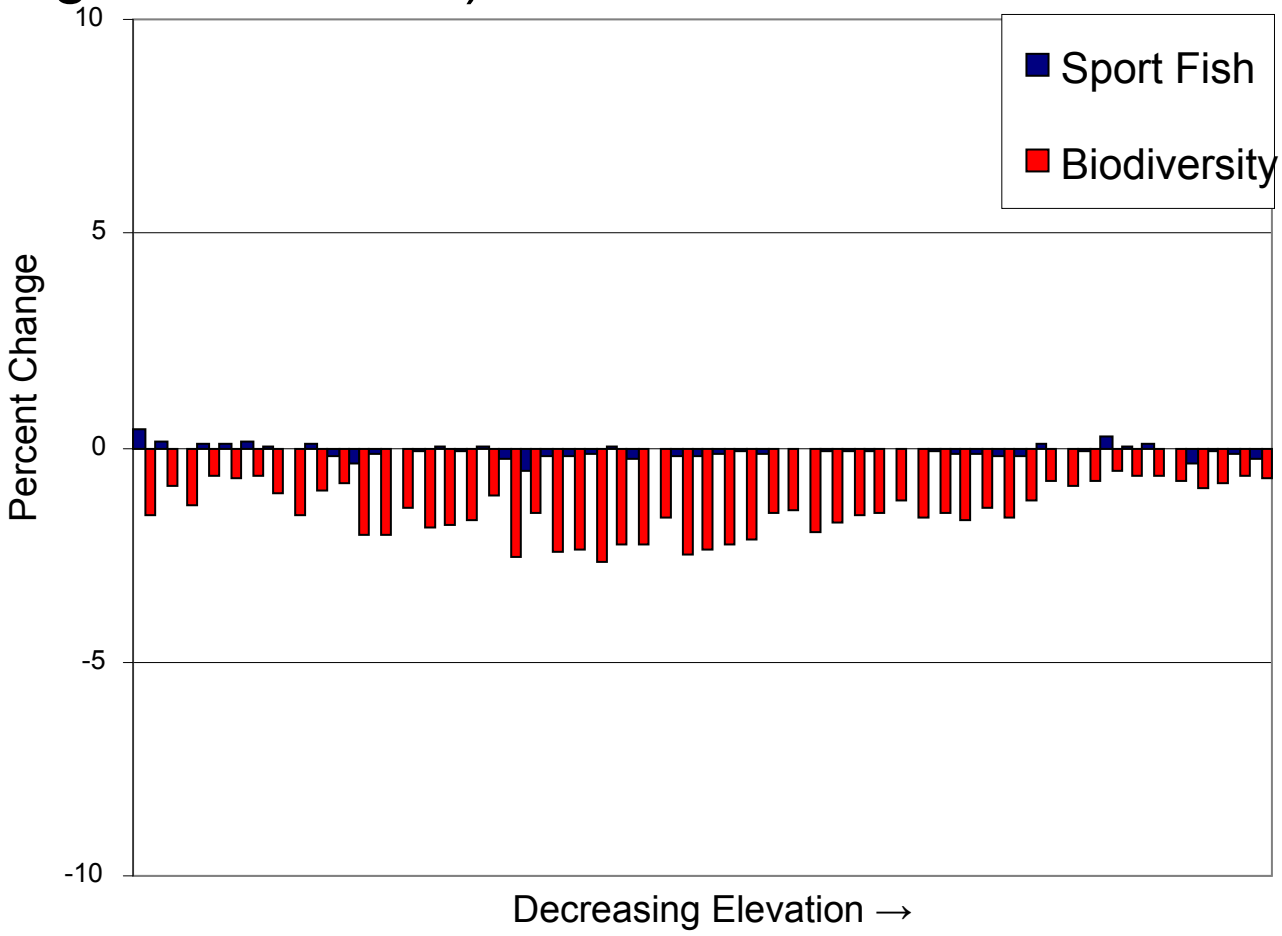
Future Temperature Scenario

(+1 C, IPCC for 2020 in SE)

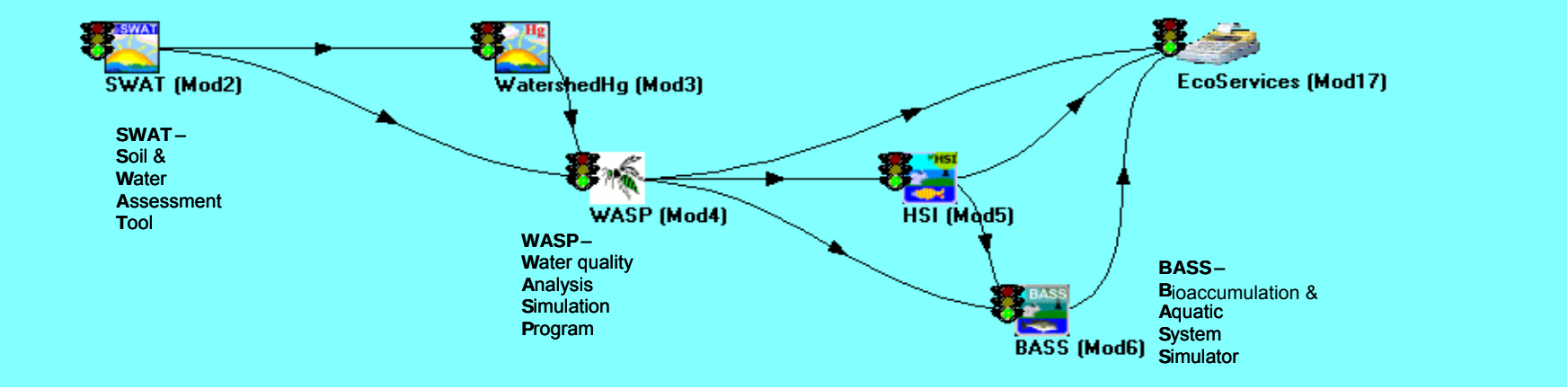


Future Flow Scenario

(Flow (-10%) & Velocity (-3%) for 2020-2040 in SE, Seager et al. 2009)

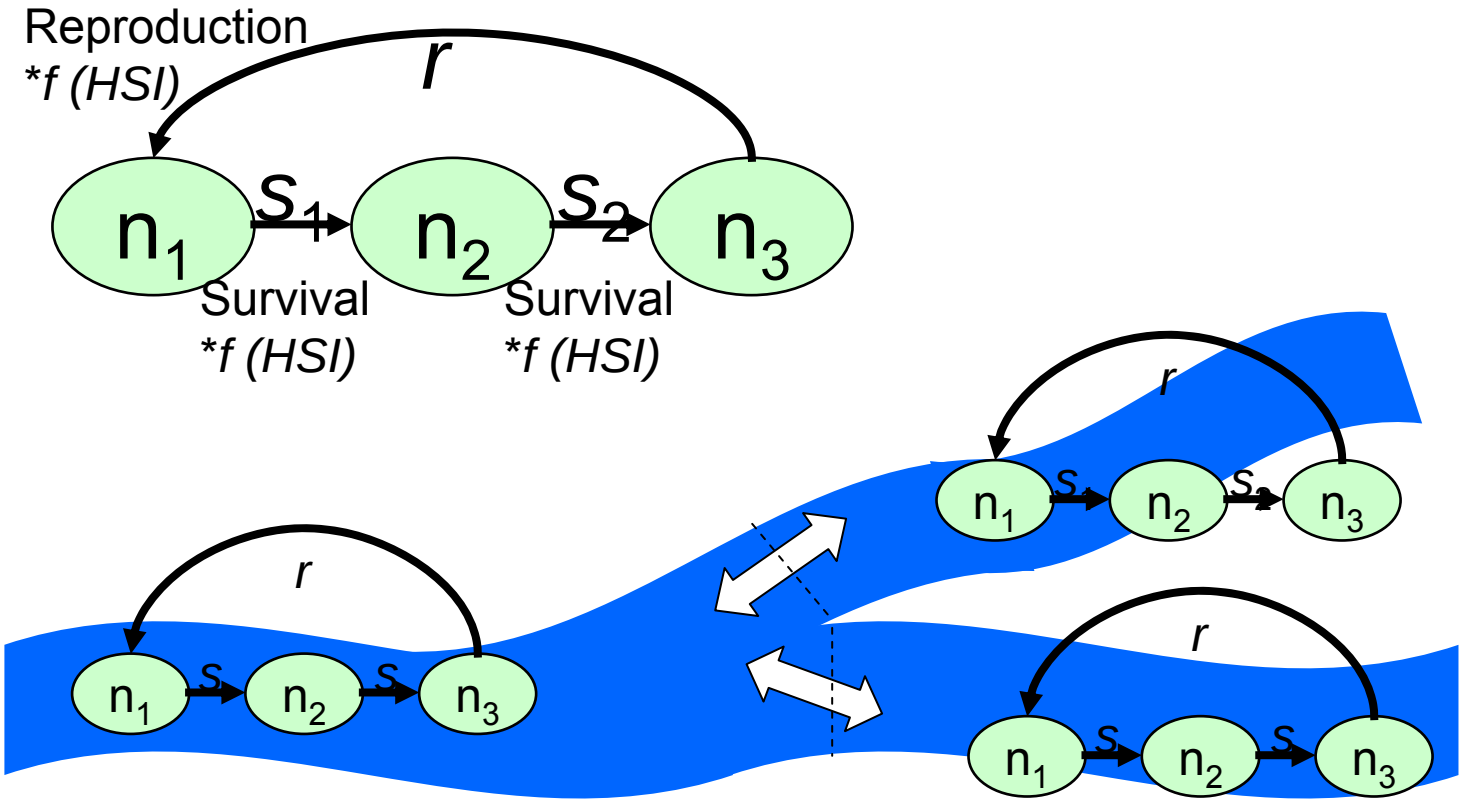


Linked Models for Scenario Analysis



Models are dynamic and process-based

Spatial Metapopulation Model for Viability Analysis



Conclusions

- Sport fish and biodiversity services have distinct responses to stressors
  - Services response depends on location

- Some species are more important service providers than others

Conclusions

- Three concepts of Biodiversity Service
  - Species richness – hard for people to relate to
  - Naturalness – “My grandchildren will enjoy the streams I enjoyed”
  - Charismatic (iconic) species (T/E) – may be the best measure

- Models can relate decisions on landscape to the services people care about

Acknowledgements

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