

# From Carp to Cattails: Utah Lake Ecosystem Monitoring

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[@JGaetaFish](#)



**Tim Walsworth, PhD**

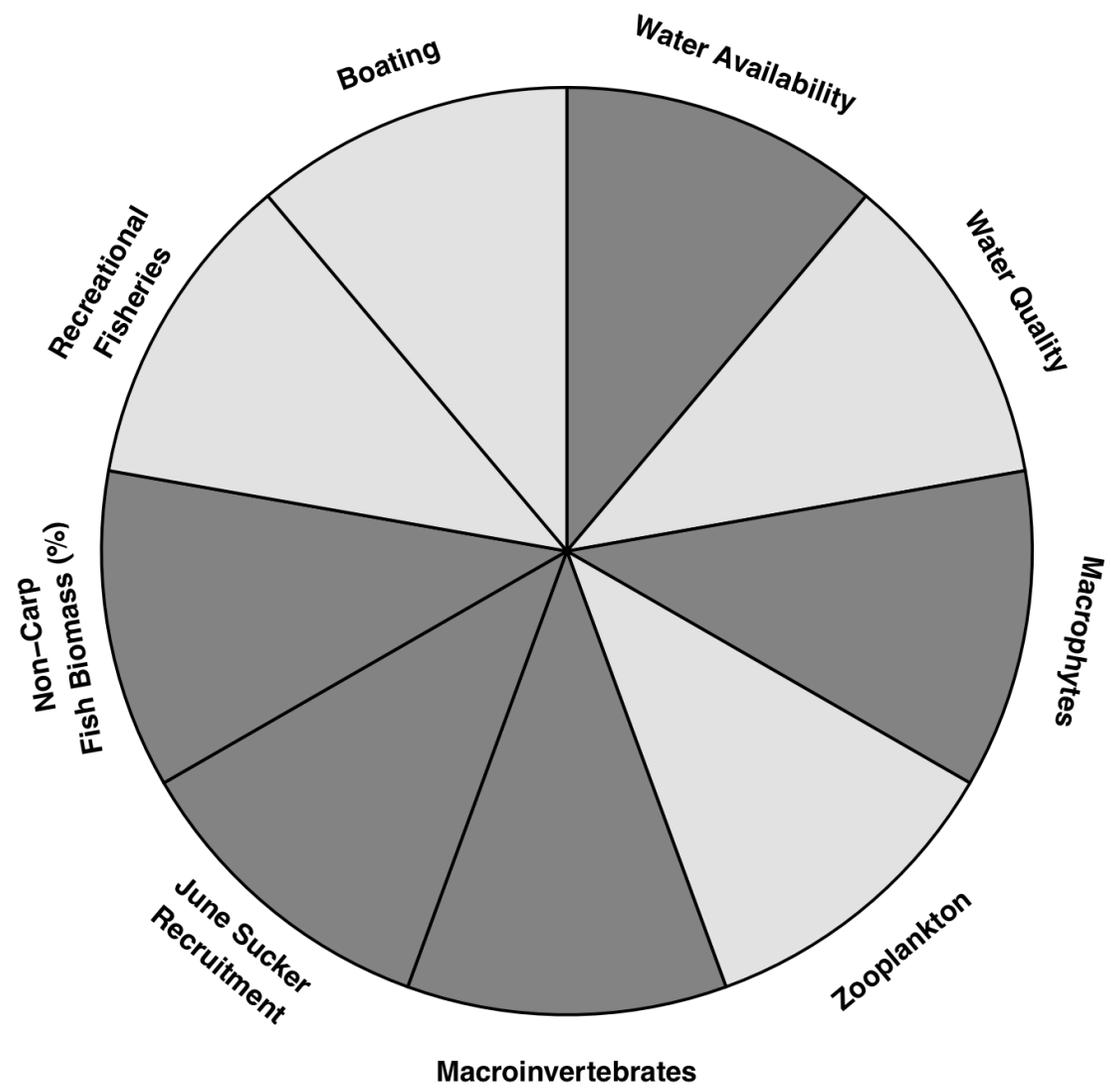
**Ryan Dillingham**



**Kevin Landom, MS**

**Jamie Reynolds, MS**





# How do we mitigate impacts of established invasive populations?



Photo credit: Dave Cole

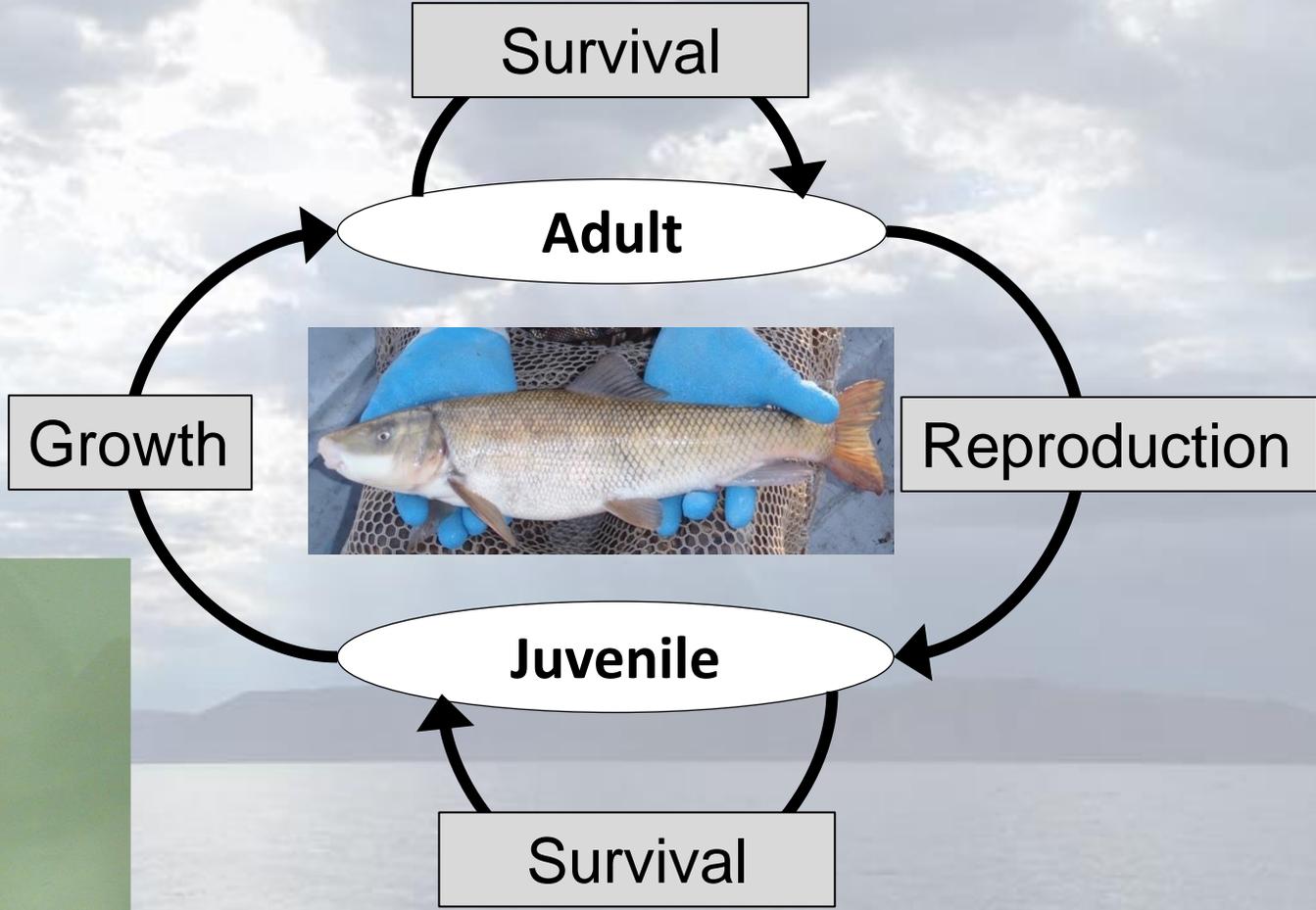
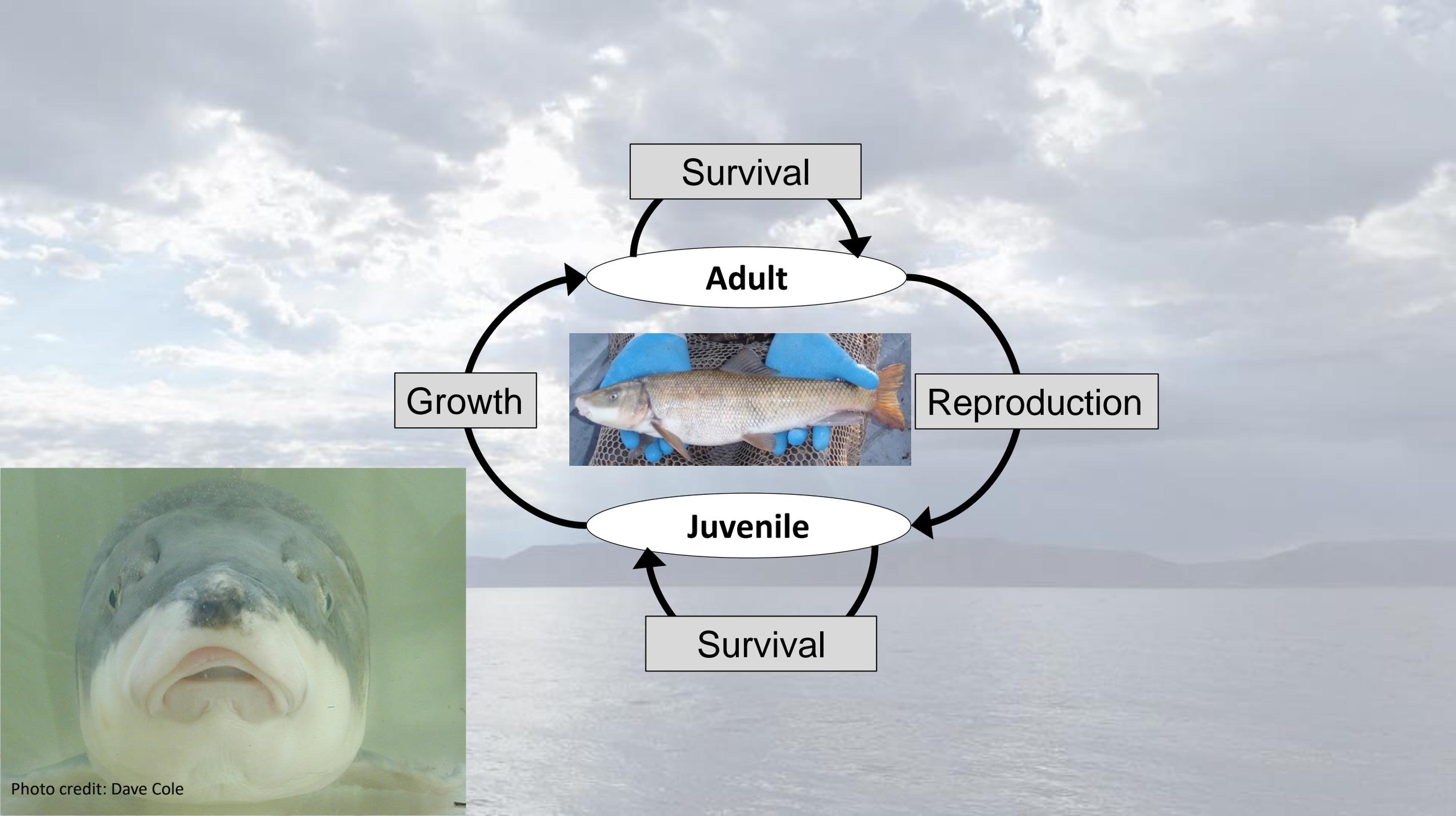


Photo credit: Dave Cole

**Invasive species**

**Invasive species**

**Habitat loss**

**Habitat loss**

Survival (drought & carp)

(drought & carp)

**Adult**

Growth



Reproduction

**Juvenile**

Survival



Photo credit: Dave Cole



Common carp  
introduced

1880s





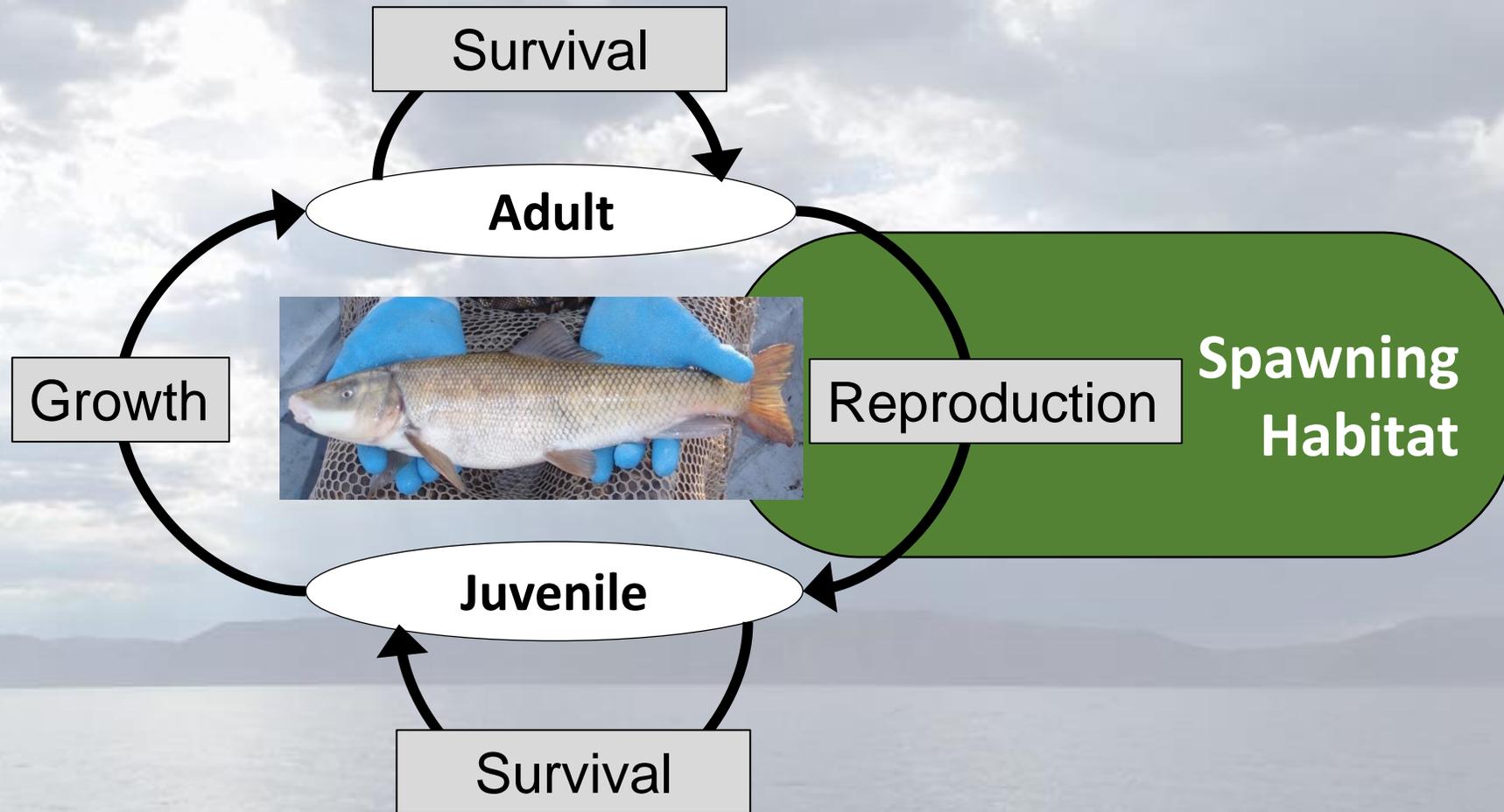
Photo credit: Dave Cole

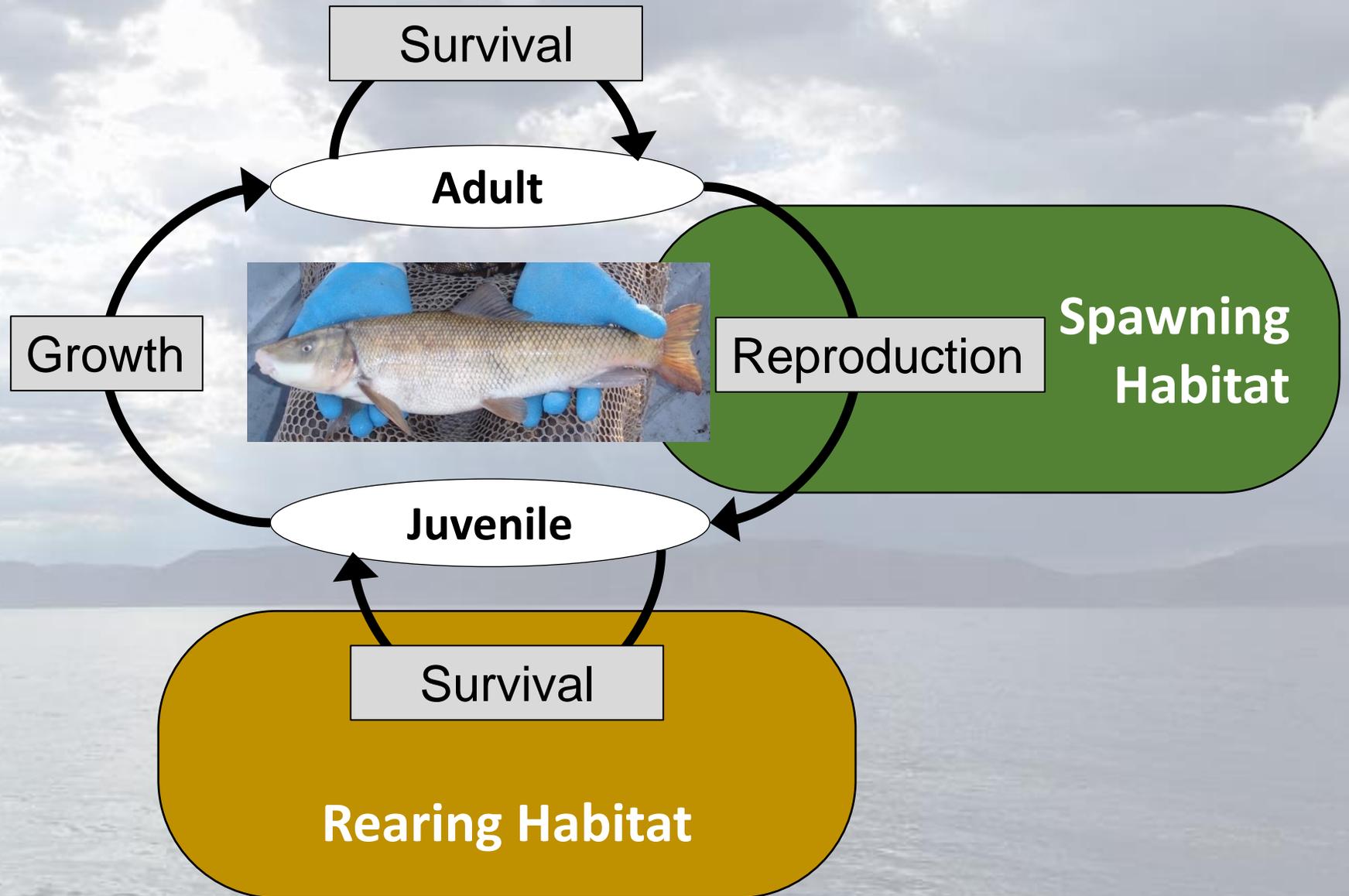
June sucker population  
300-500 individuals

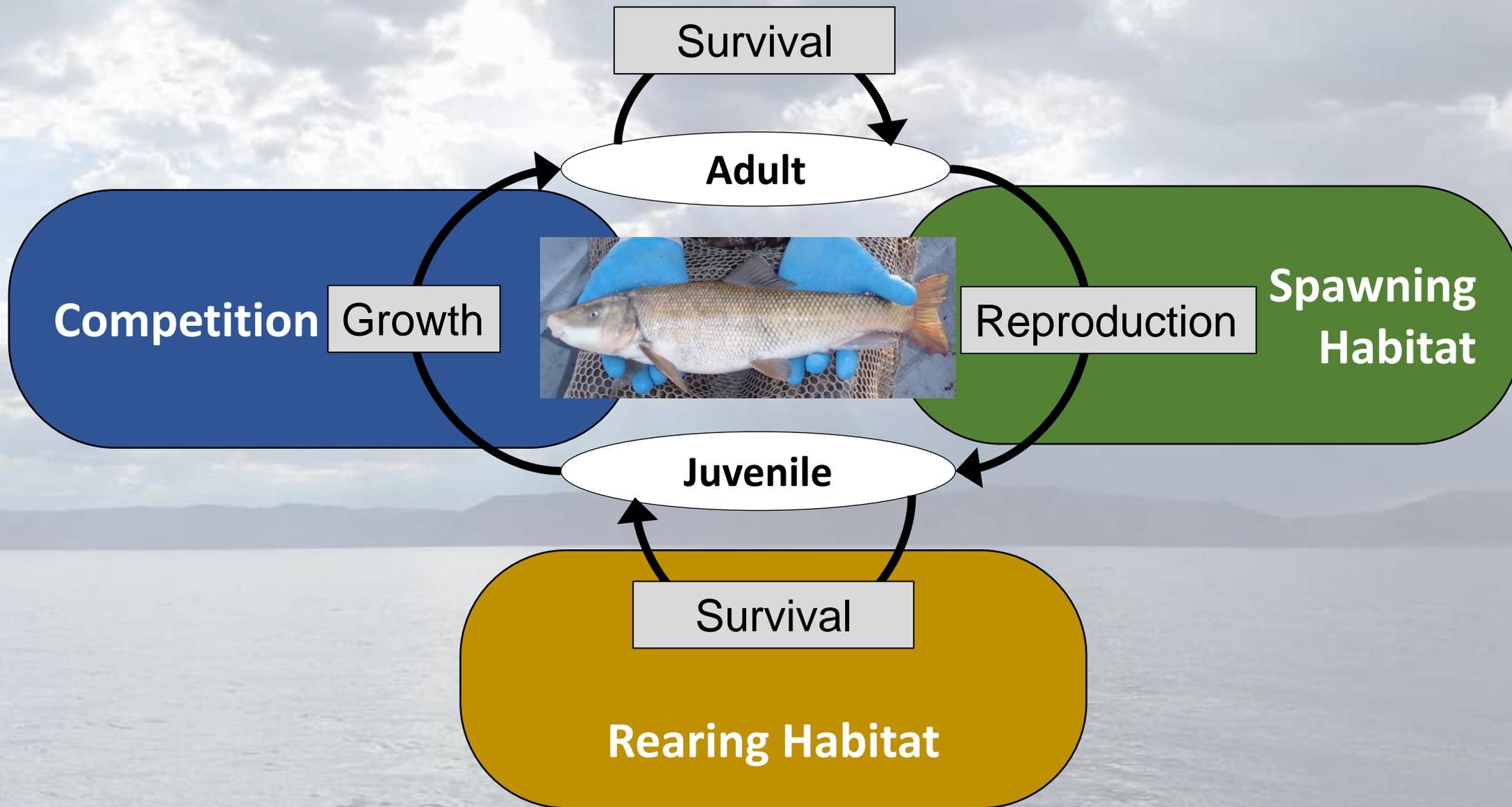
1880s

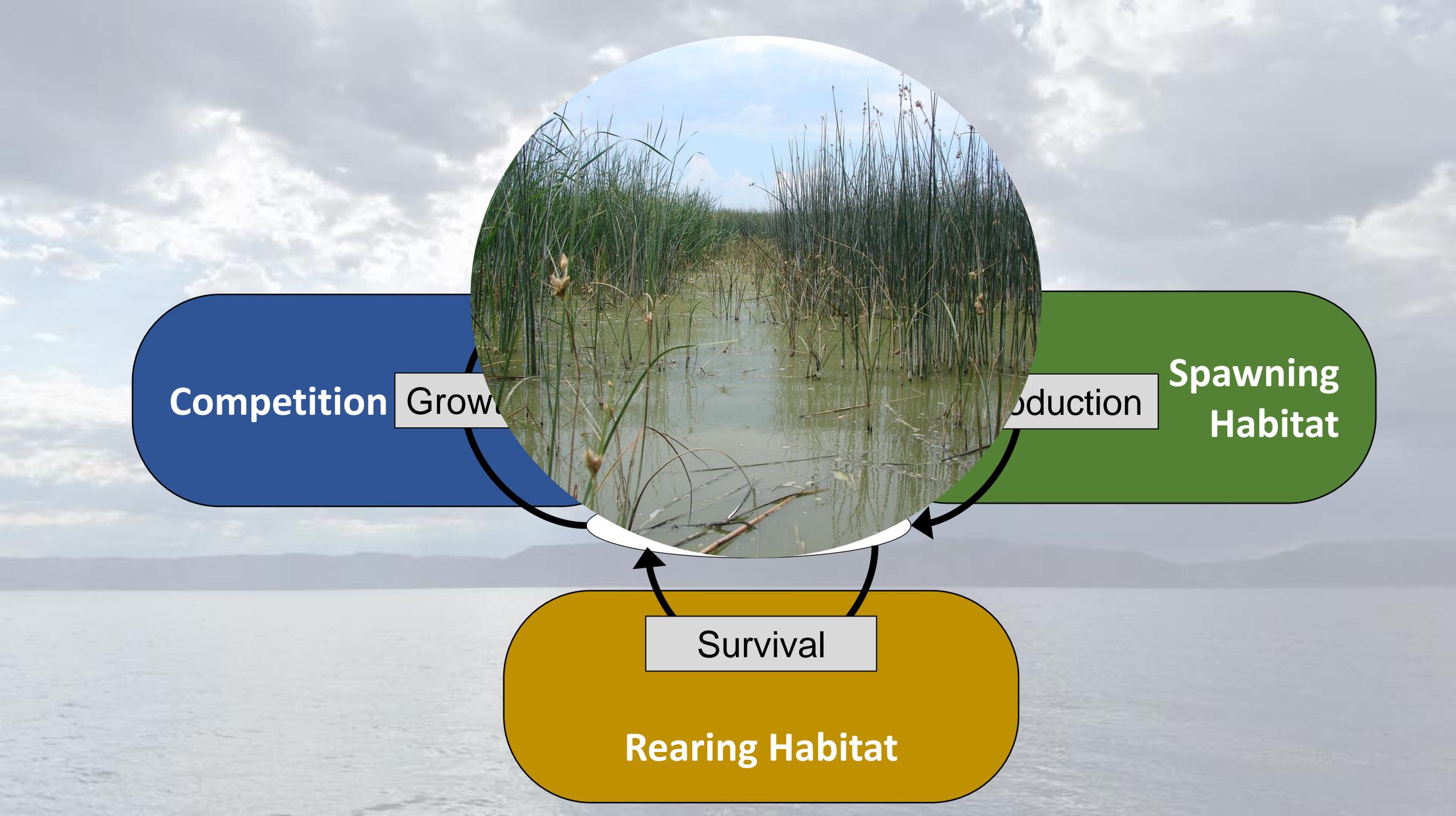
1990s











**Competition**

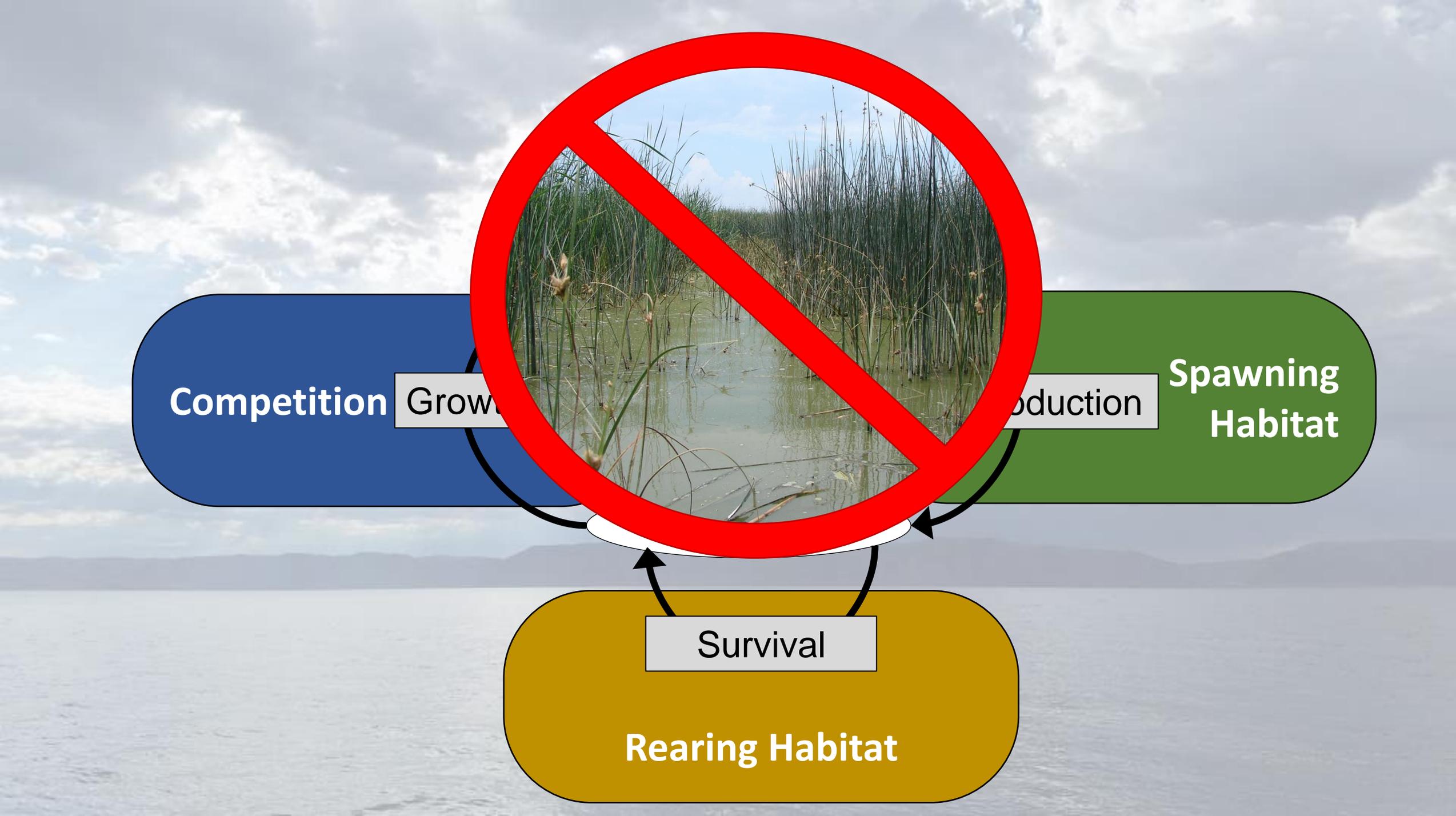
Growth

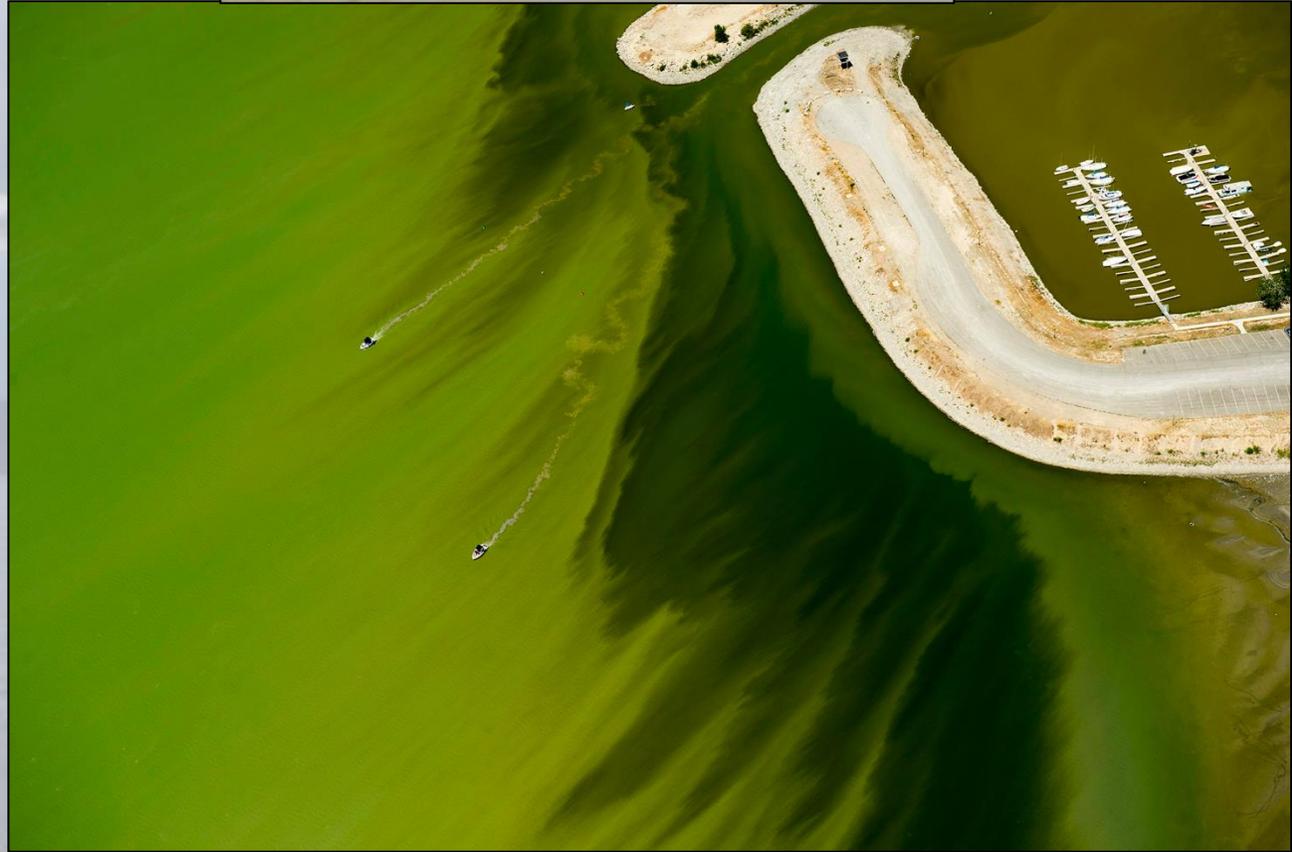
Production

**Spawning  
Habitat**

Survival

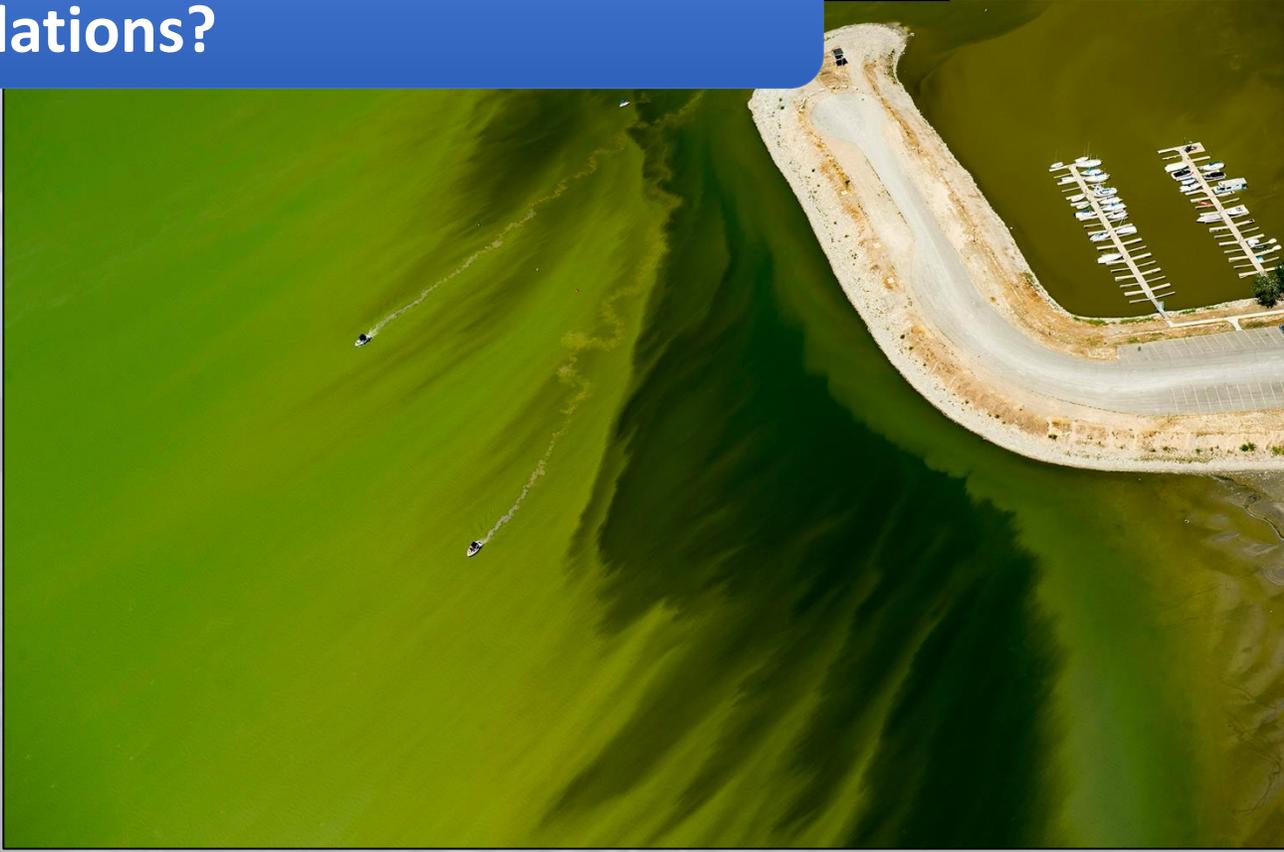
**Rearing Habitat**







How do we mitigate impacts of established invasive populations?





Carp removal effort



1880s

1990s

2009/2010



# Small scale carp removal



Experimental removal in 2009  
Commercial removal since 2010



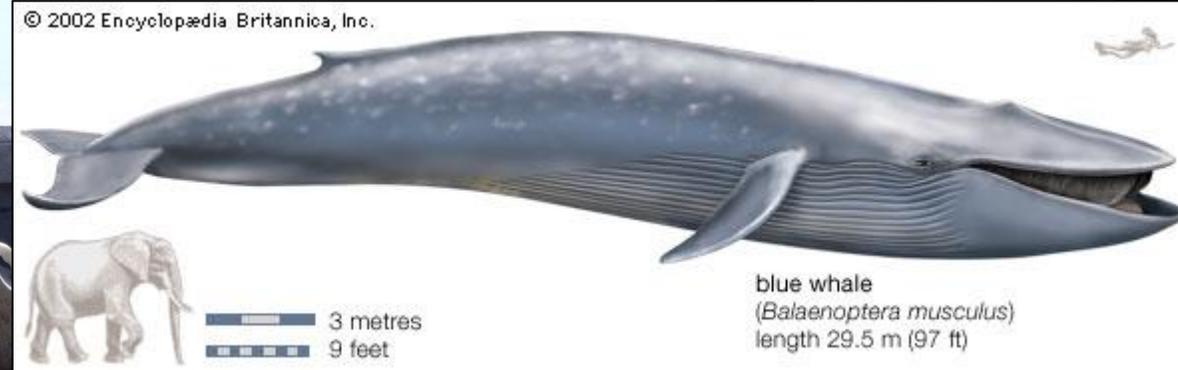
Experimental removal in 2009  
Commercial removal since 2010



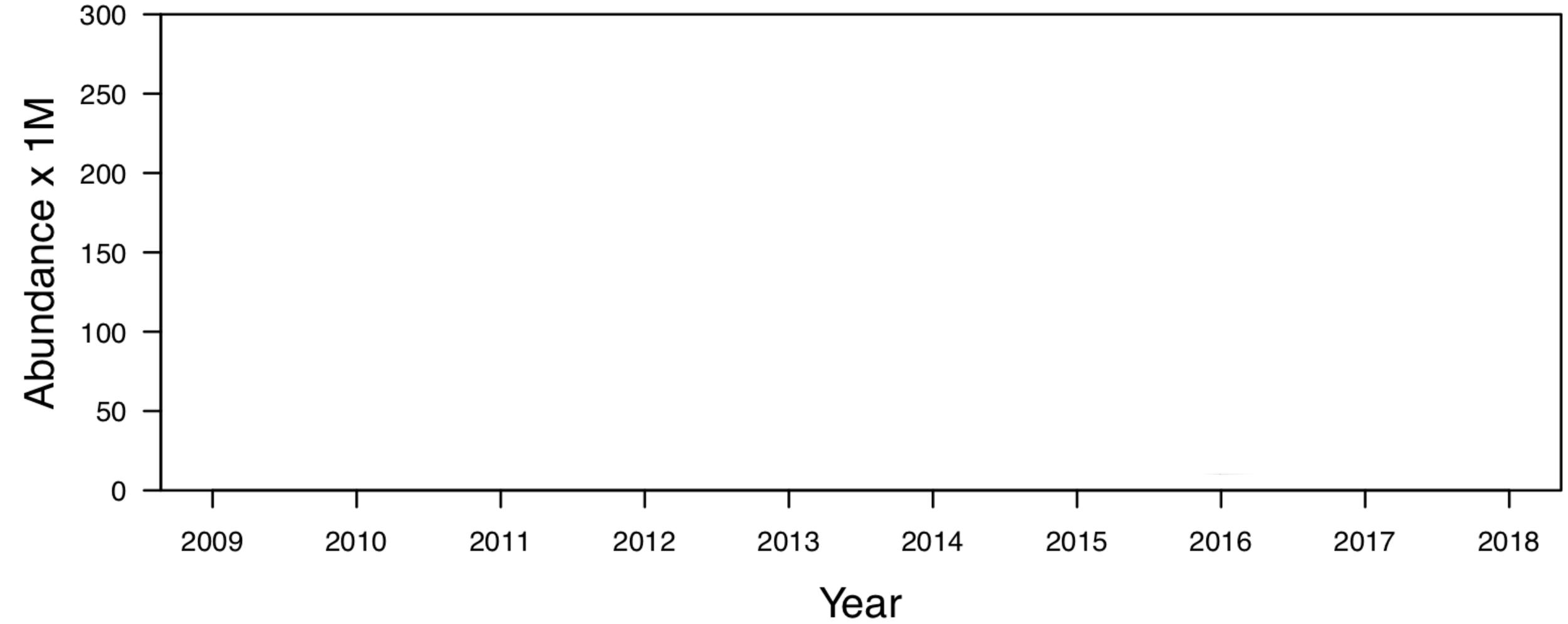
>12,000 metric tons

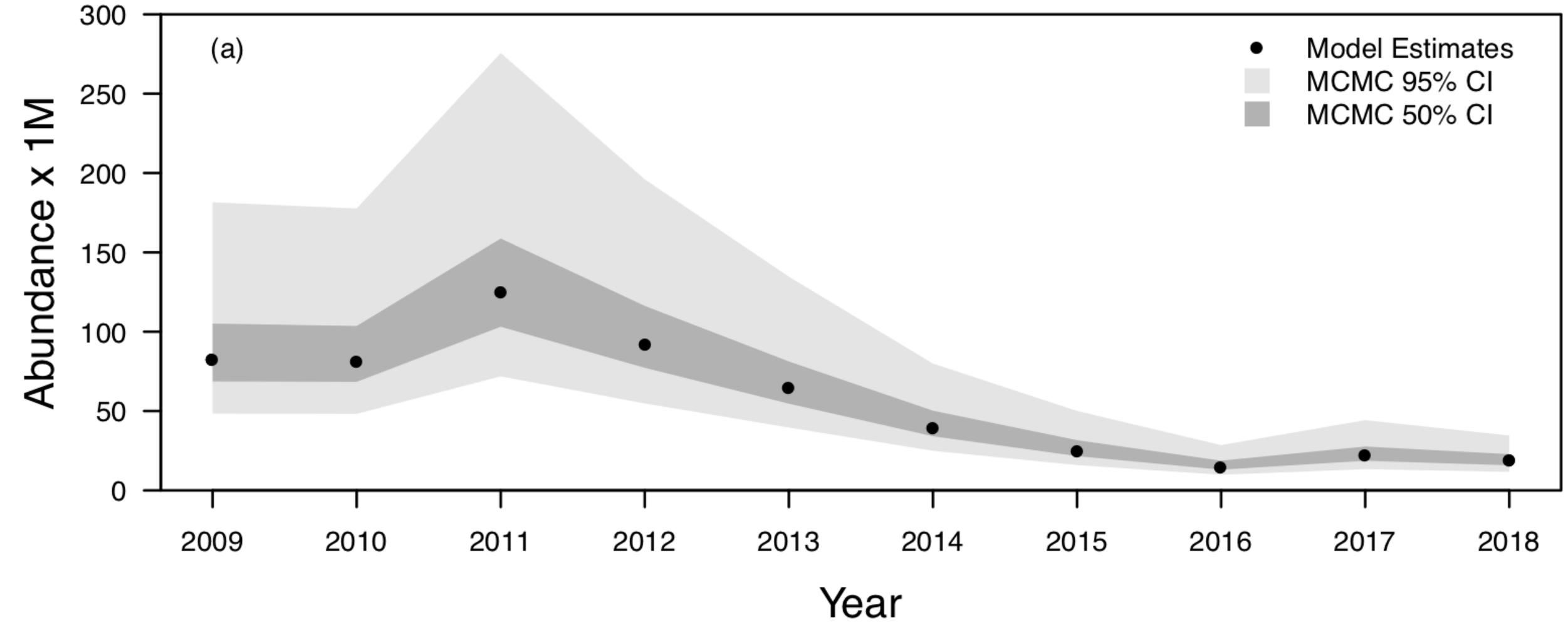


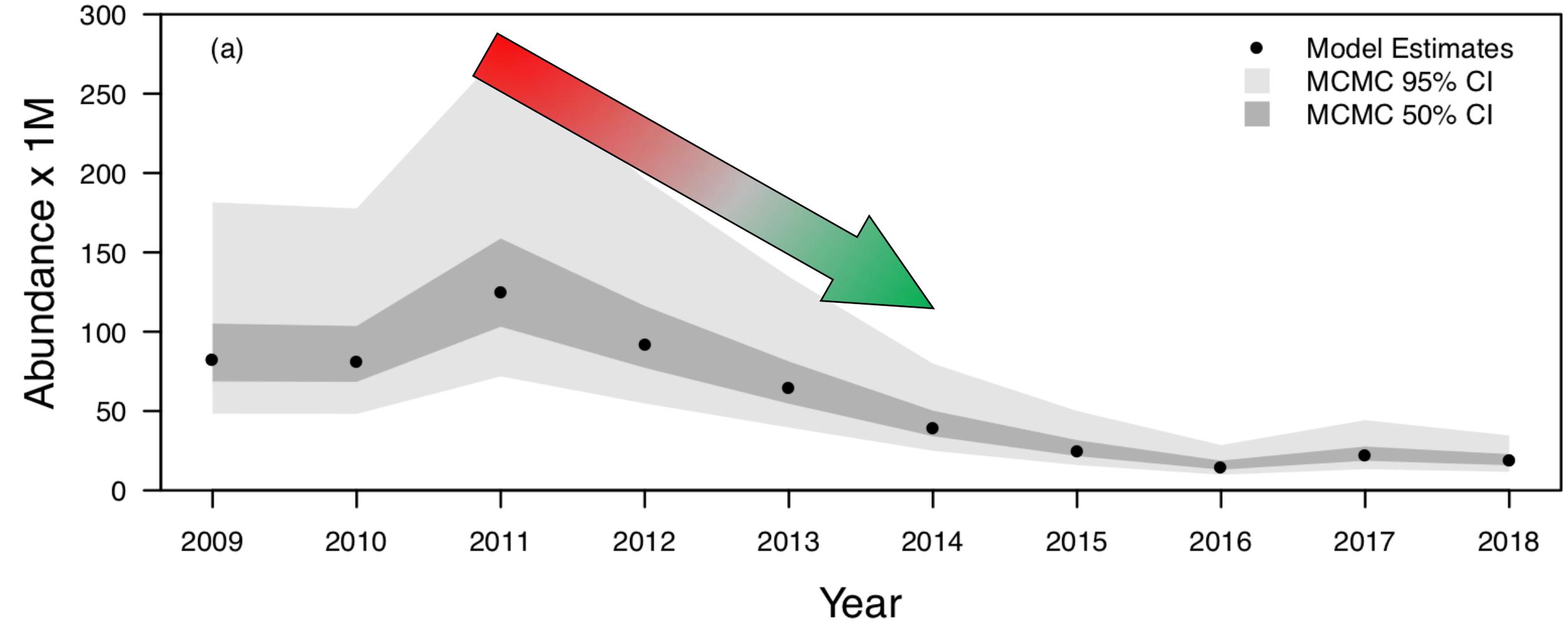
Experimental removal in 2009  
Commercial removal since 2010

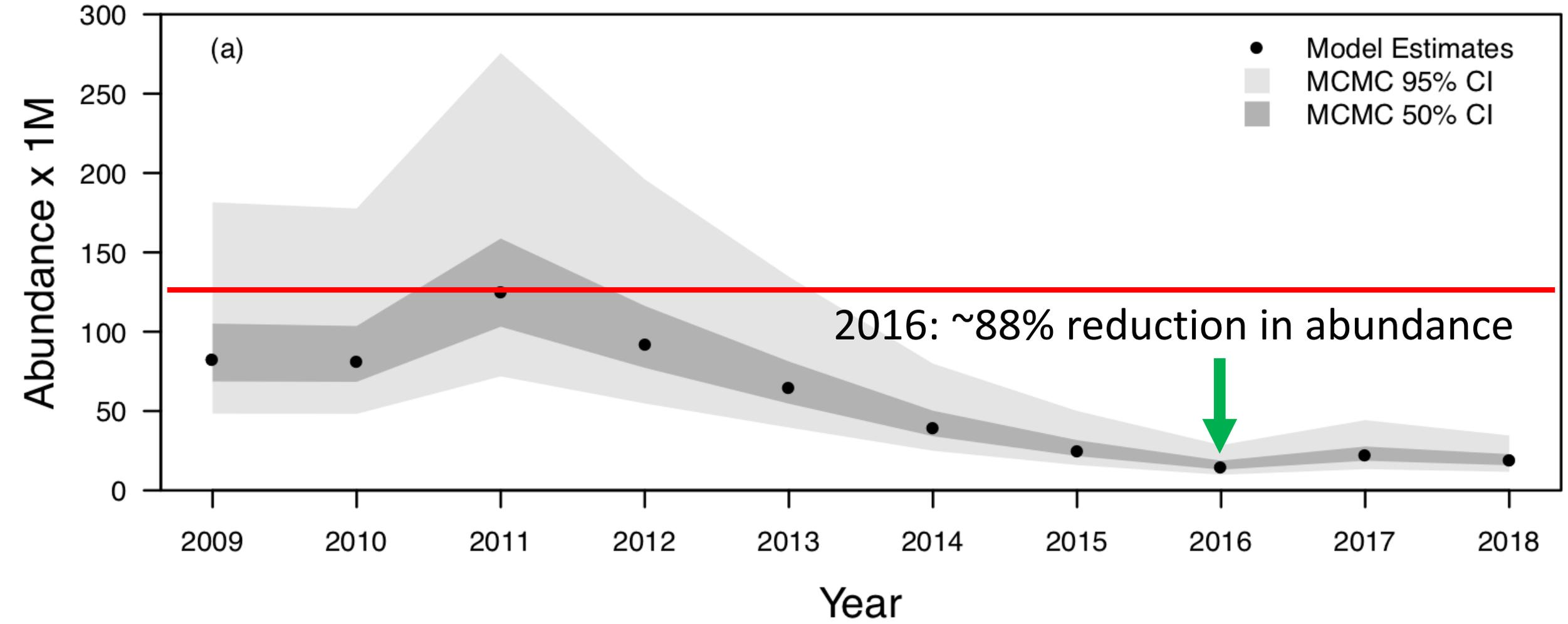


>12,000 metric tons  
~ 150 Blue whales

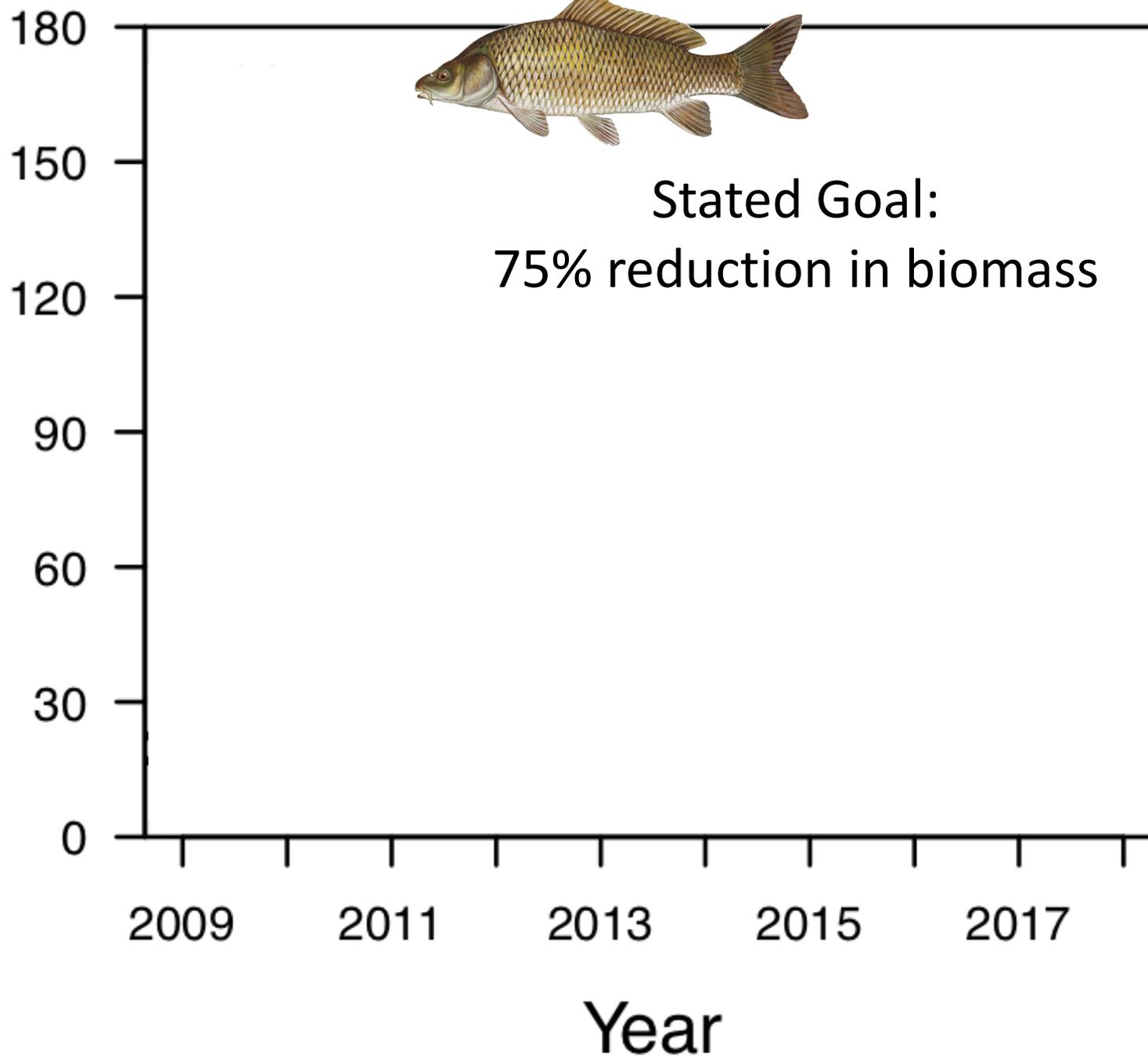


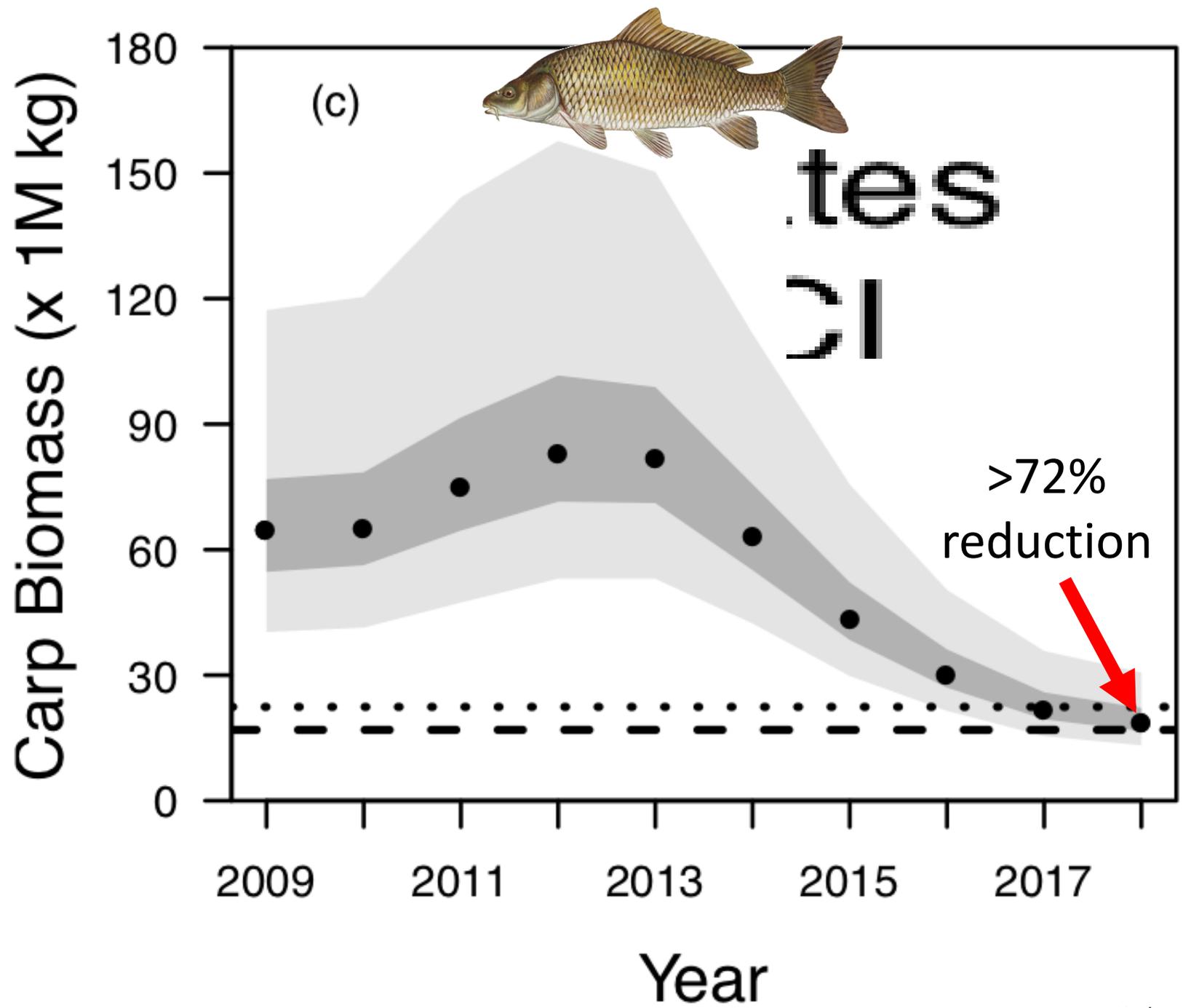


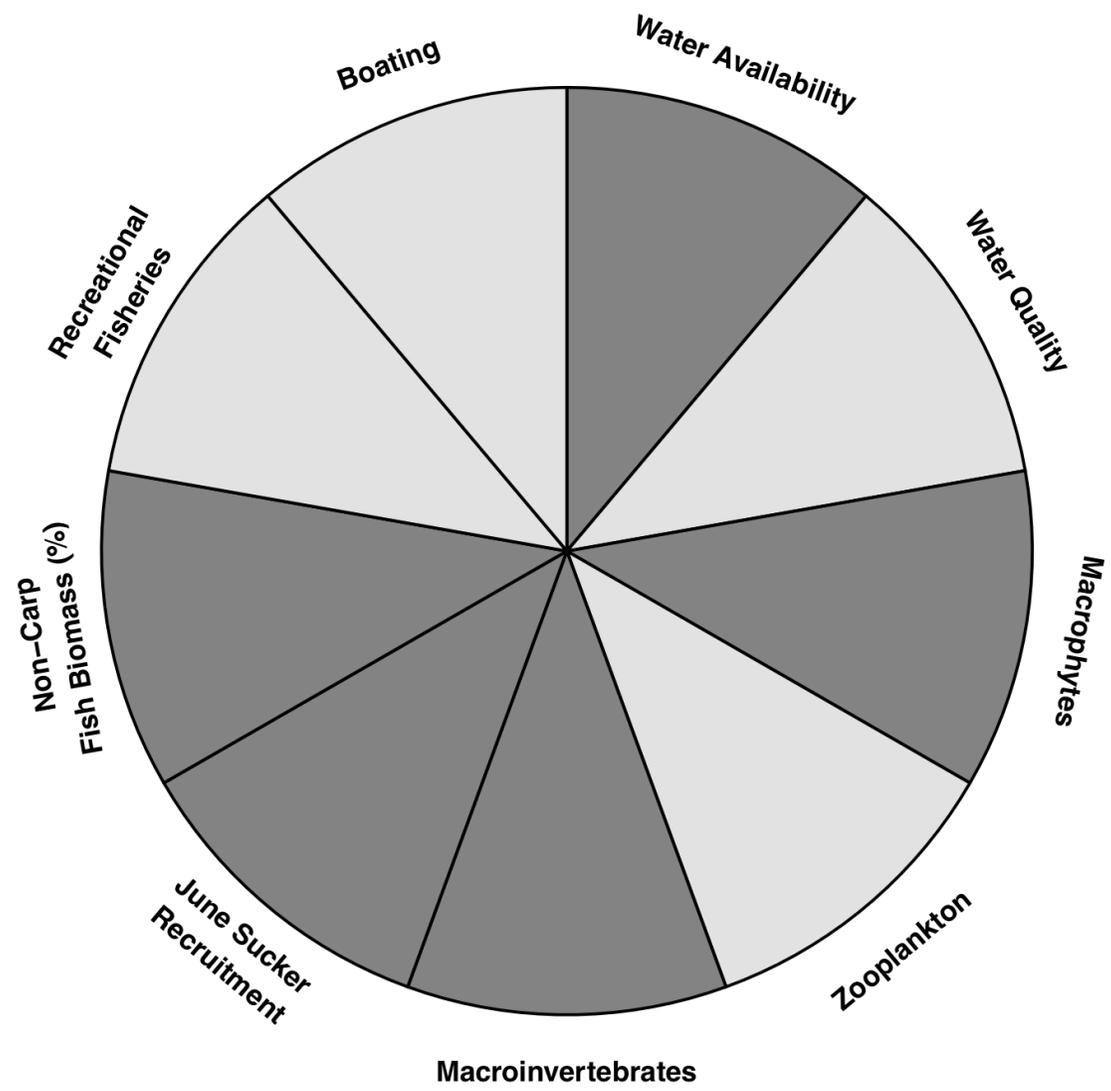


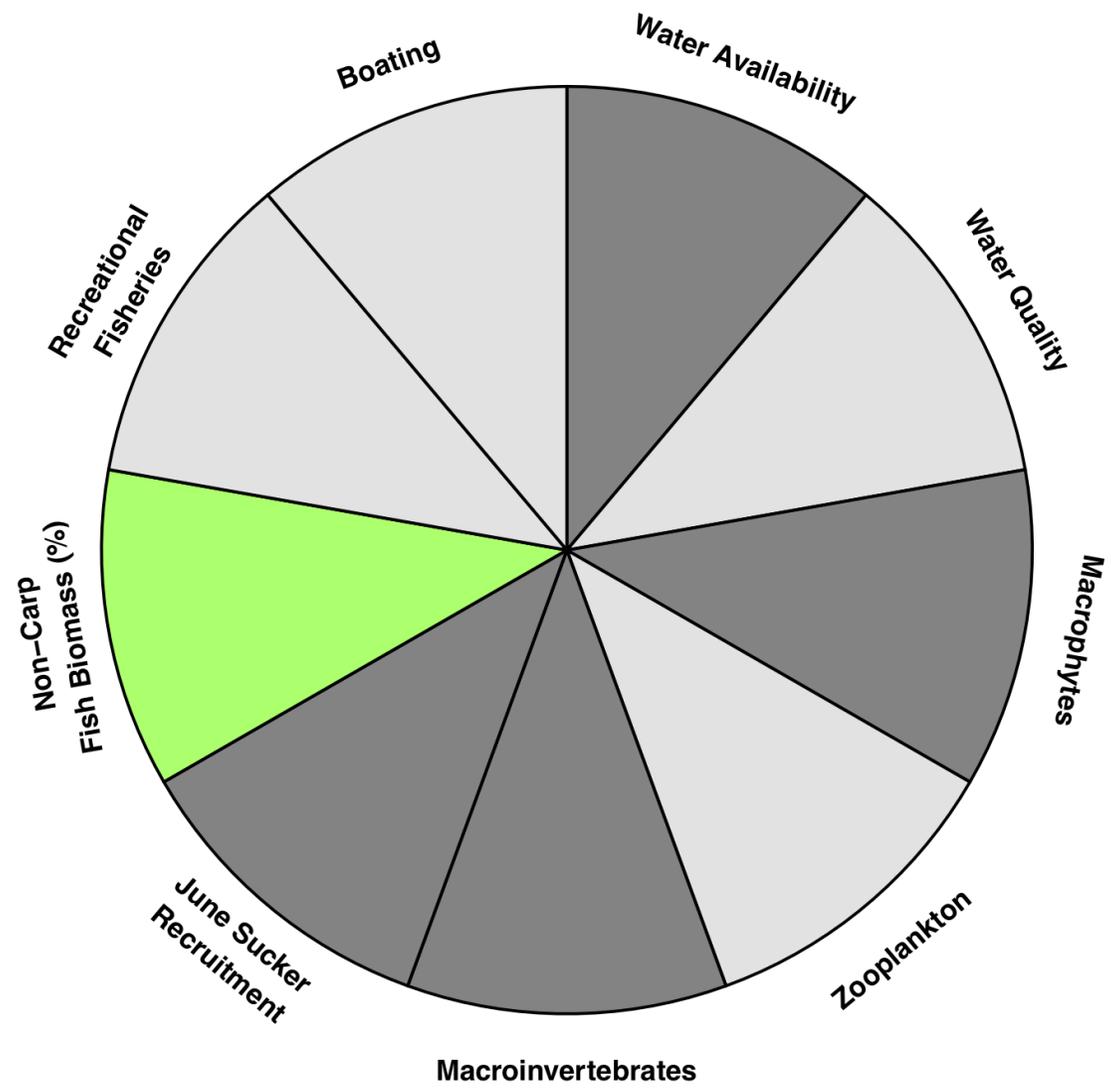


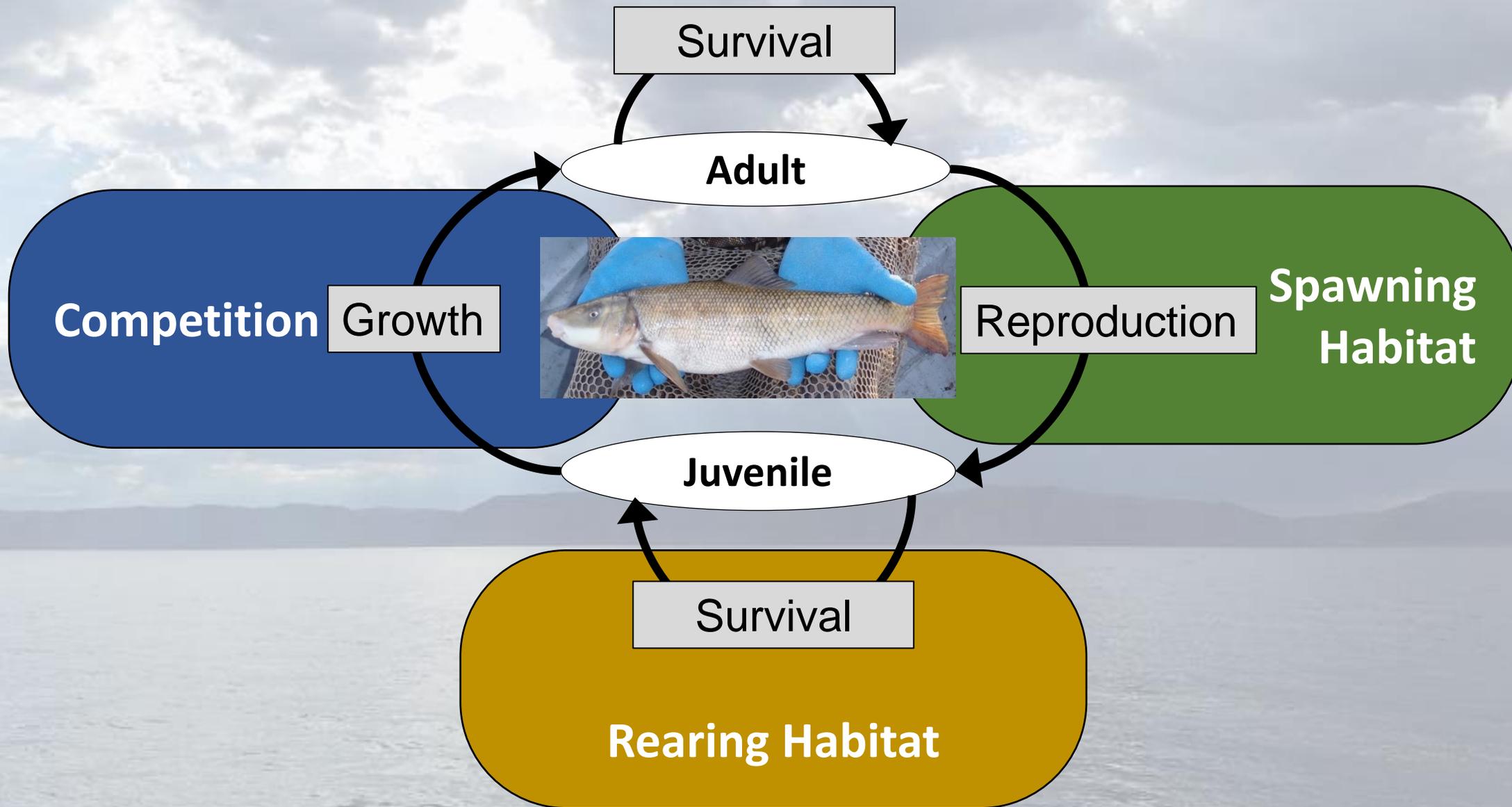
Carp Biomass (x 1M kg)

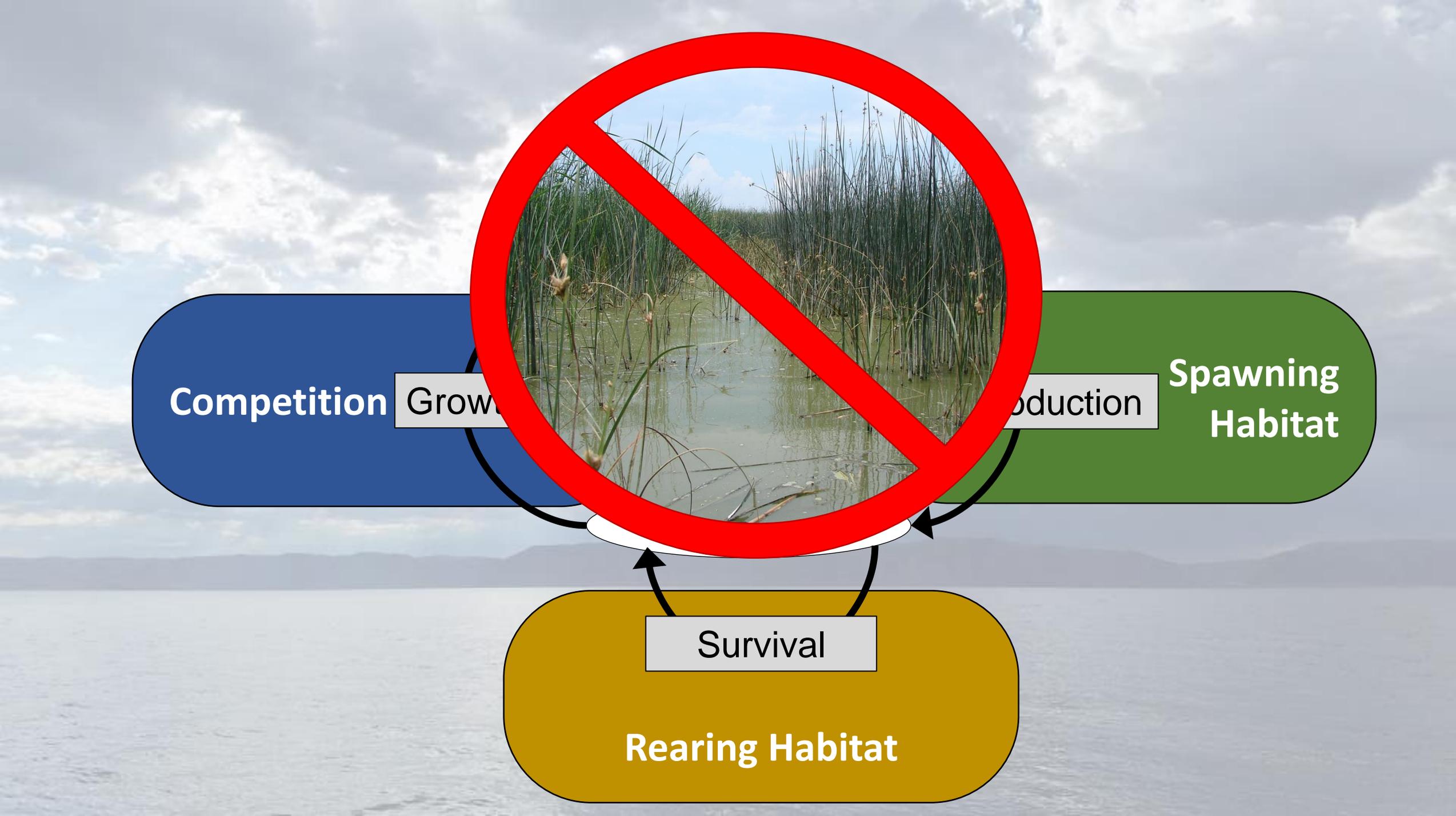












**Competition**

Growth

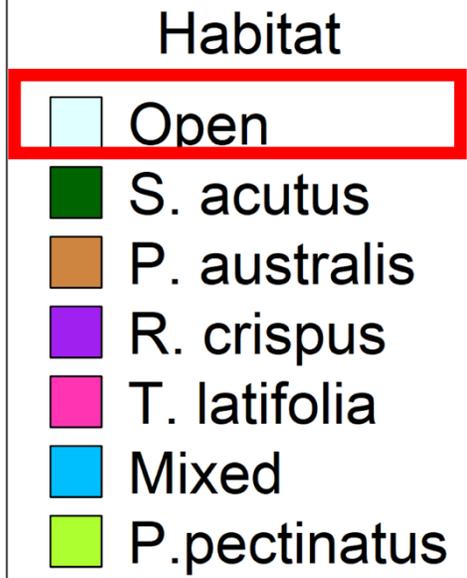
Production

**Spawning  
Habitat**

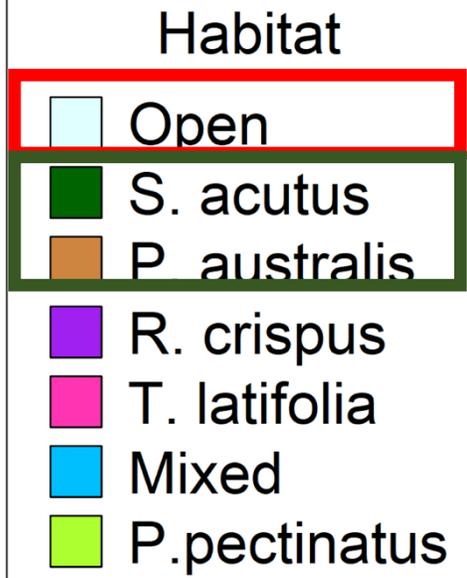
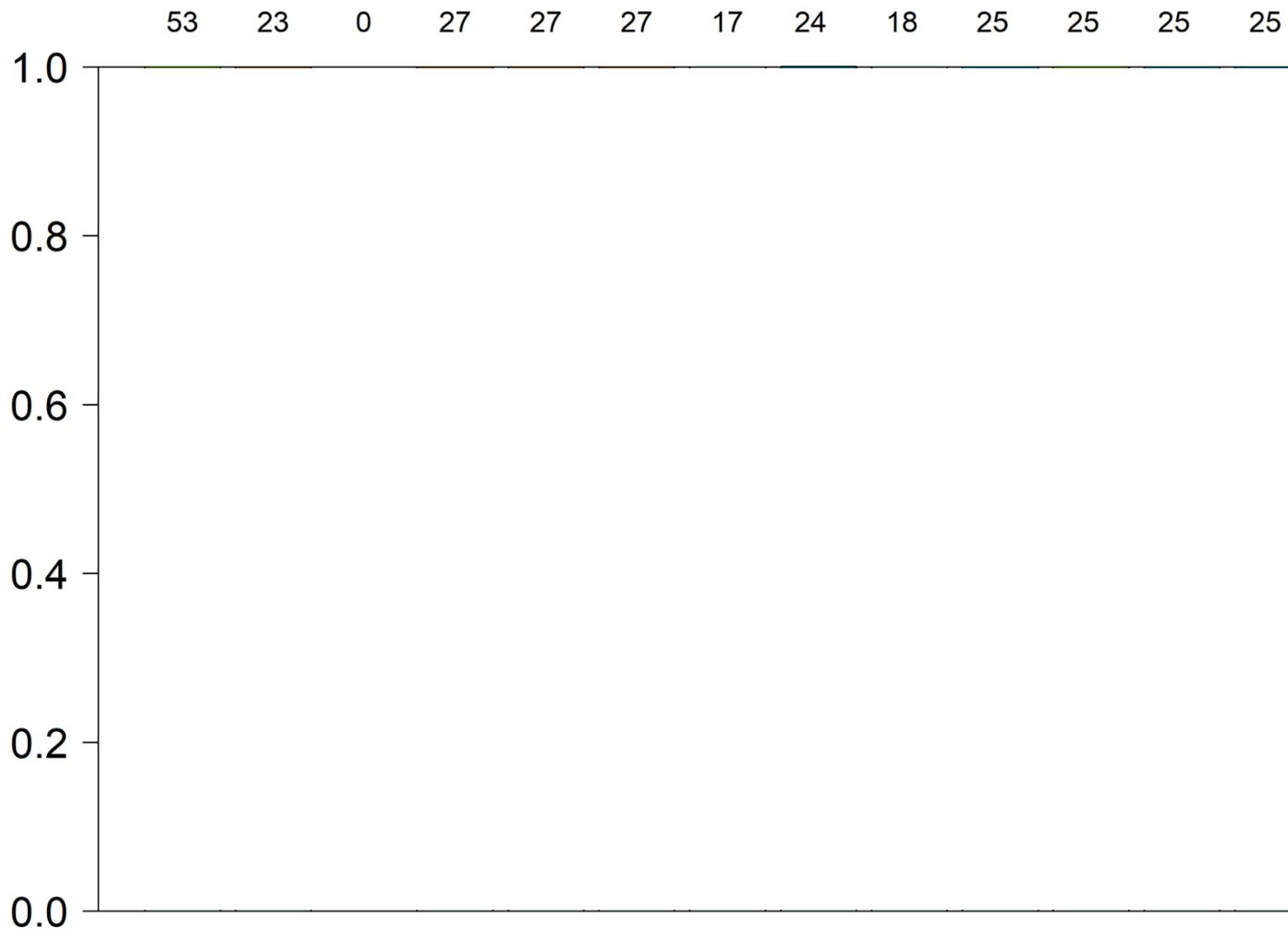
Survival

**Rearing Habitat**

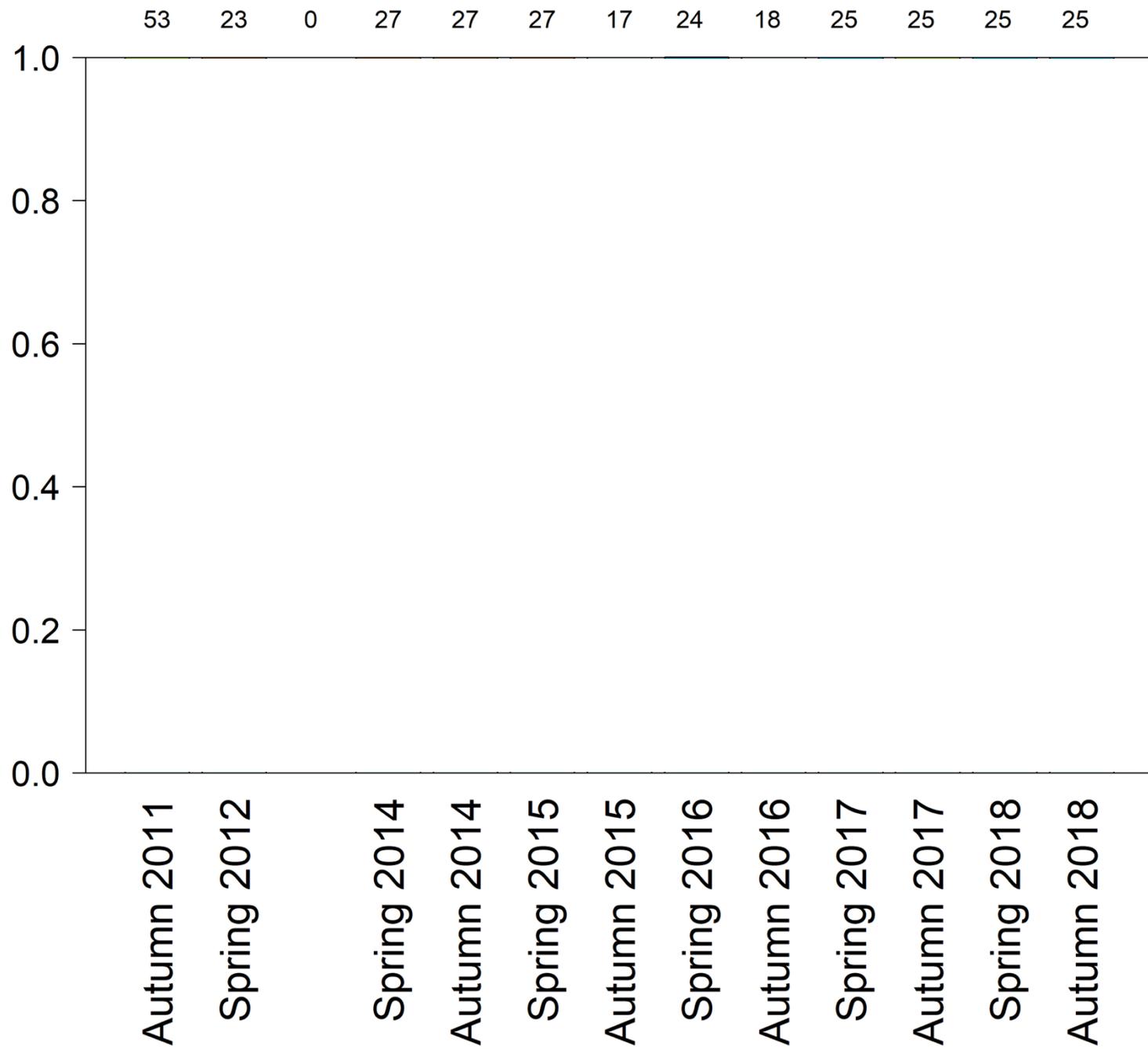
Proportion of sites sampled



Proportion of sites sampled



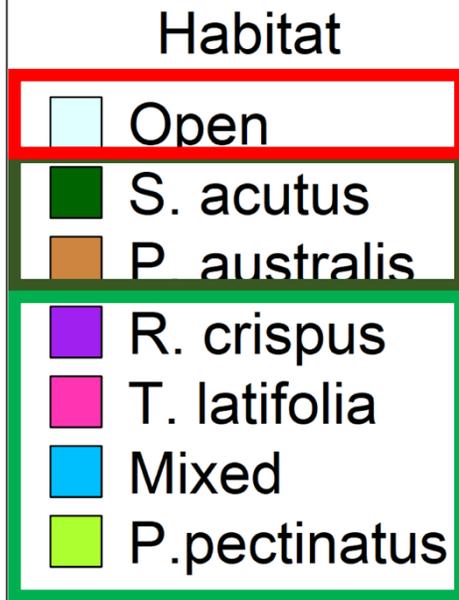
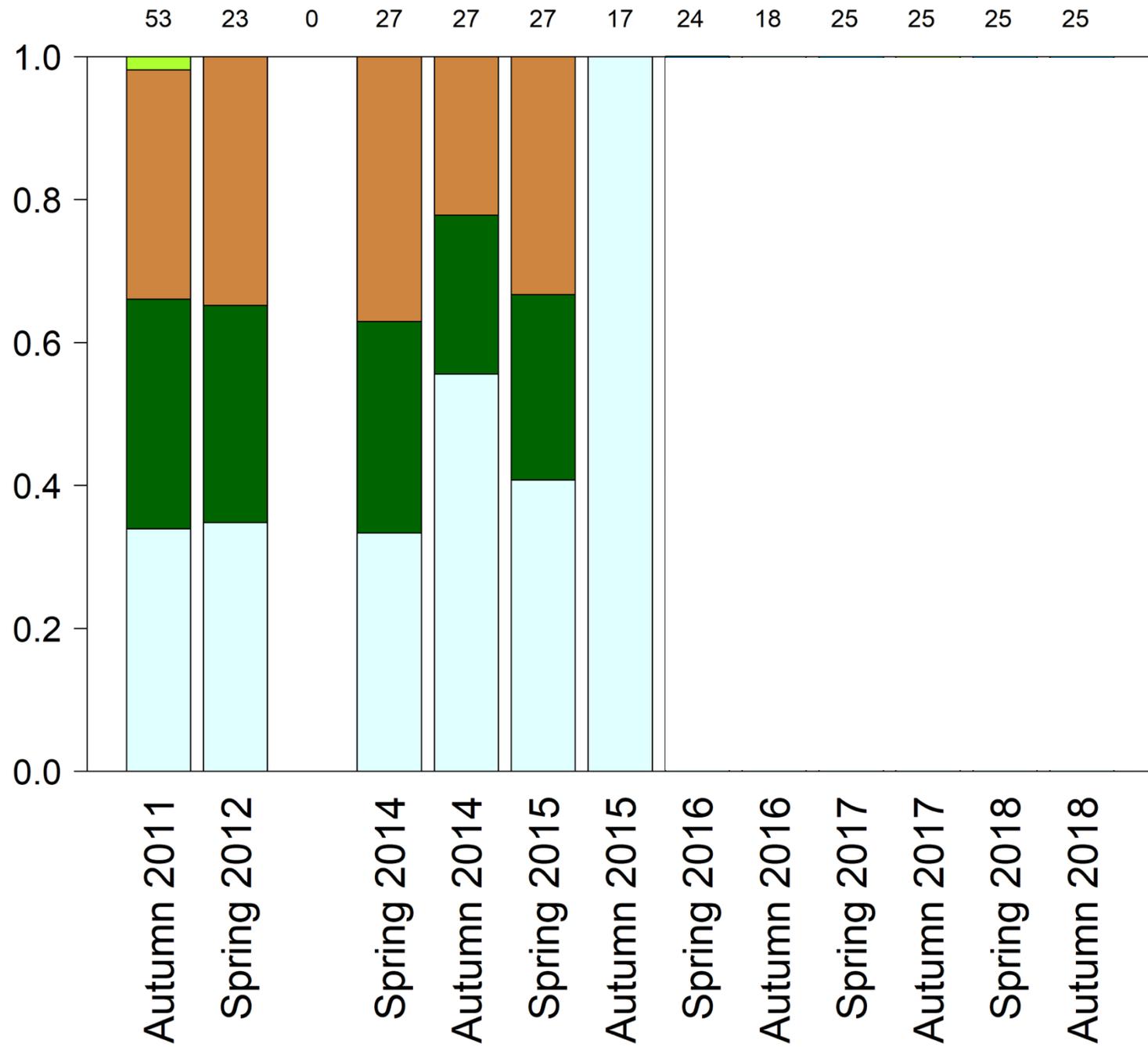
Proportion of sites sampled



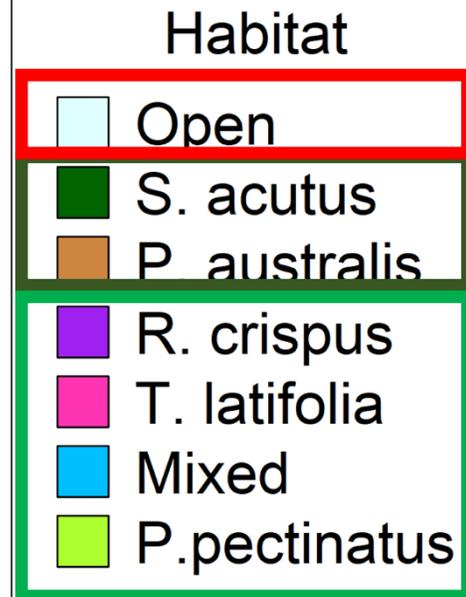
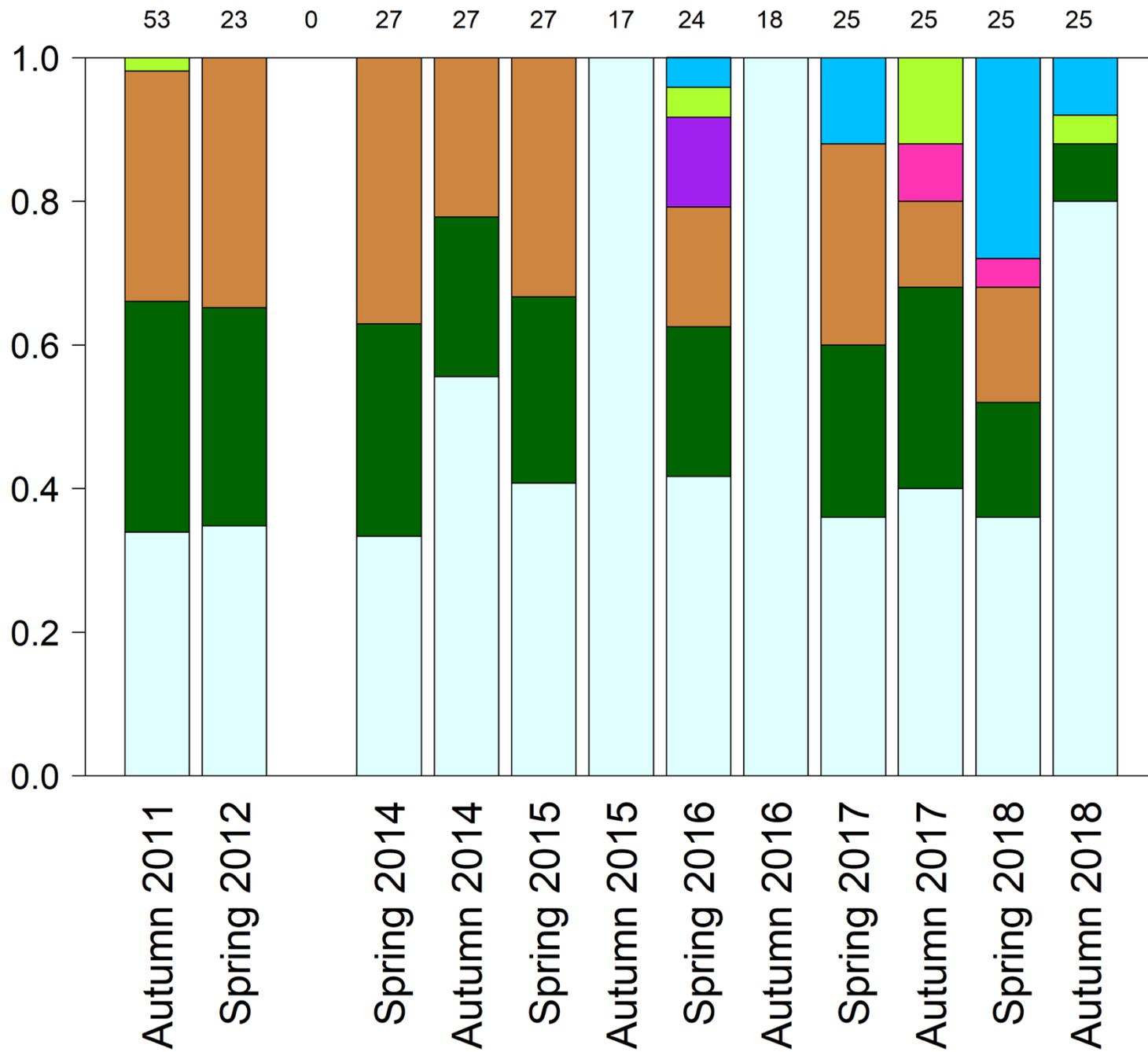
Habitat

- Open
- S. acutus
- P. australis
- R. crispus
- T. latifolia
- Mixed
- P. pectinatus

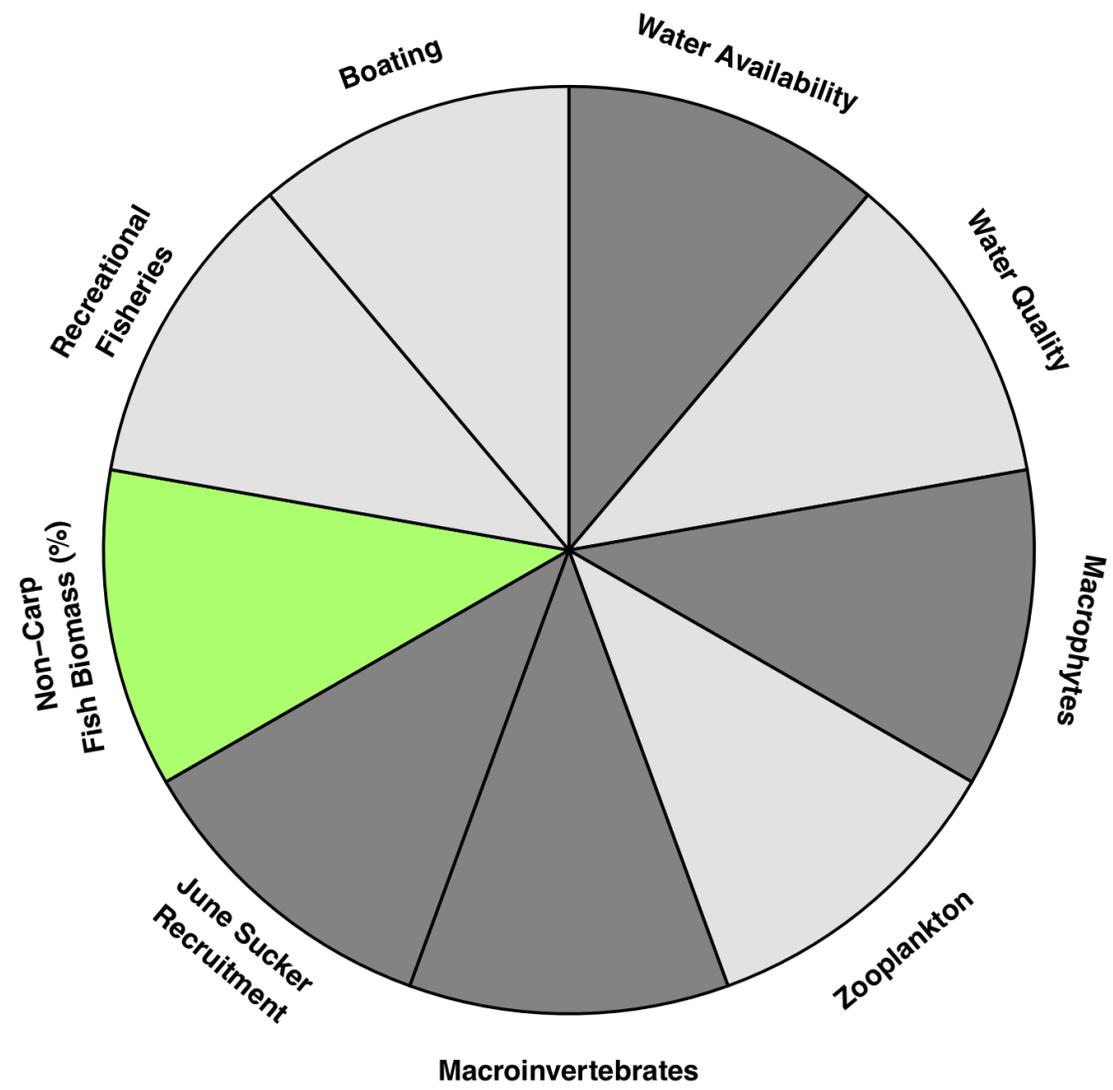
Proportion of sites sampled

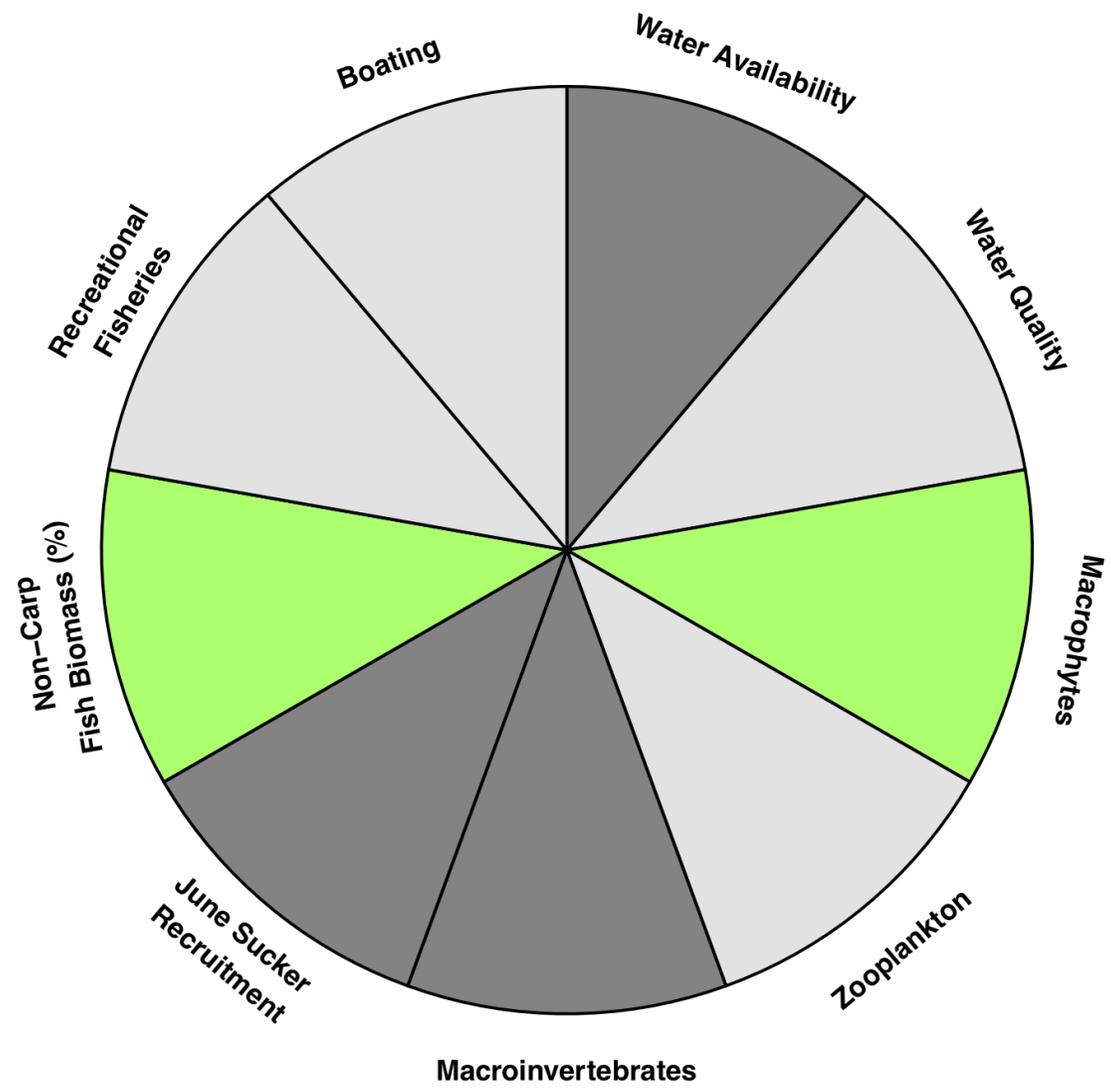


Proportion of sites sampled

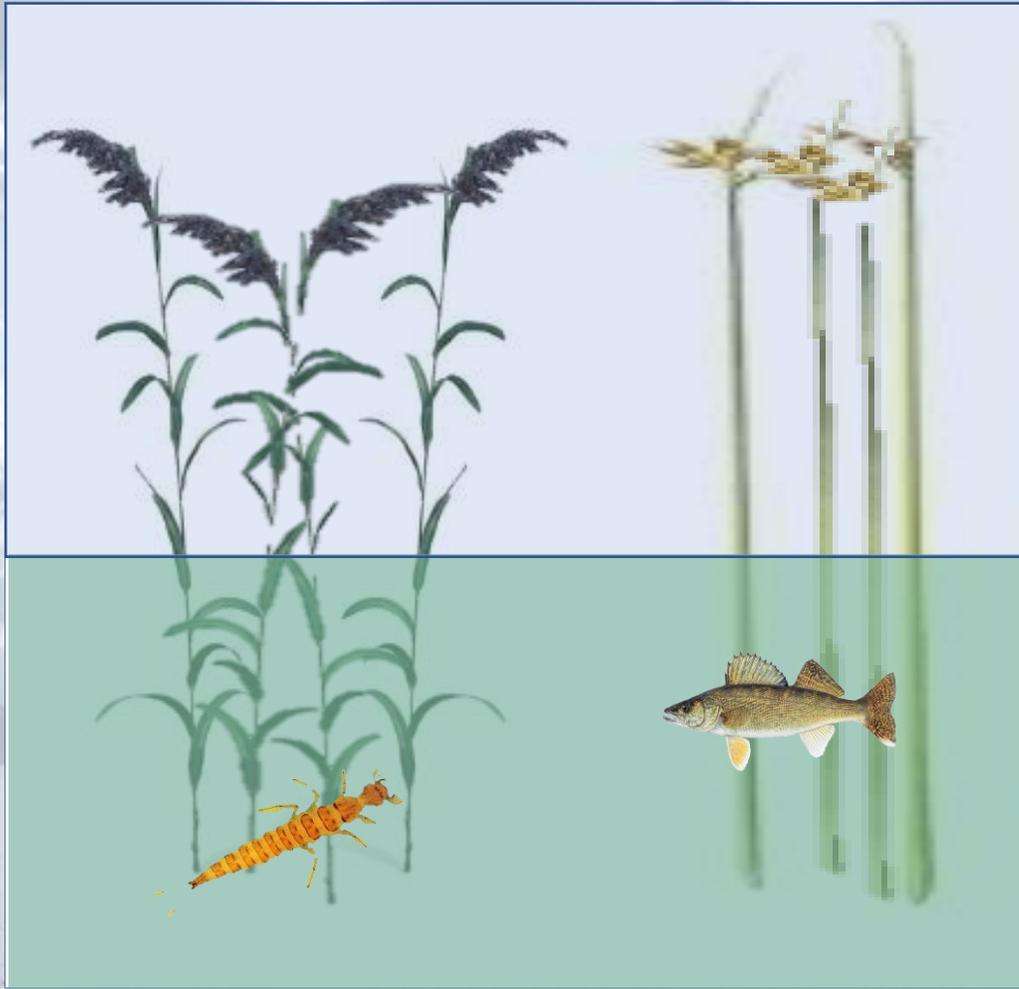




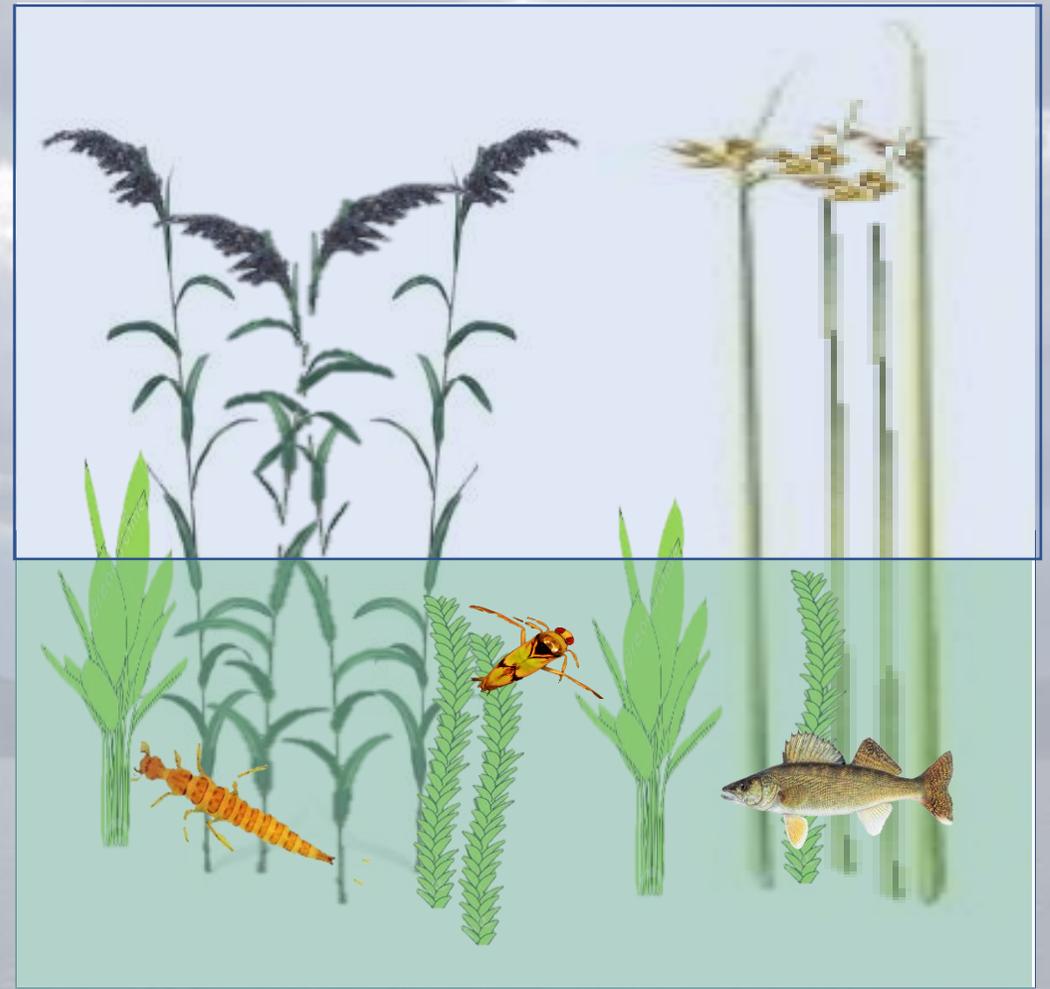




# Stalks (reed-like)

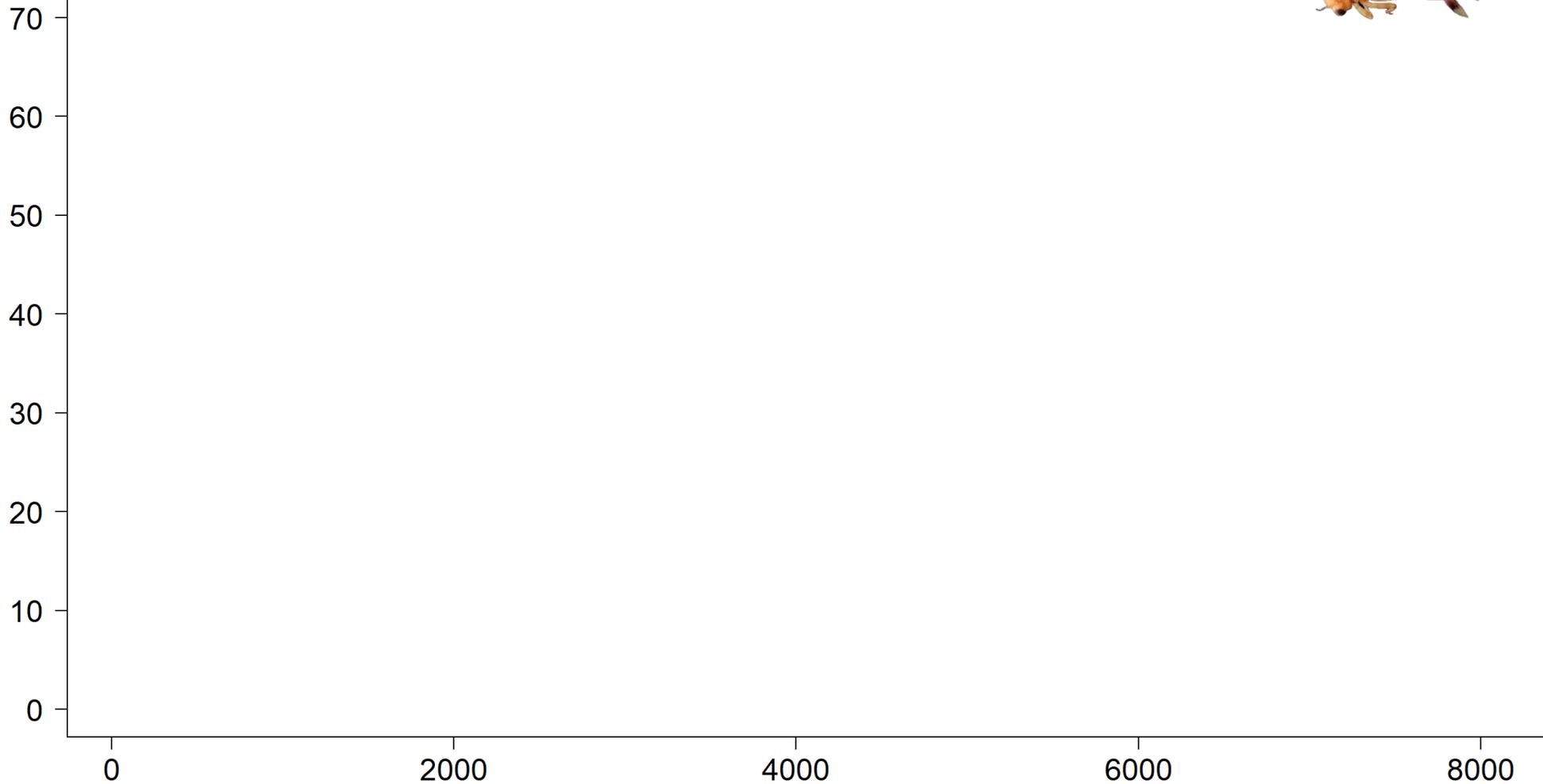


# Mixed (complex habitat)



# Macroinvertebrate Biomass and Macrophytes

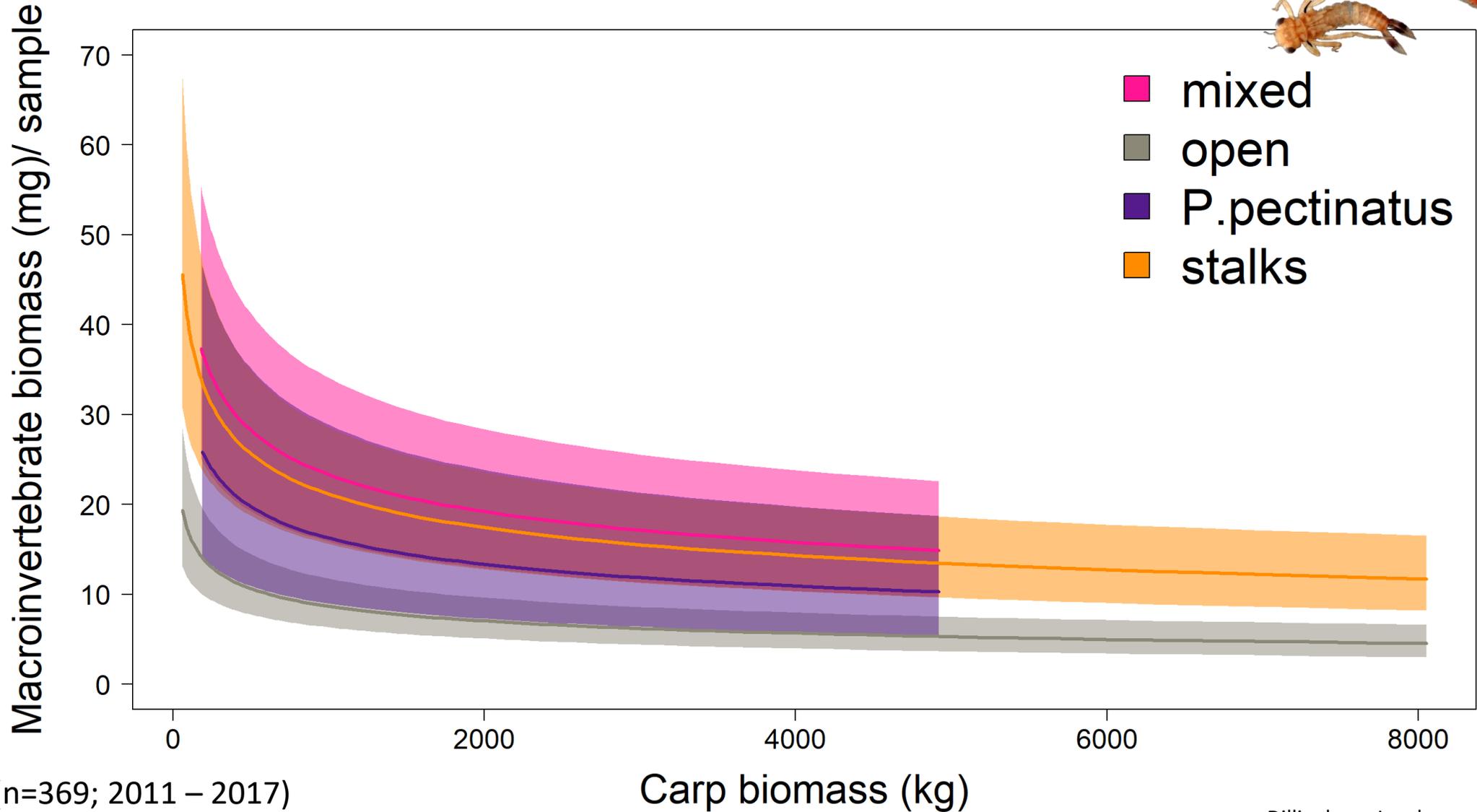
Macroinvertebrate biomass (mg)/ sample



(n=369; 2011 – 2017)

Carp biomass (kg)

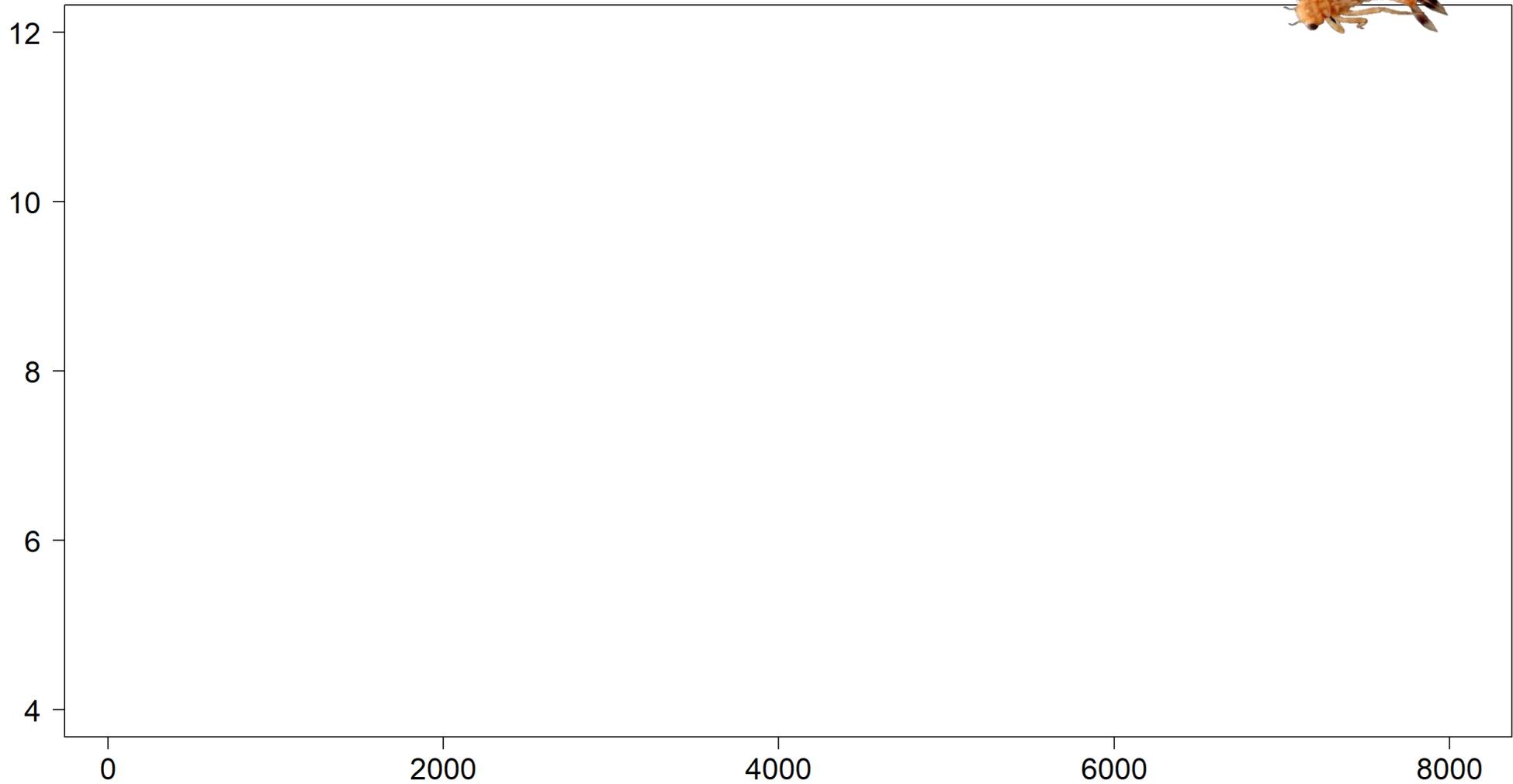
# Macroinvertebrate Biomass and Macrophytes



(n=369; 2011 – 2017)

# Macroinvertebrate Richness and Macrophytes

Macroinvertebrate Richness / sample



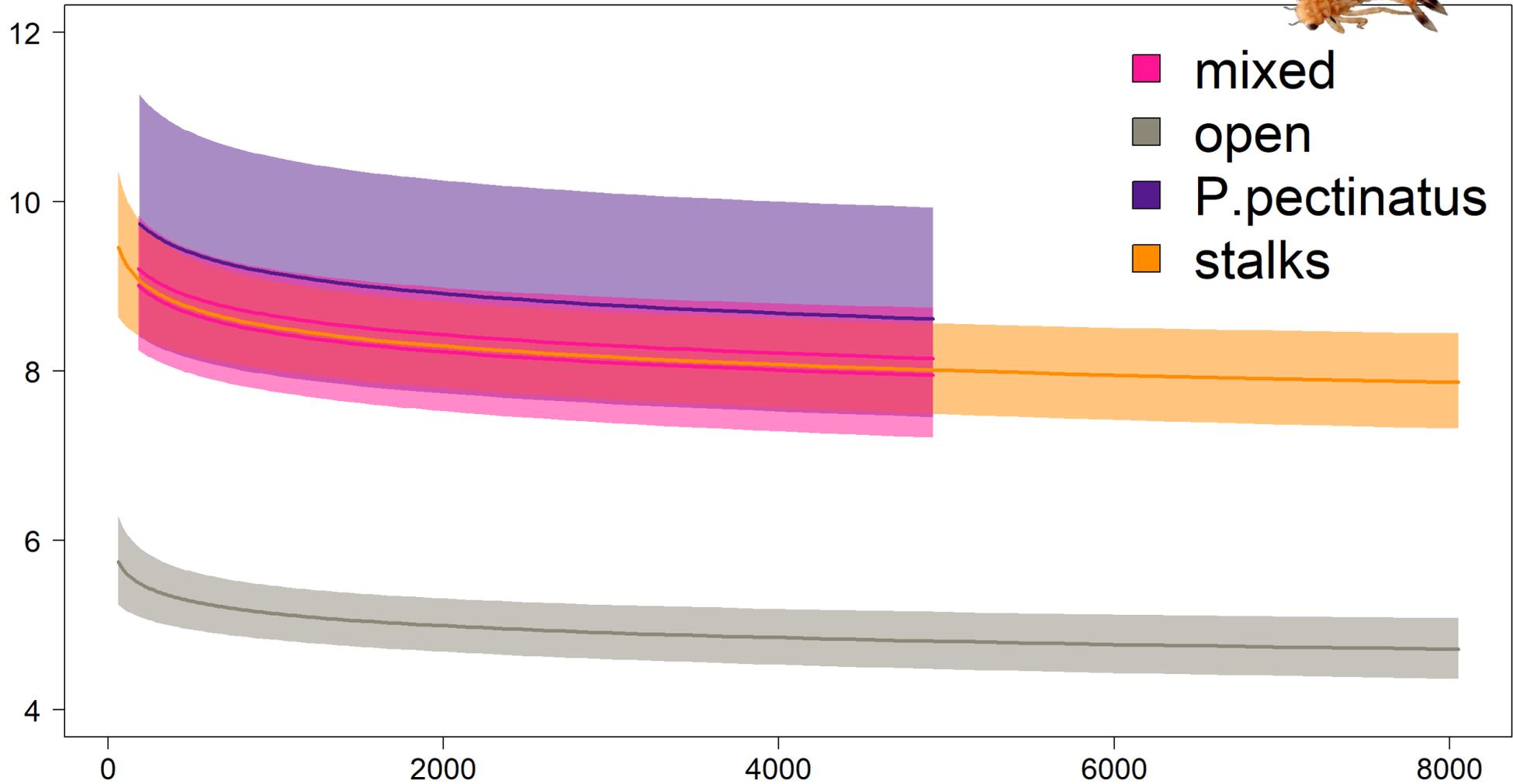
(n=369; 2011 – 2017)

Carp biomass (kg)



# Macroinvertebrate Richness and Macrophytes

Macroinvertebrate Richness / sample

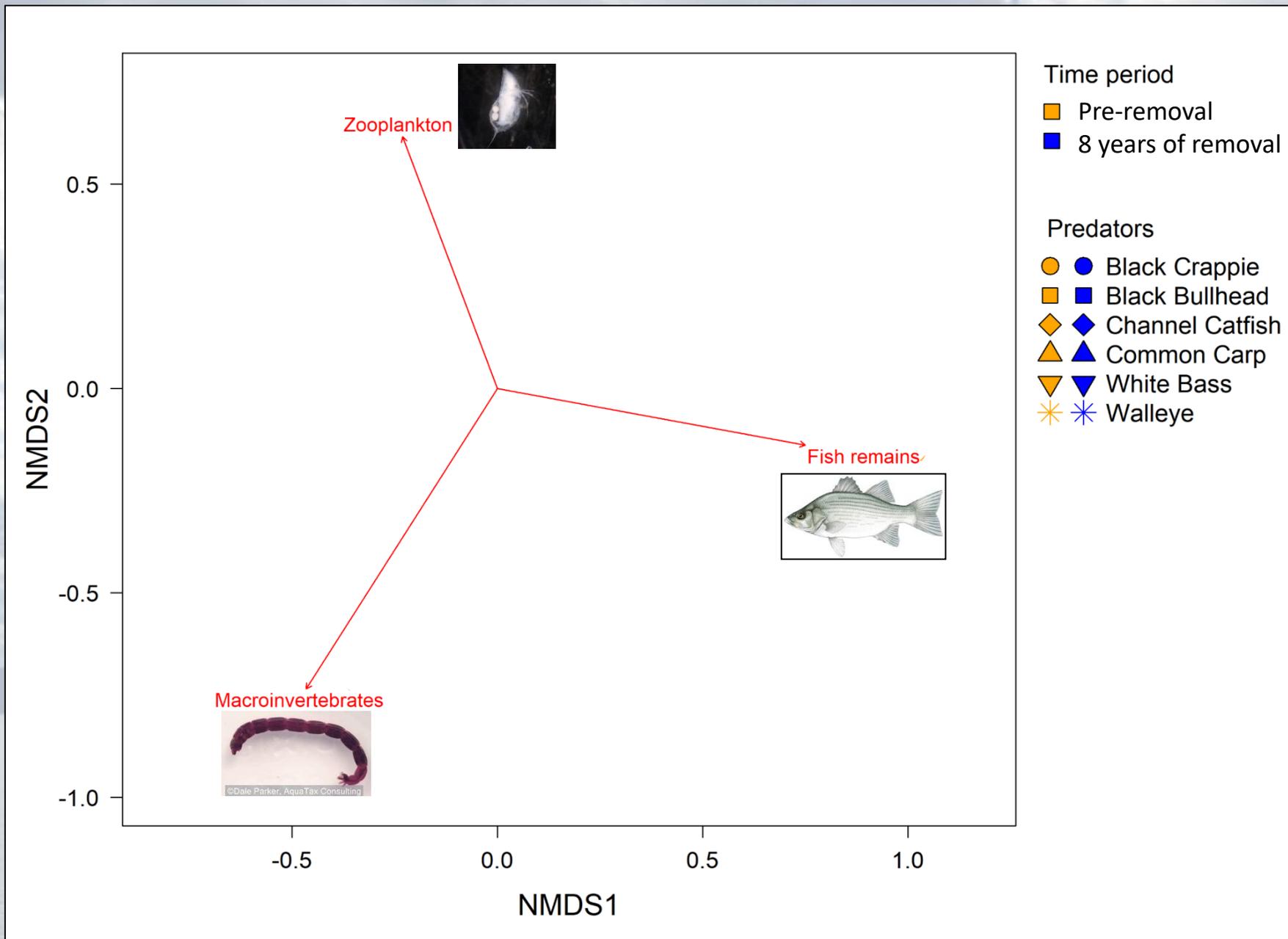


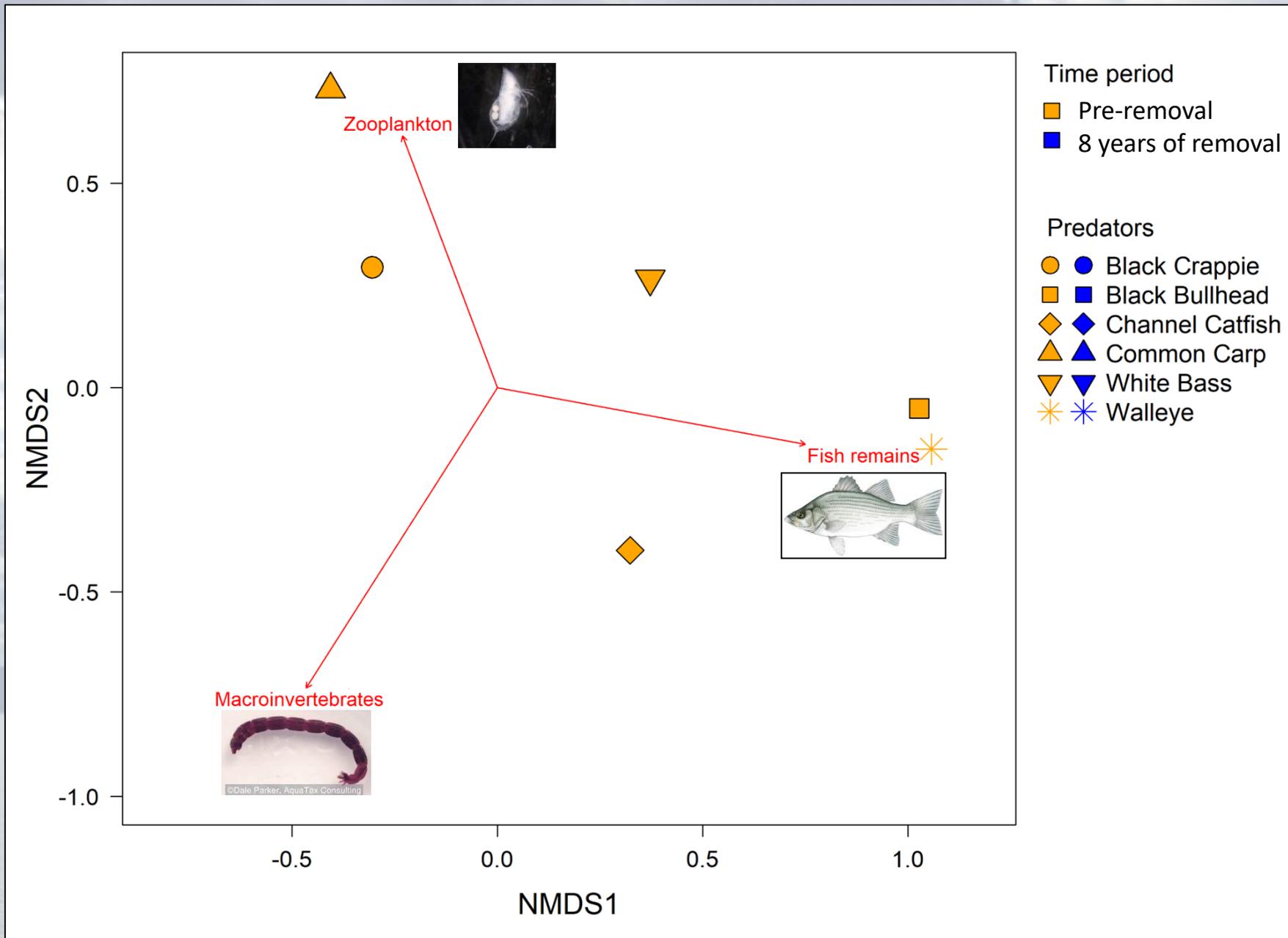
- mixed
- open
- P.pectinatus
- stalks

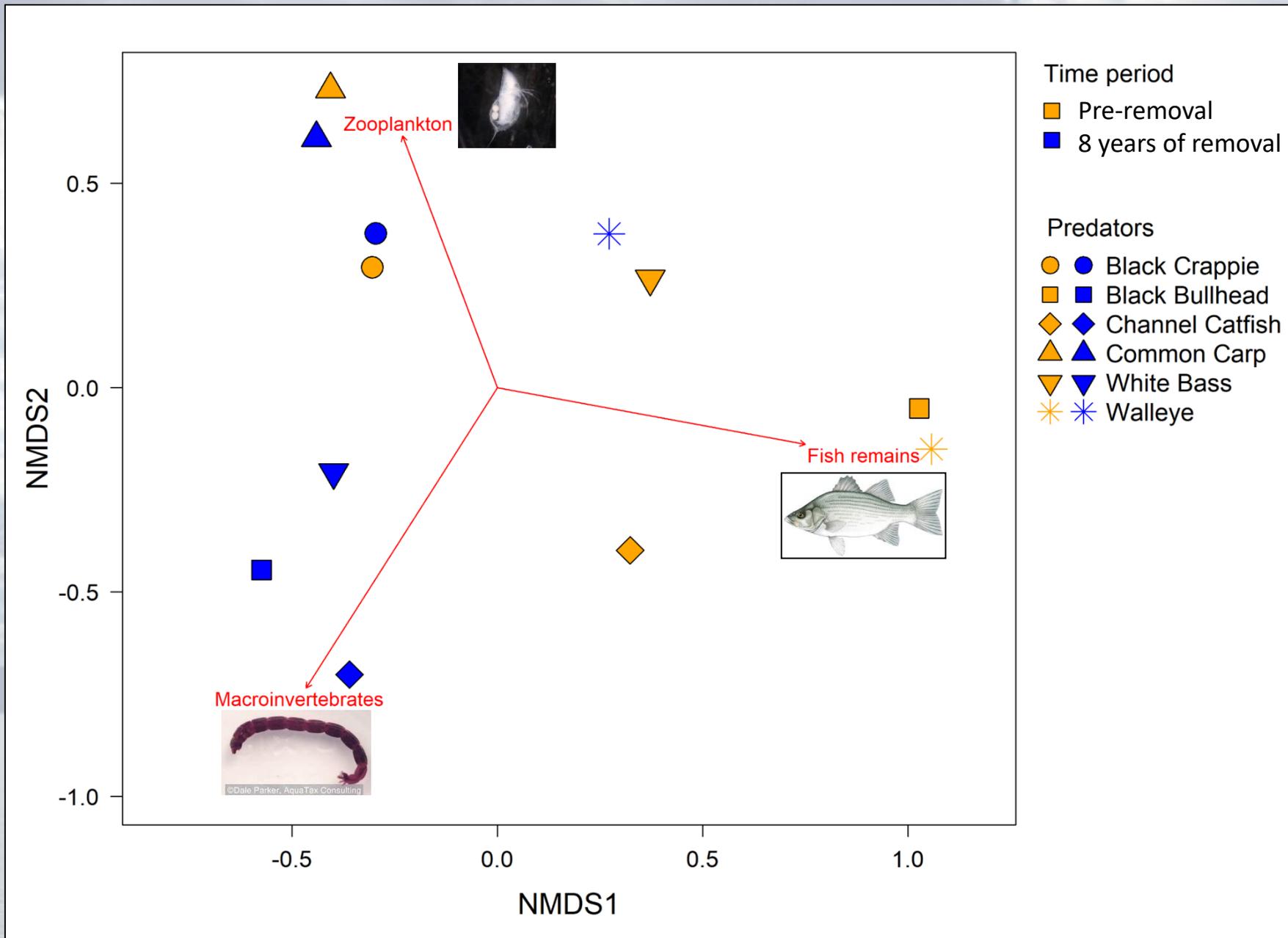
(n=369; 2011 – 2017)

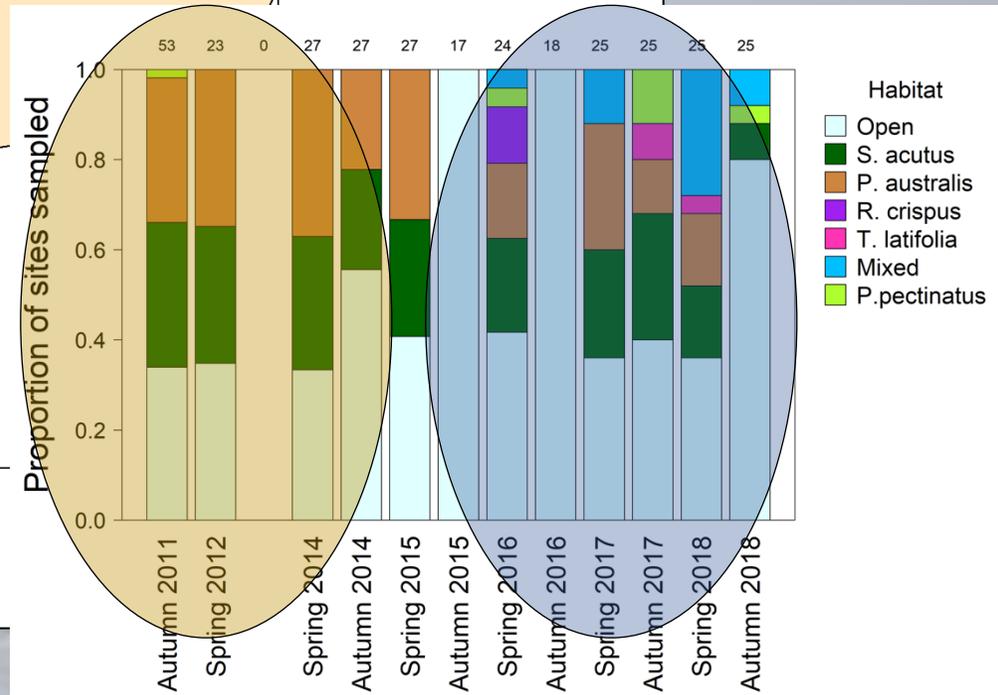
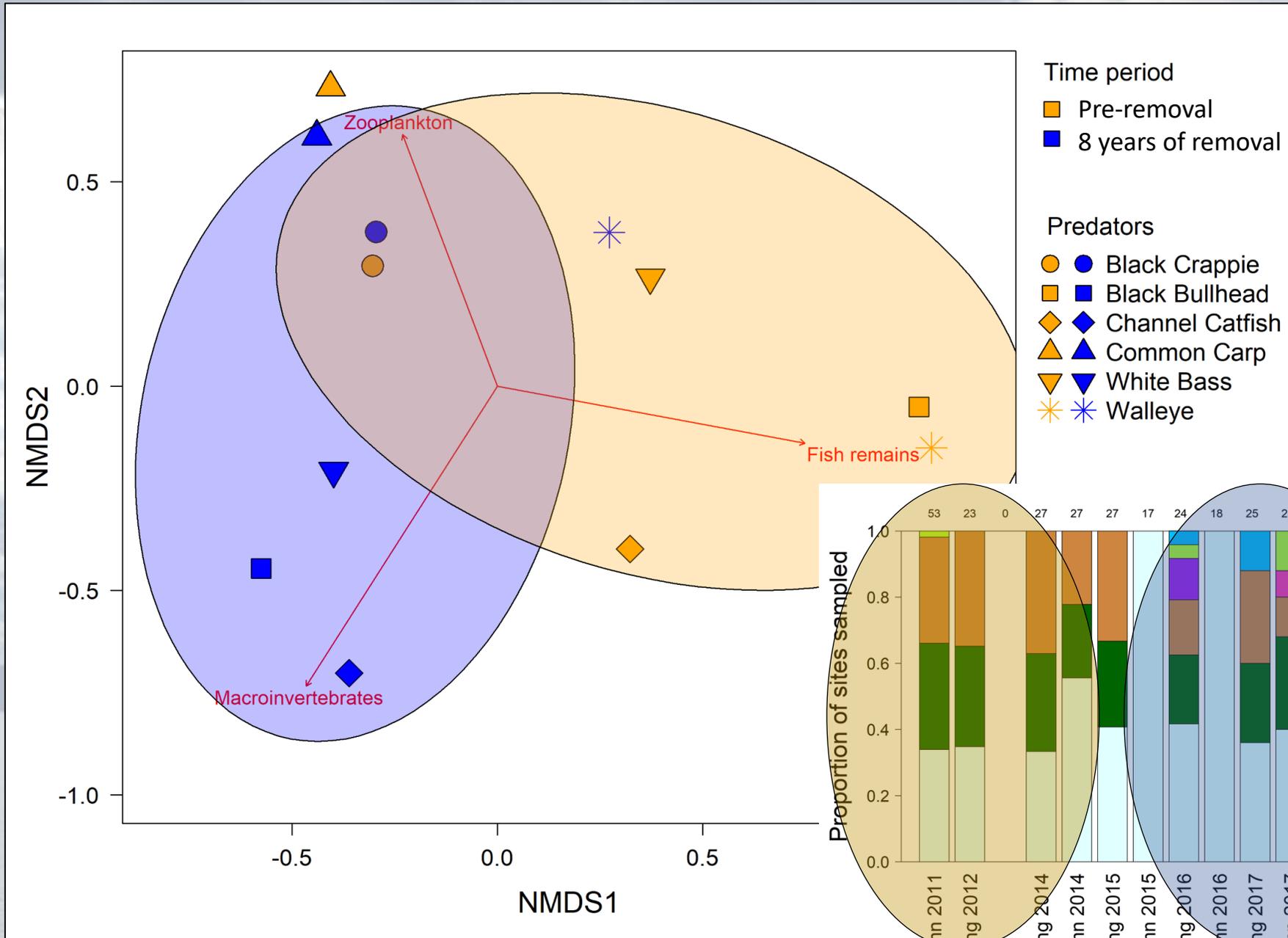
Carp biomass (kg)

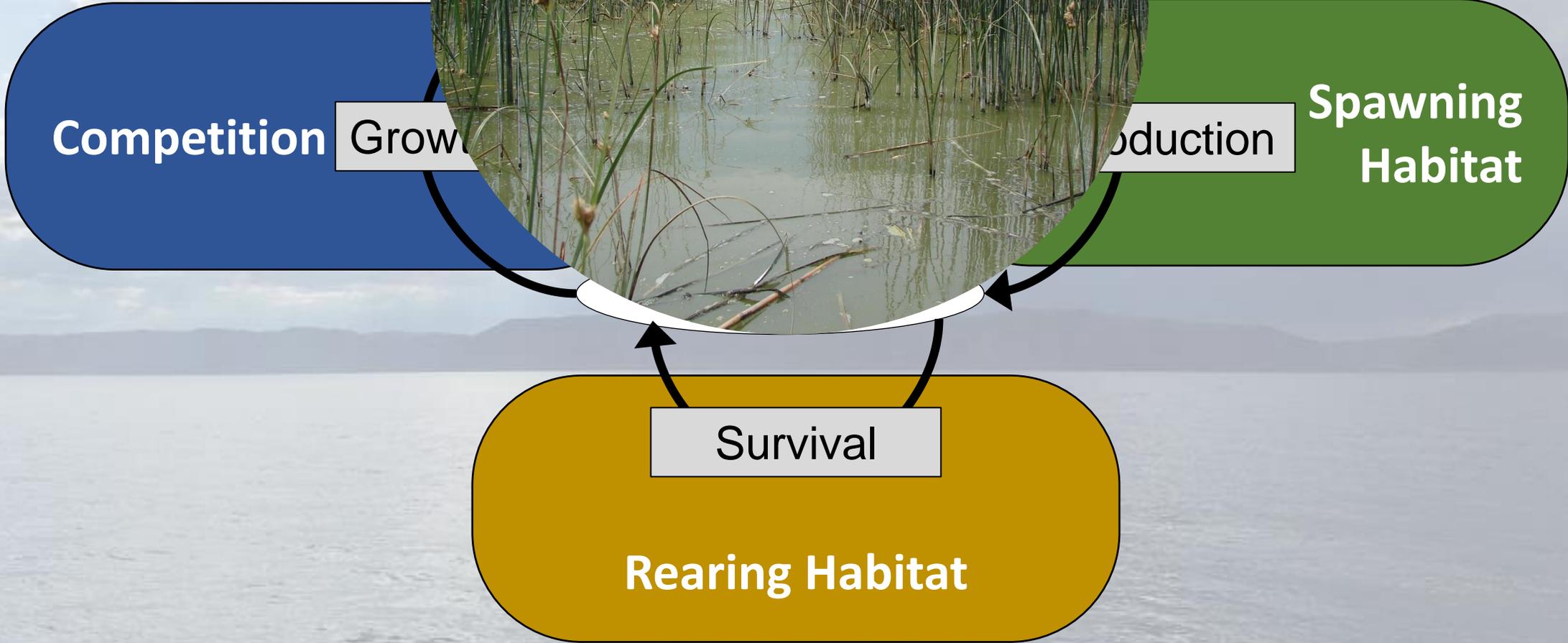
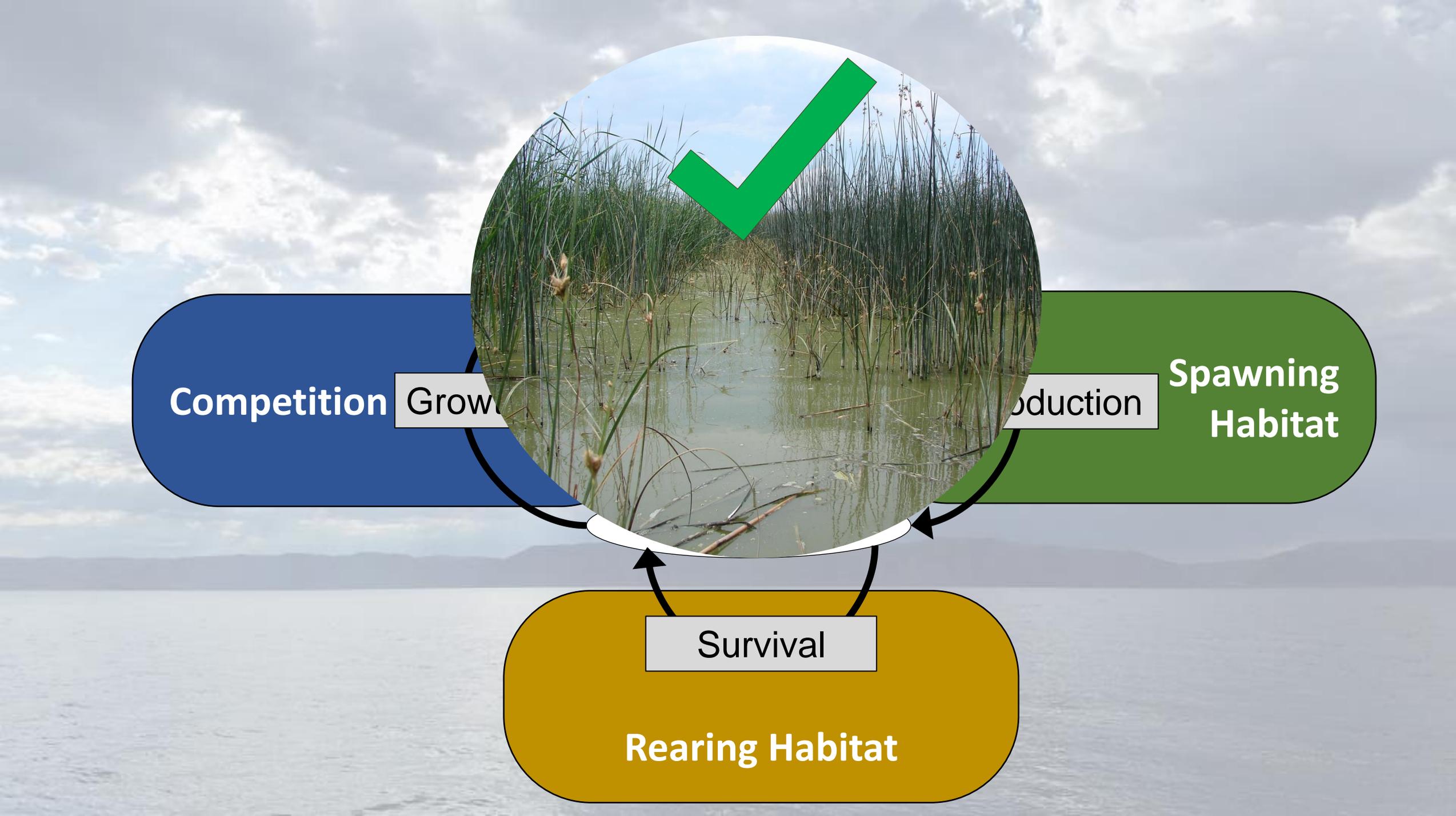


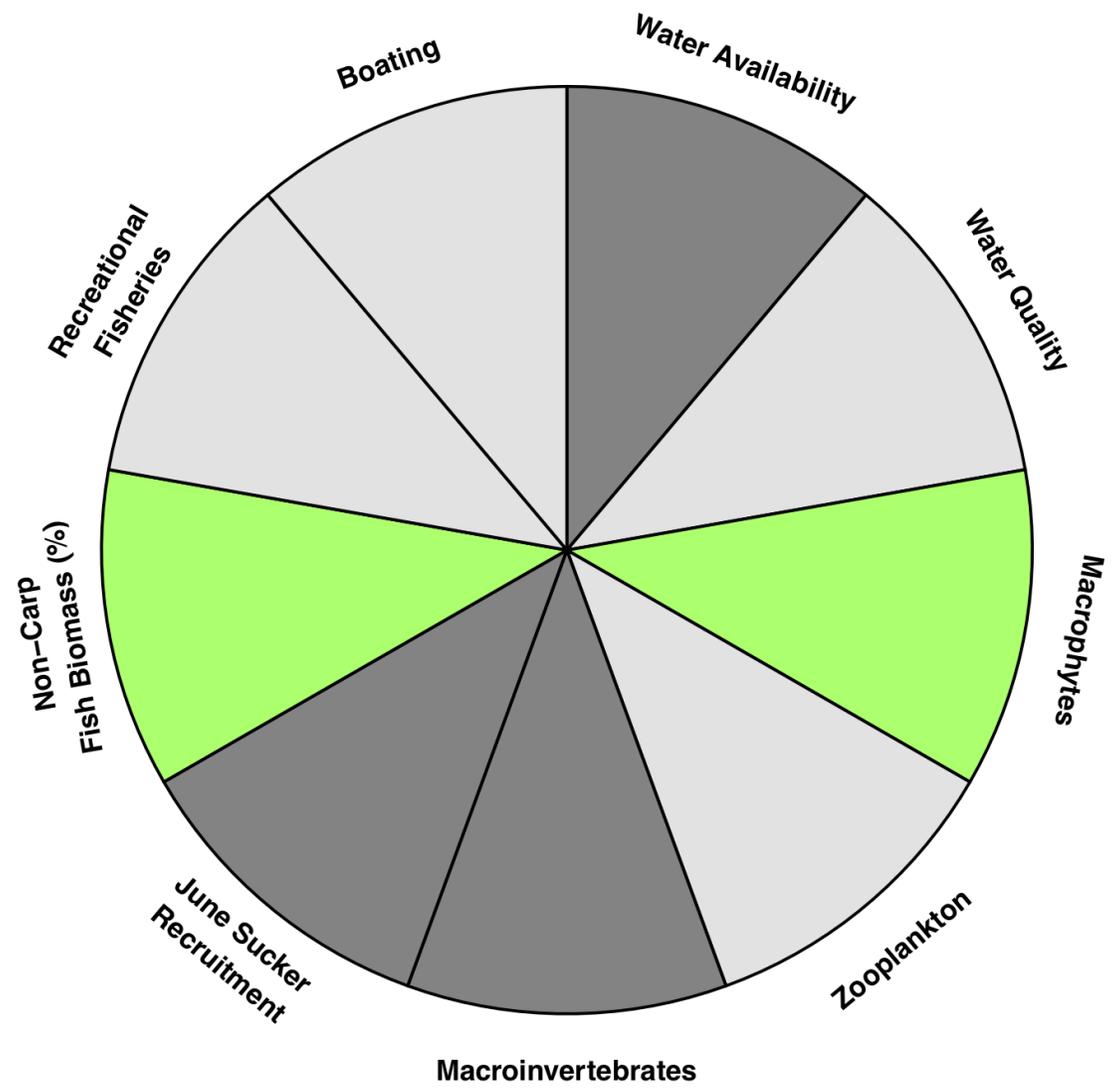


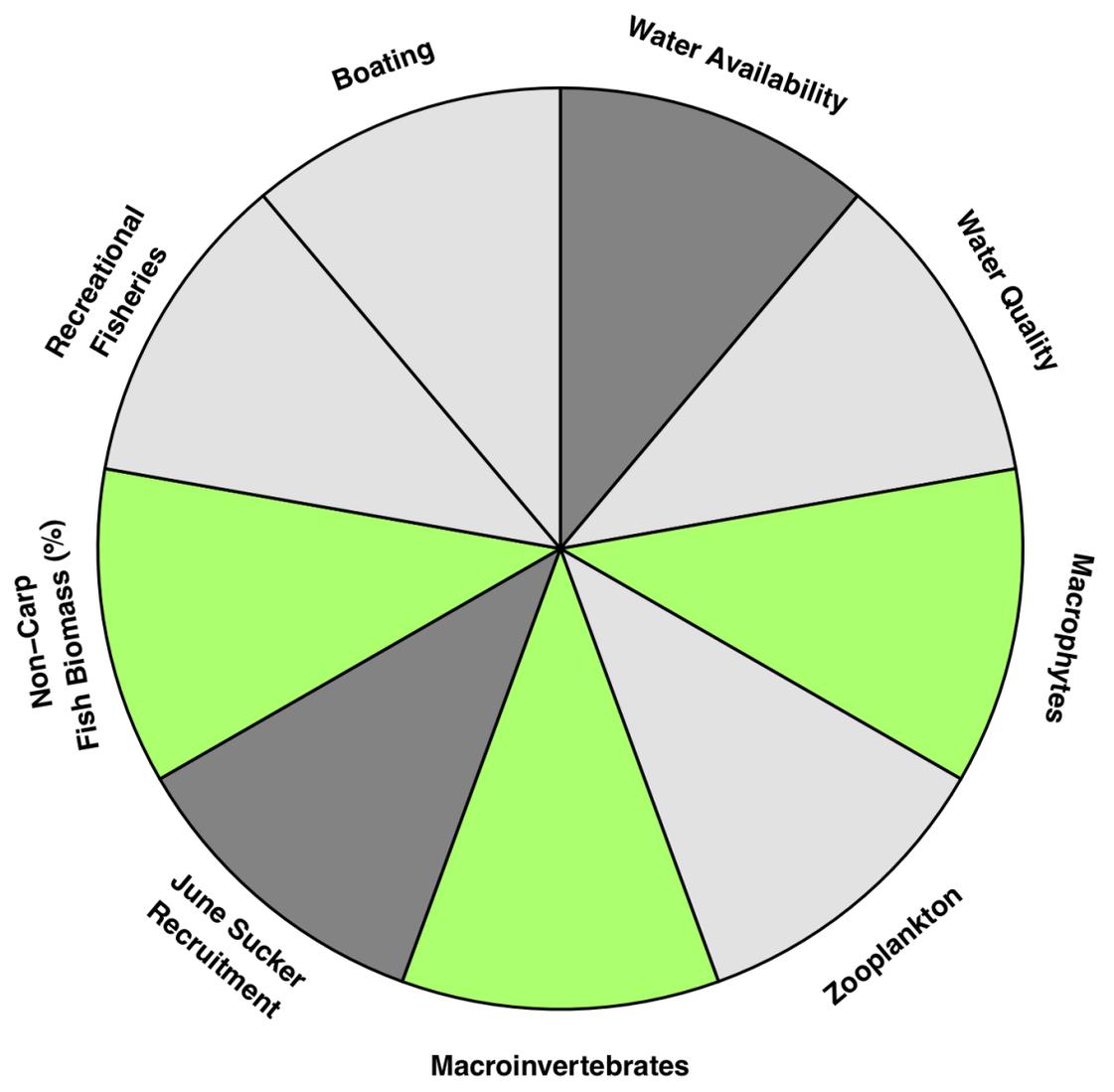












Invasive  
species

Invasive  
species

Habitat  
loss  
(drought)

Habitat  
loss  
(drought)

Competition

Growth

Production

Spawning  
Habitat

Survival

Rearing Habitat



# Early Summer 2016



**Early Summer 2016**



**Mid Summer 2016**



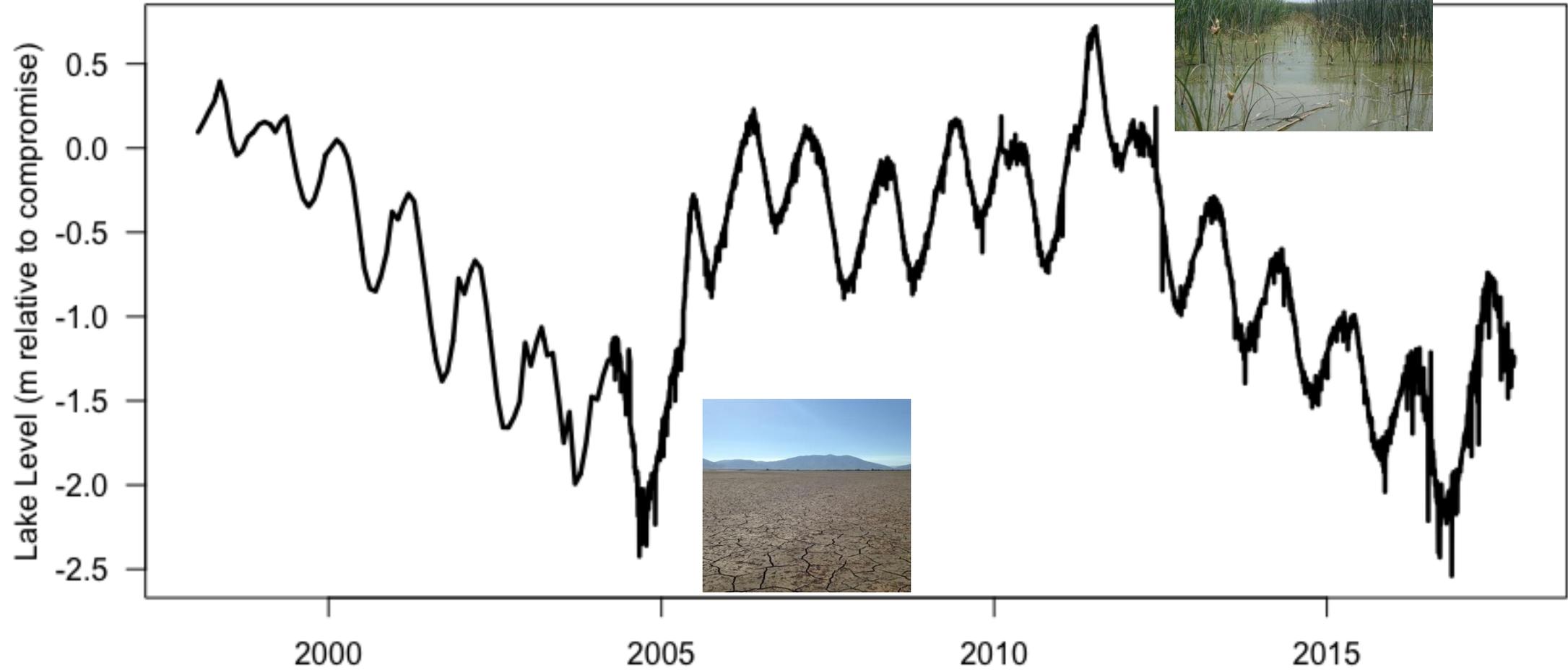
**Early Summer 2016**



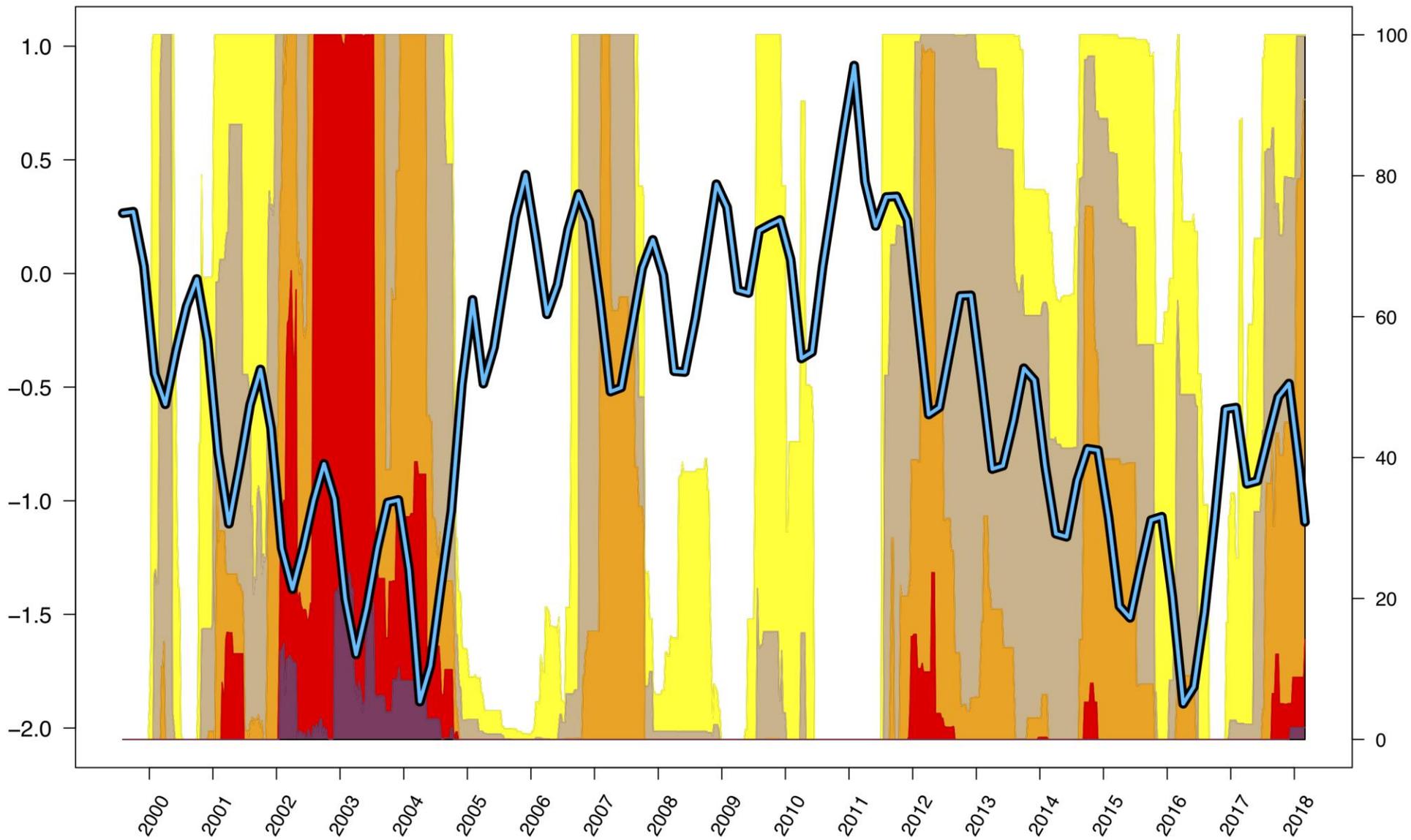
**Mid Summer 2016**



# Annual and interannual lake level cycles



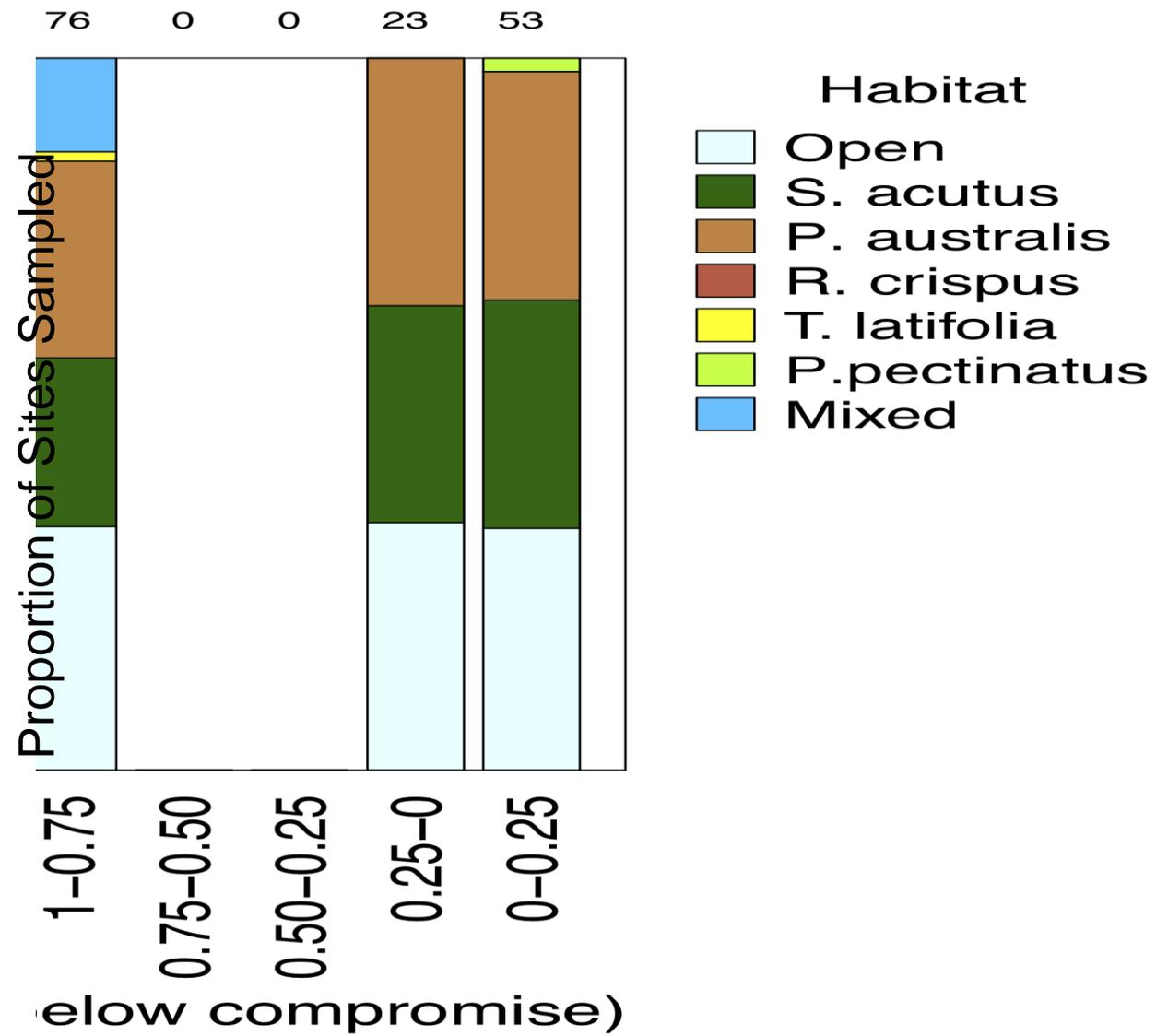
Lake level (compromise)



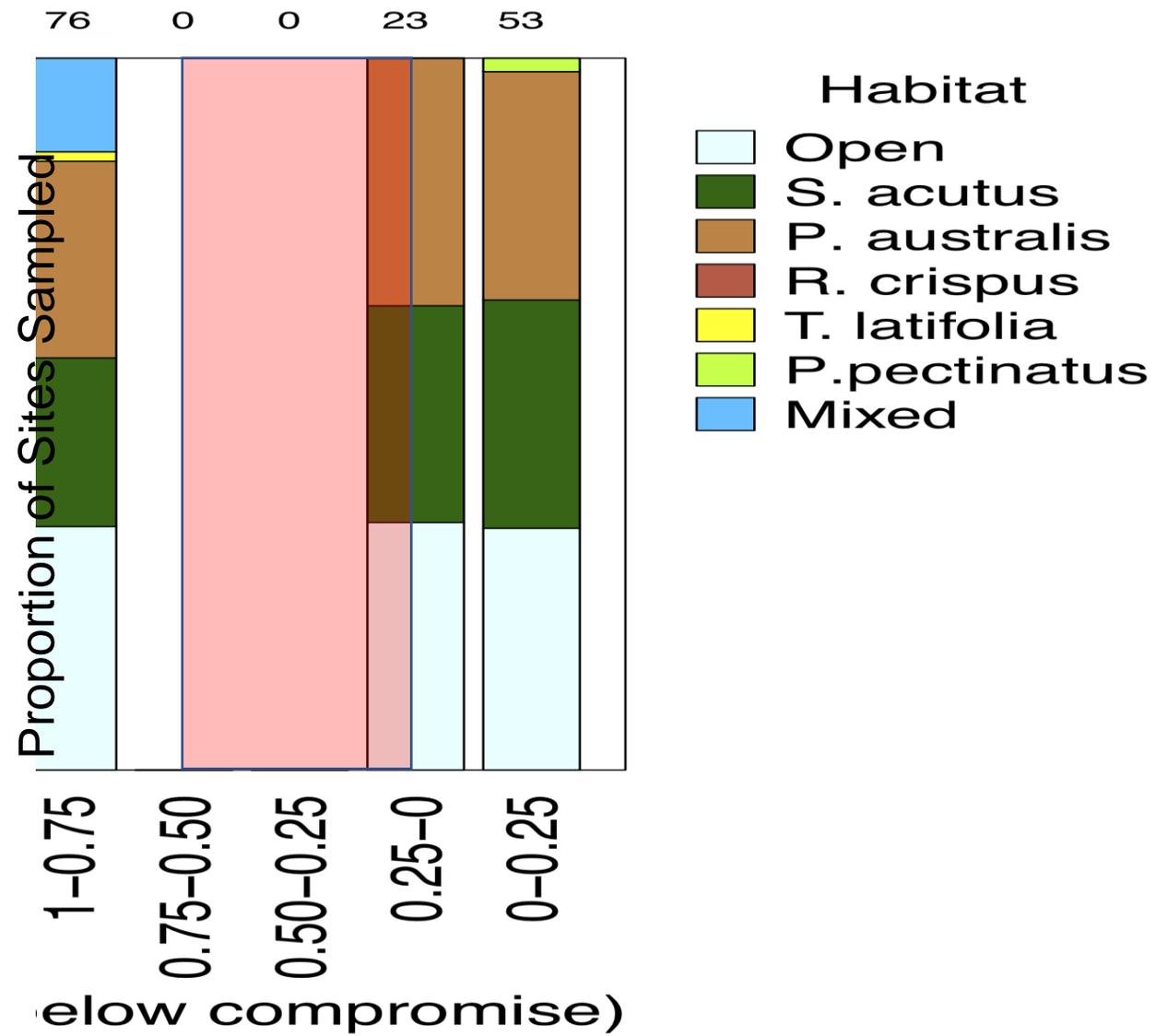
Percent of watershed

- Drought Conditions
- d0 - Abnormally Dry
  - d1 - Moderate Drought
  - d2 - Severe Drought
  - d3 - Extreme Drought
  - d4 - Exceptional Drought

# Lake Level and Macrophytes



# Lake Level and Macrophytes

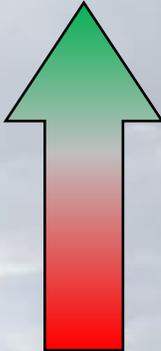
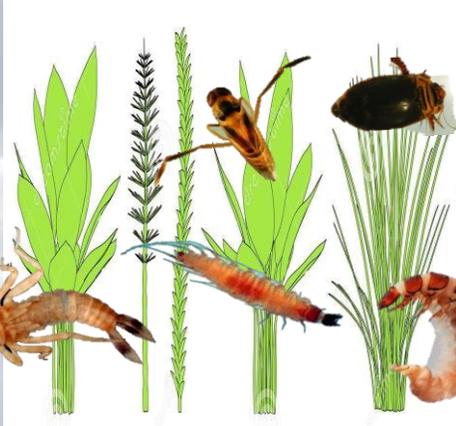
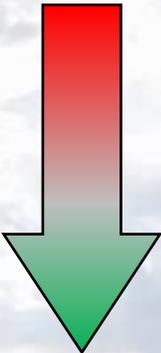


# How do we mitigate impacts of established invasive populations?

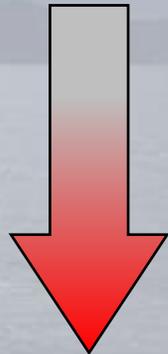
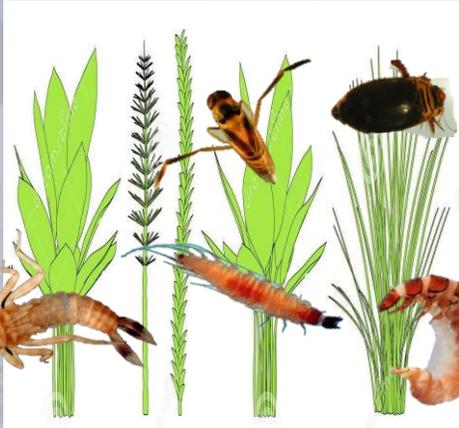
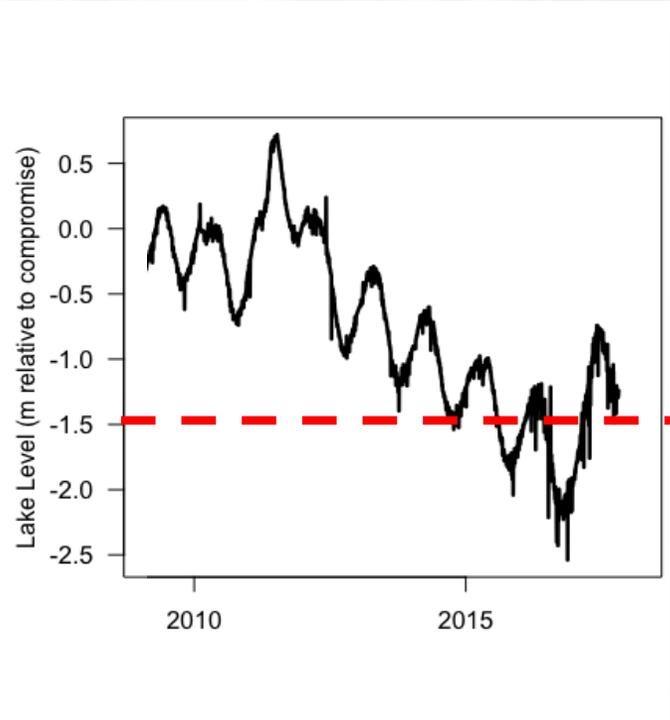
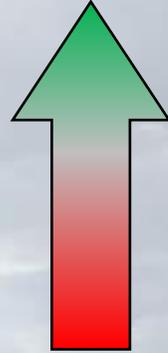
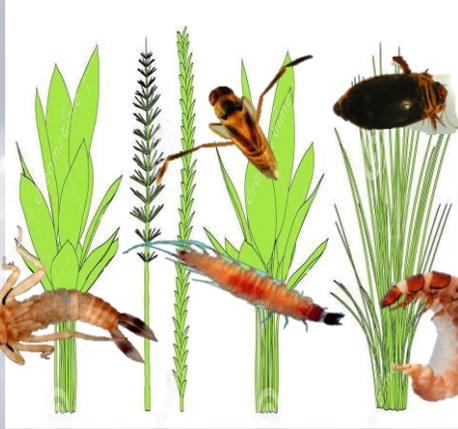
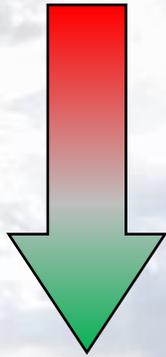


Photo credit: Dave Cole

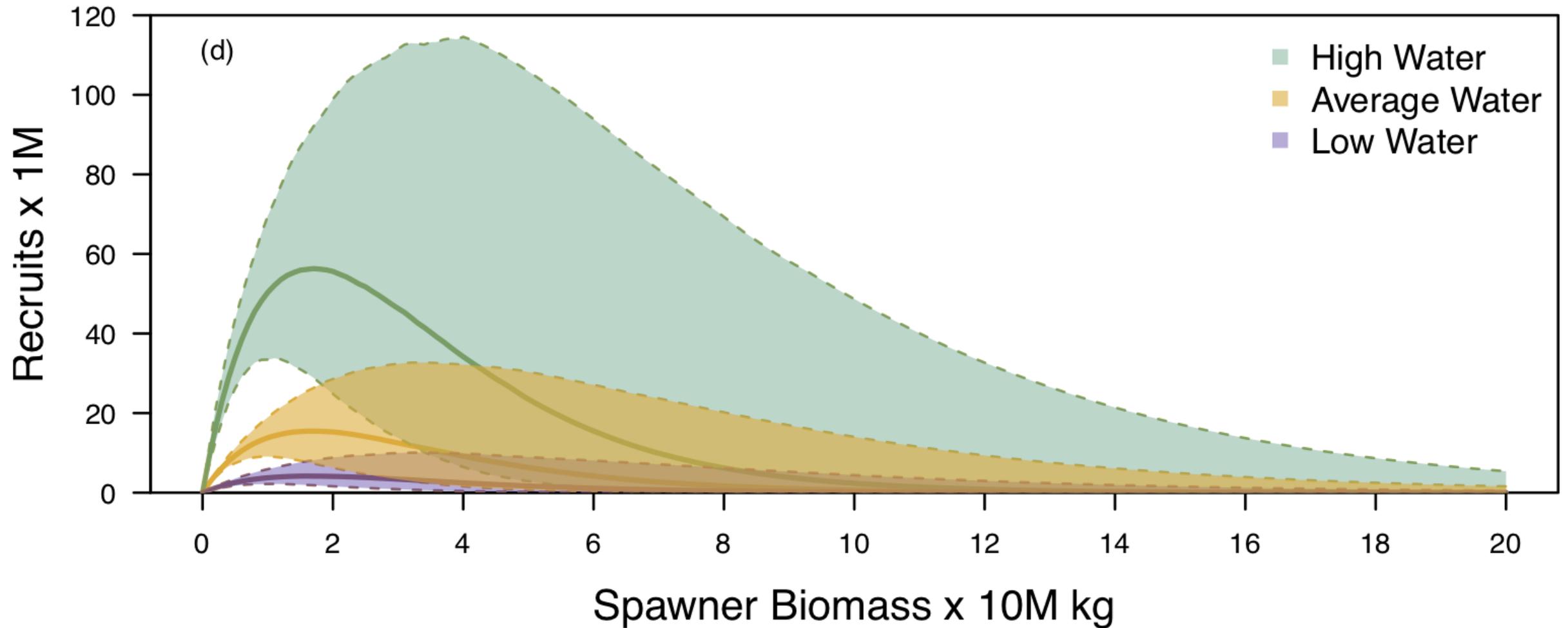
# Complex synergistic and antagonistic drivers

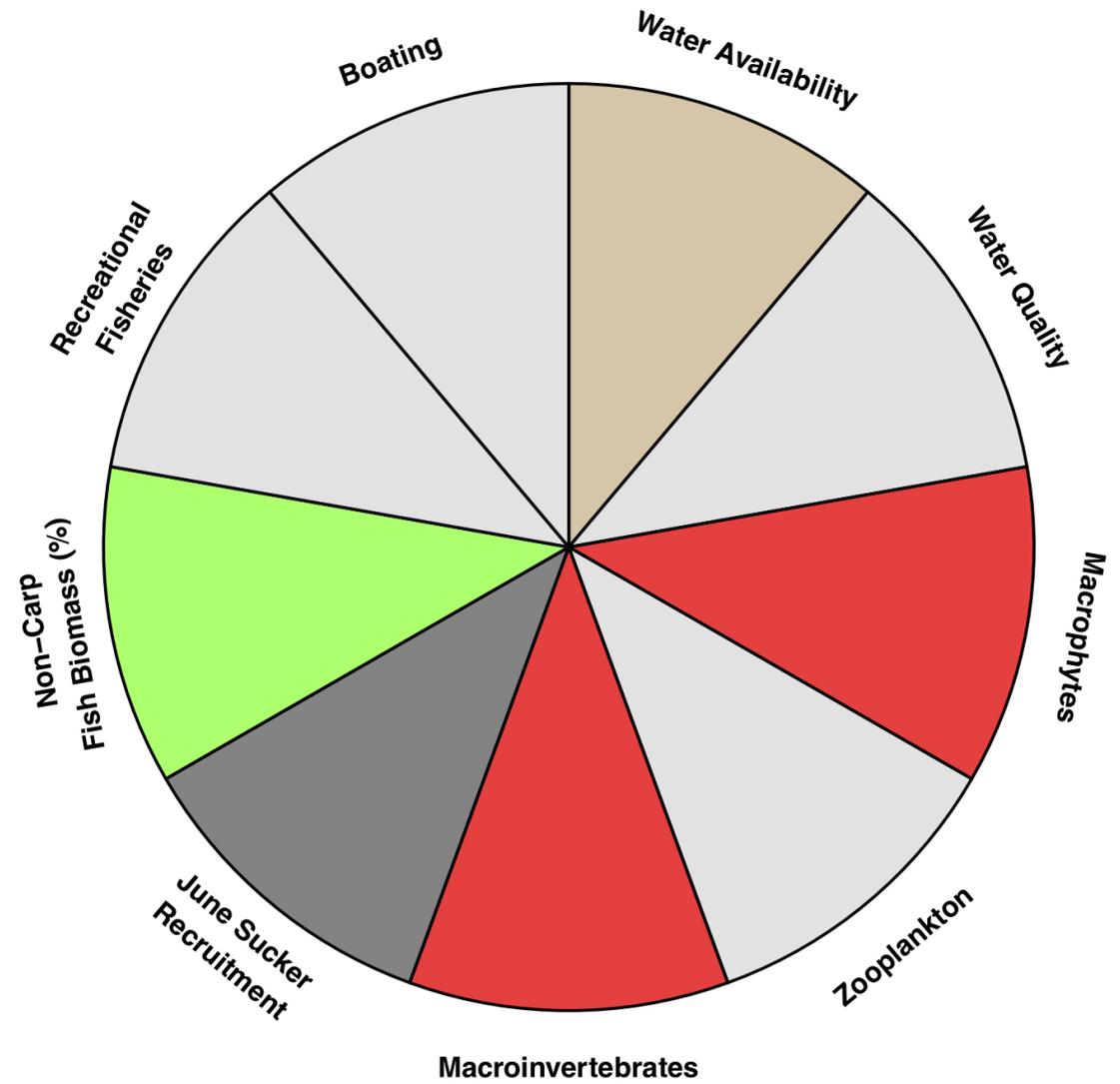
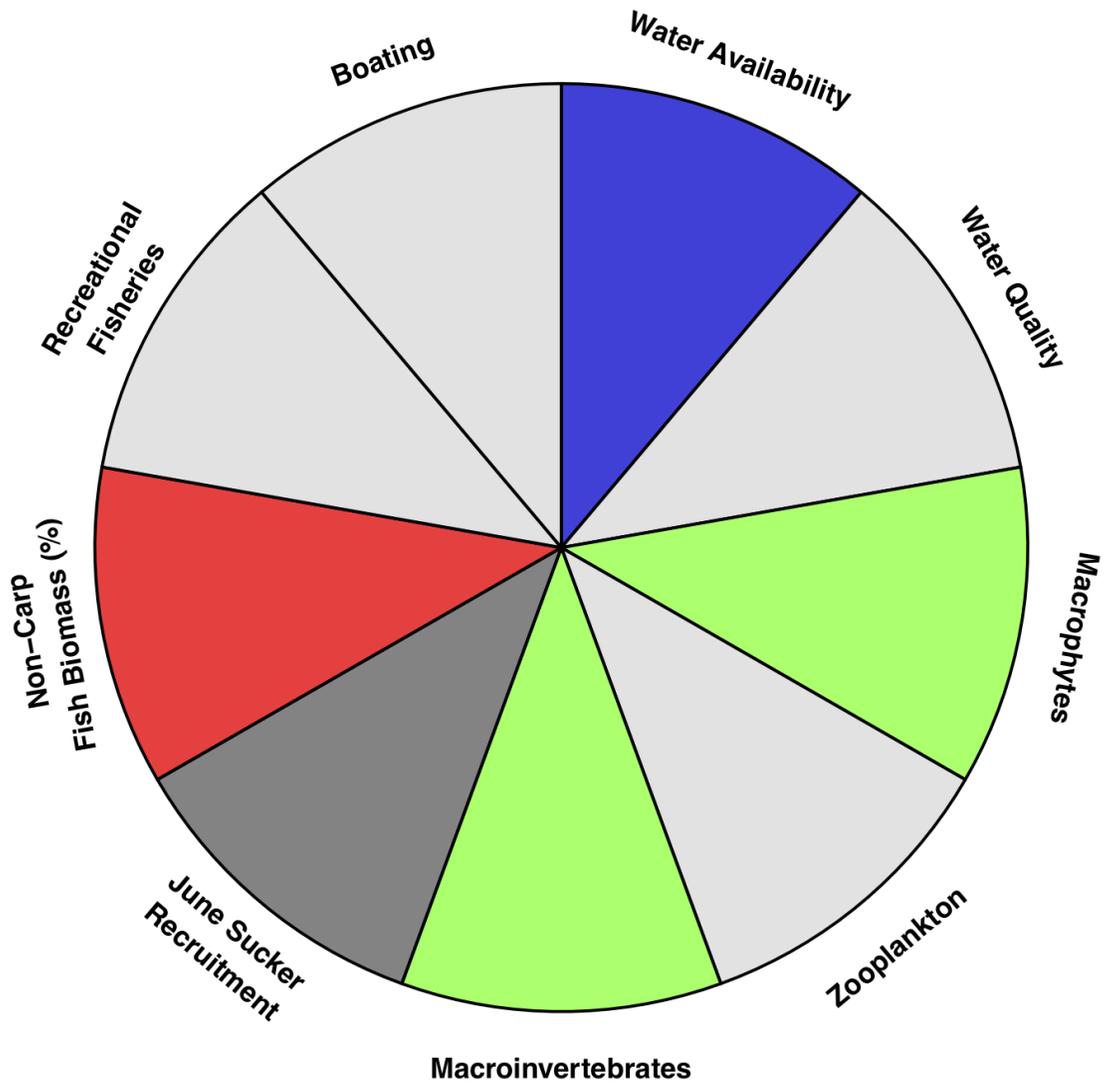


# Complex synergistic and antagonistic drivers



# Lake Level and Carp Recruitment





Northern pike  
recruitment detected

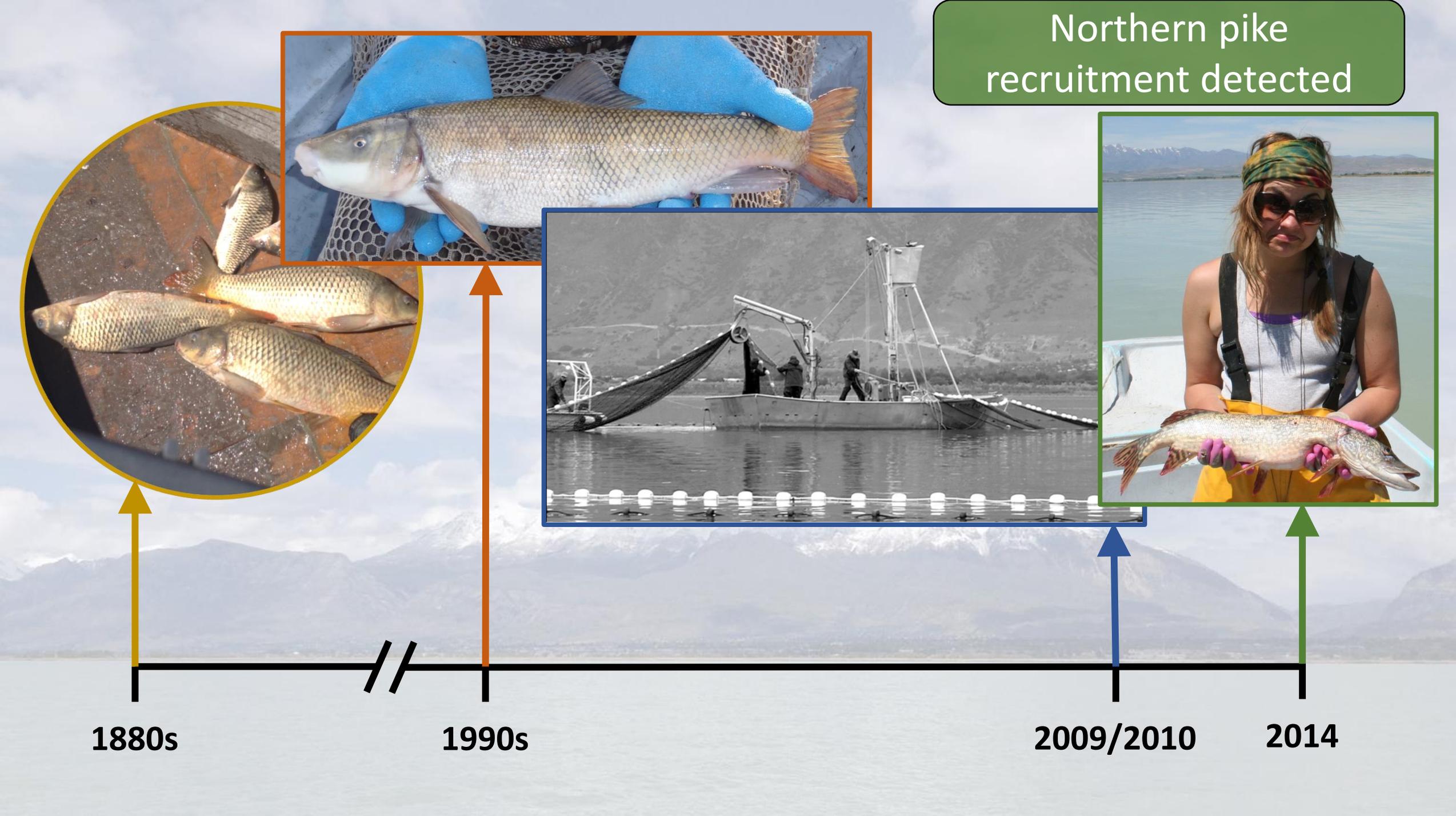


1880s

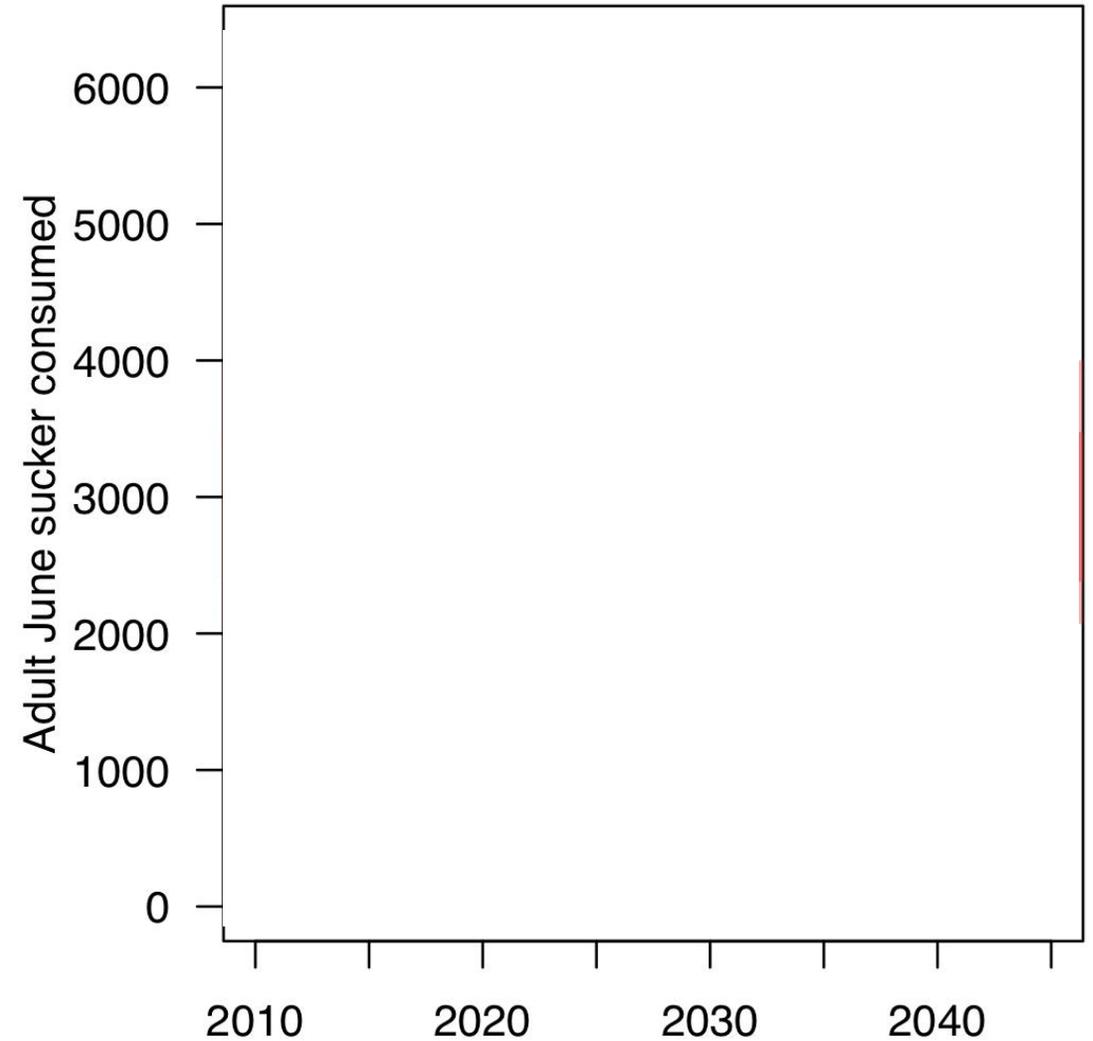
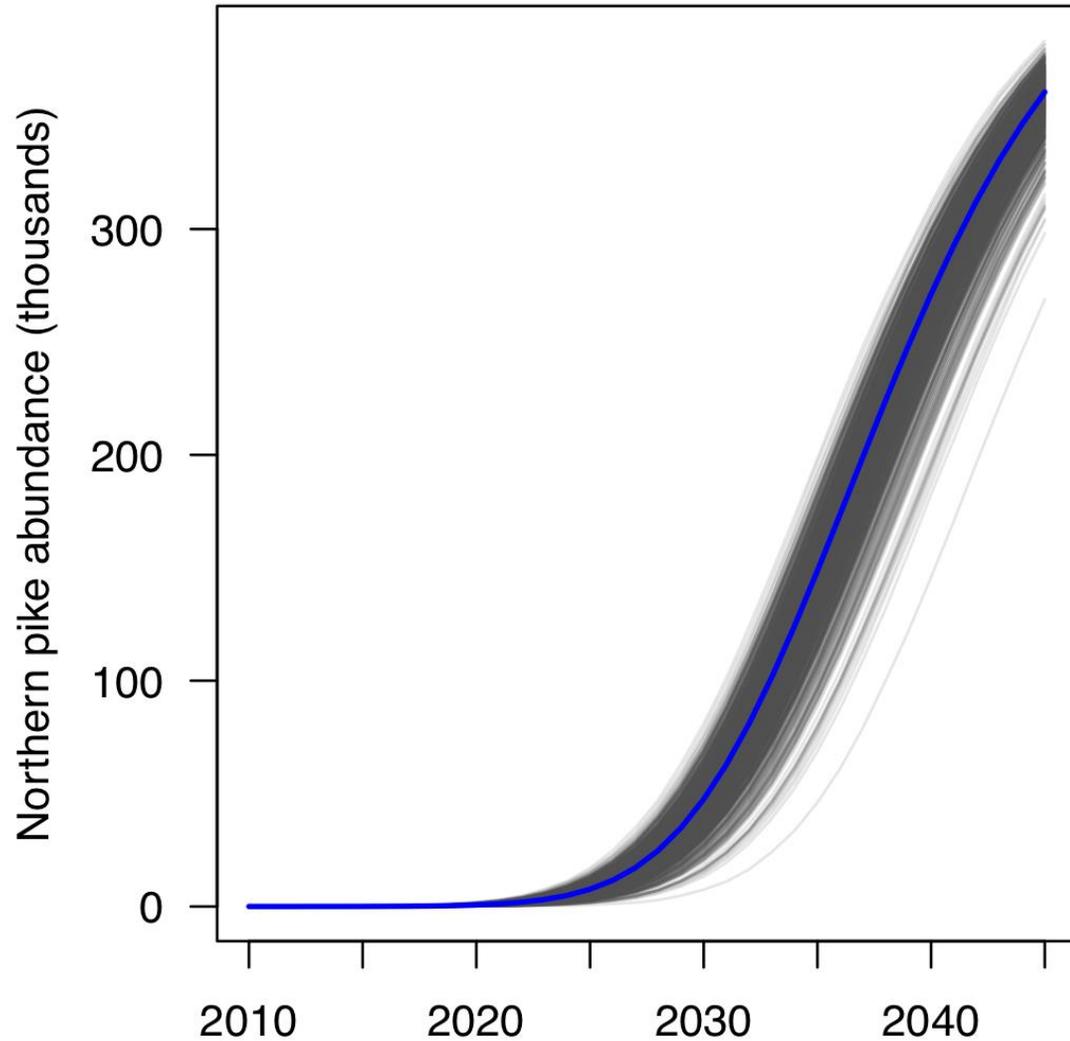
1990s

2009/2010

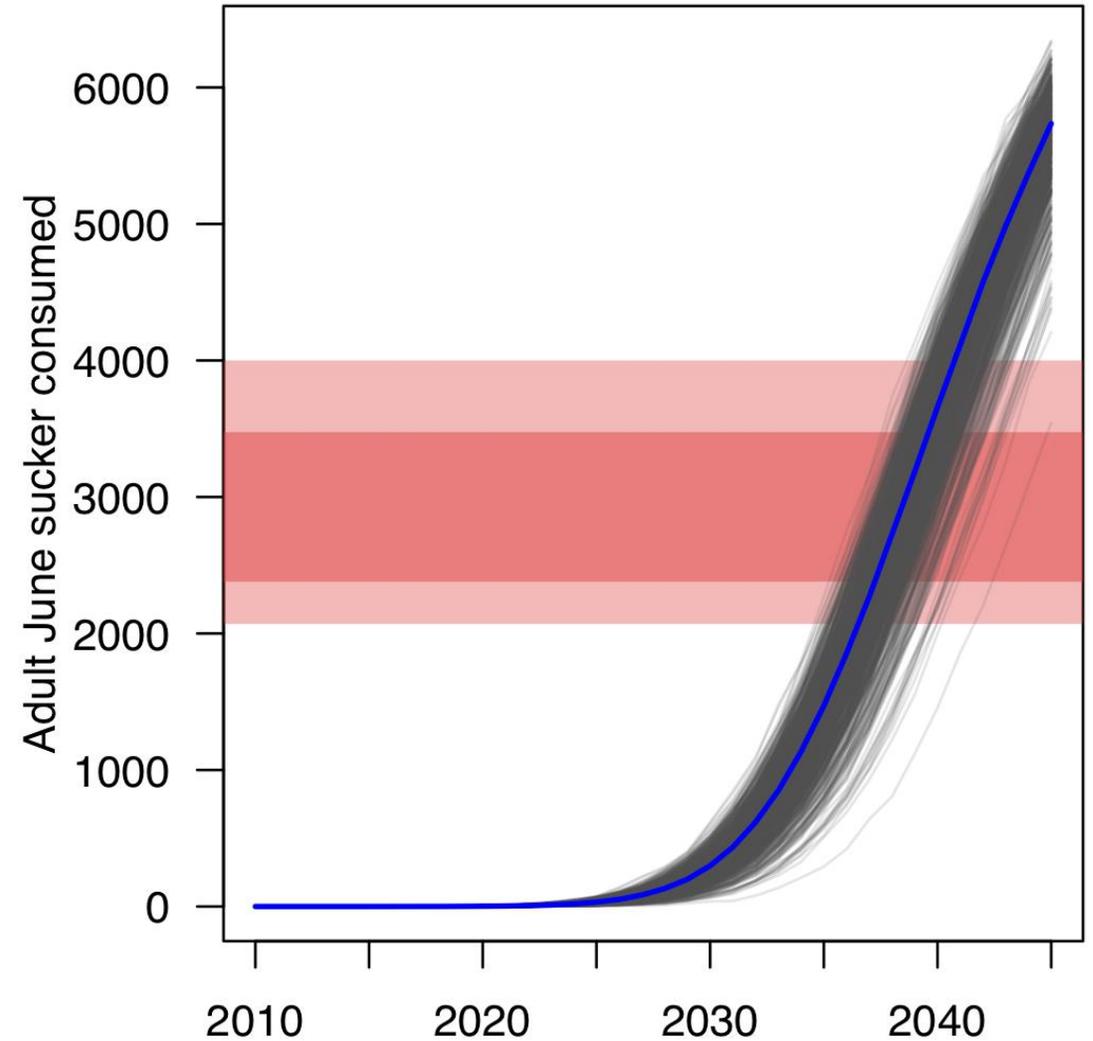
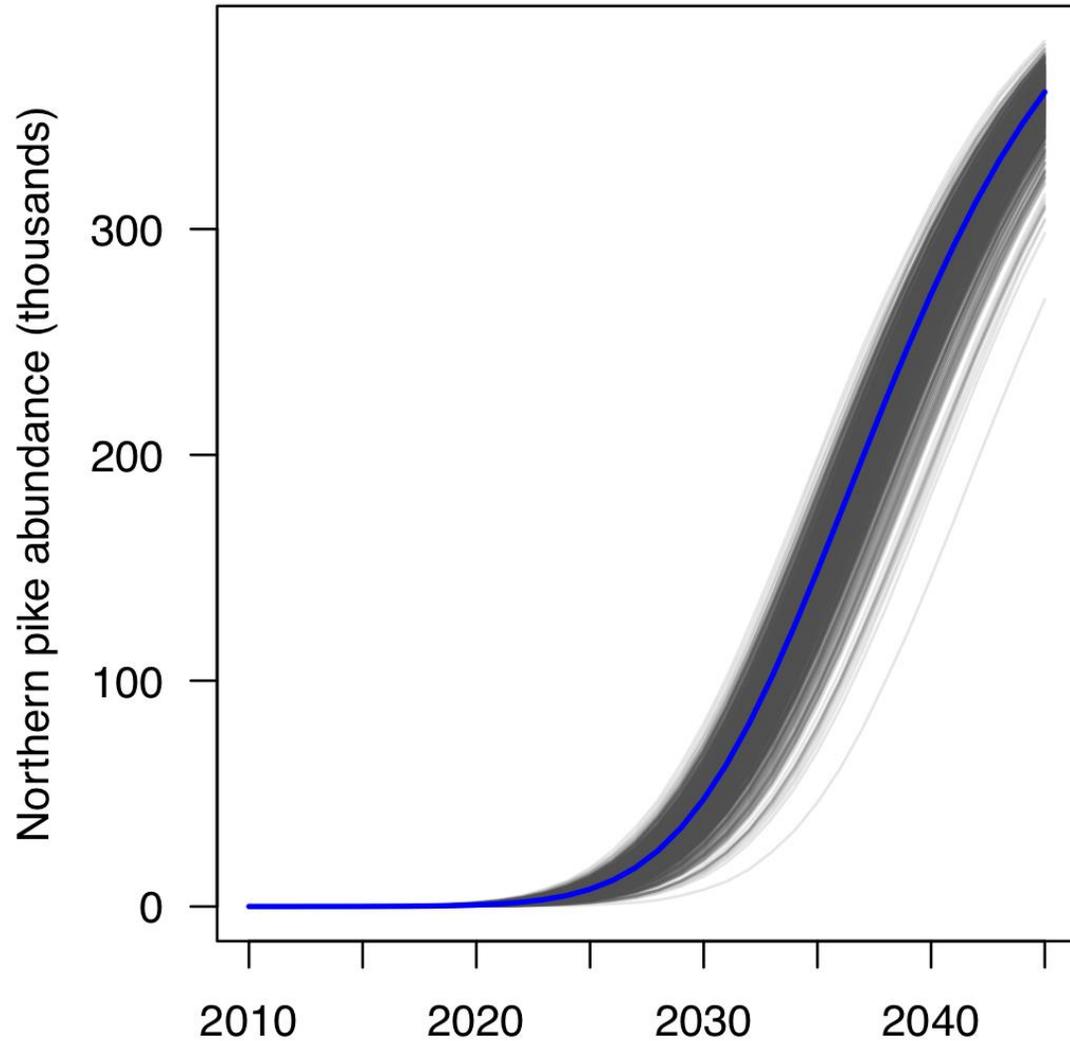
2014

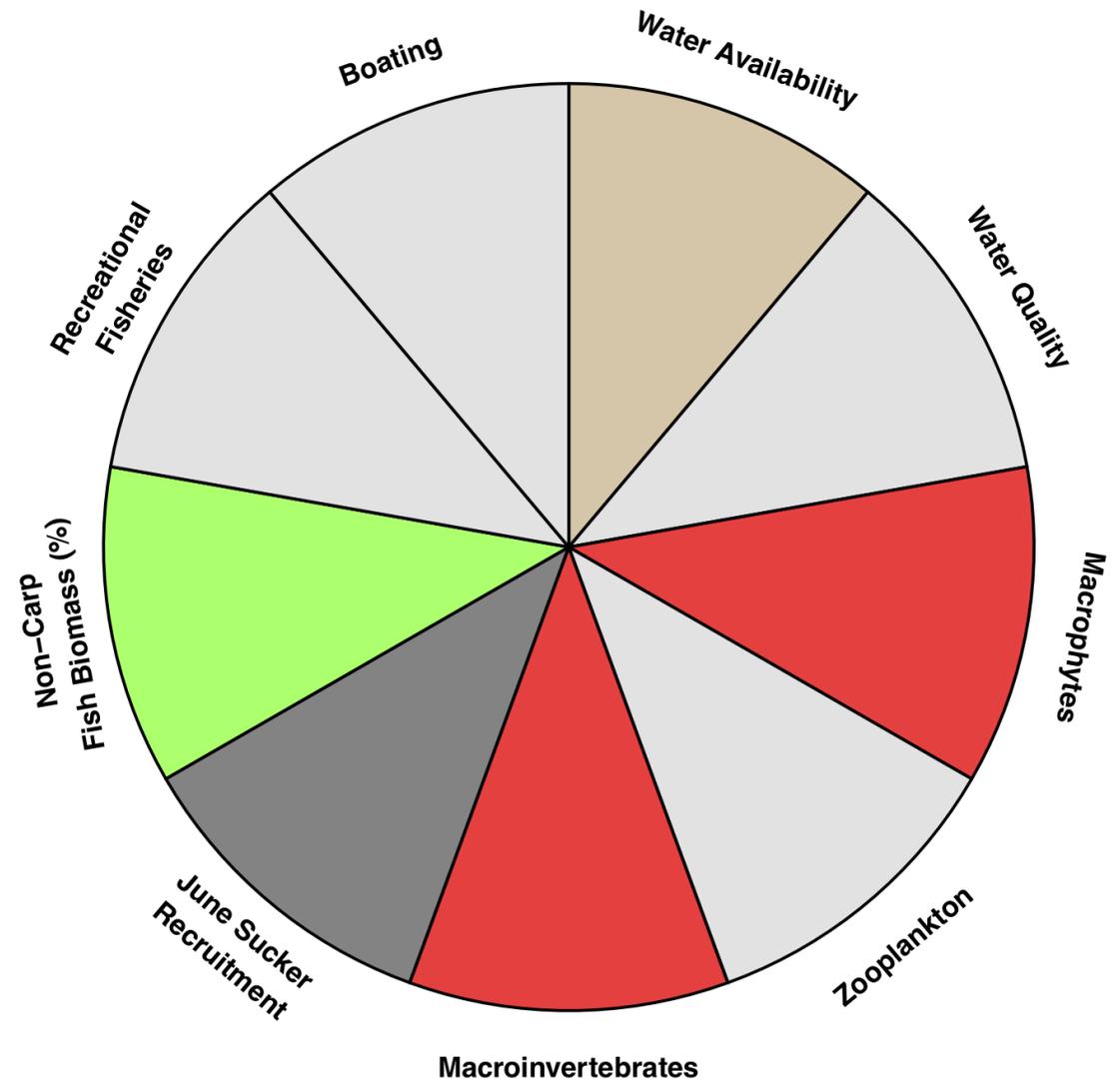
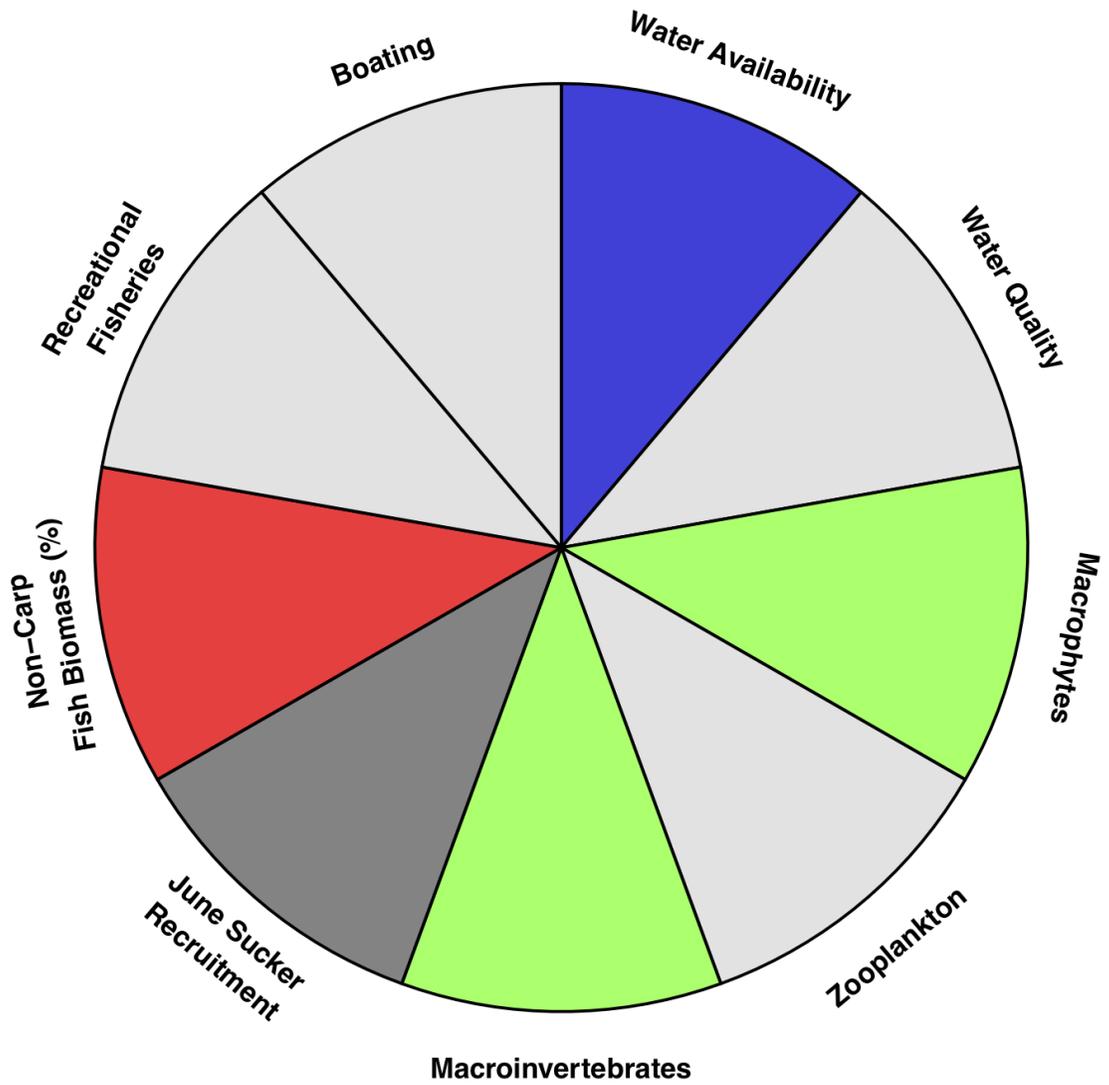


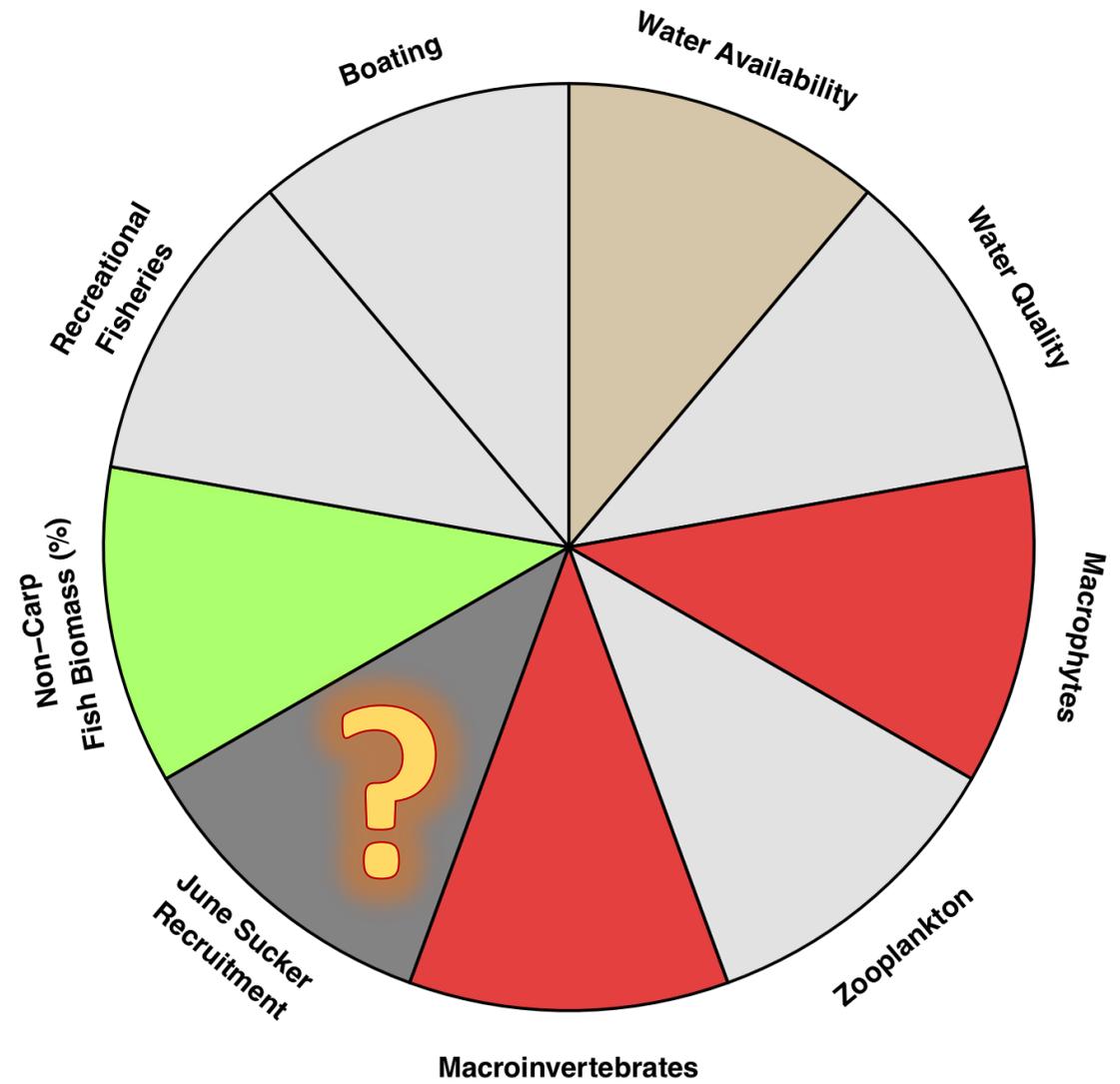
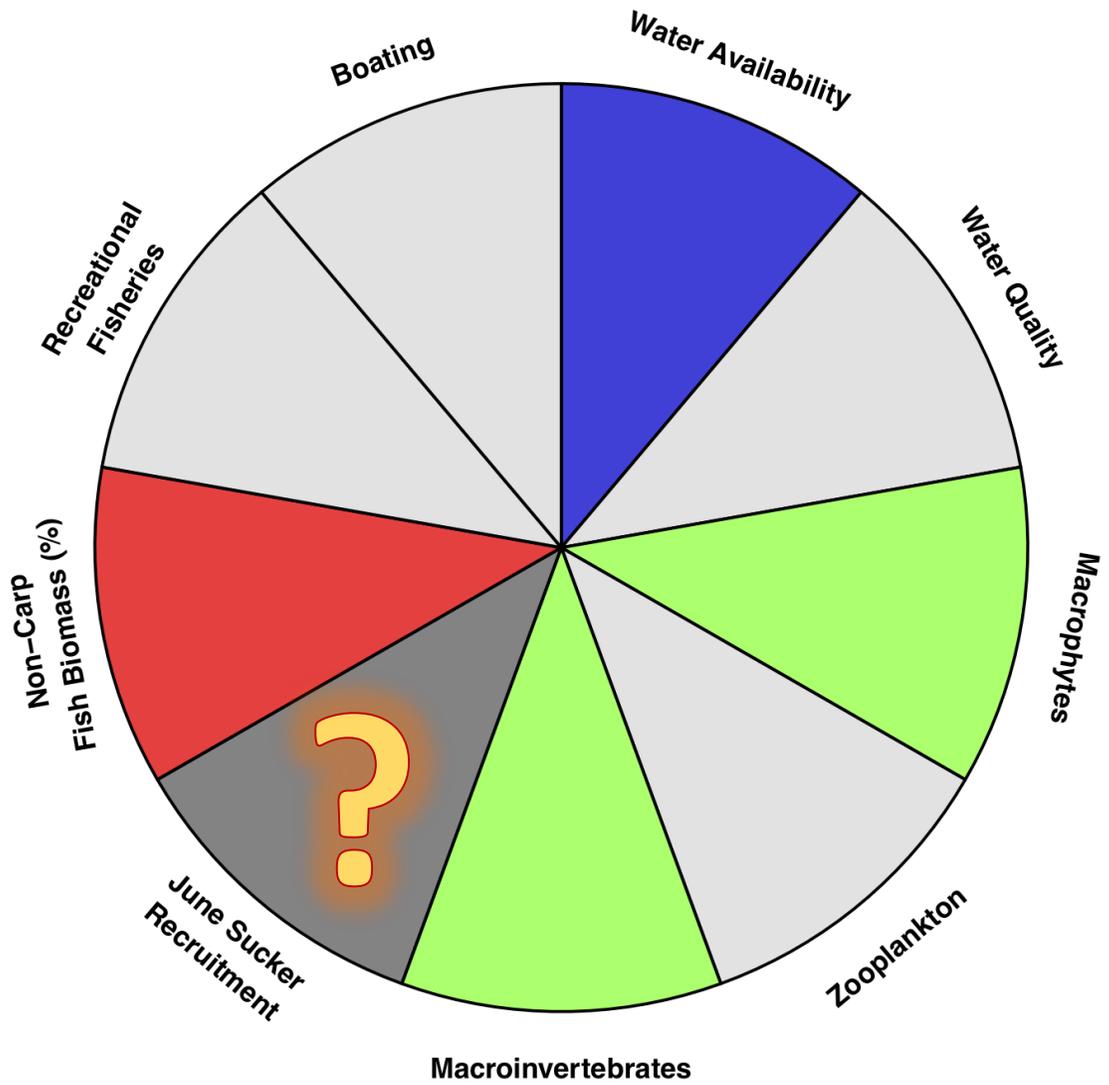
# Northern pike population and consumption trajectories



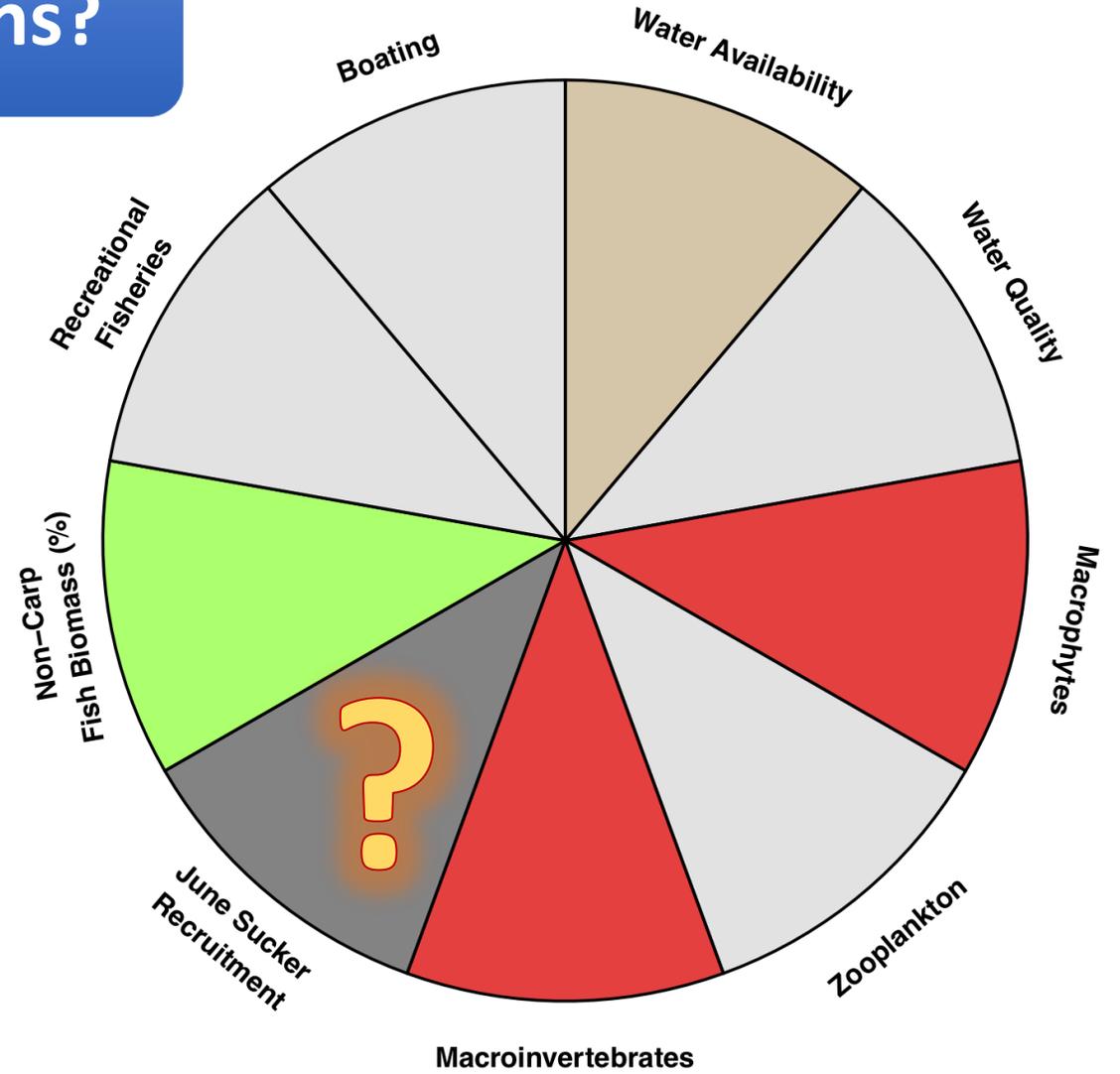
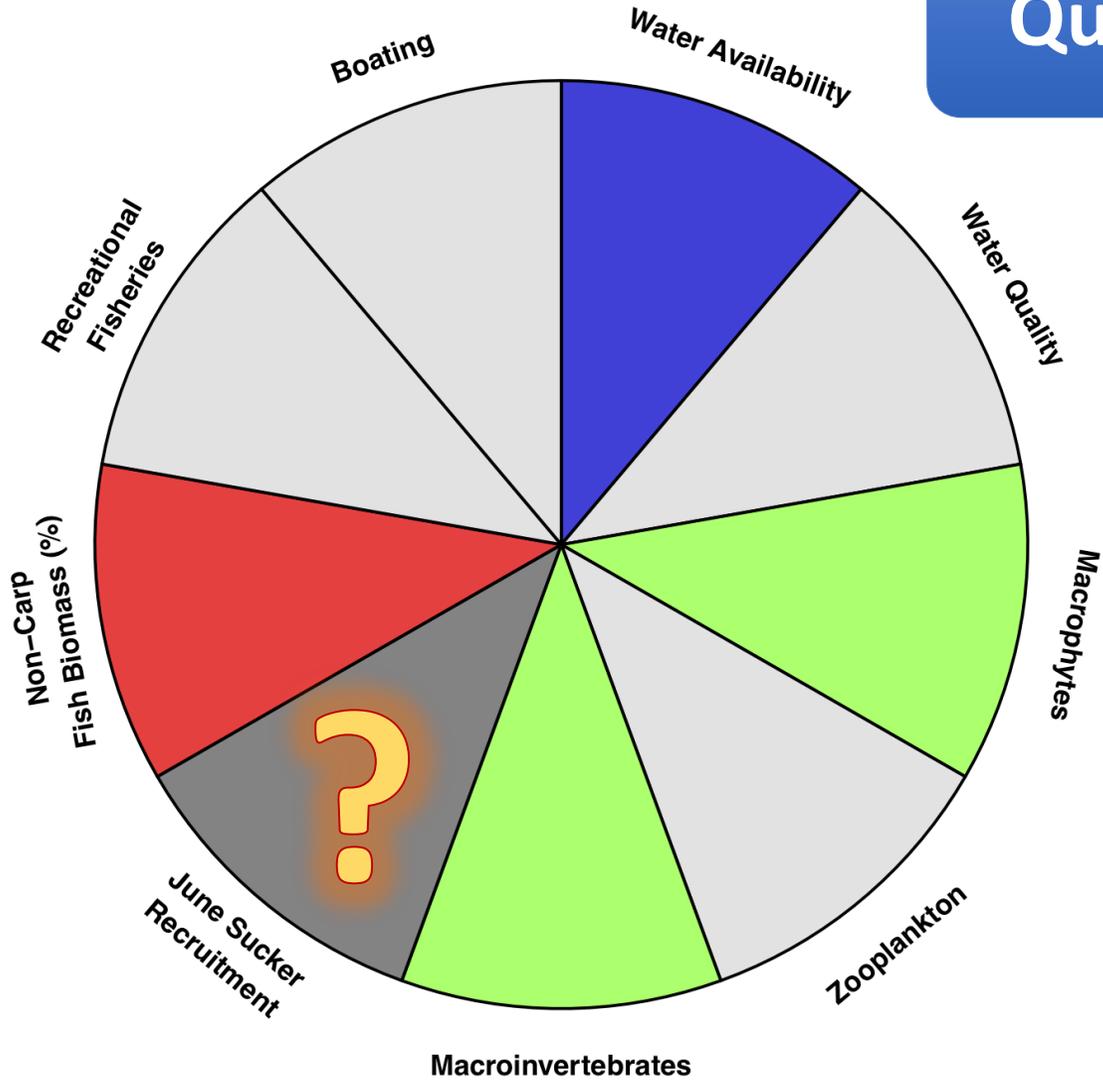
# Northern pike population and consumption trajectories







# Questions?

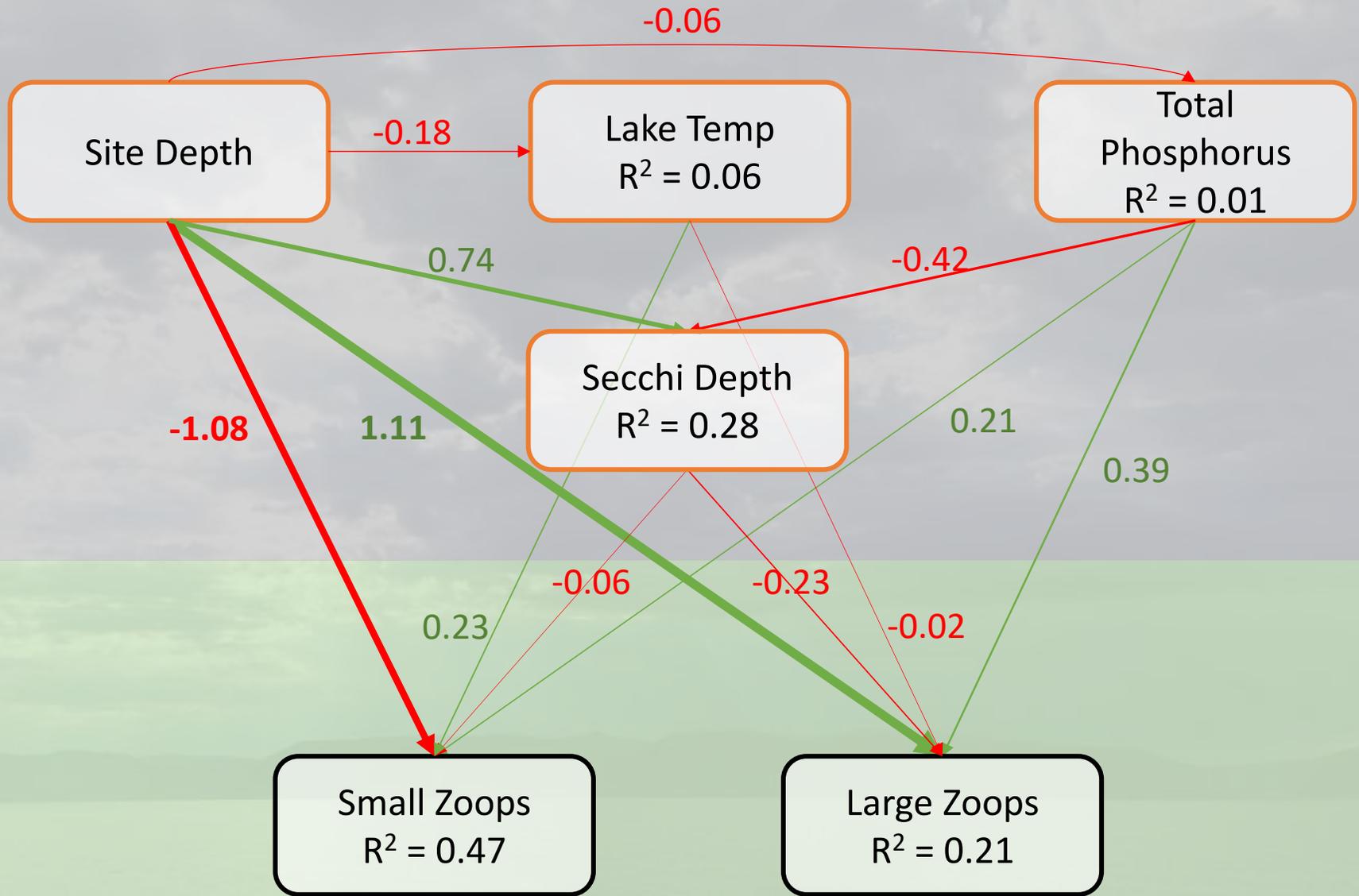


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@JGaetaFish

# Environmental Drivers



n=539 samples; 2002-2005, 2008-2017

# Environmental Drivers

# Biology

Site Depth

Lake Temp  
 $R^2 = 0.06$

Total Phosphorus  
 $R^2 = 0.01$

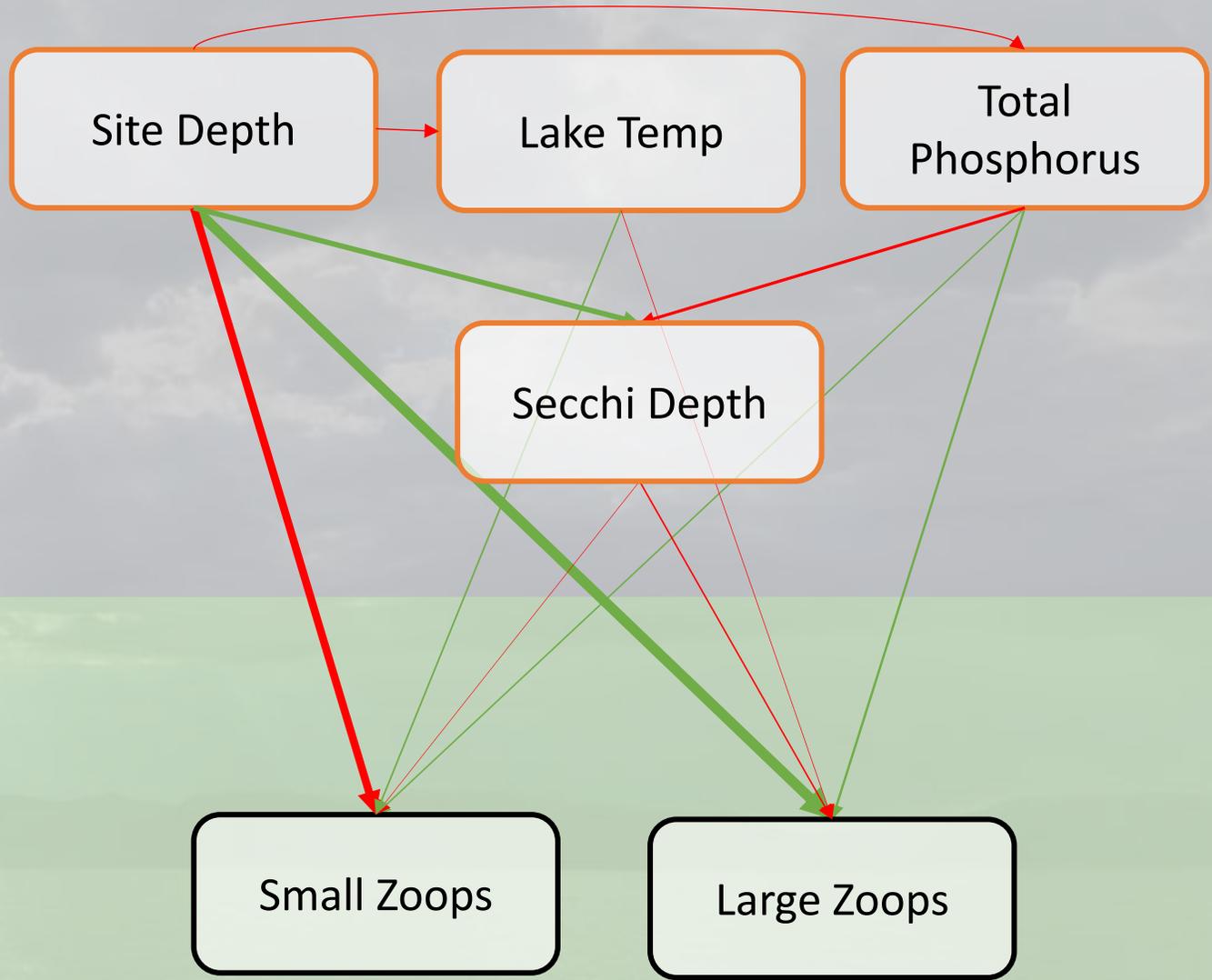
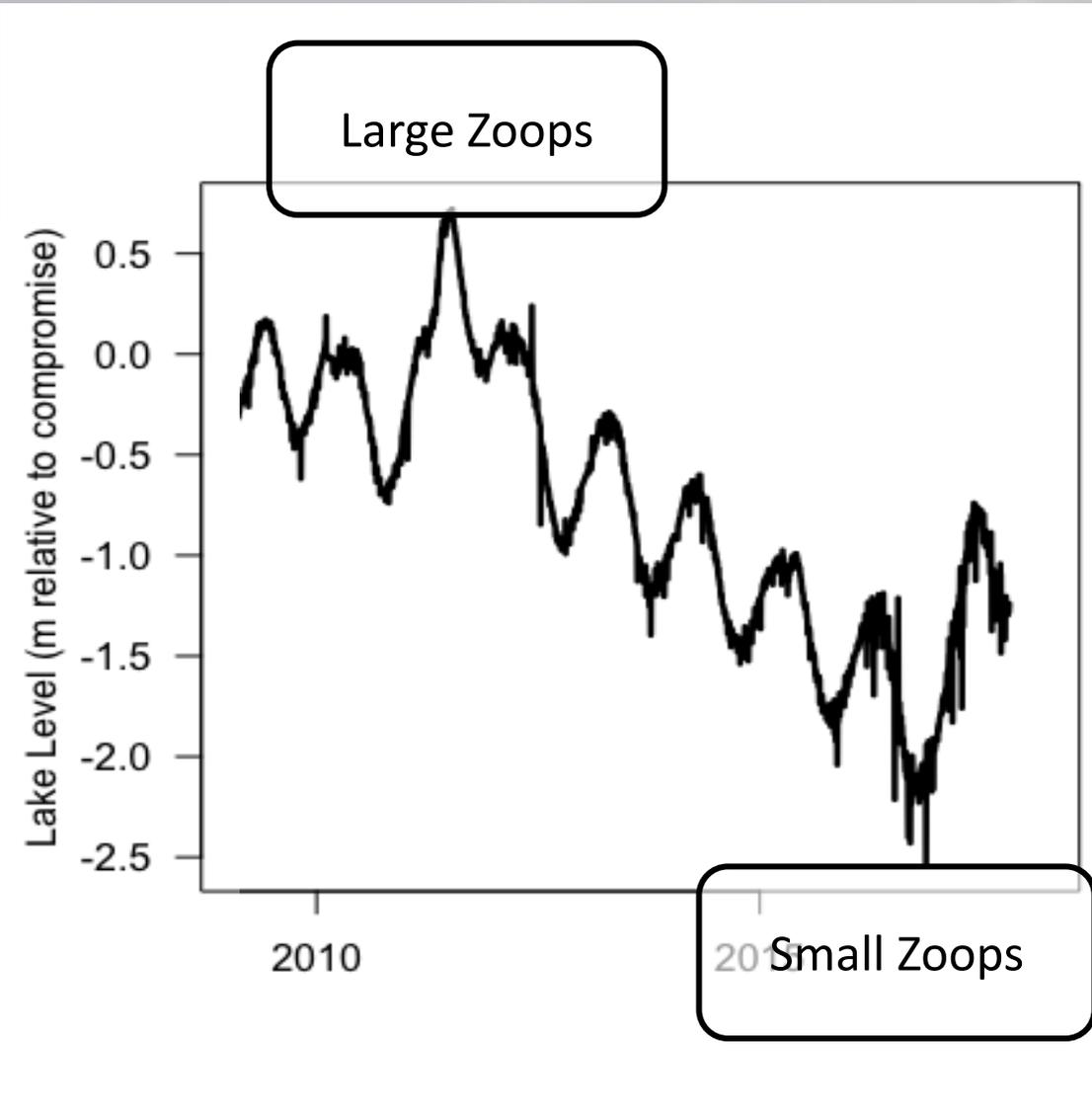
**-1.08**

**1.11**

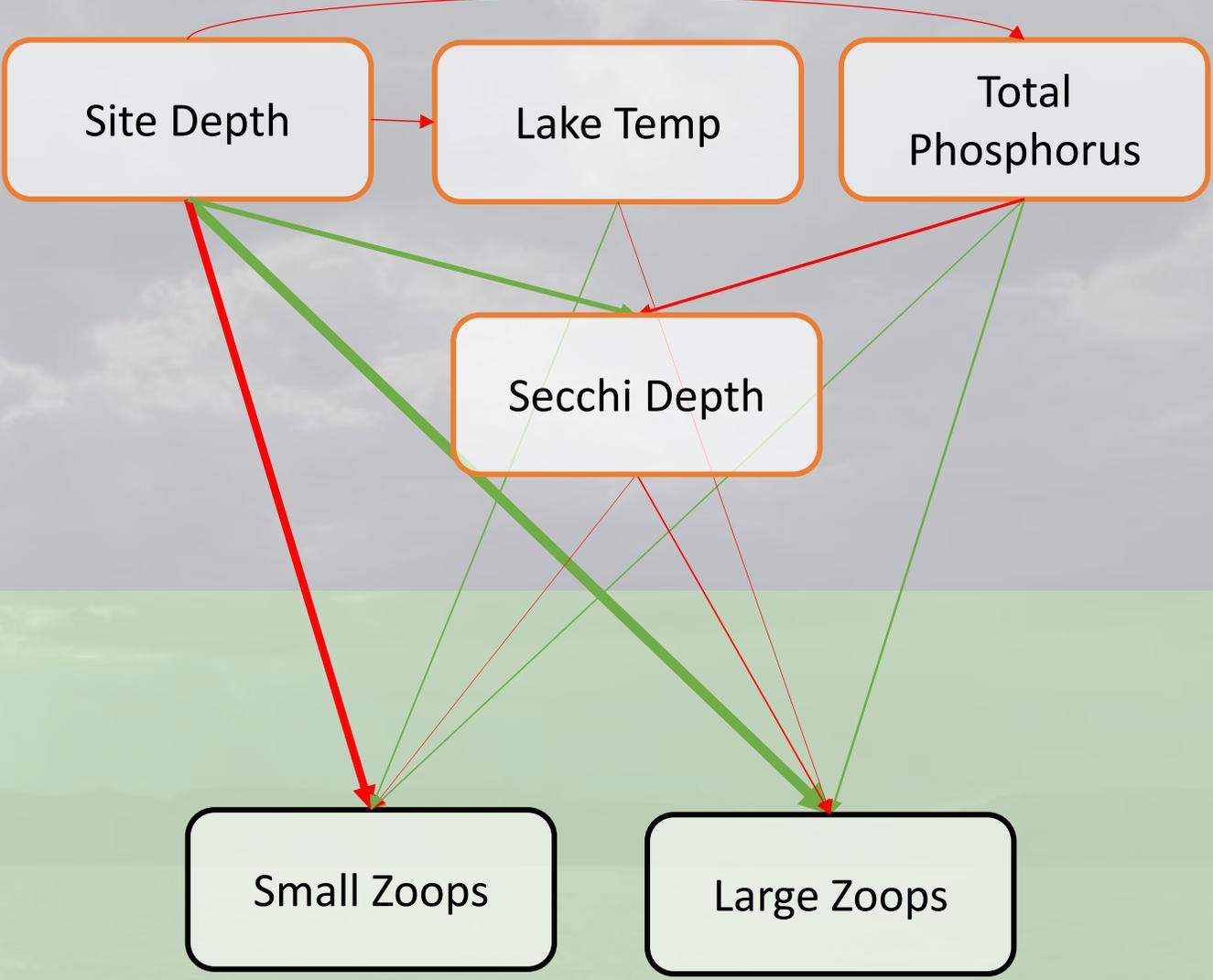
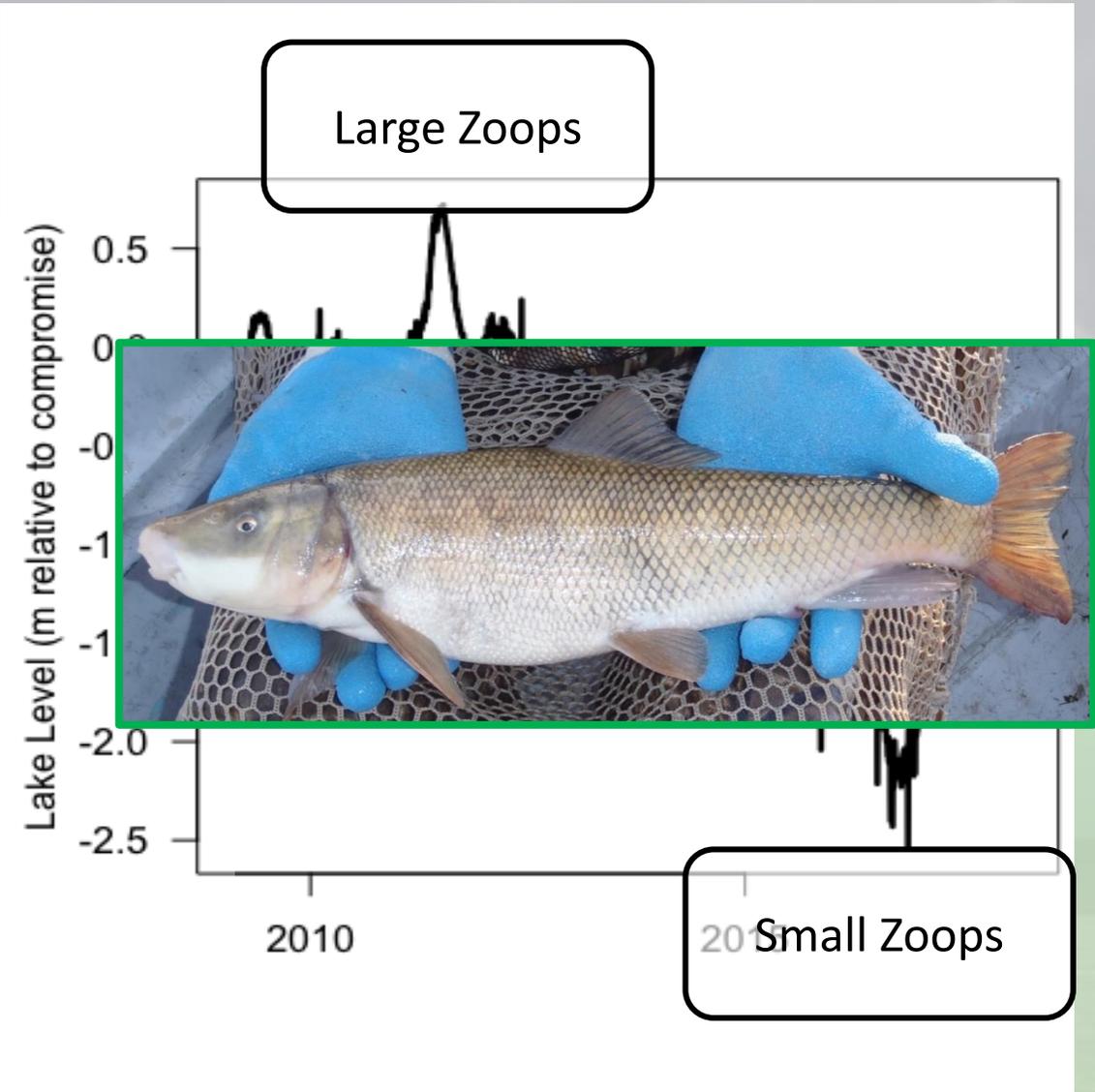
Secchi Depth  
 $R^2 = 0.28$

Small Zoops  
 $R^2 = 0.47$

Large Zoops  
 $R^2 = 0.21$



n=539 samples; 2002-2005, 2008-2017



n=539 samples; 2002-2005, 2008-2017

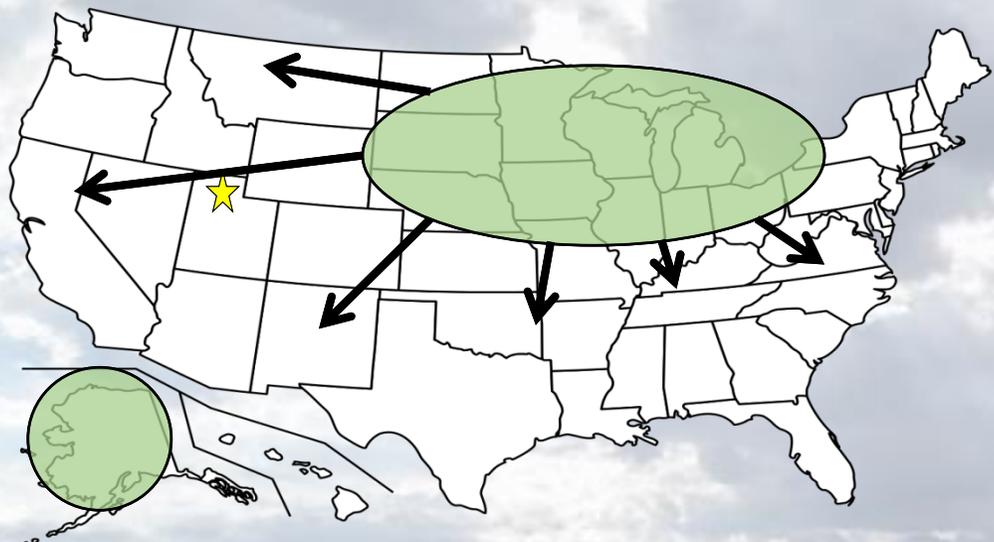
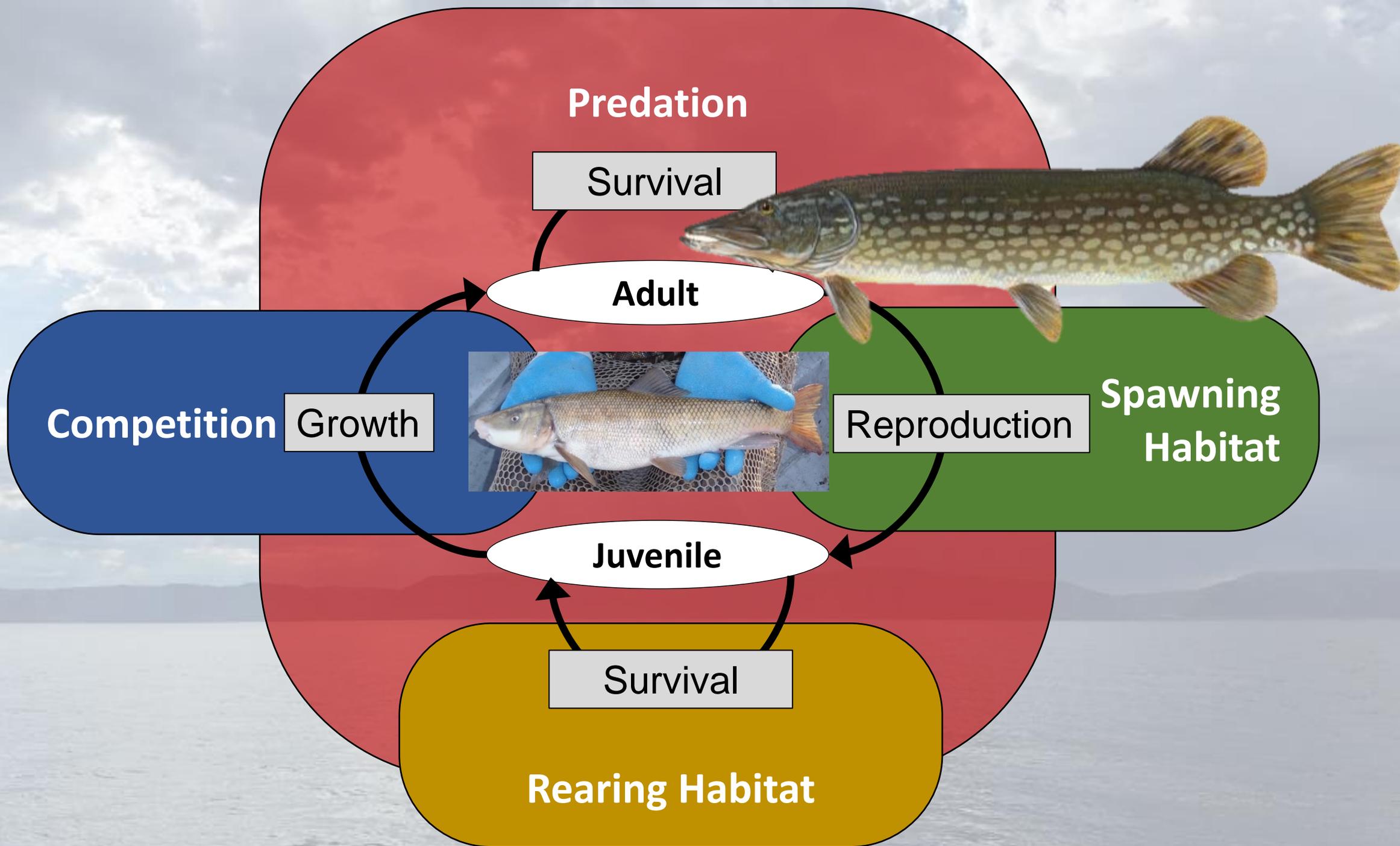


Photo courtesy of Colorado State University



Photo courtesy of Clear Lake Property Owners Association



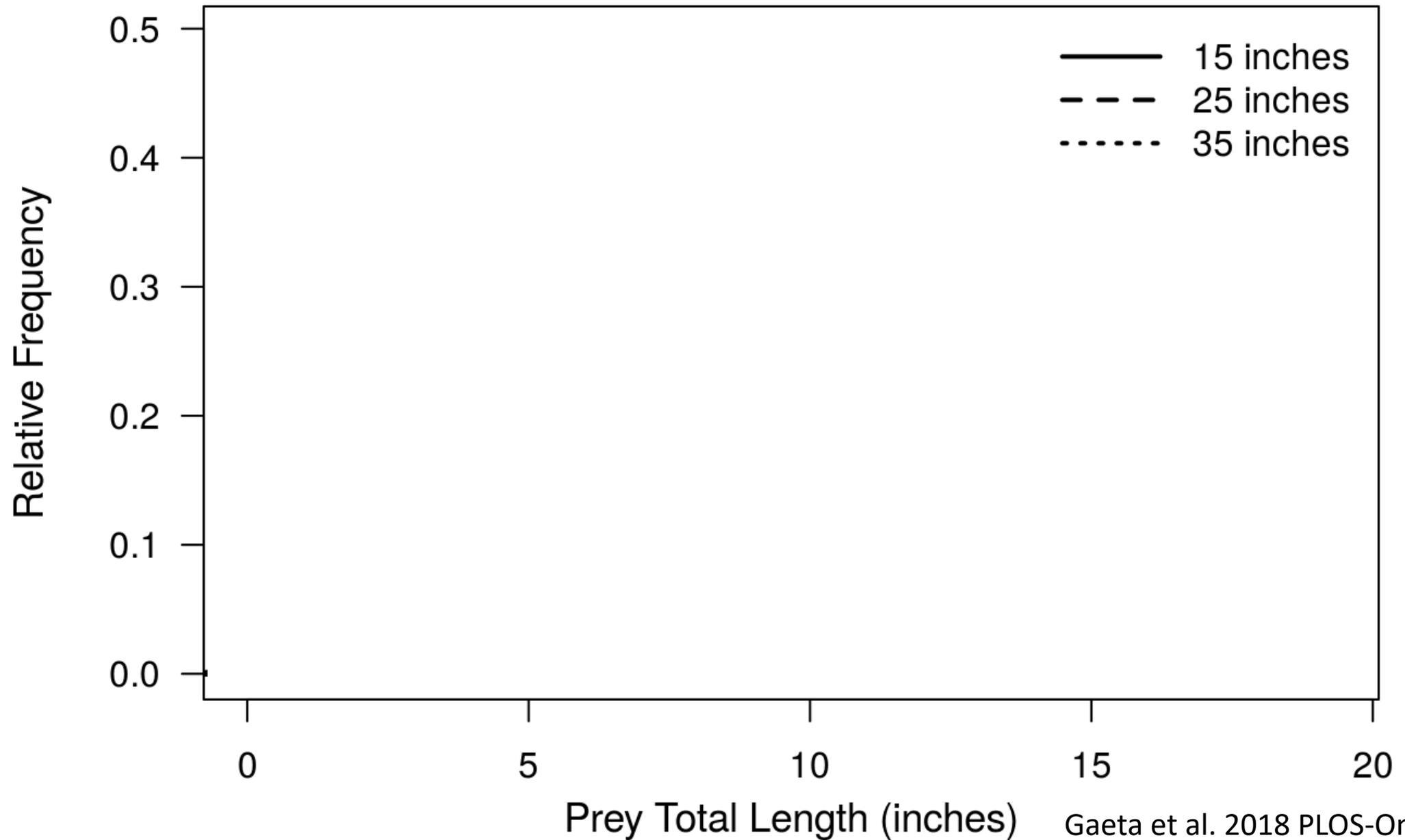


DATE: 04. 27. 2015 SITE: Ul. "Arbelle Coloca"  
SPECIES: Northern Pike (STOMACH)  
LENGTH: 240 mm WEIGHT: 76g

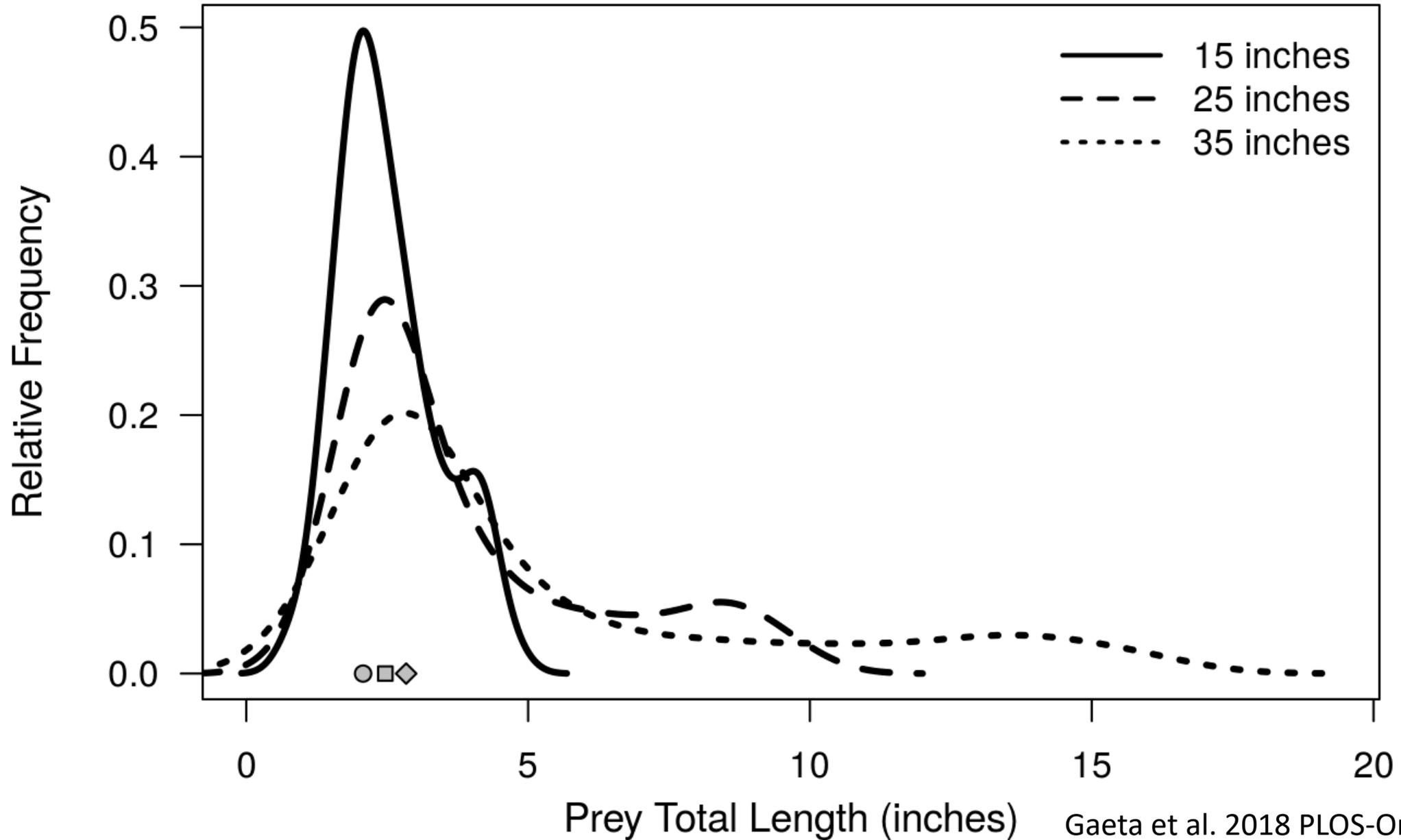
Gaeta and Reynolds *in prep*

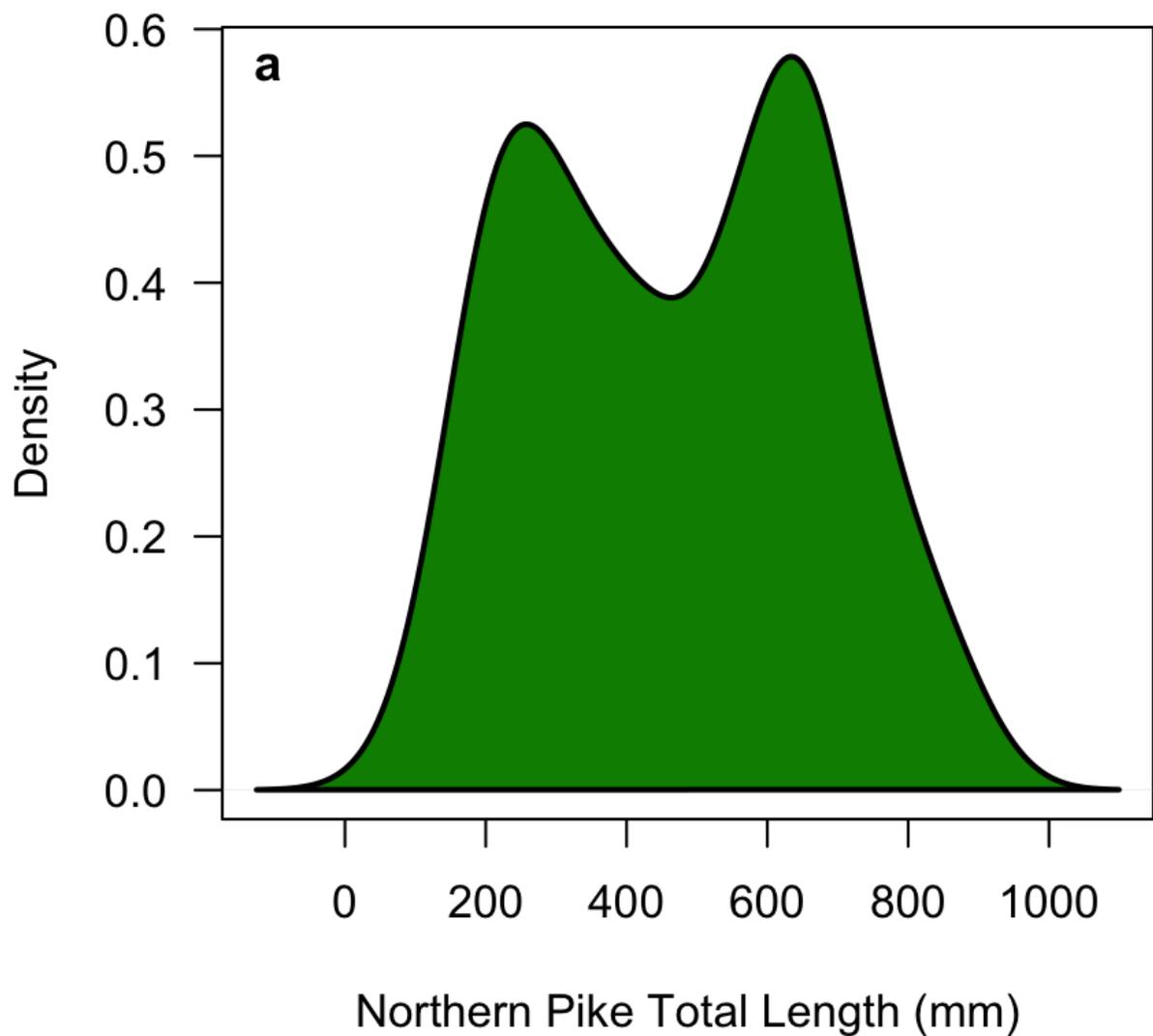
Photo credit: J. Reynolds

# Northern Pike

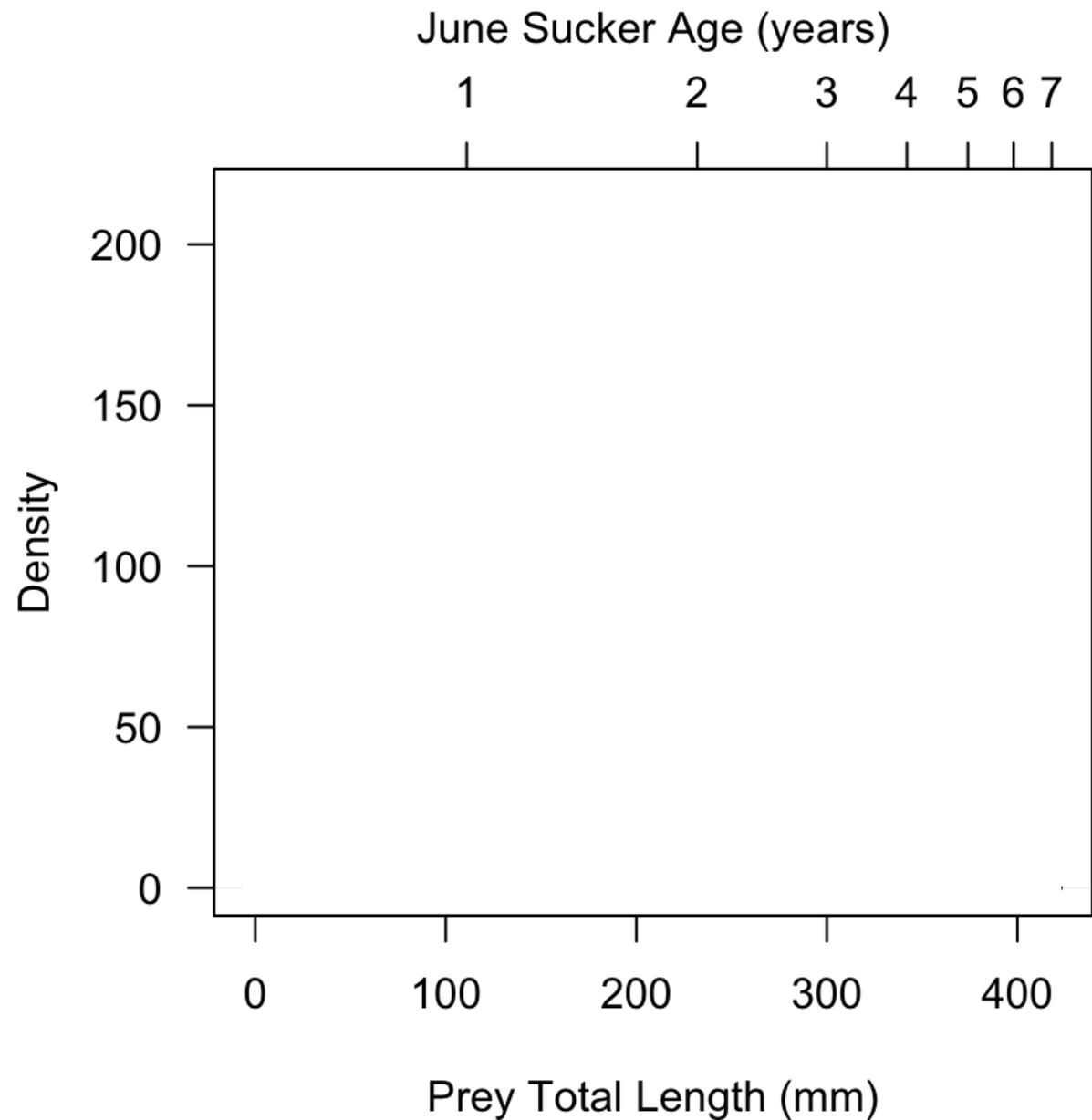


# Northern Pike

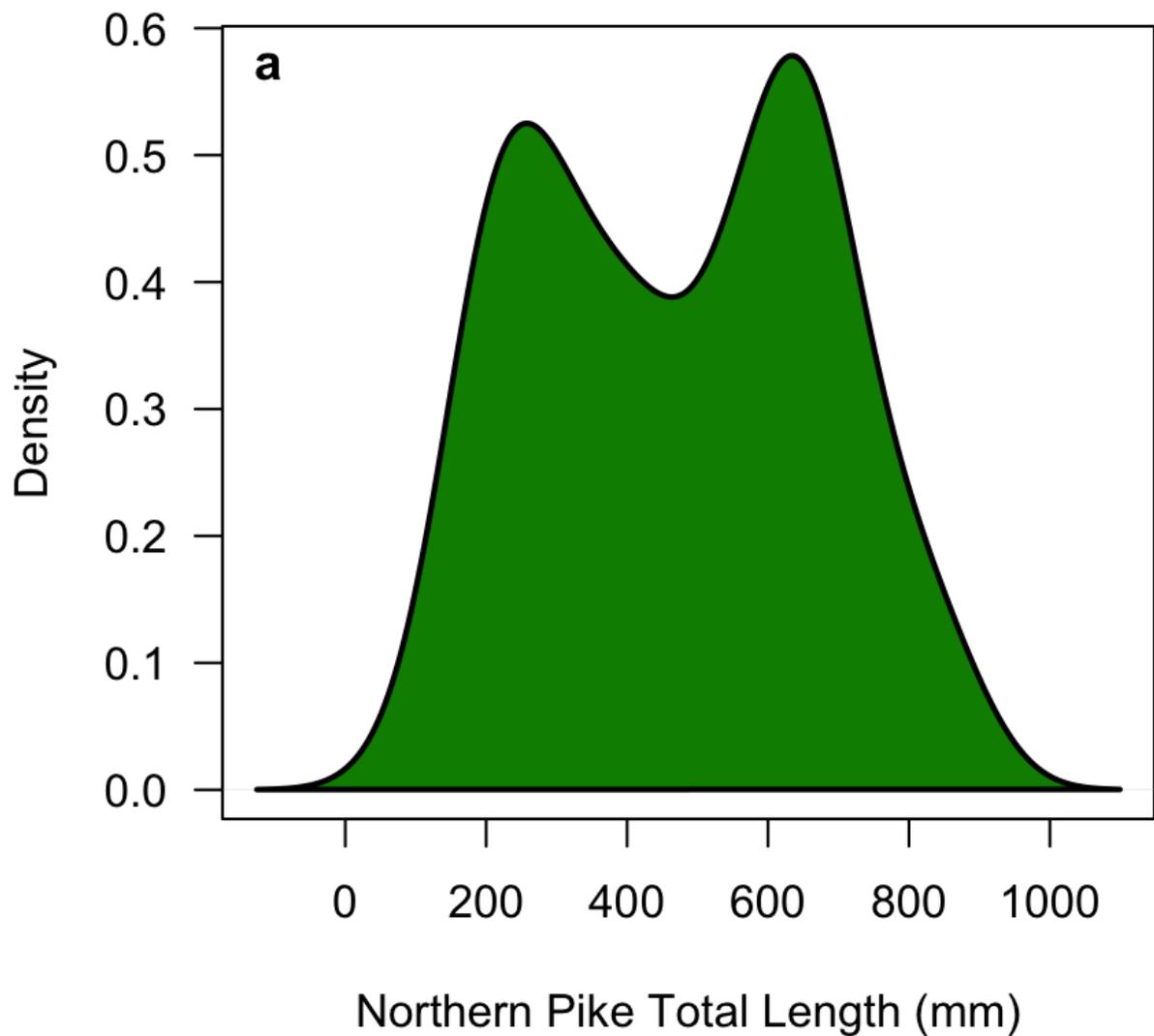




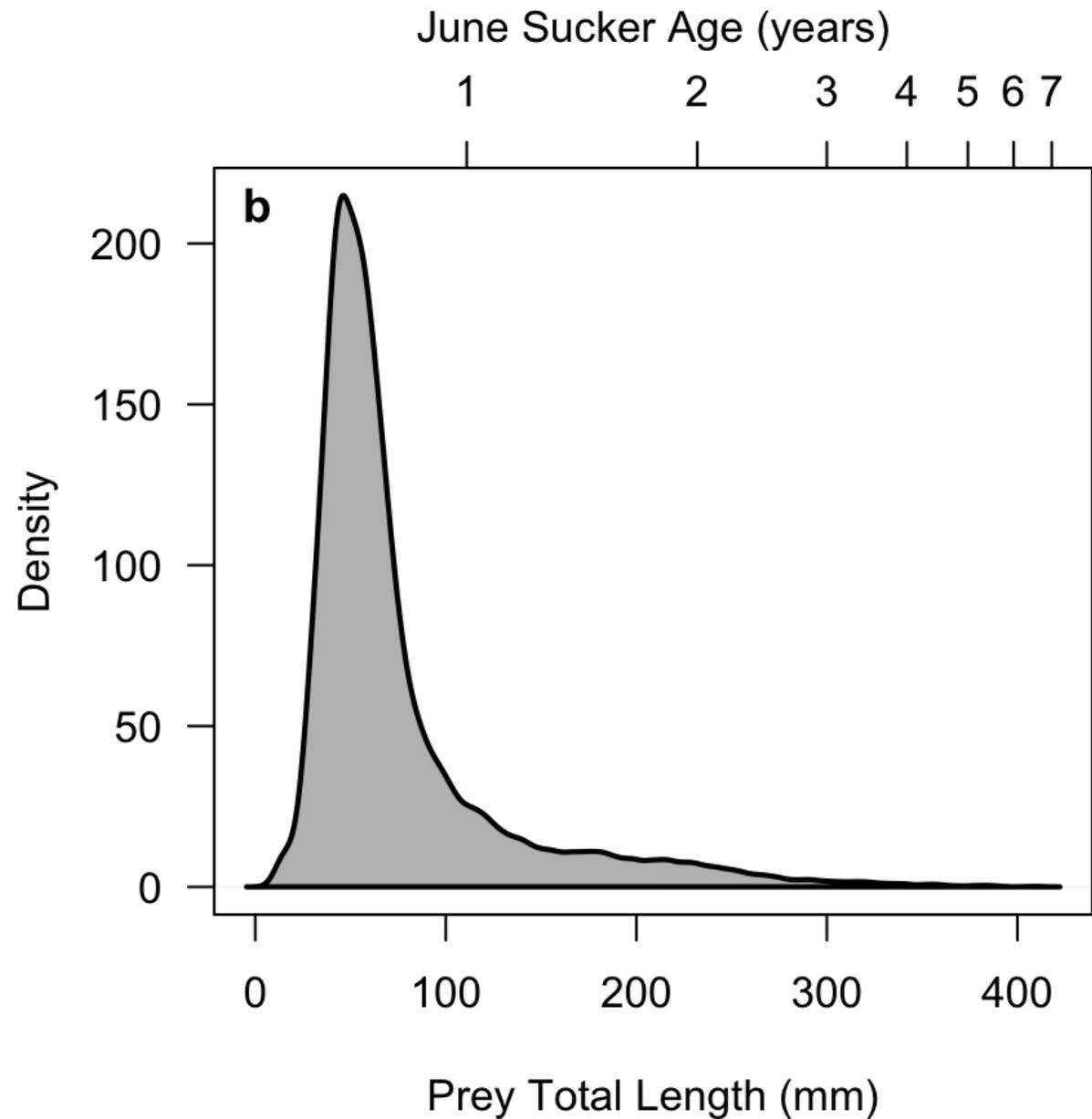
LakeEcologyLab.org/pred\_prey/



Gaeta *in press. Fisheries*

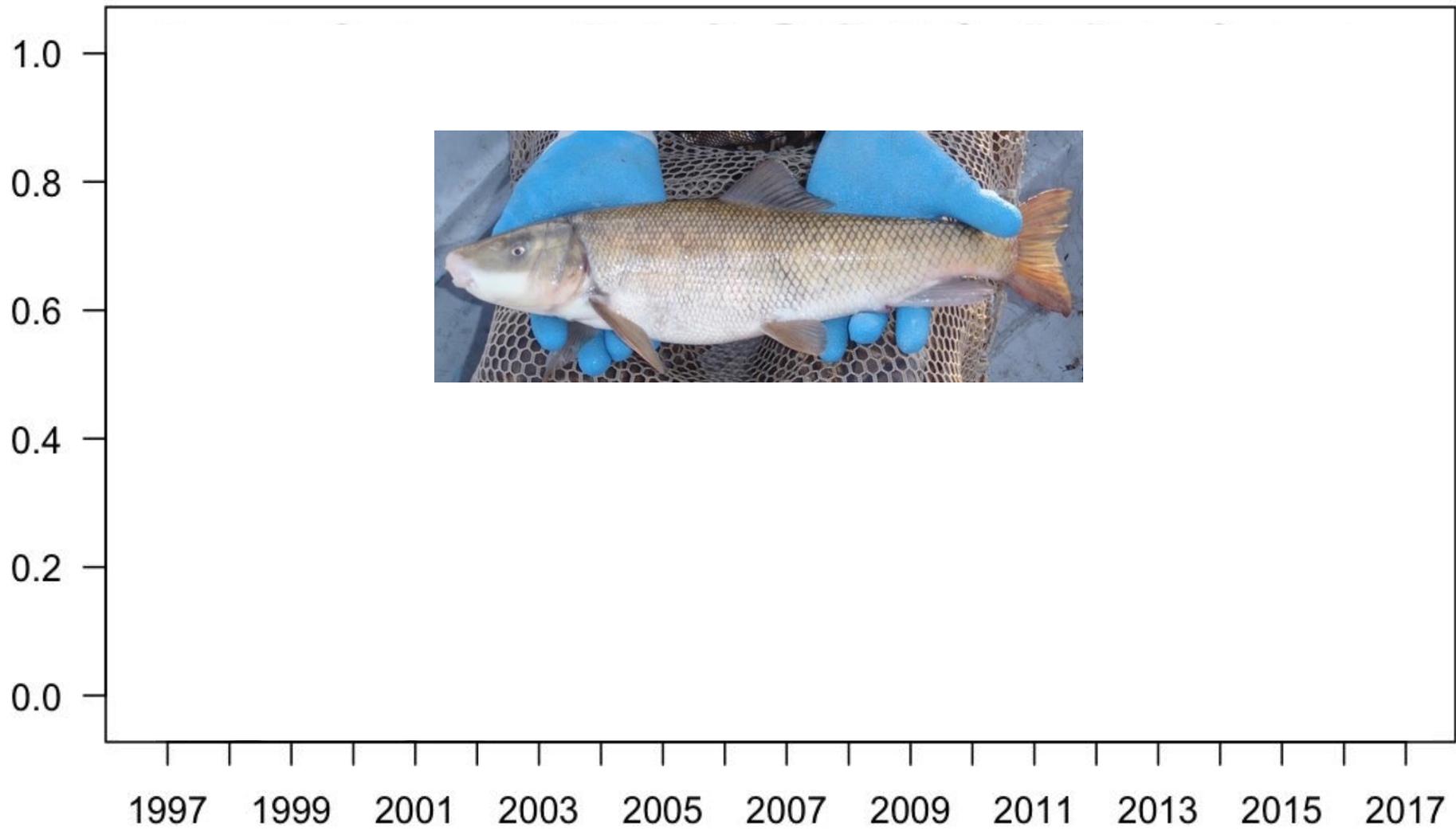


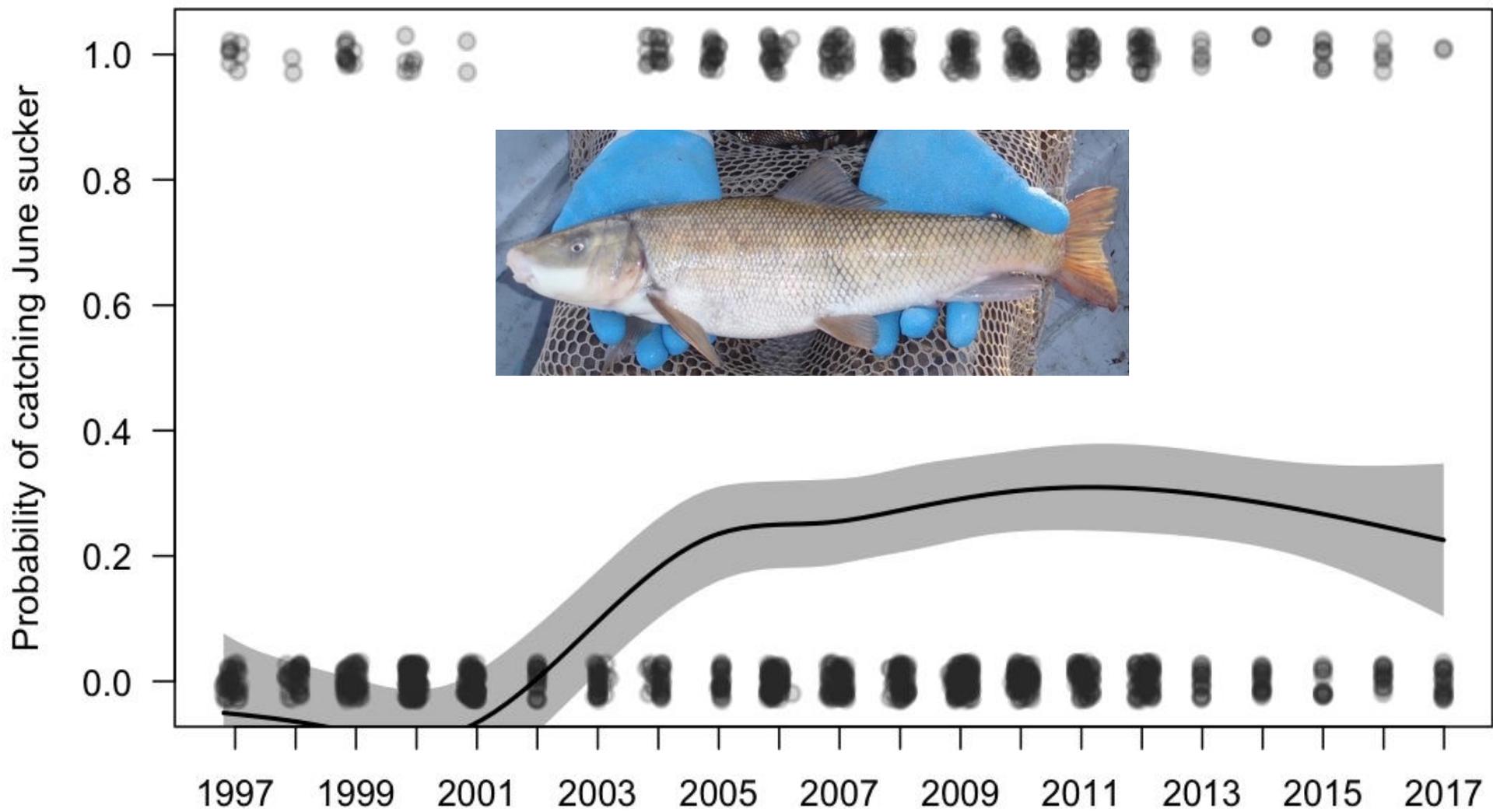
LakeEcologyLab.org/pred\_prey/



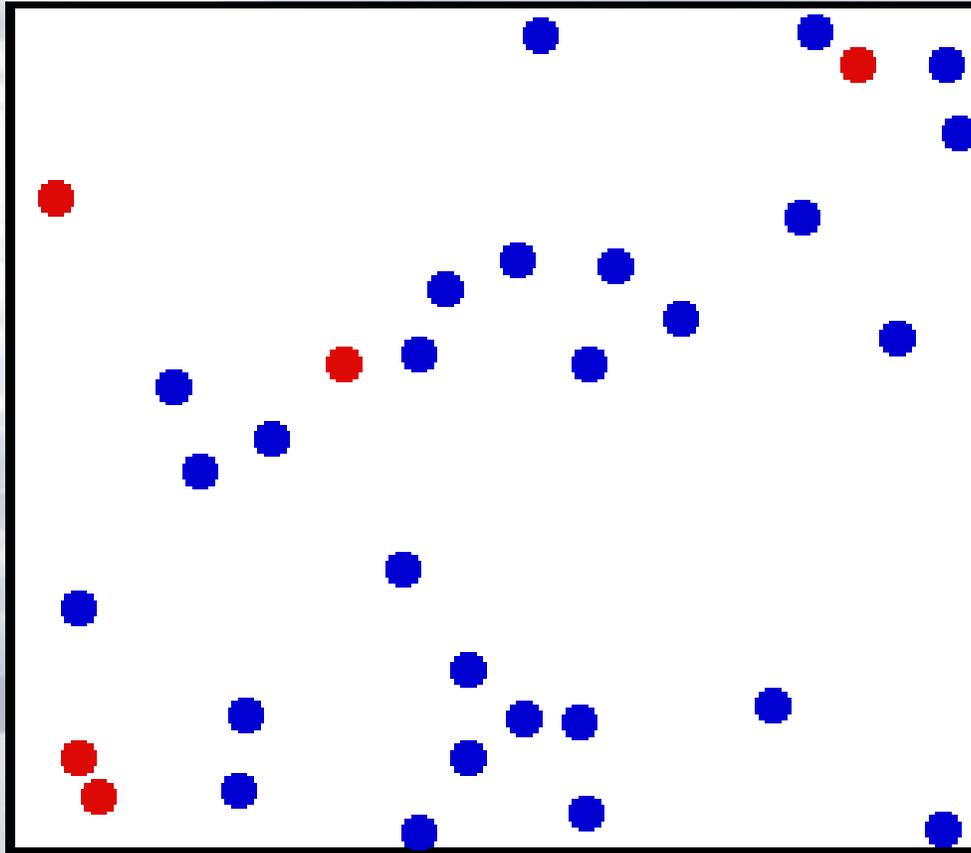
Gaeta *in press. Fisheries*

Probability of catching June sucker

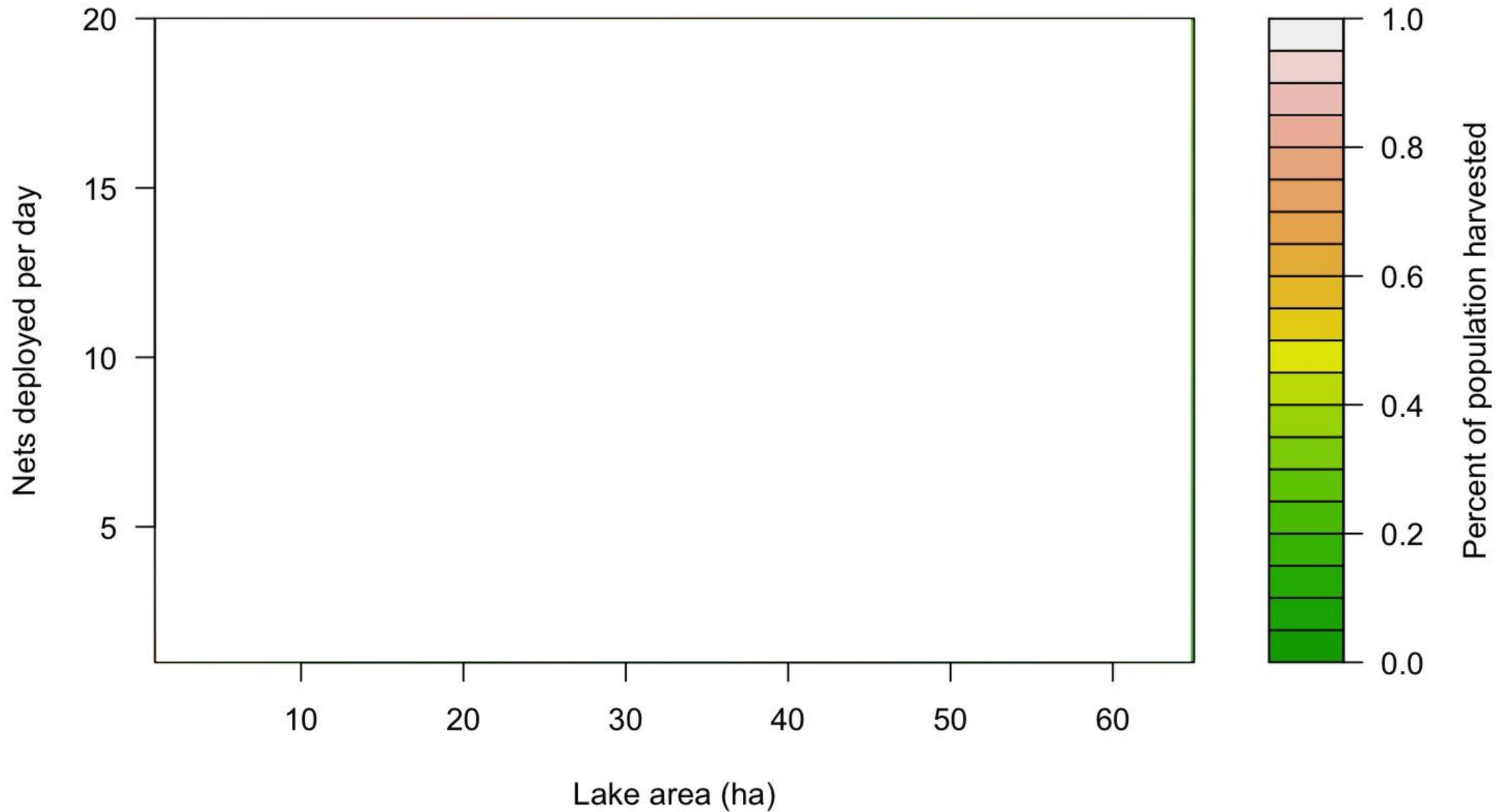




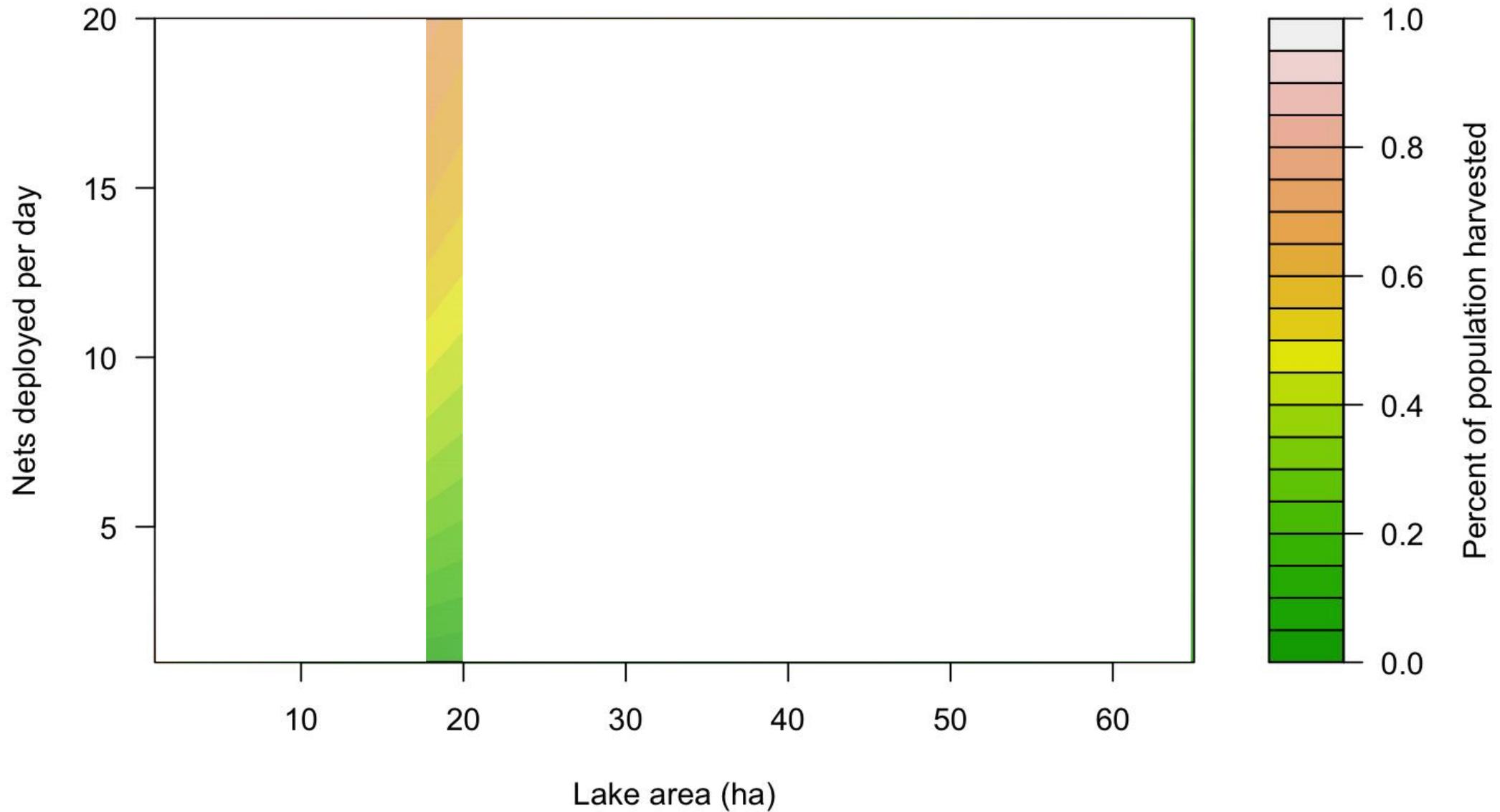
When is eradication via removal unfeasible?



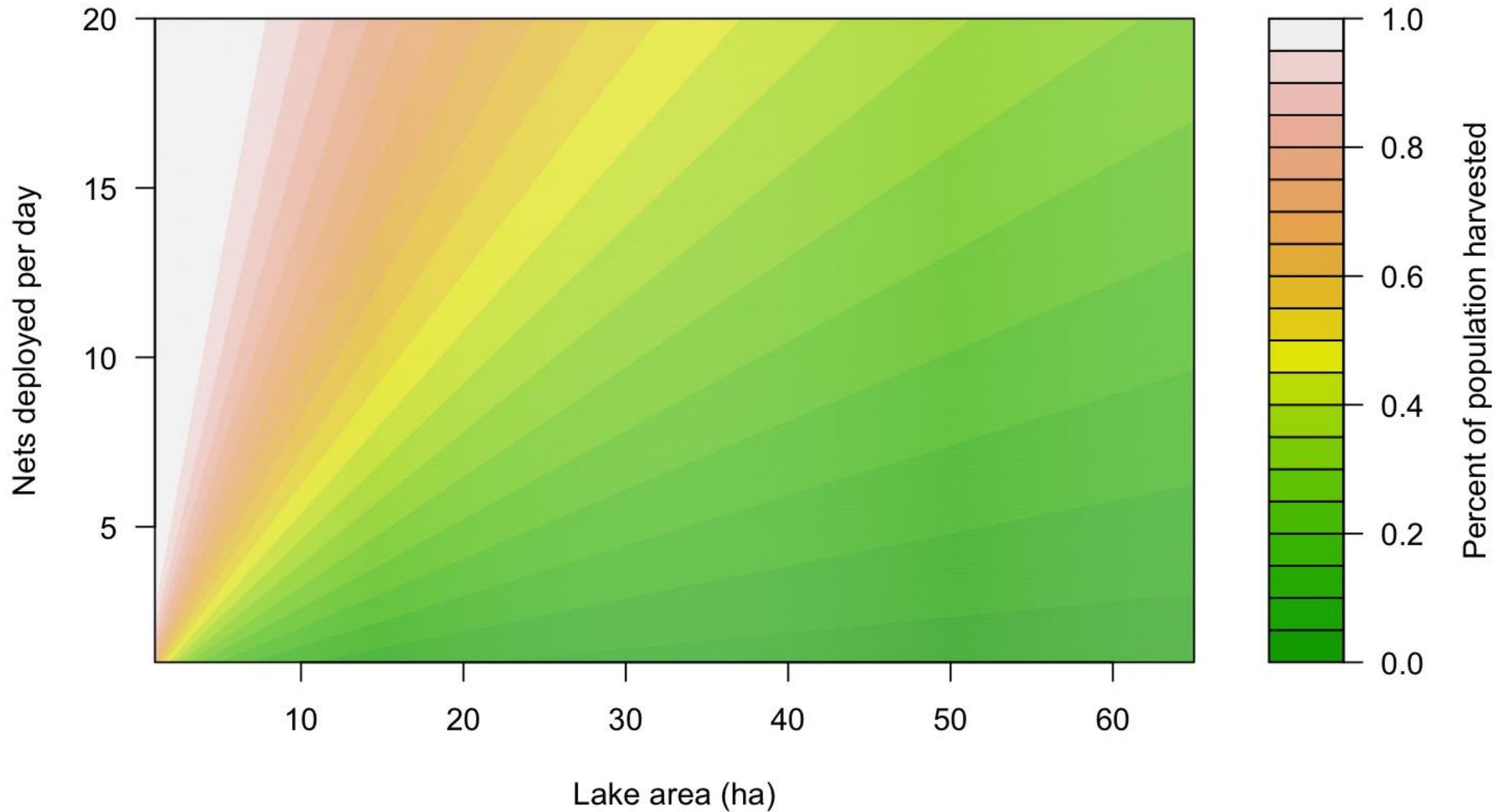
**Fyke net sampling (15.24 m) for 21 days**  
**Fish movement of 350 m per day; 10m max lake depth**  
**Initial population of 10 pike per ha**



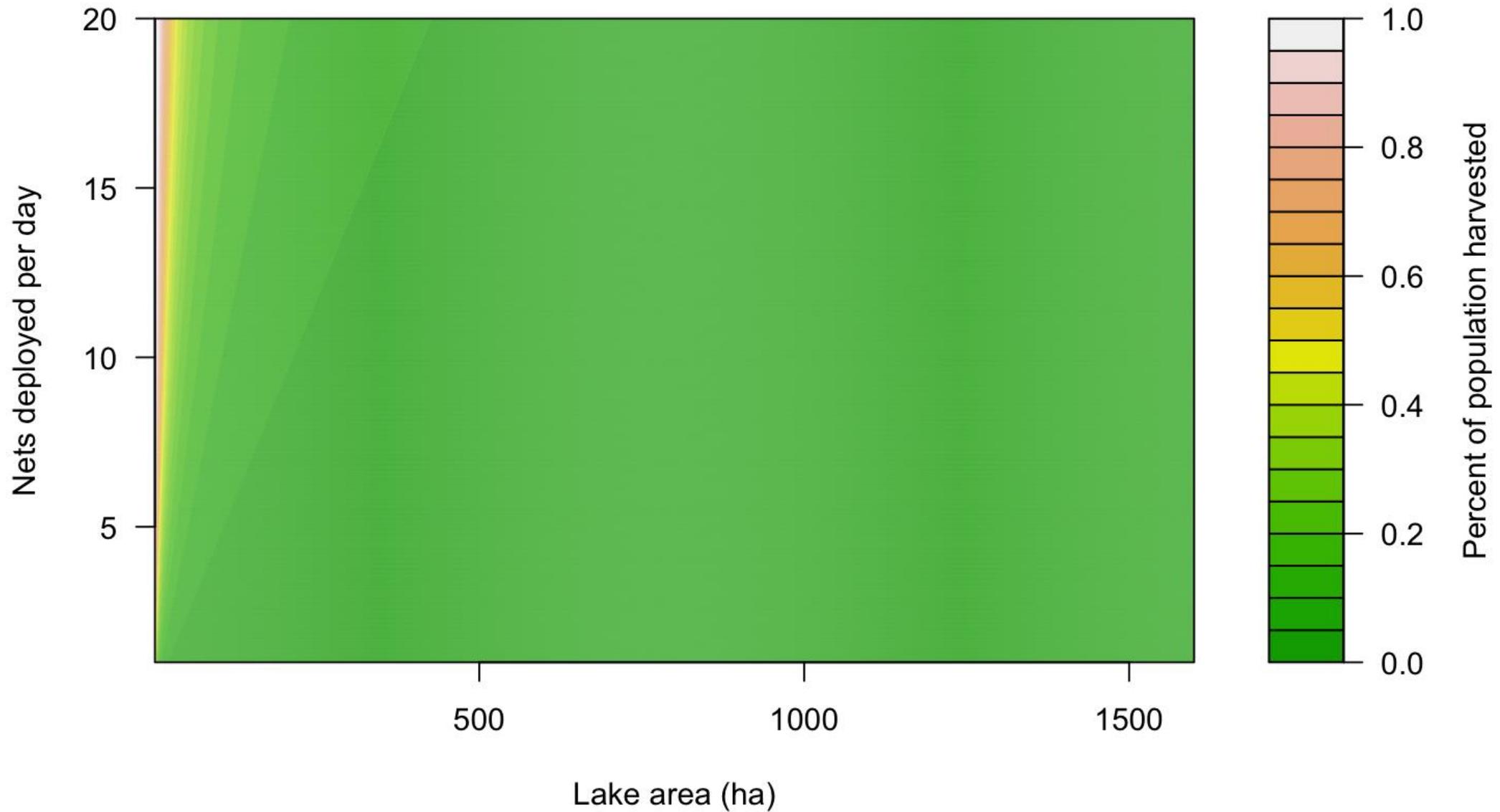
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**Fish movement of 350 m per day; 10m max lake depth**  
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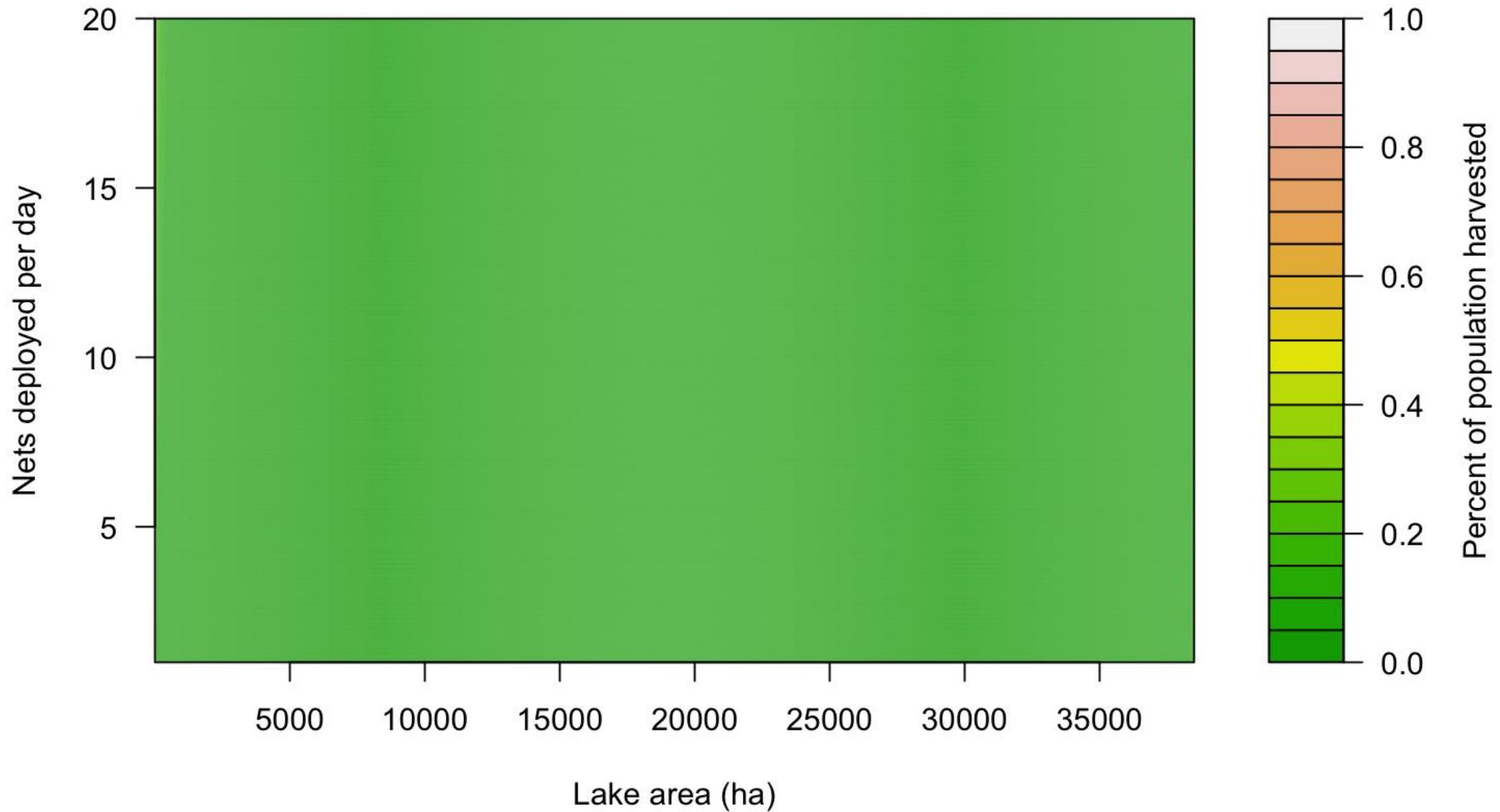
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