

# The native and introduced fishes of Clear Lake: A review of the past to assist with decisions of the future

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## Issue

- The fish fauna of Clear Lake has changed drastically over the past 140 years, with declines in the abundance of all native fish
- The causes of the decline of particular species are uncertain, complicating discussion of which impacts should be addressed and which restoration actions should be given priority, and hampering efficient and effective restoration of native fish species



## Objectives

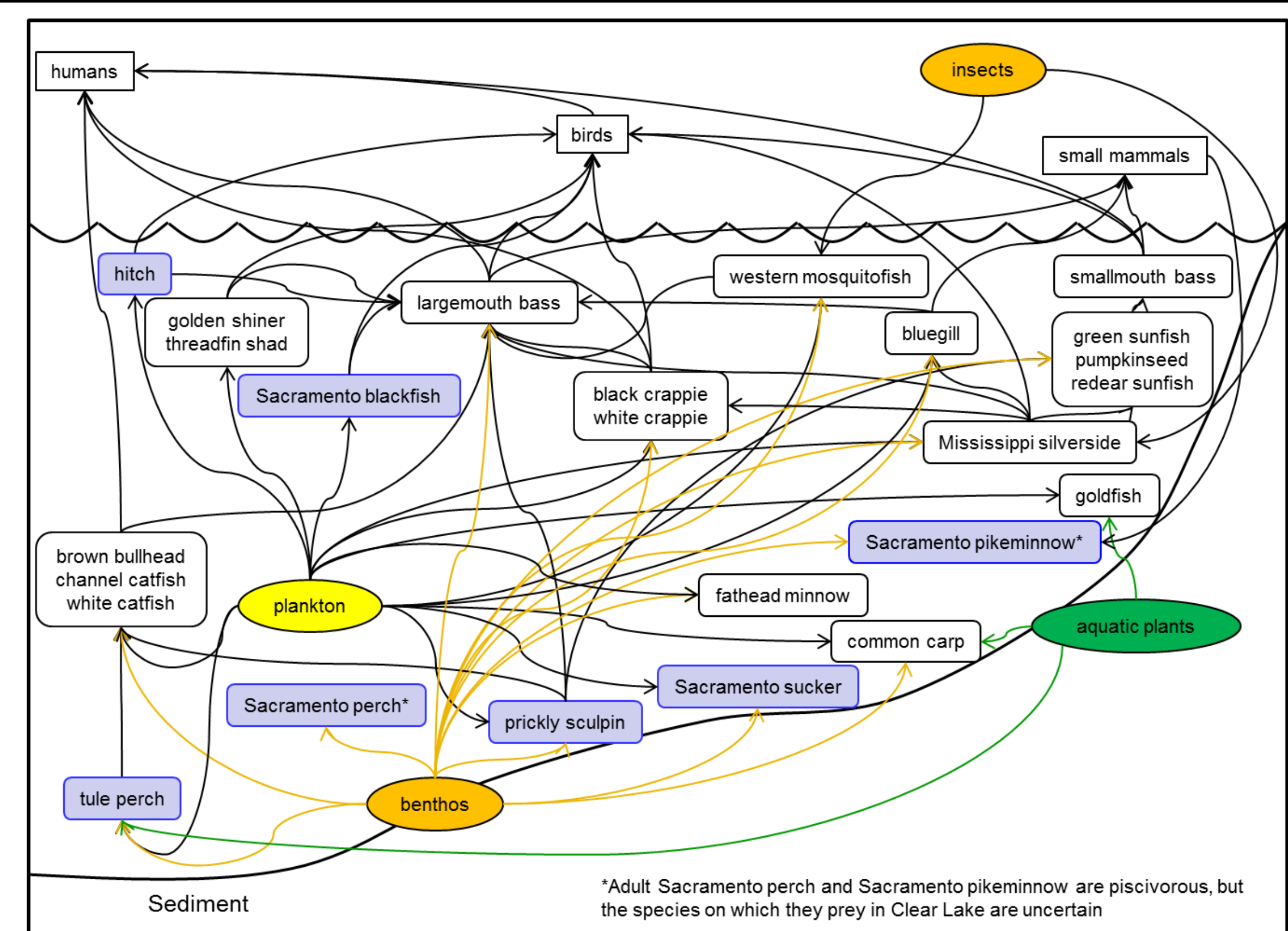
- Summarize trends in native and non-native fish species abundance
- Summarize the human activities that may have impacted fishes
- Graphically determine correlations between native fish abundance, non-native fish abundance, and other human impacts
- Suggest further research that may help to determine causal relationships and assist in the development of management strategies

## Methods

- We conducted an extensive literature search including peer-review literature, agency reports, surveys, field notes and memoranda, commercial catch records, and stakeholders' personal communications
- We determined the native and non-native fish species present in Clear Lake over time, and estimated the relative abundance of fish species

## Clear Lake Food Web

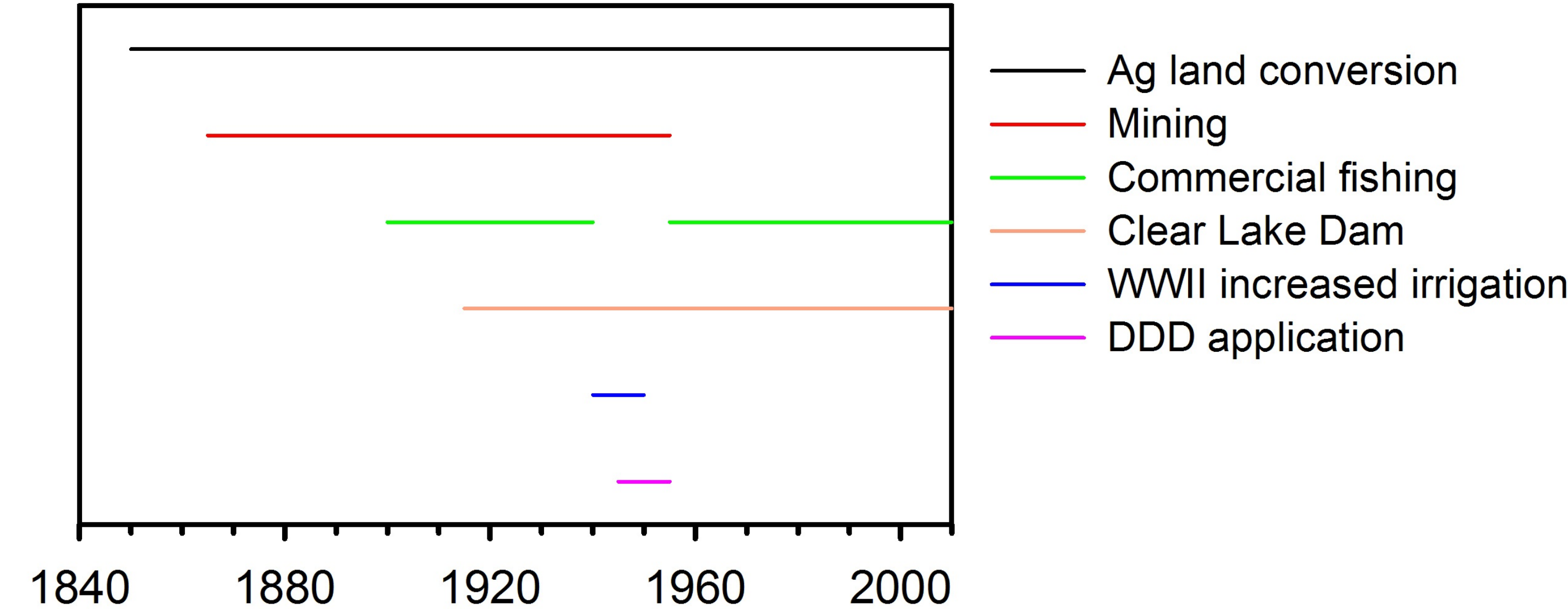
- Blue bubbles indicate native fish species.
- White bubbles indicate non-native fish species.



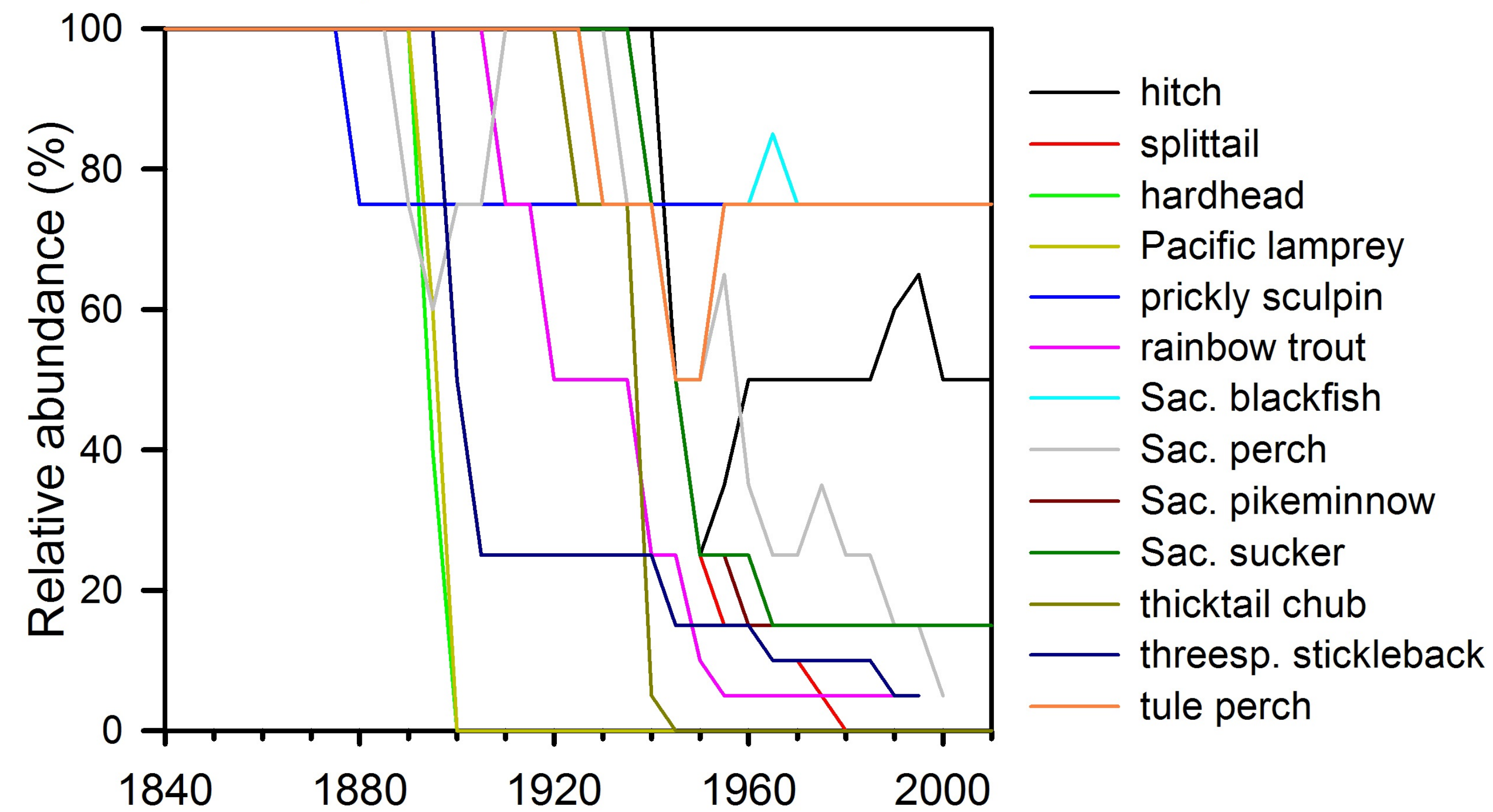
## Impacts and Fish Abundance Correlations

- Since the 1840s all native fish species declined in abundance, and several have been extirpated from the lake
- Negative abundance trends are correlated with numerous human impacts including the introduction of non-native fish species, land use change, dams, water diversions, and mining
- Fish abundance trends may be correlated with multiple impacts, making causal relationships difficult to ascertain from existing data

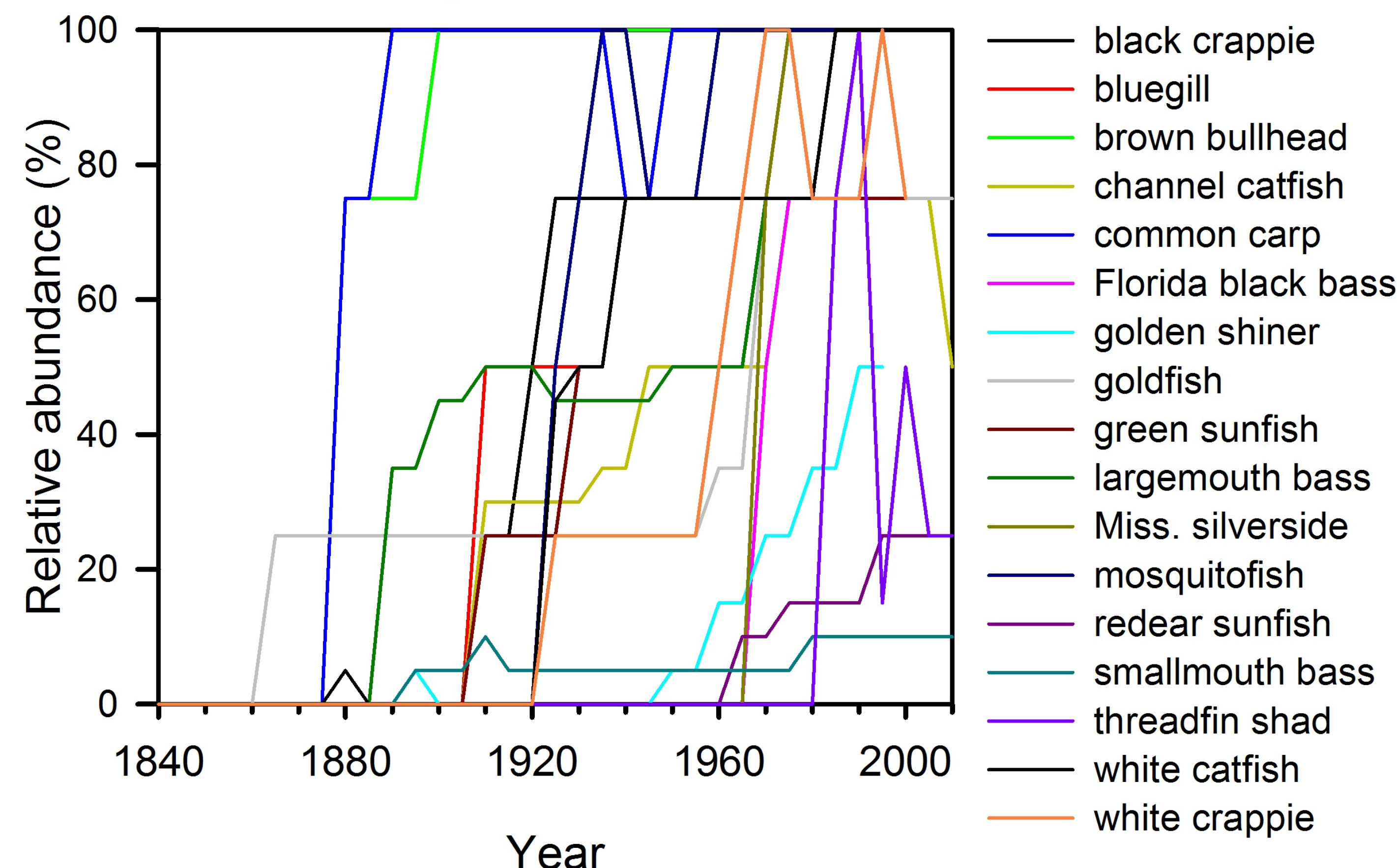
### A. Impacts



### B. Native fish species

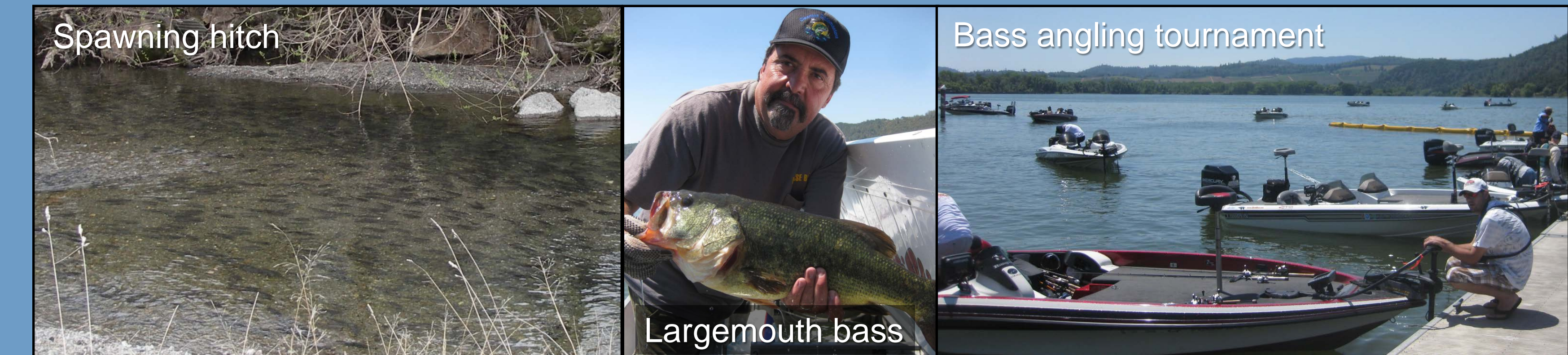


### C. Non-native fish species



## Research Opportunities

- Field studies of Clear Lake hitch and largemouth bass interactions
- Field surveys to determine the population dynamics of native fishes
- Development of a hitch population dynamics model to explore the relative importance of potential bottlenecks in the species' life cycle
- Development of a multi-species computer simulation model to bring together the existing knowledge about the Clear Lake ecosystem, and use of the model to simulate the results of management choices
- Development of a watershed hydrology model to predict how spring stream flows may change under climate change, and how this may affect hitch spawning access and timing
- A nation-wide survey of lake managers to identify strategies that have been effective in addressing the invasion of dreissenid mussels



## Conclusions

- The native fish species of Clear Lake have declined in abundance, likely due to the effects of a suite of human impacts
- While some species have been extirpated, many survive, presenting the opportunity to develop management strategies for their recovery
- Implementation of research and management experiments can increase our understanding of which impacts are most critical, inform management plans, and predict effectiveness of restoration actions

## Selected References

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