Key findings from the first three field seasons of a native and nonnative predator research program on the Stanislaus River

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INTRODUCTION AND BACKGROUND

Federal legislation (Water Infrastructure Improvements for the Nation [WIIN] Act; passed Dec. 16, 2016) required the Oakdale and South San Joaquin Irrigation Districts (Districts) and NOAA Fisheries to jointly establish a non-native predator research and pilot fish removal program in the Stanislaus River. Since 2017, FISHBIO, on behalf of the Districts, have collaborated with NOAA Fisheries and California Department of Fish and Wildlife (CDFW) to develop study plans and implement a suite of predator-related studies to meet the objectives of the program. The first is to improve knowledge of predator and predation ecology in the Stanislaus River to better inform potential management actions.

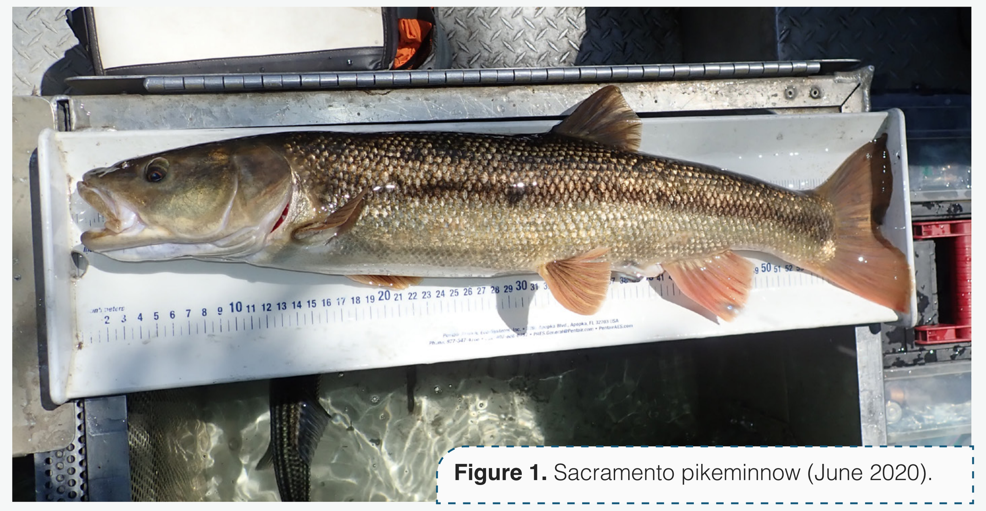


Figure 1. Sacramento pikeminnow (June 2020).

Since June 2018, electrofishing surveys throughout the Stanislaus River have been conducted to collect data in a robust and representative manner to estimate predator abundances, composition, distribution, movement patterns, and age structure, as well as their diets and impacts to juvenile salmonids. The second part of the program, focused on the management of predator populations, used experimental removals and deployments of Predator Event Recorders (PERs) to assess the effect of removals under a BACI design. Here, we focus on several key findings related to the first objective of the program (i.e., predator and predation ecology) learned from diet-related analyses from the first three seasons (2018–2020), though data collection is anticipated to continue into May of 2021.

STUDY DESIGN

- Since 2017, elements of the study design were improved through routine discussions and collaboration with CDFW and NOAA Fisheries.
- Data collected was intended to estimate predation risk in both space and time (as recommended by Grossman et al. 2013) using a sampling scheme to collect representative data on predators and their diet composition.
- Study area: The lower 66 kilometers of the Lower Stanislaus River.
- The entire reach was broken into 384 300-meter-long units from which 39 sites (~10% of reach) were randomly selected using a systematic sampling design.
- Same sites repeatedly visited on a monthly basis within and between seasons (2019–2021).
- The study reach encompasses the migratory corridor between the Oakdale and Caswell Rotary Screw Traps (RSTs), which will allow for estimates of the number of juvenile Chinook salmon both entering and exiting the reach concurrent with the predator sampling.
- Ultimately, the study has been carried out across a broad sampling area in a repeated manner, which has allowed for understanding of spatial (*i.e., how does predation occur across the landscape?*) and temporal (*i.e., when does predation occur throughout the season?*) aspects of predation on juvenile Chinook salmon.

METHODS

- Jet-powered and oar-powered electrofishing boats used to sample native and nonnative predators and their diets.
- Each site was visited twice monthly, typically on consecutive days, to estimate abundance of predatory fishes during each monthly sampling event.
- At the same time, diets were collected using non-lethal gastric lavage.
- All diet items identified visually were combined with genetic methods used for unknown fish or suspected fish.
- For each 'unknown', species identification was determined using mitochondrial DNA (16s rRNA) amplified using forward and reverse universal primers and polymerase chain reaction routines at Humboldt State University Fisheries Genetics Laboratory.

Figure 2. High water electrofishing (March 2019).

DATA ANALYSES

- To simplify reporting, species data were pooled into groups when applicable (i.e., black bass 'group' consisted of smallmouth, largemouth, spotted, and redeye bass).
- Discharge and temperature data from the USGS Gauging Station at Ripon (#11303000) was automatically downloaded from the National Water Information System (NWIS) using the dataRetrieval R package (De Cicco et al. 2018; last accessed March 24, 2021).
- Diet data (after visual and genetic identifications) were used to estimate frequency of occurrence (FO; i.e., a proportion with 95% confidence intervals) of Chinook salmon by predator species (or group) and sampling event.
- Across sites, the proportion of sites with juvenile Chinook consumption were estimated as the number of sites across events and groups where at least one juvenile Chinook salmon was consumed divided by the number of sites sampled during each event.
- For 2018–2020 data, linear regression was used to test whether FO of striped bass and black bass was related to the mean discharge and temperature from Ripon for each sampling event.

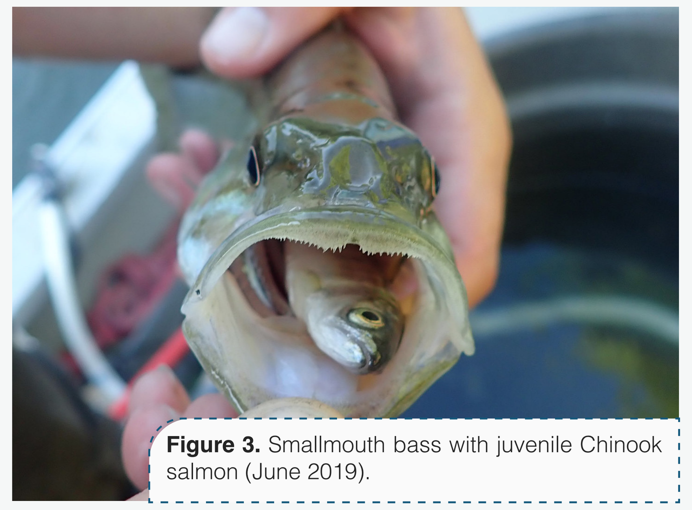
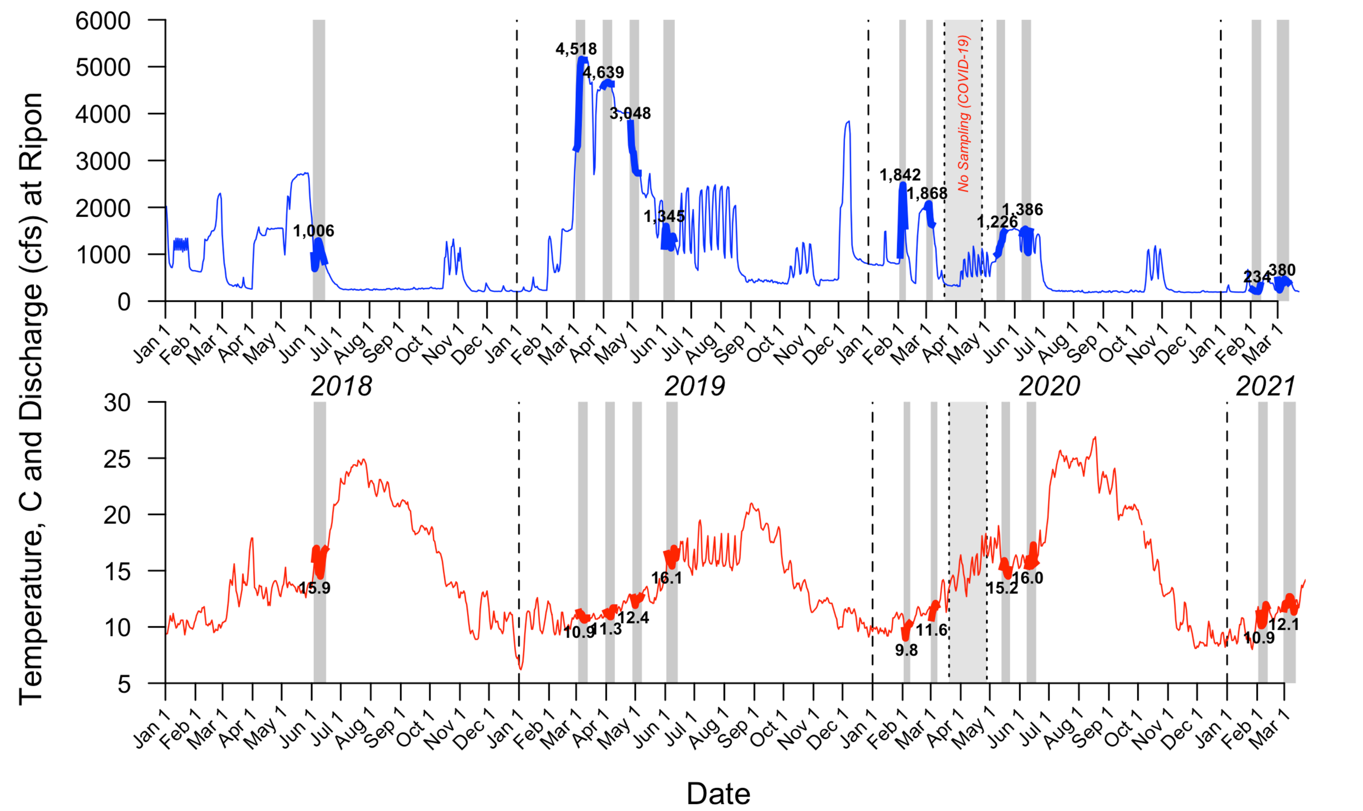


Figure 3. Smallmouth bass with juvenile Chinook salmon (June 2019).

FINDING # 1

- Sampling conducted in a variety of discharge and temperature conditions.
  - Lowest daily discharge = 203 cfs; Highest daily discharge = 5,160 cfs.
  - Lowest mean event discharge = 234 cfs (Feb. 2021); Highest mean event discharge = 4,639 cfs (Apr. 2019).
  - Lowest daily temperature = 9.0℃; Highest daily temperature = 17.3℃ (upper limit for sampling is 18.0℃).
  - Lowest mean event temperature = 9.8℃ (Feb. 2020); Highest mean event temperature = 16.1℃ (Jun. 2019).

Figure 4. Discharge (top plot; in blue) and water temperature over the course of the field sampling period measured at USGS gauging station at Ripon. Gray vertical bars denote sampling events from 2018–2021 and thick blue and red bars highlight discharge and water temperature during each sampling event with corresponding mean value.



FINDING # 2

- Predation on juvenile Chinook salmon observed during every sampling event despite low water temperatures (in early months) and high discharges (in 2019).
  - Black bass consumption occurred in every month sampled with exception of May 2020 (n = 1,216 diet samples total 2018–2020).
  - Striped bass (n = 312) consumption highest during months of April, May, June.
  - Sacramento Pikeminnow (n = 158) consumption observed infrequently, (March, May, and June).
  - No predation observed by catfish (n = 68), sunfish (n = 146), or hardhead (n = 149).

Figure 5. Map of study area with sampling locations (n = 39) from 2019–2021.

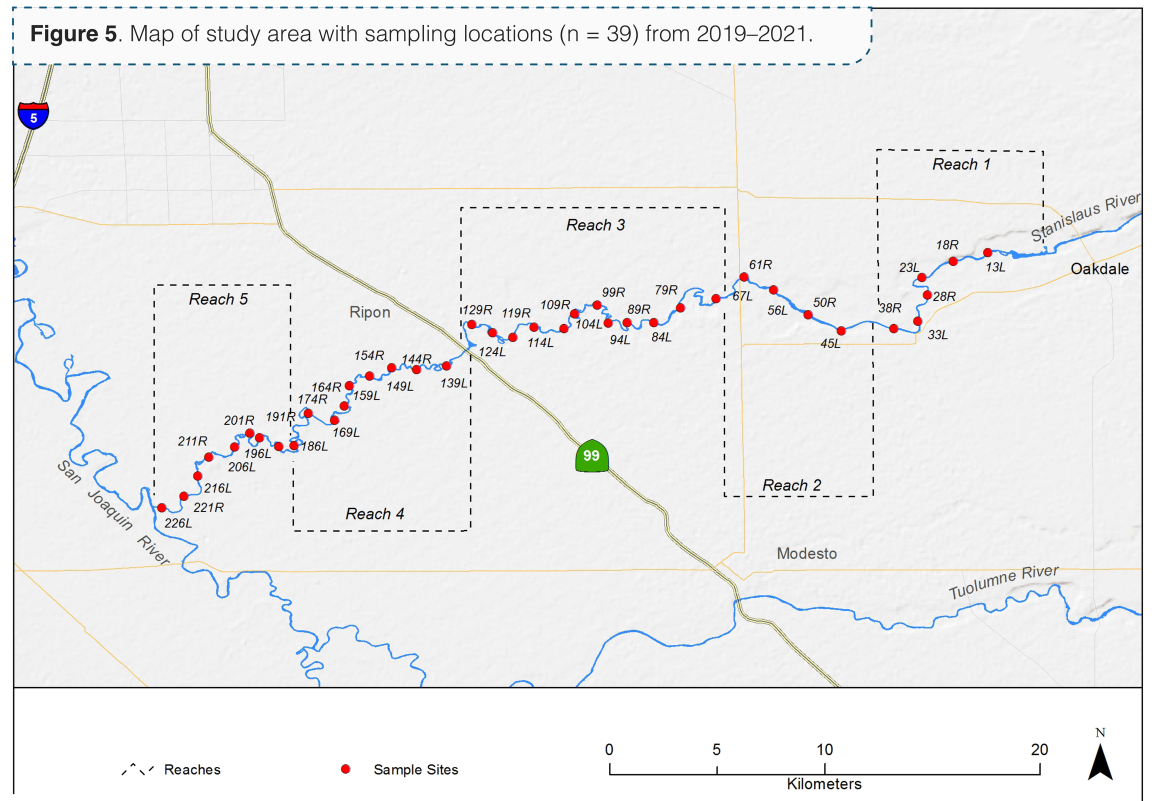
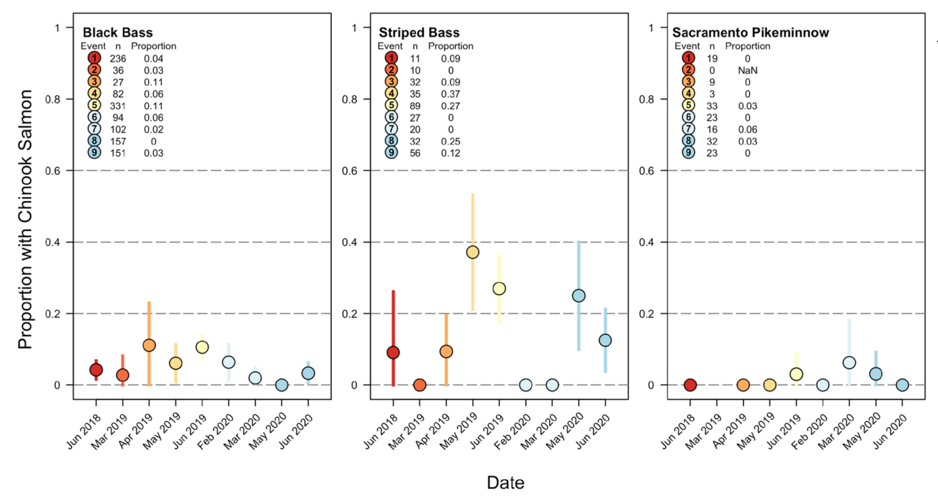


Figure 6. Frequency of occurrence of Chinook salmon in diets collected from black bass, striped bass and Sacramento pikeminnow from 2018–2020.



FINDING # 3

- Frequency of Occurrence (FO) showed seasonal trend with May having the highest estimates for striped bass and lowest for Sacramento pikeminnow.
- Less variable and lower FO for black bass, but non-zero in 8 of 9 events (Figure 6).
- Across 2018–2020 data, discharge not associated with FO of striped bass (linear regression; slope = -0.001; P = 0.71) or black bass (slope = <0.001; P = 0.37) (Figure 7).
- For black bass, temperature was not associated with FO (slope = -0.001; P = 0.80).
- For striped bass, temperature was slightly positively related to FO but insignificant (slope = 0.027; P = 0.18).

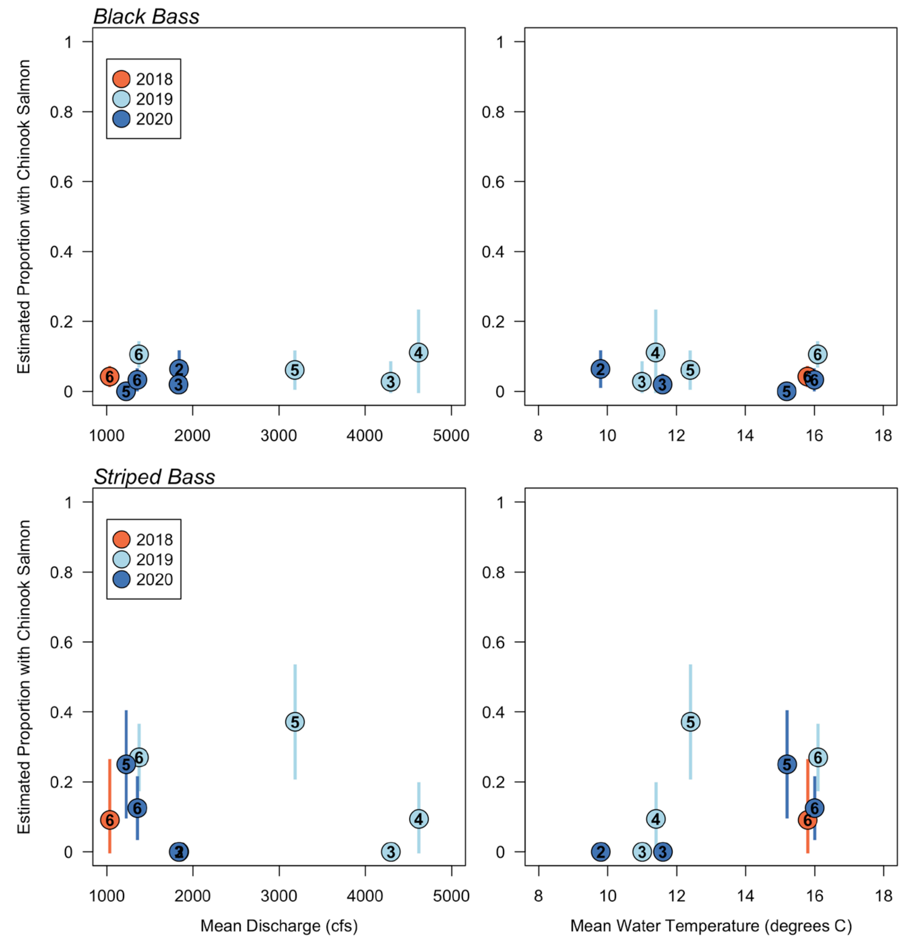


Figure 7. Frequency of occurrence of Chinook salmon for black bass (top row) and striped bass (bottom row) in relation to discharge and water temperature during each sampling event (2018–2020). Numbers denote month of sampling (2 = February; 6 = June).

FINDING # 4

- During 2019 and across all predators, sites, and events, at least one juvenile Chinook salmon was consumed in 29 of 39 sampled sites (74%; CI = 61% – 88%) (Figure 8).
- Highest proportion observed in June 2019, Chinook salmon were observed to have been consumed in 24 of 38 units where diets were collected (63%; CI = 48% – 78%).
- Notably, most sampling units were largely devoid of anthropogenic features (i.e., pumps, agricultural returns) though 21 of 39 (54%) had at least some rip rap present.

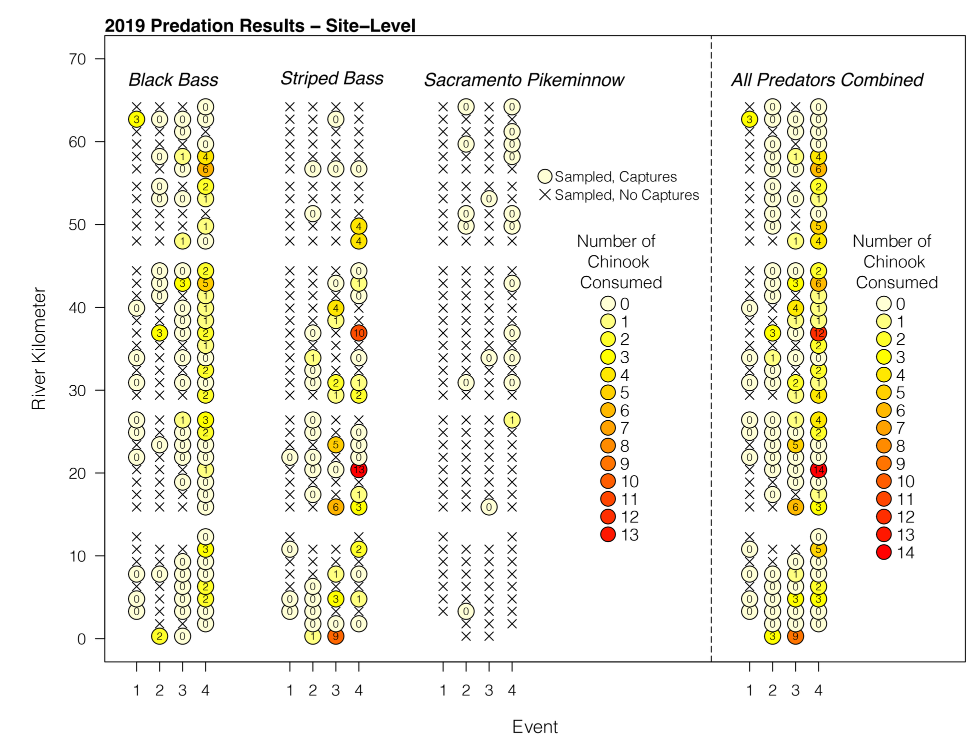


Figure 8. Total number of juvenile Chinook consumed by sampling location, predator group, and event for 2019 (March = 1; June = 4). Intensity of predation at a site shown with hotter colors (i.e., red = most predation at a site) with the total number of Chinook consumed denoted in each circle.

2021 PRELIMINARY OBSERVATIONS

Sampling during 2021 has occurred at the lowest discharge period during the study. FO for predatory fish has been low based on field observations (i.e., visual and genetic identifications not completed for 2021 season).

Observations (and captures) of juvenile Chinook salmon have been infrequent during electrofishing surveys. This is consistent with low to moderate catches at both Oakdale and Caswell RSTs during the same period. This observation suggest that prey availability is very important for context to better understand predation ecology (i.e., FO expected to be low during periods with no or low prey availability).

NEXT STEPS

- Complete field sampling and diet processing for 2021.
- Analyze all data (i.e., diet composition, frequency of occurrence, among others) between and within years.
- Complete data analyses and reporting of sampling results for all years to CDFW, NOAA Fisheries, Districts, and other interested parties.
- Integrate 2021 Stanislaus project data with South Delta predator study conducted concurrently to assess spatial patterns in predator and predation ecology across nearly 140 kilometers of migratory corridor transitioning from riverine to Delta habitats.
  - For more information, see concurrent poster presentation on the ***Ecology of piscivorous sport fishes in the San Joaquin river and South Delta*** presented by Tyler Pilger (FISHBIO).

ACKNOWLEDGEMENTS

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HAVE QUESTIONS?

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