Predation of Juvenile Salmon in the Tuolumne River

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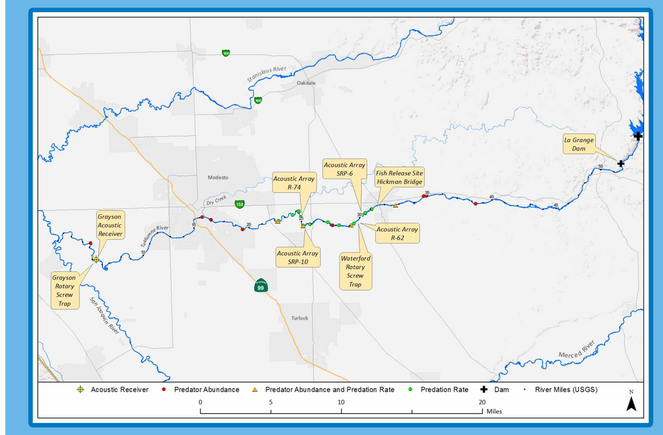
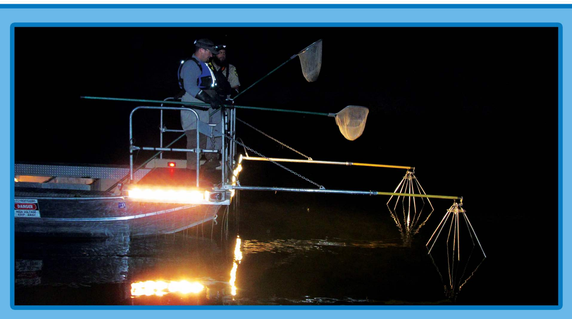
FISHBIO ARTICLE





PREDATOR MOVEMENT TRACKING

Acoustic Tag System Overview

1. Fish movements were monitored with an HTI Acoustic Tag Tracking System (ATS), which uses a fixed array of underwater hydrophones to track movements of fish implanted with acoustic tags.
2. Two-dimensional (2-D) position tracking arrays were deployed at select sites to detect movement of both tagged Chinook and tagged predators.
3. Single hydrophone arrays were deployed at select riffles (above & below) to detect movement through these habitat units.

Predator Tagging

1. Hook and line surveys as well as electrofishing were conducted between April 26 and May 16, 2012
2. Predatory fish >150 mm were tagged with an acoustic tag (HTI Model 795 LG).
3. Tagged fish were allowed to recover in a live well and released back into the river near the original site of capture. During the recovery period, tagged fish were monitored to confirm the operational status of each transmitter. All fish were acclimated to river conditions prior to release.

Chinook Salmon Releases

1. Acoustic tags (HTI Model 795 Lm) were surgically implanted into 222 coded wire tagged Chinook salmon provided by CDFG from the Merced River Hatchery (MRH). An additional 600 coded wire tagged Chinook salmon, also provided from MRH, were marked photonically and were released to accompany the acoustic tagged fish.
2. Releases of tagged and marked Chinook salmon were made on May 9-10, May 16 - 17, and May 21 - 22, and were timed to occur at flows of 2100 cfs, 280 cfs, and 415 cfs.

Differential Habitat Use

1. Two-dimensional acoustic tracking was used to evaluate the role of flow in segregating potential predators from outmigrating Chinook salmon within the special run-pools. Results showed overlap between acoustically tagged Chinook and predators at the three tested flows (280 cfs, 415 cfs, and 2,100 cfs). Striped bass were found to have the greatest overlap in habitat use with Chinook salmon (18.4 percent - 46.3 percent), followed by largemouth bass (5.8 percent - 30.5 percent), and small mouth (0.2 percent - 38.2 percent).
2. Acoustic detections within riffle 62 and riffle 74 and estimated residence times within riffles suggest that predator species (largemouth bass, smallmouth bass, and striped bass) were able to move unrestricted through riffle habitats at all test flows. Tracking technology did not allow for precise determination of tagged fish locations within the riffles.

STUDY GOALS AND OBJECTIVES

The goal of this study was to increase understanding of the current effects of predation on rearing and outmigrating juvenile Chinook salmon (*Oncorhynchus tshawytscha)* and rainbow trout/steelhead (*Oncorhynchus mykiss)* in the lower Tuolumne River. The study consisted of the following three components related to salmonid predation by native and non-native species in the lower Tuolumne River:

1. Predator abundance - estimate rexlative abundance of predator fish species such as largemouth bass (Micropterus salmoides), smallmouth bass (Micropterus dolomieu), Sacramento pikeminnow (Ptychocheilus grandis), and striped bass (Morone saxitalis)
2. Predation rate - update estimates of predation rates from previous surveys (e.g., TID/MID 1992)
3. Predator movement tracking - determine relative habitat use by juvenile Chinook salmon and predator species at typical flows encountered during the juvenile salmonid outmigration period.

KEY FINDINGS

- An estimated 33,981 juvenile Chinook salmon passed Waterford rotary screw trap during March 1 - May 31, during this period potential Chinook consumed by predators was 42,189.
- January through mid-June: 96% loss of juvenile Chinook salmon between Waterford and Grayson rotary screw traps.
- Analysis of 2007-2011 rotary screw trap data indicates 74%-98% mortality of juvenile Chinook between Waterford and Grayson.
- No evidence of predation of juvenile *O. mykiss.*
- No significant change in juvenile Chinook transit time between tested flows (280 cfs, 415 cfs, and 2,100 cfs).
- No differentiation of habitat use between tested flows (280 cfs, 415 cfs, and 2,100 cfs).

SUMMARY

Total potential consumption of juvenile salmon was estimated to be about 42,000 individuals during March 1 - May 31, 2012, with about 15% of potential consumption attributed to striped bass, 49% to smallmouth bass, and 37% to largemouth bass. Estimated abundance of juvenile salmon at the Waterford rotary screw trap during January 3 - June 15, 2012 was approximately 62,000, and approximately 34,000 of those salmon were estimated to pass Waterford during March 1 - May 31 which corresponds to periods for which predation rates were estimated.

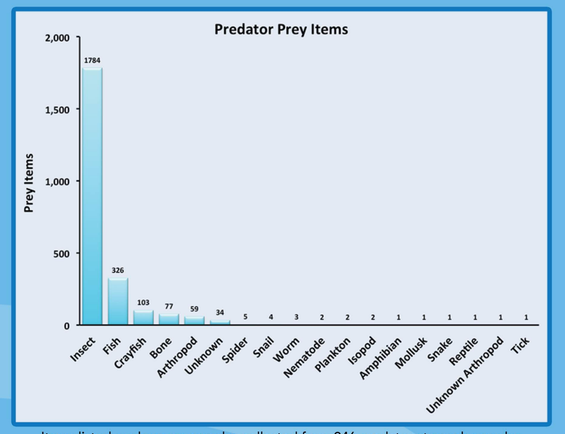
During January - June 2012 it is estimated that approximately 96% of juvenile salmon were lost between the rotary screw traps at Waterford and Grayson. This study provides the first direct assessment of potential predation impacts to juvenile salmon in the Tuolumne River and findings indicate that predation by introduced predators appears to be a significant source of mortality in at least some years.

Densities of acoustic tagged Chinook salmon and predators in SRP 6 at (a) 280 cfs, (b) 415 cfs, and (c) 2,100 cfs and densities of acoustic tagged Chinook salmon and predators in SRP 10 at (d) 280 cfs, (e) 415 cfs, and (f) 2,100 cfs (Chinook salmon: blue, largemouth bass: orange, smallmouth bass: green, striped bass: red and Sacramento pikeminnow: purple). Darker shaded areas represent 90th percentile and lighter shading represents 95th percentile densities. Note: where polygons overlap, not all species present may be visible.

Predator	Distribution	Riverwide Abundance	Abundance Between Screw Traps	Potential Percent of Impact	Potential Chinook Consumed
Smallmouth Bass	RM 3.7- 38.4	3,796- 5,843	2,476	48.5%	20,501
Largemouth Bass	RM 3.7- 32.9	5,354- 8,378	2,406	36.7%	15,495
Striped Bass	RM 3.5 - 35	477- 758	99	14.7%	6,193
Sacramento Pikeminnow	RM 27- 38.4	1,111- 1,768	50	0 %	0
				Total	42,189

PREDATOR ABUNDANCE

1. The k-pass removal method was used to estimate abundance of each target species (>150mm) in 12 sampling units between RM 3.7 and RM 38.5, via boat electrofishing. Sampling was conducted during the summer months to minimize potential handling of salmonids.
   a. Block nets deployed to satisfy assumption of closed population
   b. Assumed equal probability of capture between passes
2. Abundance estimates for each target species were produced for the lower Tuolumne River between RM 0 and RM 39.4 by expanding abundance estimates from sampled units to unsampled portions of the river using average estimated densities by shoreline length and area.
3. In a 25-mile reach between two rotary screw trap monitoring locations where juvenile salmon abundance was estimated, the lower 95 percent confidence bounds for species abundance determined by depletion electrofishing expanded for shoreline length were 2,406 largemouth bass, 2,476 smallmouth bass, 99 striped bass, and 50 Sacramento pikeminnow during summer.



Items listed are base on samples collected from 246 predator stomach samples

PREDATION RATE

1. Sampling was conducted, via boat electrofishing, at 12 sites between RM 22.4 and RM 31.1 during March 22-29 and May 1-9.
2. Prey items were collected from largemouth bass, smallmouth bass, striped bass and Sacramento pikeminnow > 150 mm FL by inserting an acrylic tube through the esophagus into the stomach and flushing the stomach with water to disgorge the contents (Van Den Avyle and Roussel 1980; Kamler and Pope 2001).
3. In the laboratory, all identifiable prey items found in predator stomachs were classified to order and for fish prey, to genus and species. All intact prey items were measured to the nearest millimeter (mm). Standard lengths (SL), fork lengths (FL), and total lengths (TL) of fish were taken when possible. All identifiable prey items, regardless of taxon, were enumerated. Hard parts from digested fish (e.g. cleithra and dentaries) were used to help identify fish to genus and when possible, were measured to estimate the original prey length. Diagnostic bones from Chinook salmon were identified using bone keys developed by Hansel et al. (1988) and Frost (2000).
4. Of the 246 stomach samples examined, 30 contained juvenile Chinook salmon, with eight of these samples from smallmouth bass, 11 from largemouth bass, and 11 from striped bass. No juvenile Chinook salmon were observed in the stomach contents of Sacramento pikeminnow. Smallmouth bass that consumed juvenile Chinook salmon were at least 185 mm FL, largemouth bass were at least 207 mm FL, and striped bass were at least 180 mm FL.
5. Species-specific predation rates averaged for all run-pools and special run pools sampled during March and May were 0.07 juvenile salmon per predator per day for largemouth bass, 0.09 for smallmouth bass, 0.68 for striped bass, and 0.0 for Sacramento pikeminnow.