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Hallwood Restoration Project – Predation Experiment

Yuba River – Central Valley, California

Predation experiments reveal:

- **Rearing habitat quality dramatically alters residence time and survival of juvenile Chinook Salmon**
- **Where waters temperatures are warm and predator densities are rich, mortality rates of juvenile salmon can be as high as 64% within 72 hours.**
- **Individual predators can have a disproportionate impact on predation rates of juvenile salmon.**

Historic mining has created unnatural features within many Central Valley rivers. These features include overly large and deep backwater pools that persist throughout the warm summer months, supporting invasive plants and potential fish predators of juvenile Chinook Salmon (e.g., Fig 1: Top panel). As part of a large collaborative effort, CBEC, SYRCL, & Cramer Fish Sciences initiated a large-scale experiment in April 2016 that focused on Chinook Salmon rearing habitats in the Yuba River, California. This experiment is part of a pre-project assessment of backwater habitats targeted for restoration and was designed to test how environmental conditions and the abundance of warm-water piscivorous fishes, such as bass and sunfish, impact the residence time and survival of juvenile fall-run Chinook Salmon in these valuable rearing habitats. Results from this experiment will help define potential benefits that can be gained by restoring these habitats. More broadly this experiment will help to improve our understanding of predator-prey dynamics of warm-water piscivorous fishes and juvenile Chinook Salmon.

Approximately 2,000 hatchery-reared juvenile Chinook Salmon marked with Passive Integrated Transponder tags (PITtags) were released into two separate backwater habitat sites. The Hallwood backwater site is targeted for restoration and the Kino backwater site served as a control. Both experimental sites are approximately 8 miles upstream of Marysville, CA near the community of Hallwood in an area known as the Yuba Goldfields. Juvenile salmon were allowed to rear in these backwater habitats until they volitionally moved downstream and were captured in a fyke net blocking the downstream exit from each site (Fig. 1). The trap boxes were checked once per day where captured fish were identified by their unique PITtag IDs and their lengths and weights were recorded.

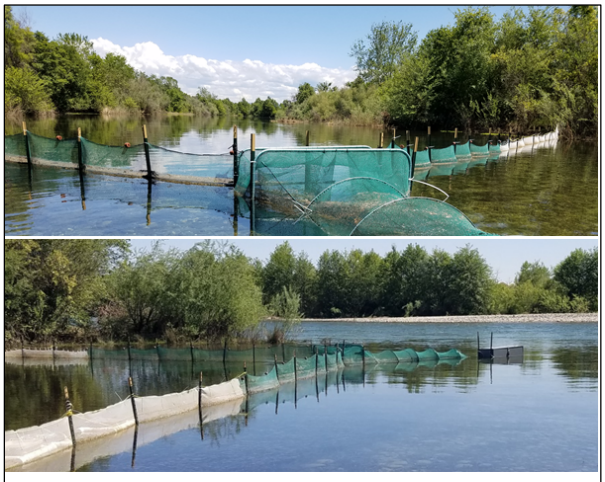

Fig 1. Installed fyke net and trap box at the Yuba River Hallwood restoration site, California.

Survival and residence time of juvenile salmon in the Hallwood and Kino backwater habitats appeared to be strongly influenced by habitat quality and predator presence. Of the original 1,000 fish deployed at the Hallwood site, ~ 65% were recaptured in the downstream fyke net with a maximum residence time of 16 days for an individual fish. We recaptured ~36% of the 985 fish released in the Kino backwater site with a maximum residence time of 3 days. Given these results, we can assume that juvenile salmon rearing in, or navigating through, un-restored backwater habitats may experience mortality rates as high as 64% within 72 hours.

We observed an abundance of warm-water invasive and potentially piscivorous fishes in two Yuba River backwater habitats during this experiment. Between the fyke traps and our seining effort we captured over 1,860 invasive warm-water fishes in the Hallwood and Kind backwaters. Over 10% of these invasive fish were potentially piscivorous (i.e., Fork Length > 150mm) with the capacity to prey on juvenile Chinook Salmon. Examining the stomach contents from some of these predators revealed remarkable rates of predation from individual fish. For example, we observed one largemouth bass (*Micropterus salmoides*) with nine PITtags in its digestive system, of which six were regurgitated from its stomach contents (Fig. 3). As well, we noted that a number of smaller warm-water fishes were capable of predating on juvenile salmon (Fig. 3 inset). The number of potential predators and the rates of predation were likely primary factors that contributed to the decreased residence time and increased mortality rates for juvenile Chinook Salmon in these degraded habitats.

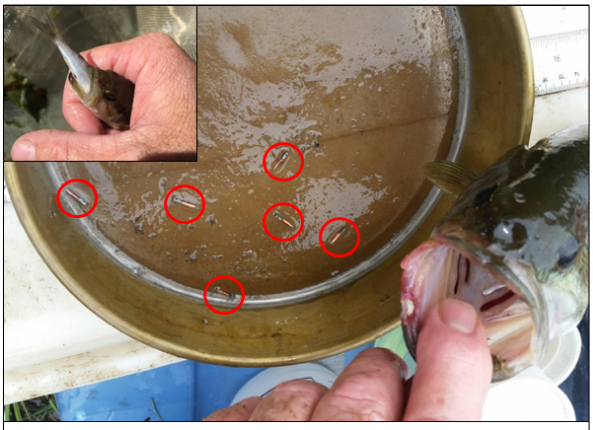

Fig 3. Predators regurgitate PITtags (circled in red) from juvenile Chinook Salmon they consumed.

The Hallwood predation experiment has helped to highlight that the alteration of some Yuba River backwater habitats has created environments where invasive warm-water fishes can thrive and proliferate. The value of backwater habitats to juvenile salmon in the Yuba River is impacted independently and interactively by warmer that average water temperatures and increased predator prevalence. Specifically, temperature affects fish physiology, predators increase mortality risks, and warmer water temperatures facilitate increased prevalence and metabolism (feeding rates) of warm-water predatory fishes. Looking forward, we aim to identify how restoration actions applied to backwater habitats can be used to mitigate for the adverse effects of elevated water temperatures and predator prevalence to increase the utility and benefits of these backwater habitats for juvenile Chinook Salmon.