DELTA SCIENCE FELLOW 2020

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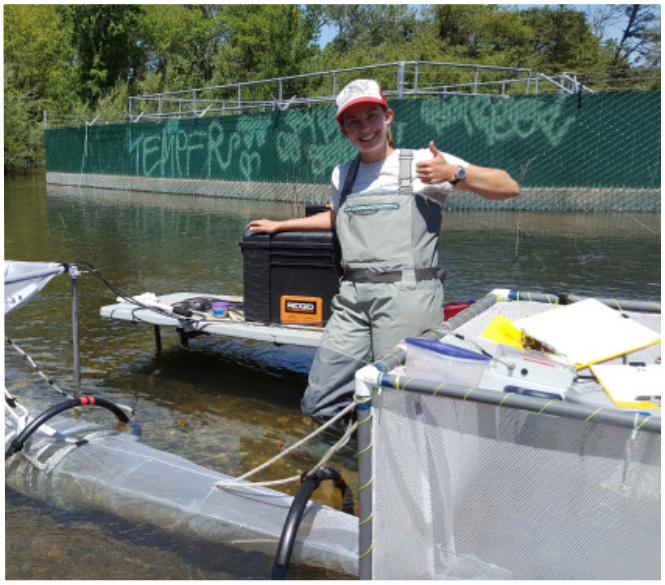
WHY THIS RESEARCH MATTERS

Chinook salmon are an iconic part of California's environment and heritage, and important both economically and culturally. In the Sacramento River, the winter-run Chinook population is endangered, and there is strong interest in restoring these populations. To do so, resource managers need to better understand the pressures on wild populations. Predation by nonnative predators affects survival of young salmon but may also affect the behavior of salmon. Changes to salmon behavior also have costs but are not currently considered in management. Managers need information on how predators affect juvenile salmon behavior, how they might vary under different conditions, and how they scale up to affect populations.

Habitat, hatcheries, and nonnative predators interact to affect juvenile salmon behavior



First field experiment set-up, where Megan timed hatchery and wild juvenile salmon swimming downstream through the enclosure with and without a plastic largemouth bass replica. Credit: Dave Fryxell

PROJECT

This study explored how nonnative bass affected both hatchery and wild juvenile salmon behavior on the Lower Mokelumne River California. The researchers combined experimental methods with modeling techniques to examine how habitat and salmon origin (hatchery vs. wild) influenced salmon antipredator behavior, and how these context-dependent decisions scaled up to affect salmon populations.

RESULTS

In this study, Delta Science Fellow Megan Sabal developed a new conceptual framework to understand how directionally moving prey perceive predation risk and make economic decisions. This framework provides a link to connect small-scale antipredator decisions to large-scale patterns, and fitness consequences. Through a field experiment, Sabal found that hatchery salmon did not react to a model predator, while wild salmon did. This has important implications for a potential mechanism for poor hatchery salmon survival and a potential conservation strategy—predator conditioning in hatcheries. In a second field experiment, Sabal found that Chinook salmon's predation response depends on habitat, and that the fish exhibited a stronger, but slower, predation response in shady conditions compared to the sun. Preliminary results from a dynamic programming model found that salmon antipredator decisions during migration can scale up to affect ocean arrival timing, energetic condition, and adult salmon returns.

MANAGEMENT APPLICATIONS

The experimental findings of this study provide important new information for resource managers looking for the most effective ways to increase salmon adult returns by considering predator effects to salmon behavior. The dynamic programming model, which incorporates salmon antipredator decisions, habitat, and salmon origin, will allow researchers to run scenarios with different management options to compare the potential impacts on salmon behavior, survival, and adult returns. This will allow managers to design restorations strategies that fit best for specific locations and stakeholders.

Sabal has presented this research to resource managers at both the NOAA Southwest Fisheries Science Center and the State Water Contractors.

Second field experiment set-up, where Megan timed hatchery and wild juvenile salmon swimming downstream through the enclosure with and without a live largemouth bass present, while also manipulating habitat structure and overhead shade. Credit: Megan Sabal

Sorting PIT tagged juvenile salmon in preparation for running experimental trials. Credit: Katie Kobayashi

SELECT PUBLICATIONS AND PRESENTATIONS

Sabal MC, Merz JE, Alonzo SH, Palkovacs EP. 2020. An escape theory model for directionally moving preyand an experimental test with juvenile Chinook salmon. *Journal of Animal Ecology*. https://doi.org/10.1111/1365-2656.13233

Sabal MC, Workman ML, Merz JE, Palkovacs EP. *In Review*. Afraid in the shade: Juvenile Chinook salmon shift antipredator behavior in an unfamiliar migration corridor. Oecologia.

Sabal MC, Hazen EL, Bograd SJ, MacFarlane RB, Schroeder ID, Hayes SA, Harding JA, Scales KL, Miller PI, Ammann AJ, Wells BK. 2020. California Current seascape influences juvenile salmon foraging ecology at multiple scales. *Marine Ecology Progress Series*. https://doi.org/10.3354/meps13185

Sabal MC, 2019. Joint meeting of the American Fisheries Society and The Wildlife Society. Presentation. "An escape theory model for migrating prey and an experimental test in juvenile salmon." Reno, NV.

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