Hooking mortality rates for use in steelhead fisheries

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Abstract

Mortality of natural-origin salmon and steelhead due to catch and release angling can affect both the quantity and duration of mark-selective sport fisheries in the Pacific Northwest. Impacts of catch and release angling on protected stocks are typically approximated as the product of the number of natural-origin fish encountered in the fishery and a catch and release mortality rate. However, catch and release mortality rates are based upon data from relatively few disparate studies, and the influence of environmental conditions, angling gear and methods, and species or run timing are not considered. Biased estimates of angling impacts may lead to overly constrained fisheries, or excessive exploitation of protected fish stocks.

In an effort to develop a database capable of addressing these uncertainties, Mount Hood Environmental (MHE) and the Washington Department of Fish and Wildlife (WDFW) conducted a three-year paired mark-recapture study in the Cowlitz River, Washington's largest tributary to the Columbia River. Comparison of recapture rates among angled and non-angled fish were used to infer differences in survival due to catch and release. Target species included Chinook Salmon, Coho Salmon, and steelhead trout. A robust statistical analysis is in development for peer review and publication.

From summer 2017 to spring 2020, field crews invested over 7,200 rod-hours angling 2,728 salmon and steelhead. 2,042 of these fish were landed after being hooked and 1,529 hatchery-origin salmon and steelhead were marked with t-bar anchor tags containing unique identification numbers. Over 3,700 fish were also trapped at the Cowlitz Salmon Separator[1], tagged, and released into the lower Cowlitz River to serve as controls. Angled treatment fish and non-angled control fish were recaptured at the Salmon Separator, and by anglers who deposited tags at drop boxes near popular fishing areas, or reported recovered tags to creel surveyors. A small number of tagged fish were also recovered by WDFW spawning survey crews in the upper Cowlitz Basin.

Across all species, the average weighted recapture rate of angled fish was 2% lower than control fish, indicating that mortality due to angling was rare. However, results varied by species and life-history (Figure 1). Angled winter steelhead were recaptured at a rate that

[1] The Salmon Separator is a fish trap and sorting facility located at the Barrier Dam, adjacent to the Cowlitz Salmon Hatchery on the Lower Cowlitz River. Staff at the facility sort hatchery and natural-origin salmon and steelhead before transporting fish upstream of Cowlitz Falls Dam.

was 2% higher than control fish, suggesting nominal effects of catch and release on winter steelhead survival. Angled summer steelhead were recaptured at a rate that was 8% lower than control fish. The observed difference between post-release survival of summer and winter steelhead life-histories may be in part attributed to the effect of water temperature (Figure 2). Coho Salmon provided the largest sample size amongst any of the study species, and we observed no difference between recapture rates of angled and non-angled Coho. The recapture rate of angled Spring Chinook Salmon was 12% lower than control fish; a finding consistent with observations from previous Spring Chinook angling studies conducted in the Yakima and Willamette Basins.

In addition to gathering data to estimate survival rates for each species, our experimental design included documentation of angling methods, gear-type, fight time, handling time, water temperature, and river flow conditions for each fish. Recapture rates of fish caught on barbed hooks did not differ significantly from fish caught on barbless hooks (Figure 3). However, anglers using barbless hooks had a lower probability of landing fish when compared with anglers using barbed hooks. This was most pronounced while angling for summer steelhead. Fish landed with a knotted net were recaptured at a slightly lower rate than fish landed with a knotless net. Fish hooked in critical locations (eyes, gills, esophagus, tongue), were recaptured at a rate that was 11.4% lower compared with fish hooked in non-critical locations (body, maxillary, jaw, head). Additionally, fish caught using bait were more likely to be hooked in critical locations compared with fish caught using lures and jigs (Figure 4). This may explain why fish caught with bait were 15% less likely to be recaptured compared with fish caught using other terminal gear types. Furthermore, the recapture rate for each species was likely influenced by the effectiveness of different terminal gear types. For example, most Spring Chinook and summer steelhead were angled while drifting bait and these two species had lower recapture rates than winter steelhead and Coho Salmon, most of which were caught using artificial tackle such as spinners, jigs and beads. There was no apparent effect of fight time or handling time on recapture rates. However, water temperature was found to have a significant effect, where the probability for recapture declined by 17% for salmon and 9.5% for steelhead with each degree of temperature increase.

Although river flow conditions at the time of capture did not appear to influence recapture rates, river flow conditions did impact angling success. Catch per unit effort was lowest following large changes in river flow coincident with hydropower ramping and natural storm events. We experienced the highest catch per unit effort between the hours of 0500 and 1200, and 1-2 hours prior to sunset, which is when salmon and steelhead are known to be most active. We also tested for evidence of other factors that may have influenced angling success, including barometric pressure and lunar phase, but we did not observe a clear association between these variables and catch per unit effort.

This project is currently in an analysis and reporting phase. WDFW and MHE will continue developing a survival model that accounts for the full suite of variables that

effect catch and release mortality. Results reported here may change as we complete this analysis and seek peer review of our findings.

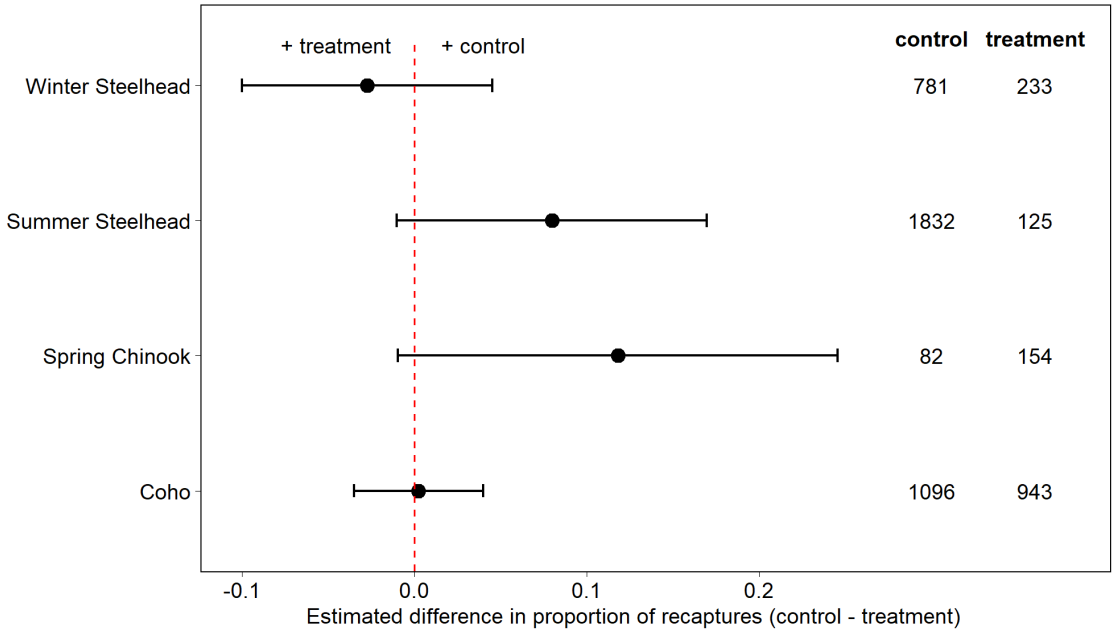

Figure 1. Two-sample test of proportion recapture of control and treatment (angled) salmon and steelhead.

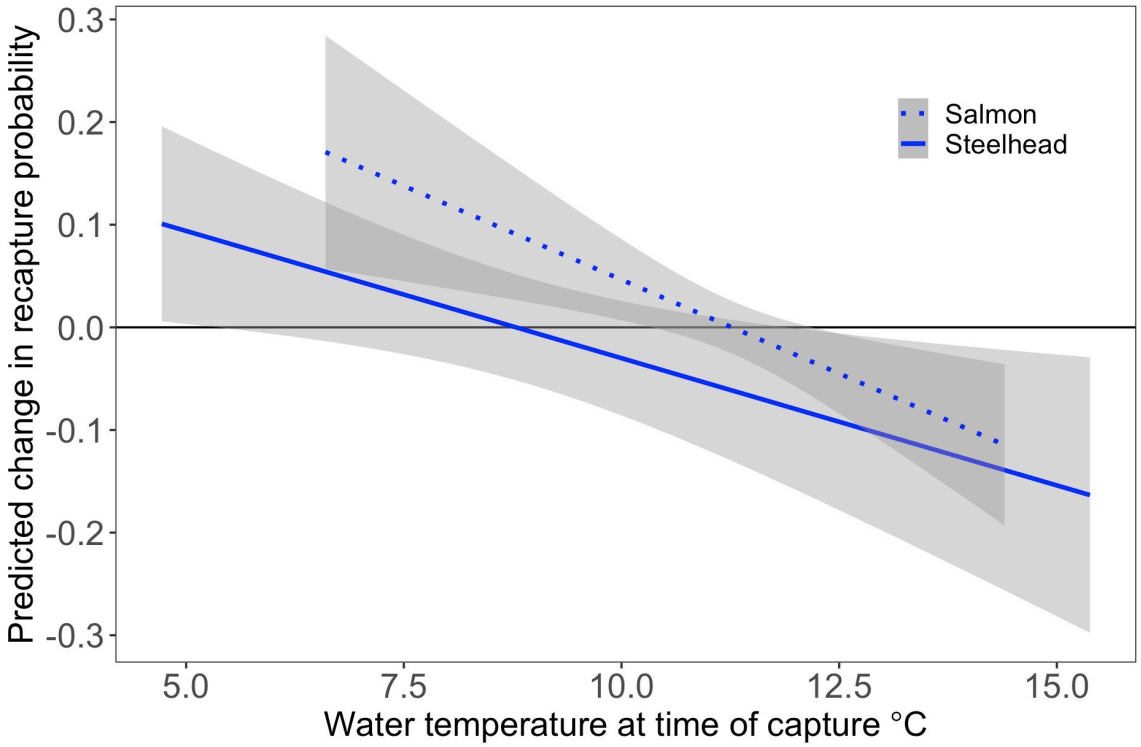

Figure 2. Effect of water temperature on the probability of recapturing angled salmon and steelhead relative to the average observed recapture rate.

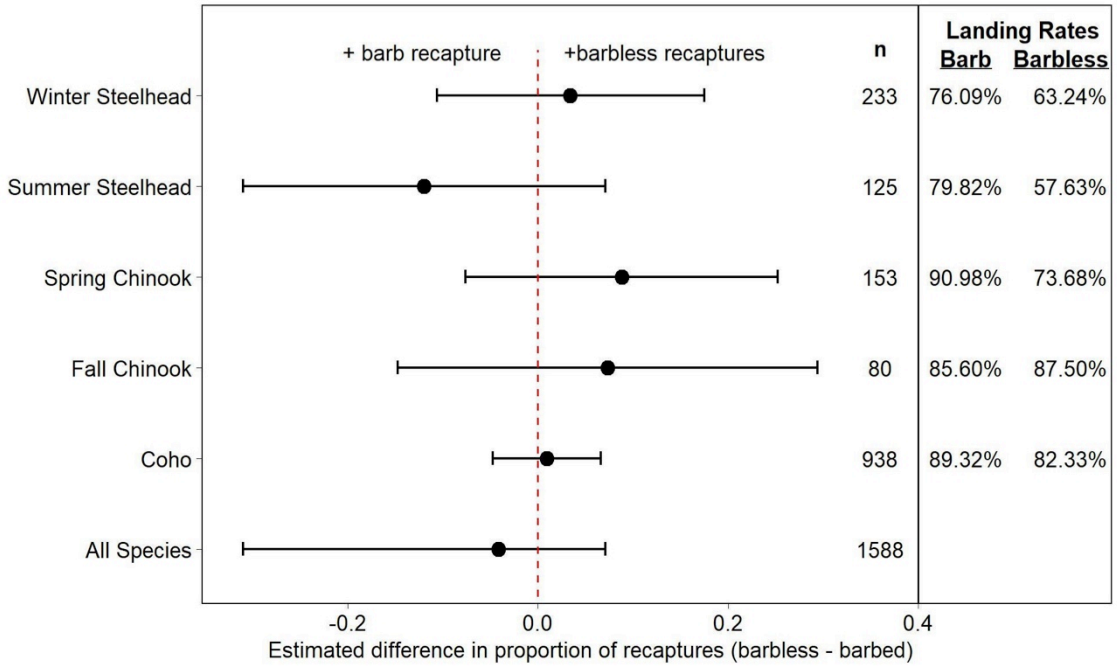

Figure 3. Two-sample test of proportion recapture of salmon and steelhead angled on barbed and barbless hooks and the influence of hook type on landing rates.

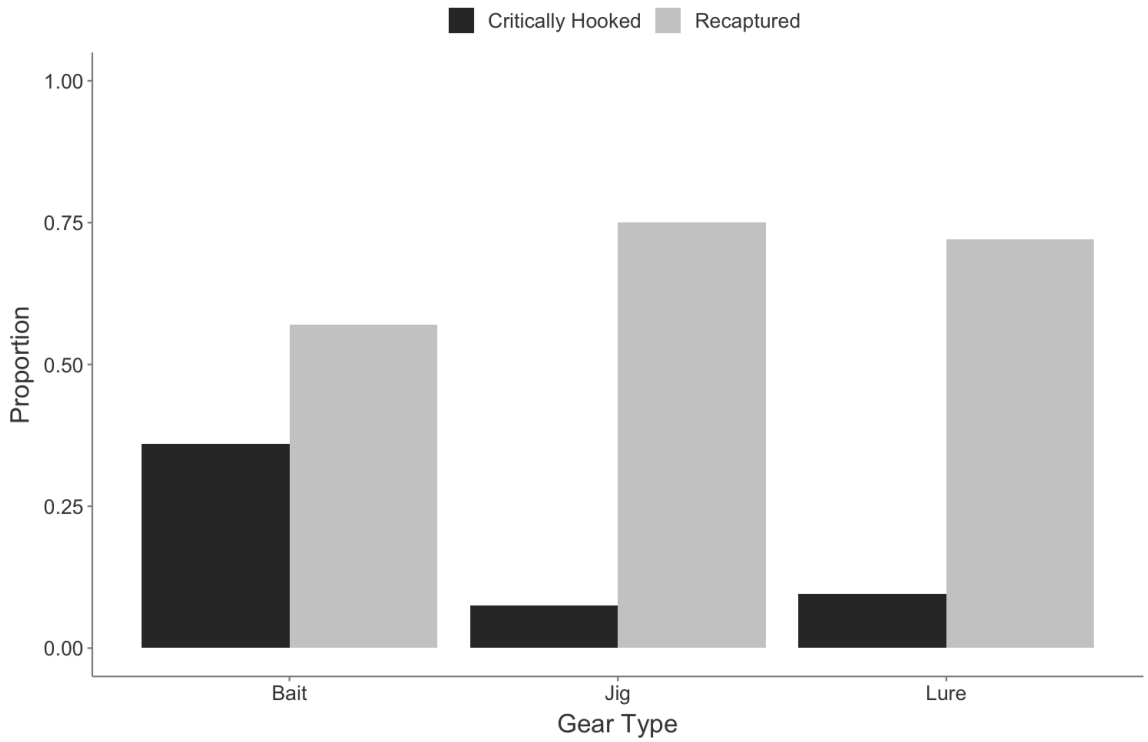

Figure 4. Proportion of angled salmon and steelhead hooked in critical locations and the total portion of fish recaptured after being angled with three different terminal gear types.