

Columbia River Salmon and Steelhead Endorsement Recreational Anglers Board
Application for Funding

Applicants: Mount Hood Environmental and Washington Department of Fish and Wildlife

Contact: Ian Courter (503-663-3697); Thomas Buehrens (360-906-6700)

Proposal Title: Cowlitz River salmon/steelhead hooking mortality study

Type of Proposal: Monitoring survival of steelhead and salmon angled in the Cowlitz River with different methods and gear types.

Date of Submission: July 6, 2016

Effective Period of Funding: August 15, 2016 to June 30, 2017. Fieldwork will occur year round. Analysis/Report writing will occur in May-June 2017.

Amount of Funding Requested: \$180,581

Activities to be Funded:

- Capture and tag salmon and steelhead in the Cowlitz River using a variety of sport fishing methods and gear types.
- Recapture salmon and steelhead at the Cowlitz Salmon Hatchery fish separator and in fisheries upstream and downstream of Mayfield Dam.
- Estimate relative survival of angled and non-angled fish.
- Observe angler catch-and-release practices at popular fishing areas on the Cowlitz River.
- Document findings in a written report

Background: Implementation of gear-type restrictions has been an effective regulatory strategy for reducing the impact of sport fishing on naturally reproducing populations of fish in the Pacific Northwest, particularly for catch-and-release trout fisheries where resident fish are potentially caught multiple times during their life span (Taylor and White 1992). Such strategies have included restricting anglers to artificial flies and lures and limiting the number, type (single or multiple point) and/or size of hooks that can be used.

The Washington Department of Fish and Wildlife (WDFW) recently expanded the number of fisheries requiring anglers to use barbless hooks as a measure to protect natural-origin ESA-listed salmon and steelhead stocks throughout the Columbia River basin. Despite its popularity as a conservation measure for catch-and-release trout fisheries, it remains uncertain whether this regulation increases survival rates of hook-and-line captured salmon and steelhead. It is assumed that salmon or steelhead captured with a barbless hook will be released more quickly while sustaining less injury, thereby giving the fish a greater chance of survival. However, available empirical data from

disparate studies suggest that hooking location may be more influential than hook type when determining causes of capture-related mortality (immediate and post release) for hook-and-line captured salmon and steelhead (Cowen et al. 2007; Lindsay et al. 2004; Taylor and Barnhart 1996). For these reasons, Washington State barbless hook regulations have generated concern among sport fishermen who question whether these regulations are effective at protecting natural-origin salmon and steelhead from capture-related mortality.

In addition to minimizing release mortality of natural-origin salmon and steelhead, Washington sport fisheries managers often aim to provide opportunities to harvest hatchery-origin fish. Successful capture and retention of hatchery-origin salmon and steelhead may reduce the risk of genetic and ecological impacts of hatcheries (Naish et al. 2007) in addition to generating economic activity and fulfilling fishery mitigation obligations related to the operation of hydroelectric projects. Unfortunately, fisheries regulations designed to protect wild stocks may be in direct conflict with those designed to achieve high hatchery fish retention rates if gear type restrictions intended to protect wild fish also result in reduced catch of hatchery fish. For example, anglers have made anecdotal claims of experiencing lower landing rates (number of fish released and/or retained divided by the total number of fish hooked) due to the propensity for fish to become unhooked while being brought to shore or boatside with barbless hooks. However, very little empirical data exists to affirm these anecdotal experiences.

Therefore, Washington's current regulatory policy to restrict salmon and steelhead sport fisheries to barbless hooks in some areas operates on the assumption that use of barbless hooks reduces-capture related mortality, and possible lower landing rates of hatchery-origin fish has been deemed an acceptable trade-off for this conservation measure.

In March of 2016, the Cowlitz River Ad-Hoc Group, representing sport fishing interests in the Cowlitz Basin, contacted Mount Hood Environmental (MHE) regarding preparation of a study plan to quantify the survival of salmon and steelhead captured with barbed and barbless hooks by sport fishermen in the Cowlitz River. The research project described here, a collaborative approach between MHE, WDFW, and Tacoma Power, reflects MHE's response to that solicitation. If we are successful in acquiring funding for the proposed study, the data we collect will be essential for developing scientifically-supported regulatory strategies that minimize the impact of sport fishing on protected natural-origin salmon and steelhead stocks while maximizing angling opportunity.

Project Objectives:

- 1) Determine whether use of barbless hooks increases survival of salmon and steelhead caught and released in the Cowlitz River.
- 2) Quantify the capture efficiency of barbed and barbless hooks while angling for salmon and steelhead in the Cowlitz River.
- 3) Use data collected in this study in conjunction with creel and catch record card data to model the impacts of barbless regulations on rates of wild fish mortality

and hatchery fish harvest in two fisheries—a hatchery fish intensive fishery (e.g. Cowlitz) and a naturally supported catch-and-release fishery (e.g. Wind or SF Toutle).

WDFW is currently developing analytical tools to model the impact of different sport fishing gear-types on long-term steelhead survival (Buehrens and Cochran, WDFW, unpublished data) by relating gear type to hooking location and hooking location to mortality rate (Lindsay et al. 2004). It is our intent to ensure that hooking mortality data collected in the Cowlitz River serves to improve the predictive power of these models by collecting additional information on hooking location and short-term mortality rate, as well as gear type and hook type.

In particular, we are interested in the trade-off between potential increases in hooking mortality and landing rates while using barbed hooks. In such a case, higher landing rates while using barbed hooks in hatchery-augmented fisheries may offset the impact of higher hooking mortality rates on natural-origin fish if anglers are able to obtain their retention limit more quickly (less lost fish) and thereby hook fewer fish during each outing. Conversely, landing rates may be comparable for both barbed and barbless hook types, in which case barbless regulations are not reducing hatchery fish harvest rates as some have surmised.

Proposed Activity: The Cowlitz River is an ideal location to study salmon and steelhead hooking mortality. Each year, thousands of hatchery-origin salmon and steelhead return to the Cowlitz Basin, providing the largest harvest-oriented sport fishery in Washington outside of the Columbia River main stem. Adult hatchery-origin salmon and steelhead that evade capture and return to Cowlitz Salmon Hatchery and Cowlitz Trout Hatchery are used for broodstock, transported into the upper Cowlitz Basin for reintroduction and nutrient enhancement, recycled downstream for additional fishing opportunity, or distributed to food banks. Therefore, the return of large numbers of hatchery-origin fish provides an opportunity to angle hundreds of salmon and steelhead that can be reliably recaptured when they enter hatchery holding pens or become harvested in the fishery.

Between the fall of 2016 and summer of 2019, we will hook-and-line capture and release natural and hatchery-origin, spring and fall Chinook salmon, coho salmon, winter steelhead, and summer steelhead with barbed and barbless hook types using a variety of terminal tackle commonly deployed by Cowlitz River sport fishermen (Table 1). A combination of experienced and naïve fishermen will participate as anglers during the study. However, our primary aim is to capture large numbers of salmon and steelhead (Table 2); therefore, experienced anglers will do the majority of the fishing. Fishing efforts will target areas within approximately 5-10 miles downstream of Mayfield Dam because this is the river segment where the highest concentrations of fish may be found and capturing fish near the hatcheries will increase our chances of recapturing angled fish.

After a capture event, each fish will be randomly assigned a handling time ranging from short (<1 minute) to long (>1 minute). During handling, fish will receive two t-bar anchor

tags with unique identification numbers, one on each side of the dorsal fin attached to the pterygiophores (Dell 1968). The use of two tags should minimize the risk that captured fish will be unidentifiable due to tag loss, and double-tagging will allow us to estimate the rate of tag loss for incorporation into our survival models. Further, we will employ a method previously described by Hyun et al. (2012) to account for potential loss of both tags in mark-recapture studies. For each tagged fish, in accordance with WDFW creel and hooking mortality study protocols, we will also document its species, origin (hatchery/natural), sex, hooking location, hook type, gear type, angling method, fight-time, fish condition factor, fish length, handling time, and the water temperature. Fish with previously sustained injuries, such as unhealed gillnet or lamprey wounds, will be released untagged. The number of fish hooked, but not landed (by species and origin (hatchery/natural) when possible), and hours fished per angler will also be recorded.

There are a variety of biotic and abiotic factors that may influence hooking mortality rates. Therefore, fishing effort will be distributed spatially and temporally to represent the wide range in conditions experienced by salmon and steelhead caught in the lower Cowlitz River sport fishery downstream of Mayfield Dam. To achieve our target sample sizes (Table 2), we anticipate averaging 30-60 rod hours per week during periods of high catch-per-unit-effort when large sample sizes may be most easily obtained, with additional fishing time invested as needed to maintain adequate tagging rates. The most intense fishing effort will occur during the peak adult migration period for each salmon/steelhead race evaluated. Sample sizes were chosen based on a predetermined level of angling effort before being examined post-hoc with statistical power analyses to verify their adequacy for testing our hypotheses (see page 7).

To make relative comparisons between survival rates for fish caught on barbed and barbless hooks, tagged fish will be recaptured via one of three methods: 1) collection at the Cowlitz Salmon Hatchery fish separator, 2) angler reporting, or 3) creel surveys. The Cowlitz Salmon Hatchery fish separator will serve as our primary point of recapture. Depending on species and race, approximately 30-90% of the fish we tag and release while sport fishing are expected to return to the separator located downstream of Mayfield Dam. Angling is our second most likely method of recapture. Anchor tags will be custom printed with a website address and phone number anglers can use to report their catch in the event that a tagged fish is caught in the fishery prior to entering the hatchery separator. Harvest rates differ for each race, with fall runs experiencing the lowest harvest rates (~10%) and spring and summer runs experiencing the highest harvest rates (~40-70%), but they do provide reasonable expectations about the proportion of tagged hatchery-origin fish that may be harvested by anglers (Table 2). While voluntary tag reporting rates are uncertain, a reasonable assumption is that at least 18% of harvested fish with anchor tags will be reported by anglers (T. Kock, USGS pers. comm.). We may also be able to achieve a higher reporting rate if we implement a rewards program. Anglers will be educated and encouraged to report capture of both hatchery and natural-origin fish. Finally, existing creel surveys conducted in the Lower Cowlitz River will also provide recapture data. WDFW creel surveyors are already recording anchor tag numbers for other salmon/steelhead monitoring efforts. Anchor tag colors and numbers will

facilitate identification of our study fish so that data can be efficiently shared with our research team.

For the purpose of monitoring long-term survival of angled fish, tagged salmon and steelhead will be opportunistically retained and held as hatchery broodstock until maturity. Broodstock collection occurs on a set schedule throughout each adult salmon and steelhead migration period with in-season adjustments as needed to meet broodstock targets. Broodstock fish are transferred to hatchery holding pens and held until spawning. WDFW and Tacoma Power staff have agreed to incorporate hatchery-origin tagged fish when available into their broodstock so that prespawning mortalities can be monitored in the hatchery. Mortalities will be recorded during normal raceway maintenance operations and surviving fish will be recorded prior to use for broodstock, or other purposes. During days when broodstock are not collected, tagged winter steelhead, spring Chinook salmon and coho salmon will be incorporated into the Upper Cowlitz Basin adult salmon and steelhead trap and haul program. These fish will be relocated to the Tilton, Upper Cowlitz, and Cispus Rivers where additional recapture data will be obtained via sport fisheries in the Tilton River and Lake Scanewa. A subsample of untagged fish collected in the separator will also be anchor-tagged during sorting at the separator to serve as control groups for both hook-and-line caught fish held in the hatchery, as well as for fish transported to the Upper Cowlitz River. The number of control fish in each control group will be proportional to the number of angled fish released at each location in the Upper Cowlitz Basin, and retained in the hatchery for broodstock.

Finally, to provide additional context for application of our study findings to fisheries management, field technicians will observe and record angler handling practices at popular fishing areas, such as Blue Creek and downstream of Mayfield Dam. The purpose of this component of our study is to determine how natural-origin fish are typically handled and released. The majority of fish tagged in our hooking mortality study will be handled by experienced biologists and anglers in accordance with our handling protocols and WDFW regulations for release of unmarked fish. Therefore, an understanding of the proportion of fish caught in the fishery and released following practices required by law for release of natural-origin fish may be important for understanding the transferability of our findings to the fishery.

Effort/Assistance Required: This proposal seeks funding for two scientists and two field technicians to conduct the work described above, which includes fieldwork, data management, analysis, and reporting. Additional fish tagging and data collection will be provided by Tacoma Power staff at no cost to the project.

Table 1. Sport fishing methods/gear-types and races of salmon and steelhead to be evaluated during the Cowlitz River Hooking Mortality Study.

	Lure Single/Treble Hook	Baited Lure Treble Hook	Bait Single Hook Under Float Single/Double Hook Troll	Jig	Fly
Spring Chinook	✓	✓	✓		
Fall Chinook	✓	✓	✓		
Coho	✓	✓	✓	✓	
Winter Steelhead	✓	✓	✓	✓	✓
Summer Steelhead	✓	✓	✓	✓	✓

Table 2. Lower Cowlitz River hatchery-origin return (HOR) sport fishing harvest rates, expected Cowlitz Salmon Hatchery (CSH) fish separator recapture rates, combined expected recaptures of anchor-tagged fish, and target sample sizes for each species/race evaluated in the Lower Cowlitz Hooking Mortality Study. HOR harvest and CSH recapture rates extracted from the In-season Implementation Tool (Tacoma Power 2013).

	HOR Harvest	CSH Recapture	Combined Recapture Rate*	Annual Angling Target
Spring Chinook	38%	62%	69%	87
Fall Chinook	9%	91%	93%	65
Coho	10%	90%	92%	87
Winter Steelhead	60%	40%	51%	197
Summer Steelhead	70%	30%	43%	235

* Assumes an 18% angler reporting rate for harvested fish

Budget Summary:



**MOUNT HOOD
ENVIRONMENTAL**

Estimate

PO Box 744
Boring, Oregon 97009
503-663-3697

Date
07/01/16

<p>Funding Request: Columbia River Salmon Steelhead Enhancement Fund Cowlitz River Salmon/Steelhead Hooking Mortality Project August 2016 - June 2017</p>
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Description	Quantity	Rate	Total
FISH TAGGING & ANALYSIS			
IAN COURTER, Principal Investigator: Project Management	96	90.00	8,640.00
IAN COURTER, Principal Investigator: Project Planning/Meetings	80	120.00	9,600.00
IAN COURTER, Principal Investigator: Analysis & Reporting	160	120.00	19,200.00
THOMAS BUEHRENS, WDFW Senior Scientist: Project Planning/Meetings	80	50.00	4,000.00
THOMAS BUEHRENS, WDFW Senior Scientist: Analysis & Reporting	240	50.00	12,000.00
Field Technician I: Fish Capture and Tagging	860	32.00	27,520.00
Field Technician III: Fish Capture and Tagging	860	46.00	39,560.00
FISH TAGGING & ANALYSIS SUBTOTAL			120,520.00
ANGLER OBSERVATION			
Field Technician I	160	32.00	5,120.00
Field Technician III	160	46.00	7,360.00
ANGLER OBSERVATION SUBTOTAL			12,480.00
GUIDED FISHING			
GUIDING SUBTOTAL	10	450.00	4,500.00
FIELD EQUIPMENT & SUPPLIES			
Daily Boat Rental (MHE), Fuel, Maintenance Costs	82	200.00	16,400.00
Monthly Truck Rental (MHE)	12	380.00	4,560.00
Truck Mileage, Maintenance Costs	17,200	0.54	9,288.00
Fish Tagging Equipment & Supplies	1	1,093.00	1,093.00
Sampling Supplies: Bait	42	60.00	2,520.00
Sampling Supplies: Rods & Reels	12	225.00	2,700.00
Sampling Supplies: Lures	42	50.00	2,100.00
Sampling Supplies: Line, Hooks	4	525.00	2,100.00
Sampling Supplies: Swivels, Weights, Divers, Misc.	4	580.00	2,320.00
FIELD EQUIPMENT & SUPPLIES SUBTOTAL			43,081.00
Total			\$180,581.00

Need for Proposed Activity: Providing data to inform WDFW’s fishing regulations for salmon/steelhead sport fisheries in the Cowlitz River and throughout Washington.

Benefit of Proposed Activity: With an estimated total economic value in excess of \$20 million annually¹, Cowlitz River fisheries are arguably the most heavily utilized salmon and steelhead sport fisheries in Washington State. Whether current barbless hook regulations provide the intended benefit for protection of natural-origin salmon and steelhead is a key concern for this fishery and others throughout the Columbia Basin. If use of barbless hooks reduces sport fishing impacts on natural-origin salmon and steelhead, policy-makers may choose to implement similar rules statewide as a measure to recover ESA-listed stocks and to protect non-listed stocks against overutilization. Conversely, if barbless hooks do not reduce catch-and-release mortality, the unintended impacts of these regulations may be higher hook encounter rates for natural-origin fish, higher stray rates of hatchery fish, reduced angling satisfaction, and reduced opportunity for inexperienced and young anglers. Our findings will provide empirical data to support management decisions regarding barbless hook regulations for salmon and steelhead fisheries in Washington. This data is essential to the protection of native salmon and steelhead populations, as well as the vibrancy and sustainability of sport fishing in the region.

References:

- Cowen L, Trouton N, Bailey RE. 2007. Effects of angling on Chinook salmon for the Nicola River, British Columbia, 1996–2002. *North American Journal of Fisheries Management* 27(1):256-267.
- Dell MB. 1968. A new fish tag and rapid, cartridge-fed applicator. *Transactions of the American Fisheries Society* 97(1):57-59.
- Hyun S-Y, Reynolds JH, Galbreath PF. 2012. Accounting for tag loss and its uncertainty in a mark–recapture study with a mixture of single and double tags. *Transactions of the American Fisheries Society* 141(1):11-25.
- Lindsay RB, Schroeder RK, Kenaston KR, Toman RN, Buckman MA. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. *North American Journal of Fisheries Management* 24(2):367-378.
- Naish KA, Taylor JE, Levin PS, Quinn TP, Winton JR, Huppert D, Hilborn R. 2007. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. *Advances in Marine Biology* 53:61-194.
- Tacoma Power. 2013. Annual Project Review Procedures Manual: Steps for Implementing the Cowlitz Annual Project Review: 20 pp.

¹ 5 year average in-river harvest (Tacoma Power 2013) multiplied by 10 angler days per fish and \$58 per fish (TCW Economics 2008).

- Taylor G, Barnhart RA. 1996. Mortality of angler caught and released summer steelhead: Steelhead trout catch report. California Cooperative Fishery Research Unit; Humboldt State University Foundation; California Department of Fish and Game. 31 pp.
- Taylor MJ, White KR. 1992. A meta-analysis of hooking mortality of nonanadromous trout. *North American Journal of Fisheries Management* 12(4):760-767.
- TCW Economics. 2008. Economic Analysis of the Non-Treaty Commercial and Recreational Fisheries in Washington State. 36 pp.