THE OSPREY

The International Journal of Salmon and Steelhead Conservation

Issue No. 98 *January 2021*

Historic Decision Ends Atlantic Salmon Farming in Waters of BC's Discovery Islands

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The Osprey is a joint publication of not-for-profit organizations concerned with the conservation and sustainable management of wild Pacific salmon and steelhead and their habitat throughout their native and introduced ranges. This unique partnership includes The Conservation Angler, Fly Fishers International, Steelhead Society of British Columbia, SkeenaWild Conservation Trust, Wild Salmon Center, Wild Fish Conservancy, Trout Unlimited and Wild Steelhead Coalition. Financial support is provided by partner organizations, individuals, clubs and corporations. The Osprey is published three times a year in January, May and September.

Cover Photo Courtesy NASA

ISSN 2334-4075

Klamath Dams Removal Moves Forward

by Jim Yuskavitch

With an official announcement on November 17, 2020, it appears that after decades of planning, complex negotiations and unanticipated setbacks, the removal of the four lower dams on the Klamath River — a longtime goal of wild fish advocates — is at the cusp of becoming reality.

That announcement detailed a Memorandum of Agreement that has been signed by the states of California and Oregon, the Karuk and Yurok tribes, PacifiCorp and the Klamath River Renewal Corporation (KRCC) to push forward on the dam removal process, opening up 400 miles of habitat currently inaccessible to salmon, steelhead and other fish species.

The agreement among the parties includes:

● Jointly ask the Federal Energy Regulatory Commission (FERC) to remove PacifiCorp from the license for the project and add California, Oregon and KRRC as co-licensees for carrying out dam removal. Adding the states as co-licensees provides assurances that the project will have sufficient financial backing while honoring settlement terms that stipulate PacifiCorp would not be a co-licensee for removal.

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● Demonstrate their firm commitment to dam removal.

● Agree to nearly double available contingency funds held by KRRC and contractors and, in the unlikely event that additional funds are needed beyond that, Oregon, California and PacifiCorp will share the costs equally to address FERC's requirement to ensure full funding for the project.

● Confirm that the KRRC will remain the dam removal entity for the project.

● Plan to navigate the final regulatory approvals necessary to allow the project to begin in 2022 with dam removal in 2023. Site remediation and restoration will continue beyond 2023.

● Retain the liability protections for PacifiCorp's customers established in the Klamath Hydroelectric Settlement Agreement.

The four dams in question — Iron Gate, COPCO 1, COPCO 2 and JC Boyle — were built in between 1912 and 1964 primarily to provide hydropower and were constructed without fish ladders, which blocked upstream spawning and rearing habitat for the river's large historical runs of salmon and steelhead.

Anglers fish for steelhead below Iron Gate Dam, the lowermost dam on the Klamath River slated for removal. Photo by Jim Yuskavitch

Assuming no more bureaucratic hitches, wild fish advocates long-held dream of taking out those dams may begin as early as next year.

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Please go to the subscription/donation form on page 23 or on-line at http://www.theconservationangler.com and donate whatever you are able. Thank you.

Jim Yuskavitch
Editor, The Osprey

Serge Karpovich: Losing a Pioneering Wild Steelhead Conservation Icon

By Pete Soverel

In late January 2021, wild steelhead lost a pioneering icon — Serge Karpovich (6/13/1929-1/20/2021). Absent Serge, there would be no Wild Salmon Center, no Conservation Angler, no Kamchatka Steelhead Project, and no Lamzov scholarships, no US-Russia scientific collaboration on Pacific wild steelhead populations.

Serge and I have been fast friends dating to our 1993 introduction. He was one of the most remarkable men I have ever encountered over sixty years — thirty years of naval service and thirty in steelhead conservation. Serge was the son of a storied Russian family (Michael and Tatiana Karpovich) who spent 30 years as a CIA clandestine service officer followed by thirty years of steelhead conservation work (Wild Salmon Center board member, policy advisor to The Conservation Angler).

Serge's father came to the United States in May, 1917 as a special assistant to Boris Bakhmetev, who was a representative of the Russian Provisional Government (post Tsar, pre-Communist) on a mission to the United States to establish a Russian Embassy in Washington, DC and negotiate a major loan ($500 million) to keep the Russians in the war against Imperial Germany. Michael Karpovich joined Bakhmetev with the understanding that his stay in the United States would be temporary allowing him to return home in time for Christmas of 1917. Bakhmetev successfully completed both assignments, but before Karpovich could return to Russia, historical events intervened in the form of the overthrow of the Kerensky government and the resulting civil war between communist and White Russian forces which left Karpovich high and dry in America separated from his wife, Tatiana, who was serving as a nurse in the White Russian army. Karpovich became a highly esteemed professor of linguistics at Harvard and was reunited eventually with his wife following the communist victory in the civil war. The rest of Michael Karpovich's relatives were stranded in Russia.

Serge was born in Boston. Following graduation from Harvard, Serge joined the CIA — the perfect clandestine officer: a highly educated, native Russian speaker. Serge was always tight lipped about his CIA service but, in a touch of irony, following the collapse of the USSR he partnered with his former adversary MG Victory Budonov who directed the American section of the KGB. Their company advised western investors seeking business opportunities in the newly opened Russian economy.

He was one of the most remarkable men I have ever encountered over thirty years of naval service and thirty years of steelhead conservation.

At this juncture, my good friend and former CIA operative John Sager wondered about Russian steelhead. John contacted his CIA colleague Karpovich who maintained an office in Moscow, "Can you find out about Kamchatkan noble trout" (aka steelhead)? This led eventually to Moscow State University's (MGU) Professor Ksenya Savvaitova, the world's expert on Kamchatkan steelhead. She informed Serge that yes there were steelhead in Kamchatka, but steelhead were a protected species listed in the Russian Red Book of "Rare and Disappearing Species" — roughly equivalent to "threatened" under the US Endangered Species Act. Further, she informed Karpovich that angling for protected steelhead was strictly prohibited. She noted that while they were well familiar with Kamchatka steelhead populations and distributions having conducted extensive field work dating to the mid-1970s, however, due to the collapse of USSR, they were without funding, and were no longer able to conduct field expeditions. Serge informed Savvaitova that he had American friends (meaning Sager and me) who might be able to help as they had "money."

Serge offered to fund travel by Savvaitova and her MGU partner, Valerie Maximov, to Seattle to meet with Sager and Soverel to explore options. I was instantly taken with Savvaitova. Together, we plotted an exploratory expedition incorporating anglers as the main funding source providing the kernel of what evolved into the joint Russian-American Kamchatka Steelhead Project:

- *Western anglers donate money to American not-for-profit scientific organizations (Wild Salmon Center 1994-2002; The Conservation Angler 2003-present).*
- *The western NGO then funds the field expeditions.*
- *Donating anglers accompany the expedition and collect biological samples by catch-and-release fly fishing.*
- *MGU analyzes field samples and publishes annual reports as well as specific monographs (over two dozen to date) on various scientific topics arising from the field expeditions.*

Serge liked the model and volunteered to fund a preparatory trip to Kamchatka by professor Maximov to organize the first field expeditions: identify an outfitter; select the initial rivers to be surveyed; secure the necessary federal and local permits for the collection of biological samples. Viola! The Kamchatka Steelhead Project was born and continues to this day. Although Serge

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Serge Karpovich and Koryak wrangler enroute from Kvachina camp to the Snotalvayam River, four miles distant. Photo by Pete Soverel

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did not participate in the initial 1994 expedition, he did joined the Wild Salmon Center board of directors where he served for six years. He also participated in a dozen or so KSP field expeditions and, for the remainder of his life, was a trusted advisor first to the WSC and the TCA.

As can be seen from the foregoing, the KSP would not have been possible without Serge's central role —– funder, advisor, cheerleader and cautionary restraint on my occasional rash behavior. The KSP is a model of how to fund and conduct a serious research program in remote wilderness settings bringing together disparate entities and bridging culture divides. The KSP has uniquely contributed and continues to provide to greater understanding of wild steelhead biology and responses to changing environmental conditions. The KSP, which Serge made possible, is certainly the longest running study of wild steelhead in the world. Over the ensuing quarter century of close collaboration wilderness tent sharing, Moscow visits, Serge and I became close friends. I miss him and wild steelhead have lost one of their most important patrons —– tight lines old friend.

A Hit

Faced with continuing sharp declines of wild steelhead return to western Washington coastal rivers (Willapa, Chehalis, Humptulips, Quinault, Queets/Clearwater, Hoh, Goodman and Quillayute watersheds), WDFW conducted several outreach programs with constituent groups about potential conservation measure including: complete closures, closure on rivers with the most depressed populations, various gear restrictions (bait bans, no fishing out of boats, limited entry, perhaps restrictions on guide numbers, etc.). Most anglers and conservation groups, including all partners of *The Osprey*, urged WDFW to act boldly in the face of rapidly declining wild steelhead populations and to adopt stringent conservation measures to drastically reduce angling related mortality. The most controversial proposal centered on fishing out of boats — a measure widely supported by the non-guide community and vehemently opposed by many in the guide community. Ultimately, WDFW adopted a modest suite of regulatory restrictions:

Most anglers and conservation groups urged WDFW to act boldly in the face of rapidly declining steelhead populations.

- *Artificial lures with single barbless hooks (no bait or scents).*
- *No removal of fish from the water.*
- *No fishing out of floating devices.*
- *Release of all rainbow trout.*
- *March 31 closure (reducing the season by 2-4 weeks).*

While applauding WDFW's initiative, TCA and others suggested that these restrictions did not go far enough to halt the alarming decline of wild stocks and urged WDFW to view these restrictions as only a temporary, first step towards much more comprehensive measures to be developed between now and the 2021-2022 season. Predictably, many in the guide community went ballistic arguing that the prohibition on fishing out of a floating device was tantamount to the end of western civilization because many/most of their clients were too infirm to fish from shore with the rest of humanity. Despite interest pressure from this sector to rescind the no fishing out of a floating device, WDFW held firm.

TCA and other conservation organizations now await WDFW to begin outlining additional conservation measures. We hope WDFW will consider option such as gear and method restrictions tied to abundance, perhaps limited entry to reduce angling pressure, limitation on guide licenses and so on. In any event, we applaud WDFW for taking long overdue action.

Pete Soverel is Chair of The Osprey *Management and Editorial Committee and founder and President of The Conservation angler: www.theconservationangler.org.*

Historic Decision Ends Atlantic Salmon Farming in Waters of BC's Discovery Islands

By Alexandra Morton

On December 17, 2020 Canadian Fisheries Minister Bernadette Jordan of Nova Scotia, made the single largest decision on the fate of wild salmon in the history of Canada. She announced the federal licences for the nineteen salmon farms using the waters of the Discovery Islands would not be renewed. One third of all wild salmon in British Columbia migrate through this archipelago, including the Fraser River sockeye, once the biggest salmon run in the world and now in collapse. Mowi, Grieg and Cermaq, the owners of the farms, were told they could finish growing whatever fish were currently in their pens, but they would never be allowed to restock these farms. While this leaves some farms in the water for 18 months, the most critical channels, Okisollo and Nodales, will be empty this spring for the first time since 1992.

The stated reason for the minister's decision was that the seven First Nations of the Discovery Islands refused to support renewal of the licences. However, First Nations have said no many times over the past 30 years. It seems likely that the scent of scandal ahead of a looming election may also have played a role.

The Discovery Islands are an archipelago nestled between Vancouver Island and the mainland 200km north of the city of Vancouver. Decades of research have made it clear that the smaller the body of water, the greater the impact of salmon farms. With salmon farms sited one after the next through these passages billions of larval lice, virus particles and bacteria flowing from the farms saturated the water to become a dangerous dose. Young wild fish swimming through emerged to the north peppered with sea lice, infected with the viruses that accessed their bloodstream via their gills and deep sores carved into their spines. By the time they reached Johnstone Strait their fate was sealed, these fish would not return.

The salmon farming industry is in shock after the decision not to renew these licences — 30% of production in BC. For thirty years they shrugged off local objection, First Nation eviction notices and legal decisions. The industry and Fisheries and Ocean Canada (DFO) worked together to ignore any science measuring the impact of the industry. As wild salmon collapsed around them, the three Norwegian companies built bigger farms. There are now more Atlantic salmon in a single salmon farm than sockeye in the entire Fraser River watershed. DFO became one with the industry, swapping staff. Industry and government lawyers worked together in the courtrooms of British Columbia. Mysteriously, while every vessel packing fish in Canada must display a licence number, the farm salmon packers do not, even though they are currently considered a "fishery".

The salmon farming industry was shocked after the decision not to renew these licenses. For thirty years they shrugged off local objection, First Nation eviction notices and legal decisions.

At 1:30 pm, on December 17, I watched a farm salmon live-transport vessel stop at the mouth of Knight Inlet and drift as Minister's decision went live. The vessel, which moves young farm salmon from nursery sites to other farms for grow out, tied to a nearby farm for two days and then went back to Campbell River empty and tied up. The Norwegian salmon farming industry has to decide whether to fight this in court and try to force themselves on First Nations, who are reeling from the collapse of wild salmon, or will they gracefully accept the loss and reinvent themselves as a land-based industry, or simply leave? The loss of 19 farms comes in addition to the loss of 17 farms gradually being phased out under First Nation directive in the nearby Broughton Archipelago. Closure of the Broughton farms required a 270-day occupation of the farms and a year of talks between the Province of BC and three First Nations. Removal of the Discovery Island farms required only a few weeks of consultation. The process of removing salmon farms from British Columbia is getting easier.

Until this moment, the future of wild salmon in British Columbia, Canada was very dim. The 2019 Fraser River sockeye run was the lowest in history. The 2020 run was even lower, one third of what was forecast. The ongoing inability of government to forecast sockeye returns meant something was killing vast numbers of salmon that DFO was not factoring into their mathematical models. Chum and pink salmon that migrate through the heavily farmed regions of Nootka Sound, Broughton and Discovery Islands have crashed — there are no fisheries on them. The 2019 return of the Glendale pinks was 0.1%. Chinook in the heavily farmed areas of Clayoquot are almost non-existent.

There are also runs of wild salmon in BC that are doing very well. The sockeye that migrate into Port Alberni, where there are no salmon farms, on the west coast of Vancouver Island returned well above forecast. Pink salmon in the Quinsam River near Campbell River were abundant in 2020 and there were good Chinook returns to many southern BC rivers. It is not over for wild salmon, but there are serious problems that must be solved as the few runs left will bear the brunt of all the predation, including fishermen, and will struggle to survive.

The evidence strongly suggests that while there are many factors, a large percentage of young wild salmon are

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not making it past the salmon farms. This means fixing the other issues, such as habitat degradation, will be a futile exercise until young wild salmon are allowed to make it to sea without heavy lice, virus and bacterial infections. A virus from the Atlantic, Piscine orthoreovirus (PRV), is spreading from the farms and causes red blood cells in Chinook salmon to rupture and a bacteria causing large open sores and the disease mouth rot in the farms, the leading cause of large antibiotic use in the industry, is also spreading.

2020 saw a trilogy of big salmon decisions by the federal government of Canada and the first two made the final one all the more surprising. Last fall, then Minister of Fisheries, Jonathan Wilkinson reacted to the collapse of the Fraser sockeye by forming a Fish Health Table and tasking us to provide advice on how to reduce the impact of salmon farms, i.e. how to make them sustainable. Sea lice were a top issue. As in other regions of the world, sea lice in BC were responding to the constant use of delousing drugs with increased drug-resistance and this meant the industry can no longer reliably control them.

Sea lice infestations are just one of the many negative impacts that Atlantic salmon farms have on wild salmon runs. Photo by Tavish Campbell

Through the Canadian Freedom of Information Act, I have read increasingly urgent internal emails between DFO field biologists, veterinarians and conservation & protection officers about the rising number of farm lice and their inability to protect wild salmon from this. As they explained, current regulations only require the farmers to show that they had a plan to kill the lice. There was no requirement that the plan works. DFO staff were demanding more enforceable regulations.

Since 2000, I have been counting sea lice on young salmon as they pass salmon farms and have published extensively (https://www.alexandramorton.ca/the-science/) on the impact of these lice and, so have my colleagues. I hired photographer Tavish Campbell to document the damage that the farm lice are doing to young pink, chum, coho, Chinook and sockeye salmon. While the research made it clear farm lice are having significant impact, it was Tavish's images that made farm lice a political concern.

Sitting at the Fish Health Table with us was a senior DFO scientist who had experimentally infected young sockeye with sea lice. He recorded acute stress (glucose spikes) and profound physiological impact (inability to keep salt out of their bodies). He reported (https://pubmed.ncbi.nlm.nih.gov/30566268/) that the impact of sea lice on young sockeye was greater than the impact on young Atlantic farm salmon. While my colleagues and I argued for a hard farm lice limit, with stiff penalties for failure to comply including rapid culling, given the Fraser sockeye extinction trajectory, the DFO scientist did not mention his findings.

The first salmon farming decision of 2020 came on March 1 when, as usual, the DFO aquaculture branch ignored the advice of scientists and issued the salmon farming industry permission to have an unlimited number of sea lice for six weeks every time they exceeded the long-standing lice limit (3 adult-stage lice per farm salmon) set by the province of B.C. to protect wild salmon. Six weeks of soaking in lice-rich waters at farm after farm was a death sentence for young wild salmon. I withdrew my name from the Fish Health Table. I knew from 20 years of experience the impact this would have, and I did not want to be associated with the decision. I hired Jody Eriksson and Farlyn Campbell, who have been working with me on and off for years. They live together and so were the COVID-perfect team. Together we recorded the impact of this decision.

In the spring of 2020, thirty-four percent of the salmon farms in B.C. reported heavy lice infection on their websites. A recent paper tells us (https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1002/eap.2226) that the companies fail to report up to 50% of their lice, and still they were reporting numbers up to 5 times over the limit considered safe for young wild salmon. Fifty percent of the Discovery Island farms exceeded the limit. Predictably, 99% of the several hundred sockeye that I examined were infected at levels causing the fish acute stress, according to DFO research.

However, under the new regulations, the salmon farms were in compliance, even as Canada lost a generation of what used to be the largest salmon run

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in the world. Eaten by sea lice.

As this was DFO's fault, I did not turn to them with my findings. Instead I went to the First Nation chiefs in the Discovery Islands and the Fraser River. First Nation governments in Canada are recognized as a federal government. The Musqueam Nation in the lower Fraser River confirmed their right to fish Fraser River sockeye in court. Anything impacting their right to fish, could be viewed as infringement. In June, a group of Fraser River nations, supported by 101 nations province-wide, held a press conference in Vancouver. They wanted the salmon farms off the migration route of the Fraser sockeye before the fish went extinct.

There was no reply from the Minister of Fisheries.

The second decision came at the end of September. That was the date set by the Cohen Commission Inquiry into the collapse of the Fraser River sockeye.

After 133 days of hearings, Justice Bruce Cohen, gave DFO 8 years to either provide Canadians with the scientific evidence that salmon farms are not a risk to Fraser sockeye, or to remove the farms from the Discovery Islands. There are other farms on the sockeye migration route off the Northern end of Vancouver Island, but it was the mingling of Fraser River sockeye into the massive pathogen release from approximately 7 million Atlantic salmon in the restricted waterways of the Discovery Islands that drew his attention. In the language of 2020, salmon farms in the Discovery Islands are a super-spreader event.

On September 28, 2020 the Minister of Fisheries told Canadians that the farms could stay in the Discovery Islands. They were not a risk to wild salmon.

Unfortunately for the Minister and her government, the DFO website explaining this decision contained a significant error. While DFO did not provide any science for this decision on whether sea lice were harming the sockeye, the website explained that Atlantic salmon are more susceptible to sea lice than most Pacific salmon. This assures us that since the farmers are all about taking care of the salmon in their pens, the measures to protect the Atlantic salmon should be more than enough to protect the tougher little sockeye. However, we know from the DFO science, that no one other than DFO was aware of at this point that this is not true in regard to the Fraser River sockeye.

This statement challenged the optics of a minister in charge and failed the standard written into her mandate letter from the prime minister to use "good scientific evidence." Did anyone tell her that DFO science actually stated the opposite? This website statement undermined the integrity of her decision that salmon farms are not a risk to sockeye salmon in the Discovery Islands.

The third and final salmon farming decision of 2020 loomed quickly. On December 18 all the federal licences for the Discovery Island salmon farms would expire and by law DFO had to consult with the seven nations of the Discovery Islands, who had been receiving updates from me on the condition of the young salmon trying to migrate through their territories. It was during this consultation that a DFO science paper on the acute impact of sea lice on young sockeye surfaced.

Believe me when I say that I have seen a lot of questionable behaviour in my decades of trying to protect wild salmon from salmon farms, but the circumstances around this research perplexed me. Why had a government author of this paper sat quietly at the Fish Health Table through the discussions about the impact of sea lice? Why was he there at all, because in hindsight his silent presences paints a dark picture of collusion with industry, also at the table and arguing lack of impact? Did DFO's Aquaculture Department inform the Minister of Fisheries about this work in advance of her decision that salmon farms were not a risk to the Fraser sockeye even as the entire industry was dangerously losing control of its sea lice? While the paper was published and therefore public, no one outside DFO seemed aware of it and this had served the first two decisions, so why did it suddenly appear in advance of the third decision, where it highlighted lack of integrity of the first two decisions? DFO is a large agency and I can only guess fault lines are opening between DFO-Aquaculture and DFO-wild fisheries and that the Minister in her effort to find solid ground decided to stand with the chiefs.

Not all First Nations in BC agree that salmon farms must get out of the ocean. There are three territories where I have been told not to look at the young wild salmon migrating past salmon farms. However, I know from experience that the salmon farming companies are aggressive, and I don't think any nation was warned that letting salmon farms in ran the risk of destroying wild salmon runs. It is unclear how the other nations will respond to the recent decision to close 19 salmon farms. I am hoping the salmon farmers can see that the days of cheap and dirty farming are over. That it is time to evolve, clean up, and get out of the ocean.

What I do know for certain is that the main artery that the Fraser sockeye migrate through has been opened. While there will still be infection as the fish swim through Johnstone Strait and off northern Vancouver Island, wild salmon will swim through the narrow corridors of Okisollo and Nodales Channel for the first time since 1992, when the decline of the Fraser River sockeye began, without exposure to billions of larval lice, virus particles and bacteria. It is going to be interesting to see how the salmon respond.

Canada's Minister of Fisheries, with strong guidance from First Nations, has made a decision that will positively impact future generations. Now the natural resilience of the salmon can get back to the work of rebuilding the runs.

Alexandra Morton, an independent biologist and director of Raincoast Research, has done extensive research documenting the negative impacts of Atlantic salmon farms off the British Columbia Coast on wild salmon.

Her new book to be published April 2021, "Not on My Watch" by Random House Canada, chronicles the dark story of the salmon farming industry.

For more information about her work go to:
www.AlexandraMorton.typepad.com

To learn about Raincoast Research visit their website at:
raincoastresearch.org

A Free-Flowing Mainstem Hood River

The Hood River watershed 10 years after Powerdale Dam removed

By Alix Danielsen

It was October of 2010, and for the first time in over a century the lower mainstem of the Oregon's Hood River was flowing freely. Four miles upstream from the mouth of the Hood River, the removal of the Powerdale Dam had just been completed after seven years of planning. Fast-forward to today, and the Hood River Watershed is ten years into a post-dam recovery. There are clear success stories to report, including the recolonization of the watershed by Pacific lamprey after a century of exclusion. The rest of the picture is more nuanced and reflects the complexities of a river system influenced by countless factors within and outside of the watershed.

The 339-square mile Hood River Watershed originates on the eastern side of the Cascade Range in Oregon. Its rivers flow north from the 11,245-foot peak of Mt. Hood to the Columbia River at an elevation of 74 feet, 22 miles upstream from the Bonneville Dam. Five headwater tributaries that drain into three main forks are fed by glaciers, contributing to a river that runs milky white during portions of the year.

The watershed has one of the most diverse assemblages of anadromous and resident fish in Oregon, including spring and fall Chinook, summer and winter steelhead, coho, Pacific lamprey, bull trout, sea-run and resident cutthroat trout, rainbow trout, mountain whitefish, large scale sucker, and two species of sculpin. The high diversity is largely due to the watershed straddling the transition zone between fish populations that reside either west or east of the Cascades. In fact, the Hood River is one of only five Oregon watersheds to have indigenous populations of both summer and winter steelhead. Another factor is the very cold water flowing from the watershed's high-elevation tributaries, making it one of fourteen cold-water refuges along the Lower Columbia River.

Like many watersheds in the Columbia Basin, the abundance and distribution of fish species has declined in the Hood River Watershed from historic numbers. Hood River spring Chinook became extinct in the early 1970s, and coho and fall Chinook populations were considered severely depressed. Bull trout were listed as threatened throughout their range in 1998 under the federal Endangered Species Act. Steelhead, Chinook, and coho were listed as threatened in 1998, 1999, and 2005, respectively.

Historically, downed wood and log jams were more common in the watershed's streams, trapping gravel, creating pools and cover for fish, providing substrate for fungi, bacteria, and invertebrates, and dampening the velocity of water flow. Human disturbance throughout the watershed, however, has compromised the river system and limited aquatic habitat. Dam construction, road building, logging, irrigation and municipal water withdrawals, conversion to agriculture, and development have contributed to fish passage barriers, low stream flows, lack of habitat complexity, and impaired water quality.

The Hood River watershed has one of the most diverse assemblages of anadromous and resident fish in Oregon.

Hydropower production in the watershed began in 1909 with the construction of the first Powerdale dam on the Hood River. That dam was removed and a new one was built at river mile 4.2 in 1923 by Pacific Power & Light. The dam generated 5 MgW of hydropower, equal to the amount of energy generated by just a few of the wind turbines that now dot the landscape in the eastern Columbia River Gorge. At the time, however, the dam was the largest single power unit in Oregon, powering the economically important Hood River Valley orchards.

Water at the Powerdale Dam was diverted through fish screens and conveyed by pipeline 3.5 miles downstream to the powerhouse. A fish ladder was located on the south side of the dam that passed most adult salmon and steelhead, but severely limited habitat connectivity for juvenile salmonids and completely blocked passage for Pacific lamprey. The bypass reach resulted in low summer flows and warm water temperatures, negatively affecting salmon and steelhead rearing by concentrating pollutants, reducing habitat, and delaying fish migration, particularly for winter steelhead and spring Chinook due to their run timing.

The 2010 removal of the dam brought numerous ecological benefits to the watershed, including the free movement of fish and other aquatic organisms and more stable and natural water temperatures along the project reach. In 2013, Columbia Land Trust accepted ownership of approximately 300 acres and Hood River County acquired the remaining 100 acres of the former Powerdale Hydroelectric Project lands. This created a prime opportunity to implement restoration projects and manage the land for conservation values and low impact recreation.

Today, the 400-acre "Powerdale Corridor" runs along three miles of the lower mainstem Hood River, just outside the City of Hood River. Kate Conley, a Natural Area Manager with Columbia Land Trust, has managed the stewardship of the Powerdale lands since 2013. Conley notes that although the recovery of riparian vegetation was slow at the highly disturbed former dam site, native trees and shrubs are finally thriving after years of planting, weed control, and soil augmentation by the Land Trust. The riverbanks and an island just downstream of the former dam location have sprouted alders and native plants in the adjacent riparian and upland zones are filling in and providing shade and habitat for wildlife.

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A floodplain restoration project within the corridor was completed successfully in 2015. About half a mile of 10-foot-diameter, above-ground, steel pipeline was removed from the floodplain and a remnant levee built to protect the pipeline was breached. High flows every few years deposit new sand on a beach-like section of shoreline that was formerly part of the levee. Less frequent higher flows have gushed through this intentional levee breach several times, reactivating historic side channels.

Elsewhere within the Powerdale property, years of vegetation restoration are gradually replacing nonnative, invasive plants with native riparian species. Columbia Land Trust and the Hood River Watershed Group are focusing on restoring two off-channel wetland areas near the mouths of two tributaries to the Hood River, with an aim to improve habitat for all wildlife species. The ponds at one site provide some of the most unique habitat within the Powerdale lands, hosting active beavers, waterfowl, and songbirds.

Throughout the watershed above the former dam site, local partners have worked together to restore native fish runs through habitat enhancement, fish passage barrier removals, streamflow restoration, water quality improvements, and other efforts that create the conditions for the watershed's rivers and streams to carry out the work of recovery themselves.

Stream habitat projects are a significant part of restoration efforts in the watershed. A particular area of focus for several decades has been in the upper West Fork Hood River, where cold, clear water provides some of the best spawning and rearing conditions for spring Chinook, coho, and summer steelhead in the watershed. Historic logging practices, including splash damming and removal of large riparian conifers, however, left insufficient amounts of large wood in streams and reduced floodplain connectivity. In the past ten years alone, the U.S. Forest Service, Confederated Tribes of the Warm Springs (Tribes), and the Watershed Group have placed over 2,200 pieces of large wood along 3.7 stream miles and reconnected floodplain in the upper West Fork and its tributaries.

Since 2010, sixteen fish passage projects have been completed in the watershed, including the removal of the Powerdale Dam. Additionally, in the summer of 2016, the Watershed Group, in partnership with the landowners and Oregon Department of Fish and Wildlife removed the Odell Dam, restoring year-round fish passage to approximately five miles of potential winter steelhead habitat in Odell Creek. In 2019, two passage-blocking culverts were removed on Evans Creek, a tributary to the East Fork Hood River. The Watershed Group and the Tribes supported the Hood River County effort that restored fish passage to approximately 1.3 miles of upstream habitat.

Ten years after Powerdale Dam was removed, the Hood River, its habitat and wild fish populations are recovering. Photo by Sam Doak.

Water is a vital but limited resource in the watershed, particularly in the late summer months when precipitation is low and irrigation demand is high. In the last 30 years, irrigation districts in the watershed have replaced over 115 miles of open canals and lateral lines with sub-surface pipelines, eliminating hundreds of end-spills and conserving more than 30 cubic-feet-per-second (cfs) of water. At the farm-level, about 40% of orchard land has been converted from low efficiency to high efficiency irrigation systems, saving an estimated 22 to 44 cfs.

These watershed conservation efforts and many others, prior to and since the removal of the Powerdale Dam, have likely contributed to fish recovery in the watershed. Nevertheless, since 2010 the overall fish recovery picture has been mixed. The Confederated Tribes of the Warm Springs and ODFW co-manage the Hood River fishery. The Tribes hold federally reserved fishing rights in the watershed, protected as part of the Treaty with the Tribes of Middle Oregon signed June 25, 1855. Treaty fishing opportunity, however, had become restricted because of low abundance and the need to protect weak or threatened stocks. In 1991, a joint ODFW and tribal effort to rebuild native summer and winter-run steelhead and reintroduce spring Chinook was launched to contribute to tribal, non-tribal, and ocean fisheries. This is part of an ongoing fish recovery effort called the Hood River Production Program and is funded by Bonneville Power Administration. Additional program goals include restoring degraded fish habitat and monitoring and evaluating the effort to improve wild production of summer and winter steelhead in the Hood River Subbasin.

The Tribes and ODFW have been monitoring fish populations in the Hood since 1991. Using PIT (passive integrated transponder) tags beginning in 2004, biologists estimate smolt abundance and survival and smolt-to-adult return rates based on recapture rates from screw traps in the Hood River and detections at other PIT tag readers along the migration route.

One of the most notable post-dam removal success stories tracked by the Tribes and ODFW is the recolonization of the watershed by Pacific lamprey. The dam excluded lamprey from most of the watershed for over 100 years, but as of 2018 they have been found in all

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three forks of the Hood River. The Tribes have been documenting this recovery and found adults and ammocoetes several miles up the East Fork Hood River and as far as Moving Falls on the West Fork Hood River. The return of Pacific lamprey to the watershed brings multiple ecological and cultural benefits. Lamprey spend the adult phase of their life in the ocean, returning to freshwater after a few years along with vital marine-derived nutrients. They arrive in early summer and can hold for up to two years before spawning. Lamprey larvae will spend approximately seven years in their natal stream burrowed into the sediment where they filter feed on algae, improving surrounding water quality. Adult Pacific lamprey are an important traditional food and have religious, medicinal, and ceremonial importance to tribal members.

Juvenile steelhead have also shown gains since the dam's removal. According to Philip Simpson, fisheries researcher with ODFW, a substantial increase in the number of wild smolts emigrating from the system has been observed since 2010. Monitoring and modeling done by the Hood River Research Program through 2020 show an average abundance of 14,087 juvenile steelhead pre-dam removal and 23,259 post-dam removal. The upward trend of abundance is encouraging from a recovery perspective. In a system like the Hood, where a good portion of spawning and rearing likely occurs in the mainstem, renewed habitat connectivity could be of fundamental importance.

Simpson cautions, however, that it is still unclear whether the removal of the dam alone produced ecological benefits influential enough to affect production to the degree observed to date. More likely, the positive trend is due to a diverse suite of factors that could include everything from habitat restoration actions, increased spawning and rearing access, improved hatchery practices, and several elements in between. For example, Simpson points to modeling that indicates that in addition to the removal of Powerdale Dam, two significant drivers of smolt production are spring flows during the brood year and low summer streamflow the year prior to outmigration.

Whether increased steelhead smolt production will translate into greater numbers of returning adult spawners is still in question, reports Simpson, although the 2014 – 2015 and 2015 – 2016 run years did have above average return years. With the recently observed downturn in ocean conditions the past few years, it will be interesting to see if Hood River steelhead can sustain above average smolt production and ensuing adult returns.

Volunteers plant native vegetation at the Powerdale River Mile 1 project site. Photo by Alix Danielsen

Ryan Gerstenberger, a fish biologist and Project Leader for the Hood River Monitoring and Evaluation Program with the Tribes, echoes the importance of factors at play outside the watershed. Gerstenberger stresses that the removal of the Powerdale Dam did not happen in a laboratory vacuum where all variables could be controlled. A complete understanding of fish population recovery is not possible without consideration of influences both within and outside the watershed. Ocean conditions and dams on the Columbia River, for example, play a strong role in limiting the number of returning salmon and steelhead to the watershed.

Gerstenberger notes that returns of adult salmon and steelhead for most stocks may actually be lower on average in the period after the dam removal than prior to 2010. This is likely due in part to decadal cycles that have been documented over time. The years between 1999 and 2012 were a period of high ocean productivity, but 2014 marked the beginning of a period of poor productivity, which is reflected in adult observations at fish traps, tag detection data, and redd counts that the Tribes have conducted in recent years. Gerstenberger points out that the removal did appear to eliminate a migration delay created by the dam. Run timing of winter steelhead and spring Chinook was advanced after the dam removal, meaning returning fish could migrate earlier and further up into the watershed to spawn. This was evidenced by a 2-3-week advance in the period during which tribal harvest of spring Chinook at Punchbowl Falls occurred after the removal.

Simpson hypothesizes that an additional benefit to the dam's removal is the enhanced ability for fish to survive heavy winter flow events. Winter flows commonly push fish down into the lower reaches of the system. Prior to 2010, this often meant fish were getting pushed below the dam and a return above the dam would have been very challenging. Once the dam was removed, this annual obstacle was eliminated.

The Powerdale Dam removal ten years ago returned the lower Hood River to a free-flowing system, resulting in clear ecological benefits. A significant lift was created in the recovery of the watershed's native fish species, but the full picture is a more complex story. There is almost no limit to potential projects that could continue to improve the health of the watershed, and there are many agencies and institutions that are poised to do the work. Coordinated planning is the key to focusing work on projects that offer the highest return. To that end, the Watershed Group and partners have been developing a strategic action plan to guide conservation work for the next 20 years. The goal of this collective effort is that by 2040, conditions in the Hood River Watershed will support viable populations of salmon, steelhead, bull trout, Pacific lamprey, and other native fish.

Alix Danielsen is Restoration and Outreach Project Manager for the Hood River Watershed Group. Learn more about their work at: https://hoodriverswcd.org

The Quicksilver Portfolio

The plan to restore wild Puget Sound steelhead

By Wild Steelhead Coalition

After three years of work, research and sometimes tough negotiations, the Puget Sound Steelhead Advisory Group (PSSAG) released their document "Quicksilver: Restoring Puget Sound Steelhead & Fisheries" in May. Tasked by the Washington Department of Fish and Wildlife (WDFW) to build practical consensus around a path forward for steelhead management in Puget Sound watersheds, this portfolio of recommendations provides a new strategic framework to recover Puget Sound's dangerously low populations of wild steelhead and also establish guidelines for sustainable angling opportunities where they are possible, or could become viable as steelhead numbers improve.

As anyone who has spent time following Washington fisheries policy knows, this dual mandate is a high-wire balancing act between science, politics, tradition, and industry. Because of this, PSSAG sought to bring anglers and steelhead advocates from every corner of the angling and conservation worlds together to find common ground. The group's members, and the constituencies they represent, sometimes differ on specific strategies for how resource managers should proceed, but at the end of the day, everyone involved in PSSAG is committed to creating a future where wild steelhead, and the long tradition of steelhead angling on Washington's incredible Puget Sound rivers, are recovered and protected for future generations before it is too late.

Wild Steelhead Coalition (WSC) board members were invited to join PSSAG and have been committed members of the group. Speaking on behalf of WSC's members, our representatives worked hard to advocate for responsible angling opportunities, science-based fisheries policy, and wild steelhead protection and restoration. While it is important that WSC participates in such groups in order to have our management priorities represented, we also acknowledge that reasonable compromise is the guiding principle of honest negotiations.

The management status quo hasn't recovered wild steelhead in Puget Sound, and a new path forward is needed. The WSC was founded twenty years ago when a group of anglers lost their popular catch-and-release wild steelhead spring fisheries in Puget Sound. In many ways, these rivers are the organization's home waters and we are committed to seeing them thrive again. We believe the Quicksilver portfolio offers a positive, collaborative working model for the angling community and a reasonable, adaptive strategy for Puget Sound wild steelhead management.

There is great urgency to this work. Puget Sound's wild steelhead populations have been reduced to single digit percentages of their historical abundance.

There is great urgency to this work. Puget Sound's wild steelhead populations have been reduced to tiny, single-digit percentages of their historical abundance. It is no exaggeration to say that these incredible fish are hovering near extinction tipping points in many of their home waters. While a few watersheds in the region have shown encouraging signs of tenuous recovery, they are not among the majority of rivers and restoration has a long, long way to go to be considered sustainable and durable. After decades of failed attempts to protect wild steelhead, our generation simply must make the effort, sacrifices and difficult decisions needed to restore these populations and the watersheds they depend upon to thrive. There is no time left, and we cannot allow wild Puget Sound steelhead to finally be lost on our watch.

The PSSAG Quicksilver recommendations now head to state resource managers and tribal co- managers for consideration, funding and implementation. As the angling community takes time to process these newly suggested management guidelines, we wanted to take a moment to explain WSC's support for the process and our thoughts on how PSSAG's recommendations could best be implemented in the coming years. While no single participant got everything they wanted, there is much to recommend in the Quicksilver Portfolio. WSC representatives particularly supported the emphasis on habitat protection and restoration, the call for increased fisheries monitoring and data collection, and protections for wild fish in watersheds like the Skagit Basin, where additional years without hatchery plantings were recommended in order to provide wild steelhead time to demonstrate continued recovery.

Before we dive into our analysis, we also want to take a moment to thank all of the PSSAG members for their years of dedication and good-faith effort to work together as a community on behalf of this incredible, iconic species as well as the fisheries and rivers we all cherish.

Quicksilver Portfolio Summary

The Quicksilver Portfolio offers an extensive plan for the management of Puget Sound steelhead rivers. While it is too long to recount here in its entirety, WSC recommends that anglers and advocates in Washington, and perhaps throughout steelhead country, read the report to familiarize themselves with PSSAG's recommendations, considerations and thinking. The plans are forward-looking and represent contemporary perspectives on fisheries management that could guide steelhead conservation and angling opportunities

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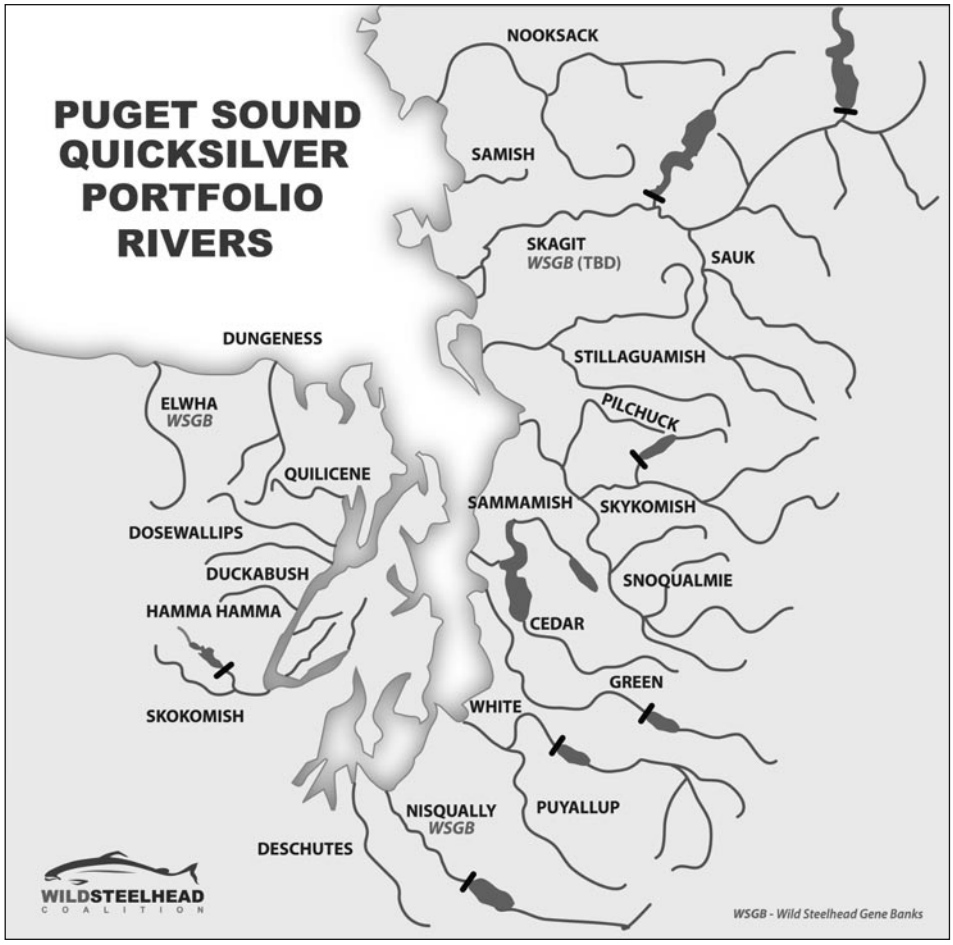
in Puget Sound for years to come if funded and implemented completely.

The centerpiece of the Quicksilver Portfolio is something PSSAG describes as an Experimental and Adaptive Approach. The authors emphasize that while hundreds of thousands of wild steelhead once returned annually to Puget Sound watersheds, the returns now hover at 5% to 10% of these once-prolific numbers. Wild steelhead teeter on the precipice of extinction in Puget Sound and the management status quo of recent decades has not been able to correct for the historic levels of habitat loss, harvest regimes, and poor hatchery practices that have led to these terrible declines in abundance. New approaches to recovery, while attempting to provide responsible and sustainable angling opportunities where they are possible, must be pursued.

PSSAG's Experimental and Adaptive Approach proposes that a variety of different management strategies be utilized on different river systems throughout Puget Sound. Their recommendations are determined by a watershed's existing habitat and potential to recover and support sustainable populations of wild fish. These different approaches could prioritize wild steelhead protection, offer multiple possible paths to recovery, and/or also provide a variety of catch-and-release and harvest opportunities for steelhead anglers, depending on the health of individual watersheds.

In order to proceed cautiously, the Quicksilver Portfolio places an emphasis on expanded monitoring of steelhead populations, sportfishing impacts, and hatchery impacts on wild populations. Constant evaluation and data collection, more extensively and widespread than is currently done, is recommended. The Quicksilver report acknowledges that throughout Puget Sound today, we simply lack complete, real-time information on the wild steelhead populations or a complete picture of steelhead smolt mortality. Monitoring and study of Puget Sound watersheds must be expanded and prioritized. Resource managers must then use this data to quickly correct course whenever this information shows what is supporting wild steelhead recovery and what is not.

The Quicksilver Portfolio organizes Puget Sound into three regions: Hood Canal and the East Strait of Juan de Fuca, Central and South Puget Sound, and the North Cascades. Within each of these regions, PSSAG makes watershed-specific recommendations based on three broad management strategies. It also provides benchmarks to help resource managers determine success or failure of recovery and guide future management scenarios as they unfold.



The first strategy involves rivers with good habitat and stable populations where wild steelhead recovery is prioritized. Catch-and-release angling would be allowed when required spawning thresholds are met in these rivers. No hatchery fish would be planted in these watersheds and some of them are already designated as Wild Steelhead Management Zones. The second strategy focuses on rivers with deeply suppressed steelhead numbers, but because of good remaining habitat, are candidates for strong recovery. This second category of rivers would have their steelhead populations jumpstarted with wild broodstock hatcheries. In some places these conservation hatcheries would be discontinued as soon as the wild fish have reestablished sustainable baselines and in others the broodstock programs would help support catch-and-release angling opportunities as long as their impacts on wild fish genetics were within accepted measurements updated constantly by rigorous monitoring. Finally, in the third category, a few segregated hatcheries would be used to provide angling and harvest opportunities as long as these hatcheries were shown to not impede wild fish recovery outside of the parameters established by State and Federal recovery plans.

In the Hood Canal and Strait of Juan de Fuca region, PSSAG points to the promising steelhead recovery efforts occurring on the Elwha and Skokomish Rivers. The Elwha is designated as a Wild Steelhead Management Zone (WSMZ) and a small conservation broodstock steelhead hatchery is currently being used there to help reestablish viable populations of wild winter steelhead following dam removal. PSSAG recommends (as is consistent with a WSMZ) that this hatchery supplementation end as soon as spawning thresholds are met by wild fish. On the Skokomish River, which after years of habitat and flow restoration work has the largest run of wild steelhead among Hood Canal Rivers, Tacoma Power is required to operate a wild winter brood-

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stock hatchery on the river's north fork to aid recovery efforts. PSSAG recommends that this program be discontinued after its required twelve years if wild steelhead demonstrate continued signs of population recovery. PSSAG looks forward to a future where responsible catch-and-release wild steelhead fishing seasons could be considered for the Elwha and/or Skokomish if populations continue to improve and stabilize.

Because opportunities to harvest steelhead are rare in this region, PSSAG recommends segregated hatchery plants on the Dungeness and Big Quilcene Rivers to offer fisheries to anglers who want to keep fish.

The Quicksilver report also notes the important research being done in the ongoing Hood Canal conservation hatchery studies. The report recommends fishery managers use the findings of these research programs to help inform and develop rigorous broodstock hatchery standards and guidelines whenever they are used throughout the region. Hopefully, the lessons learned in the Hood Canal hatchery studies can help broodstock hatcheries minimize their genetic impacts on wild populations and improve smolt survival rates when they are used to support steelhead restoration efforts.

In the Central and South Puget Sound region, PSSAG notes that the watersheds of this part of Puget Sound have dramatically suffered from urban development, pollution, logging, industry, dams, and other habitat degradations. Nonetheless, they point towards opportunities for potential steelhead recovery and angling opportunities if conditions improve. Quicksilver notes that the White and Nisqually Rivers, through past management decisions, remaining habitat, and restoration efforts, have the best chance at wild steelhead recovery. They also see good recovery potential for the Green, Puyallup, and perhaps the Cedar Rivers. Quicksilver recognizes the Nisqually remains a Wild Steelhead Management Zone and that the White, Green and Cedar currently have broodstock programs to aid steelhead recovery. Future catch- and-release angling, maybe even harvest opportunities, could be considered if these watersheds start meeting spawning recruitment goals consistently. In addition to conservation broodstock winter plants, the existing summer segregated hatchery program on the Green, to support harvest opportunity, is recommended to continue. The Sammamish and Deschutes are recommended to receive segregated early winter hatchery plants to support steelhead angling and harvest opportunities in the region.

The North Cascades region of Puget Sound contains some of the Pacific Northwest's most iconic steelhead rivers, but the wild steelhead populations of many of these famous watersheds are faint remnants of their astounding historical abundance. Years of floodplain development, dam building, destructive logging practices and hatchery supplementation have all contributed to declines. PSSAG points towards the Skagit, Nooksack, Samish and Stillaguamish River Systems as the best potential for wild fish recovery and low impact catch-and-release angling due to good remaining habitat and ongoing restoration efforts. The Quicksilver Portfolio recommends establishing a broodstock hatchery program on the Nooksack to boost early returning wild fish numbers and phase out the existing segregated hatchery program. It recommends that this new program potentially also provide a harvest fishery should it successfully meet recovery goals in the future. PSSAG recommends other harvest fisheries be supported by segregated early-winter returning steelhead hatchery programs on the Stillaguamish and Snohomish Rivers. PSSAG supports the recent catch-and-release spring fishery on the Skagit and Sauk Rivers. It recommends co-managers continue this popular fishery whenever wild fish numbers can support responsible angling opportunity.

The Quicksilver Portfolio recommends a conservative approach to the Skagit system to protect the continued recovery of wild steelhead populations in the watershed. It supports extensive monitoring of fish numbers and angling impacts and recommends the current ban on hatchery steelhead plants be maintained in the Skagit through 2028. At that point it recommends an evaluation of Skagit recovery and a consideration of wild broodstock program should the river not be showing signs of continuing recovery. Whatever is found on the Skagit at that time, it recommends that the Sauk River be managed exclusively as a Wild Steelhead Management Zone.

The North Cascades region is also home to the majority of the remaining summer steelhead populations within Puget Sound. Quicksilver emphasizes the unique nature of these populations and calls for more research to be done on summer steelhead in the Tolt, South Fork Nooksack, Deer Creek, Canyon Creek, and North Fork Skykomish so that adequate restoration and management programs can be developed to protect and restore these important runs. The Quicksilver Portfolio places special emphasis on the Deer Creek and Stillaguamish summer steelhead run now that the popular hatchery program has been discontinued there. On the Snohomish River, summer segregated hatchery plants are scheduled to be phased out in 2022 due to NOAA's requirement to eliminate out-of-basin Skamania summer steelhead in the watershed in order to limit genetic integration with the remaining wild fish. PSSAG supports this closure and recommends these fish be replaced with a wild broodstock program to rebuild stocks and, possibly, allow for some level of angler harvest in the future.

Wild Steelhead Coalition Observations

As stated earlier, the Quicksilver Portfolio of recommendations for Puget Sound is extensive and its implications are far-reaching. There are many important aspects and details in the portfolio worth consideration and discussion among steelhead anglers and advocates. In this spirit, and with an eye towards the recovery of wild steelhead in Puget Sound as our lodestar, WSC would like to take a moment to offer some observations, and clarifications, of our support for the PSSAG Quicksilver Portfolio.

1. Wild Steelhead Priority: The Quicksilver Portfolio emphasizes the need to prioritize wild steelhead recovery. It acknowledges the tiny fraction of these fish that still return to Puget Sound and unequivocally states that we must act now, and do all we can to protect and restore these populations, to have any hope of ensuring viable wild steelhead numbers and Washington's steelhead fishing tradition for future generations. From our perspective, this fact can't be overstated and must be repeated as often as possible. The loss of wild steelhead in Puget Sound is a tragedy. Extinction is a terrifying possibility. All resource management, angling opportunities, policy, and hatchery programs must be weighed with this grim inflec-

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tion point clearly in mind at all times. Washington simply must make the decisions required to protect and restore wild steelhead now. There is literally no time left. Our members want to be fishing for steelhead in Puget Sound as much as any dedicated steelhead angler anywhere on the West Coast, but it is even more important to us that our children and their children one day have the opportunity. This will only occur if we change course now to ensure there are wild steelhead returning to these beautiful, but struggling, watersheds in the years to come.

2. Habitat: PSSAG dedicates important space in the Quicksilver report to emphasize the need to restore and protect steelhead spawning and rearing habitat throughout Puget Sound. The report offers assessments of wild steelhead recovery based on viable habitat and undammed migration routes on a river-by-river basis. As human development and regional populations grew, massive amounts of steelhead and salmon habitat was lost in Puget Sound watersheds. This essential habitat continues to disappear as the region experiences accelerated urban growth. Puget Sound's best remaining steelhead and salmon habitat must be protected. Where salmonid habitat has been lost, it must be recovered and restored to the best condition possible. Dam removal on the Nooksack, Pilchuck, Elwha, and passage upgrades on the Green are great efforts. Floodplain and tributary habitat restoration is crucial. Without good habitat, there is no possible way to successfully increase wild steelhead numbers in the region's watersheds. Wild fish are resilient, but advocates need to work together to give them the habitat they require to thrive. Best of all, because all native fish exist in an interwoven web, efforts to help steelhead habitat also helps salmon, bull trout, bait fish, sturgeon, lamprey and other native fish, even Southern Resident Orcas. Habitat restoration and protection is critical for biodiversity everywhere, and we must stop this devastating loss in Puget Sound to have a chance at durable, sustaining wild steelhead recovery in these iconic rivers.

3. Monitoring: The Quicksilver Portfolio rightly emphasizes that Washington still knows too little about current steelhead populations, run timing, angling impacts, predation, survival rates, habitat utilization and hatchery impacts. Certainly, many advances have been made in fishery monitoring and assessment, but in order for resource managers to make the best decisions for wild steelhead recovery, and react and adapt to changing circumstances responsibly and effectively, they need to know much more. Therefore, PSSAG calls for investments in sonar systems to provide current and accurate fish population counts in our rivers. This technology is well demonstrated elsewhere, in Alaska in particular, and allows for critical decisions concerning fishing opportunities and spawning recruitment goals to be made in real time, based on accurate data instead of estimates. We need more measurements of spawning success, smolt survival, broodstock and segregated hatchery impacts on wild steelhead genetics, and catch-and-release angling impacts to find, isolate and respond to the critical impacts on wild steelhead populations going forward. The list goes on and on, but it boils down to this fact: Washington needs more information to ensure that resource management decisions made on behalf of wild steelhead recovery in Puget Sound are always based on well-informed science. Advocates for wild steelhead recovery should work to support funding for critical expansions of monitoring efforts throughout the region.

4. Hatcheries: Hatchery programs remain among the most controversial and contested aspects of steelhead (and salmon) management in the Pacific Northwest. Puget Sound is no exception. Without wading into the well-documented allegiances and perspectives the topic often entails, it is worth noting that the goal of PSSAG was to bring diverse advocacy and angling communities to the table to find a shared path forward. The WSC, as our name implies, prioritizes wild steelhead and their required habitat as the best option for recovery of populations and fisheries. Some of our PSSAG colleagues rely on the use of hatcheries to provide angling opportunities in degraded systems. While we won't always agree, the WSC believes it is important to be at the table to advocate for our policy perspectives and goals. We will always do so in good faith, and with an eye towards consensus building whenever possible.

The Quicksilver Portfolio recommends the use of wild broodstock and segregated hatcheries in some watersheds of Puget Sound. It explicitly demands compliance with strict Federal and State policy and emphasizes increased population monitoring to guard against ill effects on remaining, and hopefully recovering, wild steelhead populations. Where populations are greatly degraded, careful use of conservation broodstock hatcheries are recommended to protect remaining steelhead genetics in specific rivers and give the last remaining steelhead populations a necessary boost towards self-sufficiency. WSC appreciated seeing that the rigorous research being done in Hood Canal was acknowledged by the Quicksilver report. The results of these programs should help guide the use and development of conservation hatcheries throughout the region whenever they are utilized. Where new hatcheries are recommended by PSSAG, it is explicitly understood to only be possible if these programs meet approval after appropriate review established under the National and State Environmental Policy Act processes. The report emphasizes increased monitoring in order to track and adapt, and change course, whenever these programs exceed their allowed impacts on wild fish populations.

It is well-documented that hatcheries can have detrimental effects on wild steelhead recovery and it is crucial that past mistakes not be repeated. But they are also undeniably a facet of contemporary fisheries management. Resource managers must proceed very conservatively and with the utmost caution whenever they grapple with wild steelhead genetics. The wild fish are perfectly adapted to their native watersheds and every effort must be made to protect this fundamental building block of steelhead survival, resiliency and success. This is true in Puget Sound and throughout their native range. WSC is committed to prioritizing wild steelhead restoration and our representatives worked hard to advocate this position in PSSAG negotiations. To ensure fish for the future, as many watersheds as possible must have their distinct populations of wild, native steelhead protected and be allowed to recover.

5. The Skagit River: Comprising the largest watershed of Puget Sound, the Skagit and Sauk Rivers loom large to many in steelhead country. After years of decline, the WSC supported the re-

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opening of the winter and spring catch-and-release wild steelhead fishery when the watershed began to show signs of recovery. In fact, it was cause for celebration, and an important benchmark for judicious conservation ethics, because it was further proof that wild steelhead will fight to re-build their populations if protected and given access to good habitat. It should inspire all of us to continue restoring as much habitat in the basin as possible in order to help wild fish continue to successfully spawn, grow and restore their numbers.

The Quicksilver Portfolio enthusiastically supports this popular fishery as long as annual spawning goals are met. WSC takes the same stance. We spoke out in support of mangers when they declined to open the season last year when pre-season steelhead return estimates looked like they were going to be too low to responsibly sustain a fishery. The priority must be recovery of these endangered wild populations, even if it means not fishing until it is responsible to do so.

A river like the Skagit is a perfect example of where increased monitoring could be useful. A sonar in the lower river could help track daily run numbers accurately. Fishing seasons could be opened and closed immediately if numbers faltered. (Alaska currently, and successfully, manages many rivers precisely this way.) Additional fisheries staff could be used to track angler impact and research dollars could be spent studying spawning success and effective habitat restoration strategies. With meticulous monitoring and management, the mighty Skagit could become an important model of wild steelhead recovery in the 21st Century. Local communities, Washington anglers, and the entire ecosystem would all benefit from this model of visionary watershed and fishery management.

To that end, the WSC was glad to see the Quicksilver Portfolio recommend continuing to hold off on any hatchery interventions in the Skagit until at least 2028. The WSC has fought, and will continue to advocate, for the entire Skagit and Sauk watershed to be designated as a Wild Steelhead Management Zone. During previous WDFW polling, the public also overwhelmingly supported the watershed's designation and protection.

After 2028, the Quicksilver Portfolio leaves open the possibility of a wild broodstock hatchery on the Skagit if wild steelhead populations fall or are growing too slowly. WSC will be watching wild steelhead numbers closely during the next eight years. We hope the basin's wild steelhead populations continue to demonstrate ongoing recovery and that a broodstock hatchery won't even be considered. We believe the resources a new hatchery program would require would be better invested in habitat restoration efforts and expanded monitoring to support durable wild steelhead recovery throughout the Skagit watershed.

No matter what happens during the next few years, the WSC will be at the table working to advocate for this iconic Puget Sound watershed and the incredible strain of wild steelhead that return here each year.

Quicksilver Next Steps and Final Thoughts

After three years of long meetings, compromises and work groups, the recommendations of the PSSAG Quicksilver Portfolio now heads to state, federal and tribal co-managers for evaluation and potential implementation. The steelhead angling and conservation communities also now have time to evaluate the plan and consider its implications. We believe the Quicksilver Portfolio offers some good ideas and will be working hard to support these aspects of the plan as it goes out for consideration. If implemented, the Quicksilver Portfolio could provide guidance for Puget Sound steelhead recovery for years to come. It also offers a collaborative path forward for other regions in steelhead country working to restore their home watersheds and wild steelhead runs.

As we've said before, the Wild Steelhead Coalition was pleased to be included in the process. We take the "coalition" part of our name seriously and always seek productive, practical solutions across broad spectrum of anglers, scientists, conservationists, tribes, agencies, and river advocates. We know that wild steelhead need all the allies they can get. Rich Simms, one of WSC's representatives on PSSAG, summarizes the collaborative process best by saying, "The Quicksilver Portfolio is the result of a diverse group of representatives from across Puget Sound's angling and conservation community working together to establish stronger conservation goals for wild steelhead and provide quality fishing opportunities throughout the Sound. Many of us worked our tails off to get the best we could for wild steelhead recovery and fishing opportunities. These negotiations can be tough, but it is important for WSC to be at the table, working to build consensus and a better way forward."

The resiliency of wild steelhead continues to astound us. We are bolstered by good news coming from the Elwha, Skokomish, Samish, Nisqually, Skagit, Sauk and other rivers showing encouraging signs of tenuous recovery despite generations of habitat loss, overharvest and poor hatchery management compounded with recent years of tough ocean conditions in the North Pacific. We must commit to learning from what is working in these watersheds and expand those efforts so that incredible Washington rivers like the Snohomish, Skykomish, Stillaguamish, Nooksack, Green and the beautiful rivers of Hood Canal can someday recover their diverse wild steelhead populations before it is too late.

Budgets are always tight and the ongoing economic slowdown resulting from the terrible impacts of the COVID-19 pandemic will undoubtedly limit available resources in the near future. The WSC hopes that the best aspects and ideas of the Quicksilver Portfolio can earn support from managers and the financial resources will be made available to implement this new paradigm for the future of wild steelhead in Puget Sound. We will be keeping a close eye on state budgets and working to intervene in support of wild steelhead recovery wherever we can.

The Wild Steelhead Coalition is one of The Osprey's *partner organizations. You can find out more about them at: www.wildsteelheadcoalition.org*

*"QuickSilver — Restoring Puget Sound Steelhead and Fisheries" https://wdfw.wa.gov/sites/default/files/202005/quicksilver_pssag_report_fina*l

Piscine Orthoreovirus (PRV) and Ectoparasites of Young of the Year Juvenile Herring, *Clupea pallasii*, of the Salish Sea

By Anne Shaffer

Abstract

Herring (*Cupea pallasi*), cornerstone of northeast Pacific coastal ecosystems, and an important source of food for salmon and steelhead, have been in steady stock decline for over the last twenty years. Reasons are unclear. In this field study we assess young of the year (yoy) herring for two diseases: ectoparasites and Piscine Orthoreovirus (PRV). Sea lice density were found to be over two parasites per fish, exceeding the density documented to result in population crash in pink salmon, and double the density documented in juvenile herring a decade ago. From PRV analysis approximately 50 percent of the pooled yoy herring samples tested positive for PRV. Ct counts ranged from 38.69 to 35.77. [*Editor's Note: Cycle threshold (Ct) values measure the level of virus infection present in an organism.] These result*s indicate that ectoparasites and PRV may be playing a role in young herring mortality and stock decline. Precautionary principle management actions to reduce PRV and sea lice sources along the migratory corridor of young of the year herring are recommended to reduce or eliminate infection. Specifically, given the highly virulent nature of these diseases, the vulnerable nature of these small fish and the large geographic shorelines that they transit that also include net pens holding farmed salmon, well documented vectors of both diseases, it is imperative to eliminate net pens along all British Columbia and Washington state Salish Sea shorelines as a source of exposure, and is a fundamental step to conserving and restoring coastal trophic systems.

Introduction

Pacific herring (*Cupea pallasi*), are one of a guild of fish known colloquially as 'forage fish' that are critical components of Northeast Pacific marine systems. Pacific herring have complex life histories that include seasonal shoaling and migratory patterns to and from nearshore spawning grounds. Herring stocks in the Salish Sea have been declining and depressed for 20 years (Stick et al. 2014; Sandell et al. 2016).

According to Hershberger et al. 2016, herring are extremely vulnerable to viral disease and in the case of viral hemorrhagic septicemia virus (VHSV), succumb at loads below the detection threshold of a standard viral plaque assay. PRV and associated Heart and Skeletal Muscle Inflamation (HSMI) are deadly pathogens that are long time and high concern for Pacific wild salmon of the same region and with similar and overlapping juvenile coastal migration life histories (Morton et al. 2004; Krkošek et al. 2005; Webster et al. 2007; Patanasatienkul et al. 2013; Rees et al 2015 ; Morton et al. 2017; DFO 2018; Purcell et al. 2018). PRV has been documented in numerous marine fish species including families of herring and smelt in Norway (Wiik-Nielsen et al. 2012). Glover et al (2013) documented PRV in stomachs of gadids that preyed on Atlantic salmon, indicating trophic pathways of these pathogens may be occurring across guilds of fish there. Garseth et al. (2013) concluded that long distance dispersal and transmission of PRV appears to be occurring between wild and farmed salmon. Purcell et al. (2018) found PRV to be widespread among Pacific salmon stocks.

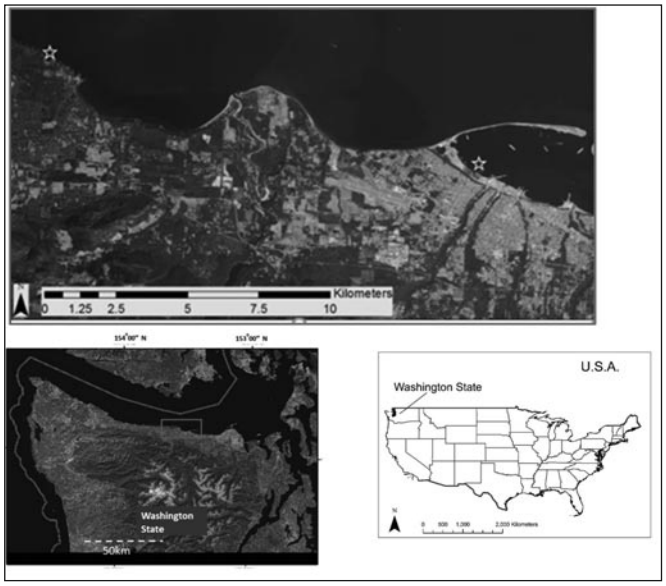

Figure 1. Collecting sites. Stars indicate sampling sites for young of the year herring collected 6 and 12 August 2019.

Despite documentation of PRV in other marine species, including juvenile salmon species occupying the same coastal zones, and forage fish in other regions of the world, the prevalence of and impact to ecosystem defining forage fish, herring, and their most vulnerable of life histories of larval and juvenile stages, are not well understood. PRV and HSMI have not been assessed in forage fish of the Salish Sea.

Sea lice are also pathogens that cause high salmon mortality that have increased in prevalence over the last twenty years and for which salmon farms are well documented to be a source (Morton et al 2004; Krkosek et al. 2007, Krkosek 2017). Krkosek et al. (2007) estimates that a density of 1.5 parasite per smolt may lead to crash of wild salmon populations. Further Barker et al. 2019 found a causative relationship between sea lice and infectious salmon anemia in salmon. Pacific herring Clupea pallasii, have also been documented to be infected with sea lice, and even theorized to be a possible reservoir for sea lice infestations of juvenile salmon (Morton et al.2008; Beamish 2009; Godwin et al. 2017). Long

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term trends in sea lice presence indi-

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cate that the proportion of juvenile herring with sea lice has increased significantly over the last decade (Shaffer et al. 2019).

Given the documentation of PRV and sea lice in Salish Sea salmon, the potential for herring infection, as well as potential factors contributing to declining herring stocks of the region, it is critical to understand the prevalence of PRV and sea lice in Salish Sea young of the year herring.

In this study we assess, for the first time, PRV and ectoparasites among juvenile young of the year herring of the Salish Sea. Young of the year (yoy) herring from juvenile forage fish migratory pathway along the nearshore regions of the Strait of Juan de Fuca, Salish Sea were collected and analyzed for PRV and sea lice species composition, life history stage, and density. The goal of this work is to quantify the risk factors for PRV and sea lice for this vulnerable life history stage of a critical component of marine coastal ecosystem of the Salish Sea.

Methods and Materials

Three hundred and four juvenile herring were collected for analysis from the Central Strait of Juan de Fuca on 6 and 12 August 2019 using snorkelers and hand held herring dip nets (Figure 1). Fish were measured to nearest mm and then immediately placed in a cooler with dry ice and processed for PRV and ectoparasite species id, density, and life history. Detailed methodology of sampling for each study follow:

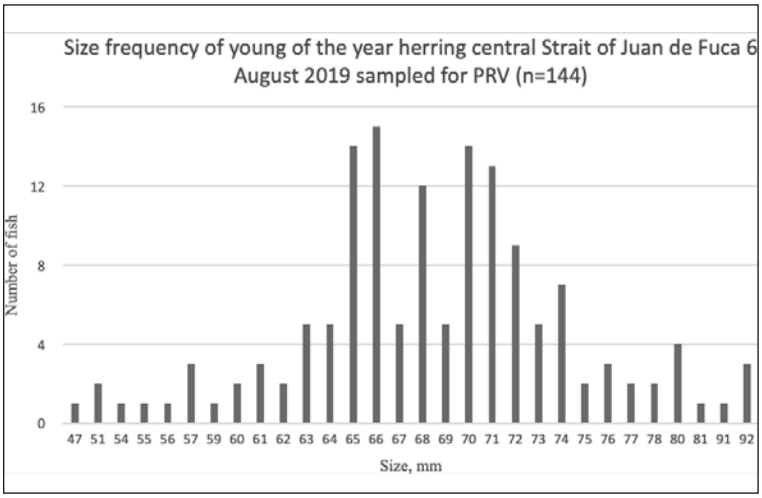

Figure 2. Size frequency of 144 young of the year herring sampled for PRV, central Strait of Juan de Fuca 6 August 2019.

PRV Analysis

A total of 144 fish were collected from Port Angeles harbor and sampled for PRV on 6 August 2019. Upon collection all fish were measured and placed immediately in a cooler with dry ice. Collected fish were shipped overnight to the Kipenge Lab (UPEI) within three hours of collected and accordance with standard handling, shipping and analysis protocols. Fish were composited into samples of 10 fish per sample. Whole fish were individually macerated to a 10% homogenate. 1.0 ml from each fish homogenate was used to obtain a pooled sample of 10 fish per sample. Each pool was tested, and if found positive (with Ct ≤39.9) then the 10 fish making up that pool were tested individually in order to identify individual fish with low Ct values for use in conventional RT-PCR to obtain PCR products for sequencing. [*Editor's Note: This is a laboratory technique for genetic testing*] The result is the number of PCR cycles to reach reliable detection of product (cycle threshold or Ct). Real-time RT-PCR used primers and probe by Haugland et al. (2011), and reaction conditions by Palacios et al., 2010. Real-time RT-PCR was done on September 02, 2019 on pooled samples, and on September 16, 2019 on individual samples. Ct up to 39.9 are positive. Ct between 40 and 45 are considered sus-

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Species	Gravid female	Adult unided sex	Total
Caligus clemensi	217 (37%)	127 (63%)	344

Table 2. Life history summary of sea lice collected from 163 young of the year herring from nearshore areas of the central Strait of Juan de Fuca 12 August 2019

Table 1. PRV Ct counts from 144 fish collected central Strait of Juan de Fuca 6 August 2019.

AVC Lab #	Sample ID # (pool or individual)	Piscine reovirus (PRV) Seg L1 TaqMan MGB probe, Cts	Piscine reovirus (PRV) Seg L1 TaqMan MGB probe, Cts
VT08082019-150(1-10)	Pool 1	0	
VT08082019-151(1-10)	Pool 2	0	
VT08082019-152(1-10)	Pool 3	37.9	
VT08082019-152-1	Pool 3:1		0
VT08082019-152-2	Pool 3:2		0
VT08082019-152-3	Pool 3:3		0
VT08082019-152-4	Pool 3:4		0
VT08082019-152-5	Pool 3:5		0
VT08082019-152-6	Pool 3:6		0
VT08082019-152-7	Pool 3:7		0
VT08082019-152-8	Pool 3:8		0
VT08082019-152-9	Pool 3:9		0
VT08082019-152-10	Pool 3:10		0
VT08082019-153(1-10)	Pool 4	0	
VT08082019-154(1-10)	Pool 5	0	
VT08082019-155(1-10)	Pool 6	38.69	
VT08082019-155-1	Pool 6:1		0
VT08082019-155-2	Pool 6:2		0
VT08082019-155-3	Pool 6:3		0
VT08082019-155-4	Pool 6:4		0
VT08082019-155-5	Pool 6:5		0
VT08082019-155-6	Pool 6:6		0
VT08082019-155-7	Pool 6:7		0
VT08082019-155-8	Pool 6:8		0
VT08082019-155-9	Pool 6:9		0
VT08082019-155-10	Pool 6:10		0
VT08082019-156(1-10)	Pool 7	0	
VT08082019-157(1-10)	Pool 8	35.77	
VT08082019-157-1	Pool 8:1		37.45
VT08082019-157-2	Pool 8:2		0
VT08082019-157-3	Pool 8:3		0
VT08082019-157-4	Pool 8:4		0
VT08082019-157-5	Pool 8:5		0
VT08082019-157-6	Pool 8:6		0
VT08082019-157-7	Pool 8:7		0
VT08082019-157-8	Pool 8:8		0
VT08082019-157-9	Pool 8:9		0
VT08082019-157-10	Pool 8:10		0
VT08082019-158(1-10)	Pool 9	36.03	
VT08082019-158-1	Pool 9:1		36.75
VT08082019-158-2	Pool 9:2		0
VT08082019-158-3	Pool 9:3		0
VT08082019-158-4	Pool 9:4		0
VT08082019-158-5	Pool 9:5		0
VT08082019-158-6	Pool 9:6		36.84
VT08082019-158-7	Pool 9:7		0
VT08082019-158-8	Pool 9:8		0
VT08082019-158-9	Pool 9:9		37.52
VT08082019-158-10	Pool 9:10		35.84
VT08082019-159(1-10)	Pool 10	0	
VT08082019-160(1-10)	Pool 11	0	
VT08082019-161(1-10)	Pool 12	37.89	
VT08082019-161-1	Pool 12:1		0
VT08082019-161-2	Pool 12:2		0
VT08082019-161-3	Pool 12:3		0
VT08082019-161-4	Pool 12:4		0
VT08082019-161-5	Pool 12:5		0
VT08082019-161-6	Pool 12:6		0
VT08082019-161-7	Pool 12:7		0
VT08082019-161-8	Pool 12:8		0
VT08082019-161-9	Pool 12:9		37.08
VT08082019-161-10	Pool 12:10		38
VT08082019-162(1-10)	Pool 13	38.58	
VT08082019-162-1	Pool 13:1		36.32
VT08082019-162-2	Pool 13:2		38.26
VT08082019-162-3	Pool 13:3		0
VT08082019-162-4	Pool 13:4		37.08
VT08082019-162-5	Pool 13:5		0
VT08082019-162-6	Pool 13:6		0
VT08082019-162-7	Pool 13:7		0
VT08082019-162-8	Pool 13:8		37.94
VT08082019-162-9	Pool 13:9		36.14
VT08082019-162-10	Pool 13:10		0
VT08082019-163(1-10)	Pool 14	37.09	
VT08082019-163-1	Pool 14:1		0
VT08082019-163-2	Pool 14:2		0
VT08082019-163-3	Pool 14:3		0
VT08082019-163-4	Pool 14:4		0
VT08082019-163-5	Pool 14:5		0
VT08082019-163-6	Pool 14:6		0
VT08082019-163-7	Pool 14:7		0
VT08082019-163-8	Pool 14:8		38.21
VT08082019-163-9	Pool 14:9		0
VT08082019-163-10	Pool 14:10		0
PRV C2-cRNA 10^6	positive control	18.35	18.59
VT09272013-495p0	positive control		
NTC (water)		0	0

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picious (Ct of last five cycles has higher uncertainity). Samples were deemed negative if there was no Ct value.

Ectoparasites

One hundred sixty juvenile young of the year herring were sampled for ectoparasites on 12 August 2019. Fish were collected using a 5um mesh net. Fish were measured, and all ectoparasites on the fish and in the dip net rinsed thoroughly with fresh water into a jar with 5% buffered formalin. Ectoparsites were identified to species and major life history stage in the lab, and identification was confirmed by an invertebrate expert at the University of Washington School of Fisheries.

Results

A total of 144 fish were sampled for PRV. Average size was 69mm (Figure 2). 14 pools of 10 whole fish each submitted to the laboratory on August 08, 2019, were tested for PRV using real-time RT-PCR with TaqMan probe for PRV segment L1. Based on this PCR test, 7 of the 14 pools (Pools 3, 6, 8, 9, 12, 13 and 14) contained PRV sequences of genome segment L1. Conventional RT-PCR for the full-length Segment S1 was performed on the individual fish in these pools (total 70 fish samples). Conventional RT-PCR for the first part of Segment M2 and a middle part of Segment L1 were also performed on any sample (pool or individual) with Ct <36.5 (total 5 samples: 2 pools and 3 individual fish) (Table 1). The sequence analysis is performed using PCR products. In this case all our conventional RT-PCR tests, which targeted three different PRV genome segments (S1, M2 and L1), were negative. i.e., there were no PCR products obtained to allow sequence analysis of the PRV detected by real-time RT-qPCR. Because of low viral load, there was no opportunity to carry out any sequence analysis of the PRV detected.

Ectoparasites

A total of 160 fish were sampled for ectoparasites on 12 August 2020. Fish were an average of 57mm +/- 6mm (Figures 3 and 4). A total of 345 adult sea lice were collected from this set of fish. This averages to 2.16 parasites per fish. All parasites were *Caligus clemens*i of which 37% were gravid female (Table 2).

Discussion

Our work documents, for the first time, PRV in young of the year herring along the Pacific coast. Ct values were positive in a surprisingly high percentage of the pooled fish, but low load volumes, due to the small fish size, made detailed analysis and sequencing not possible. These fish are quite small, and too small to be able collect individual organs quickly given limited sampling resources, so samples were taken by homogenizing the whole fish, which dilutes the target virus, that in turn likely contributing to the low virus load in these samples. While it would be informative to analyze adult fish in the hopes of acquiring more tissue and so larger loads that can be subsequently sequenced, the conundrum is that, if mortality associated with PRV occurs in young of the year fish infected with PRV, young fish may not survive to adults. Inversely, the fish that grow to adult either may not be exposed to, or if exposed, not susceptible to PRV, resulting in a false conclusion of lack of disease, or if present, PRV being misinterpreted as a 'benign disease'. Finally, it is important to interpret low load with caution. Hershberger et al. (2016) found the Viral hemorrhagic septicemia (VHSV) virus quickly expresses in fish where it was previously undetectable. The same may be true for PRV in young of the year herring.

According to Canada Department of Fisheries and Oceans (DFO), PRV was first detected approximately 30 years ago in farmed salmon. It is now believed to be one of the leading candidates causative agents of Heart and Skeletal Muscle Inflammation (HSMI) and Cardiomyopathy Syndrome for farmed salmon and trout from Norway, Chile and elsewhere (Lovoll et al. 2010; Palacios et al. 2010; Godoy et al. 2016; Wiik-Nielsen et al. 2016). Researchers also present that HSMI has never been reproduced in the laboratory without the presence of PRV (Mikalsen et al. 2012; Finstad et al. 2014). Further, PRV-like sequences have also found to co-occur with other liver and hemorrhagic diseases the disease in farmed trout and salmon around the world (Olsen et al. 2015; Godoy et al. 2016)

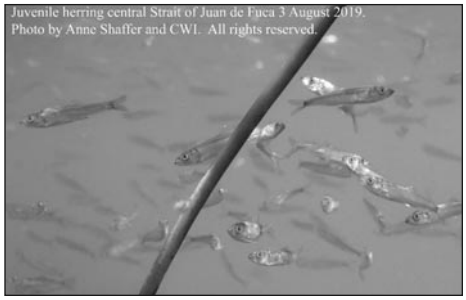

Figure 3. School of young of the year (yoy) juvenile herring collected along central Strait of Juan de Fuca infected with ectoparasites. August 2019. Photo by Anne Shaffer, Coastal Watershed Institute.

So we conclude that PRV is a risk to young of the year herring. The origin of the PRV infection is of next primary focus. Kibenge et al. (2013) was the first to report that the PRV-Ia found in BC-Canada was most similar to Norwegian PRV-Ia and suggested a timeline for the divergence of the BC-Canada PRV from Norwegian PRV-Ia. There have been several PRV sequences deposited in the GenBank database since then, and all phylogenetic analyses using all available sequences in the GenBank database support the view that 1) There are no major differences between BC-Canada PRV-Ia and Norwegian PRV-Ia; 2) The natural host of PRV-Ia is Atlantic salmon, and; 3) BC-Canada PRV-Ia is not native to BC wa-

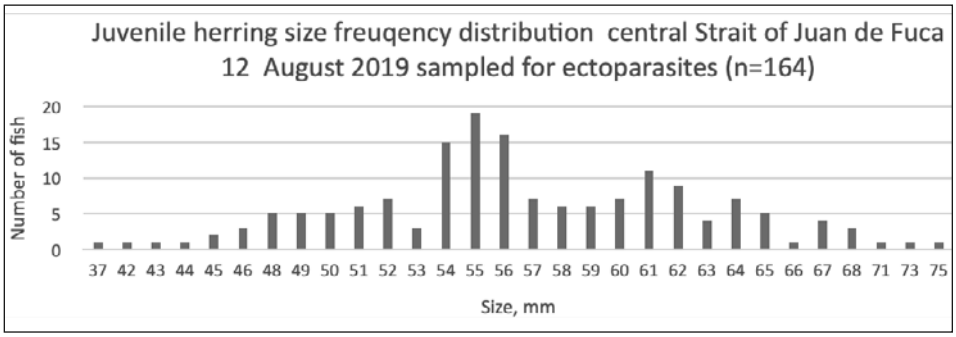

Figure 4. Size frequency distribution of young of the year herring sampled for sea lice from the central Strait of Juan de Fuca 12 August 2019.

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ters. More recent analysis by Kibenge et al. (unpublished data) suggests that PRV-Ia originally found in BC appeared later than in Chile and was possibly introduced from Norway either directly or via a third country. There was a second incursion in 2017 referred to as the "Icelandic strain".

Given that Atlantic salmon net pens have been documented to be a reservoir for disease transmission to herring (Lovy et al. 2013; Hershberger et al. 2011, 2016) as well as for PRV exposure to outmigrating salmon, we conclude net pens are also a likely source of PRV infecting young of the year herring of the region.

The presence of sea lice *C. clemensi* on herring is consistent with others' work in the region. Morton et al. (2004, 2008) documented net pens as a source of sea lice, and reported an abundance of less than one parasite per juvenile herring for 2004 and 2005. Ectoparasite density observed in this study are therefore double the abundance reported by Morton et al. (2008). Shaffer et al. (2019) documented a significant increase in the observations of juvenile herring with parasites over the last decade (Figure 5). Similar increase has also been observed in sea lice infestation of juvenile and adult wild salmon of the northeast Pacific over the last quarter of a century (Costello 2009; Morton et al. 2008).

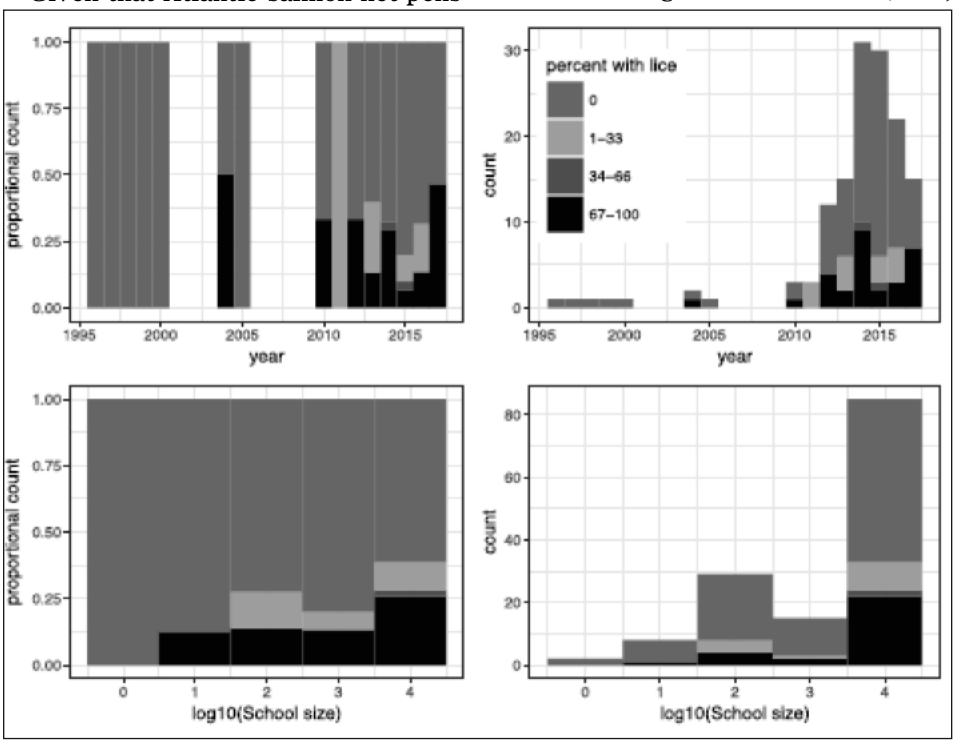

Figure 5. Average herring school size and percent of fish with parasites, by year. Panels on the left show proportional estimates to facilitate comparisons of portions. Panels on the right show absolute estimates to visualize sample sizes. (Shaffer et al 2019)

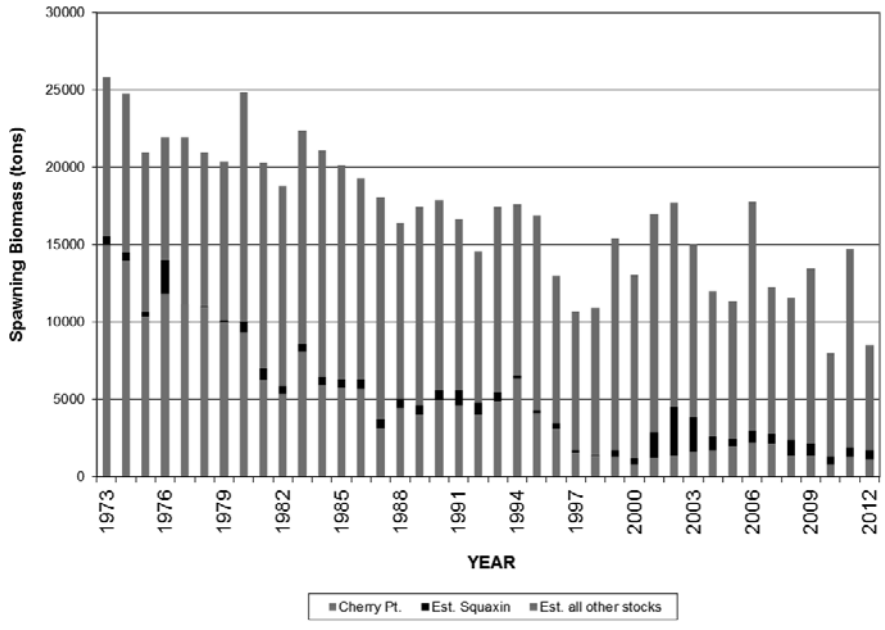

Figure 6. Herring stock status Salish Sea (Stick et al 2014)

Little is known about the impacts of sea lice parasites on juvenile herring. There is however a large set of literature on impacts of sea lice infestations on juvenile salmon. Webster et al. (2007) and Godwin et al. (2015) documented that sea lice can decrease fitness in juvenile salmon by inducing physiologic stress, invoking behavioral changes, and decreasing competitiveness. The decreased fitness may in turn result in high mortality. Ectoparasites compromise young fish's health and fitness, and ultimately, survival (Costello 2009; Webster et al. 2007). Barker et al. (2019) found that sea lice increase juvenile salmon's susceptibility to other pathogens, including deadly infections including salmon anemia virus. These stresses to smolts are modeled to have population level effects on salmon. Krkošek et al. (2007) estimated that sea lice density of 1-6 lice per pink salmon, and worst case of 1.5 parasite per smolt, may result in a population crash. Krkošek et al. (2013) concluded that parasites on salmon smolts attribute for a 39% population loss.

These observations also coincide with a troubling decrease in herring stocks of the Salish sea region (Figure 6; Stick et al. 2014). Increases in sea lice on young of the year herring also correspond to an increase in the frequency and distribution of net pens along outmigrating juvenile salmon migration corridors. Fish farms, or net pens, are now also considered a disease source for sea lice world-wide (Morton et al 2004, 2008, Costello 2009; Morton and Routledge 2016; Morton et al 2017; Thorstad and Finstad 2018). Larval herring of the British Columbia Salish Sea migrate from inland waters along shorelines driven by wind and current patterns. (Snauffer 2013). In the US, herring migration corridors for the Washington state region alone include

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no fewer than eight salmon net pens (Figure 7), and log scale that number in BC waters (Figure 8A). As larval and juvenile herring transit large reaches of shorelines of both BC and Washington in the months following emergence they are likely intercepting multiple netpens and so exposed multiple times at a vulnerable life history stage. While work has documented the trajectory of BC origin larval herring (and hake) along the Strait of Georgia, Admiralty Inlet and Strait of Juan de Fuca, similar modeling has not been done for the Washington herring larvae trajectory with the Salish Sea. Researchers have a proposal to conduct this modeling over the next year but funding is to date uncertain (Shaffer et al pers comm).

Given the prevalence of PRV and sea lice on young of the year Pacific herring documented in this study it is likely that sea lice and disease, including PRV, are factors challenging small young of the year herring as they are migrating off their natal beds of BC and Washington and resulting in increased mortality. The cumulative stress from each disease may be additive/synergistic, and result in significant mortalities contributing to declines in herring stocks of the last two decades. It is therefore important to address disease factors, including PRV and sea lice infections on young of the year herring, through management practices. Precautionary principles are the most straightforward and clearly effective tool for conservation of disease impacted migratory populations (Morton and Rutledge 2016). For PRV and sea lice, the top management source are salmon net pens located along young of the year migration corridors. Precautionary principles should be implemented to eliminate these known sources of PRV and sea lice for juvenile herring. Specifically, all net pen activities in both BC and Washington state should be transitioned to upland contained only facilities immediately. Doing so will eliminate this source of disease, and so ensure the conservation of both wild salmon, herring and the ecosystems that they, in turn depend, on and support.

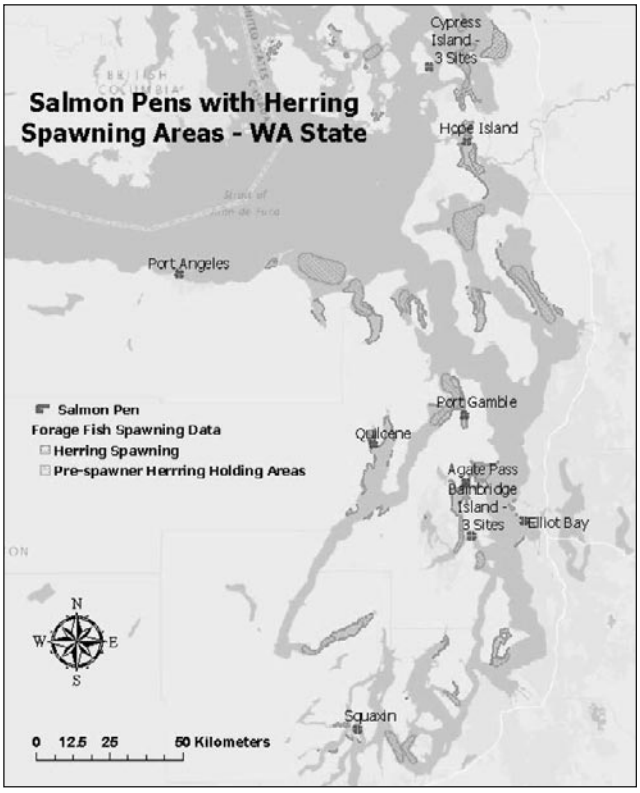

Figure 7. Distribution of herring spawn and salmon net pens, inland waters Washington state 2018. Map by Clinton Stipek, Coastal Watershed Institute

Anne Shaffer is Executive Director and Lead Scientist of the Coastal Watershed Institute, in Port Angeles, Washington. To learn more about their work visit:
www.coastalwatershedinstitute.org

Acknowledgments

Dr. Fred Kibenge and laboratory University of PEI analyzed herring samples for PRV. Dave Parks, David Harvey, Sam Schlotterback, and Jamie Michel, Coastal Watershed Institute, provided assistance with sample collection and shipping. Kurt Beardslee, Wild Fish Conservancy, provided permits for sample shipping. Bob Oxborrow, University of Washington, School of Fisheries provided QA/QC for sea lice species id. Dr. Alex Morton provided study advise and encouragement. Funding for this work was provided by Patagonia Inc and Coastal Watershed Institute. Thank you to all.

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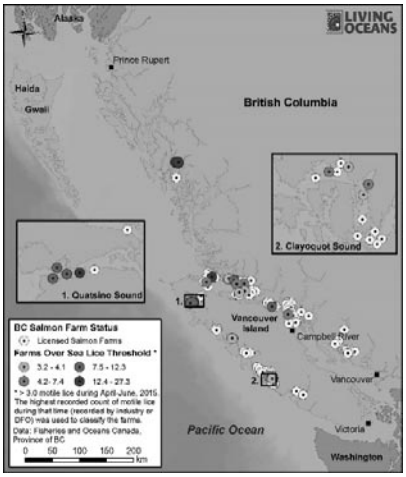
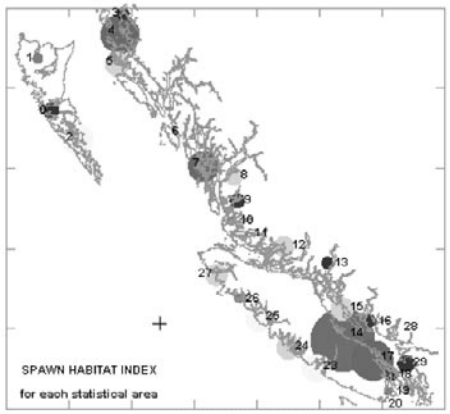
http://www.coastalwatershedinstitute.org/resources_141_3835354371.pdf





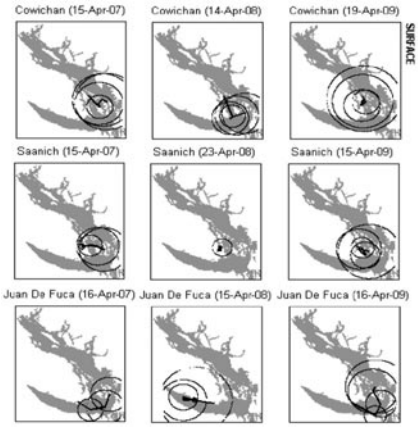


Figure 8.A (left) BC Net pen distribution and; B. middle) Cumulative herring spawning regions (1928-2015) in BC 2015. Circles depict cumulative herring spawn since 1928..Red indicates the top 5%, brown the next 10%, yellow the next 15%, green the next 20%, blue the next 25% and violet the last 25% of ranked ., and C (right). Graphic presentation of modeled trajectory of surface drifting southern BC herring spawn (Snauffer et al 2013). BC Net pen map reprinted from Living Oceans 2015, Herring spawn map reprinted from DFO 2015

State Action Protects Western Washington Wild Winter Steelhead

By Dave Moskowitz

For more than a decade, steelhead anglers and conservation groups have pushed the Washington Department of Fish and Wildlife (WDFW), fellow anglers, and communities across the northwest to act to turn the tide on a long-term decline of wild steelhead populations born in rivers in western Washington and on the Olympic Peninsula. Rivers including the Chehalis, Humptulips, Quinault, Queets, Hoh, Bogachiel and Sol Duc continue to show the same downhill trends that led to the end of wild steelhead harvest in 2015. WDFW staff explained these trends and the need for urgent conservation action as the 2020-21 angling season loomed. The key points paint a bleak picture:

● Chehalis and Humptulips: Failure to meet escapement goal in at least 3 of last 4 years and exceedance of 10% exploitation rate (ER) in two of the last 3 years.

● Willapa Bay: Failure to meet escapement goal in last 5 years.

● Queets: Failure to meet escapement goal and exceedance of 10% ER in last 3 years.

● Hoko: Failure to meet escapement goal in 2 of last 4 years.

● 2020-21 forecasts predict four of seven coastal river basins will not meet escapement goals. These forecasts predict the Hoh and Quinault Rivers will exceed escapement goals by 21% and 8%.

● Quillayute Basin (comprised of the Bogachiel, Calawah, Dickey and SolDuc Rivers) is predicted to exceed escapement — however, the more robust Sol Duc and Calawah returns mask low returns on the Bogachiel and Dickey.
WDFW Presentation Dec 11 2020

Given these population trajectories, WDFW had little choice but to implement immediate and substantial regulations to provide conservation benefits and yet still allow any fisheries at all (fishery escapements are shared by tribal and non-tribal fishers). The key points include:

● Significant tribal fishery constraints to share the allowable exploitation impacts with sport fisheries.

● Extending sport angling seasons by prohibiting fishing from a floating device.

● Reducing encounter rates for adult winter steelhead and resident fish by prohibiting the use of bait and scents.

● Protecting rainbow trout and the critical role they play in steelhead diversity and abundance by requiring safe release and prohibiting baits and scents.

● Protecting spawning and staging wild adult steelhead with earlier closing dates for most rivers.

WDFW took the right action in this situation — and not in haste, but after careful monitoring and evaluation of the best available scientific data on the health of the fish and the power and impact of the fisheries. WDFW did this in consultation with tribal co-managers and diligent and broad-based discussion with all interest groups. The NW Treaty Tribes have adjusted their practices and rest of WA needs to as well. WDFW's regulations should have changed long before the wild steelhead of Western WA and the OP came to teeter on the brink of no return.

Due to this long-term decline, the OP's wild steelhead populations are eligible for listing under the federal ESA. Anglers, Treaty Tribes, state managers and concerned citizens have limited time to stop the downward trend towards extinction. The principal focus of management must be on conservation of the wild animal — in this case – Washington's State Fish — wild steelhead.

Editor's Note: This article is a summary of available data, presentations, letters, and testimony developed by Trout Unlimited, Wild Steelhead Coalition, The Conservation Angler, and the Wild Salmon Center.

Dave Moskowitz is Executive Director of The Conservation Angler, one of The Osprey*'s partner organizations. Learn more about their work at:*

www.theconservationangler.org

2021 Preliminary Forecast*

System	Forecast	Goal	Wild Steelhead Above Escapement Goal	Sport Impact Limit
Willapa	3862	4206	-344	386
Chehalis	6600	8600	-2000	179
Humptulips	1066	1600	-534	53
Upper Quinault	1725	1600	125	63
Queets/Clearwater	3563	4200	-637	178
Hoh	2903	2400	503	251
Quillayute	9276	5900	3,376	1688

*forecasts are subject to change given continuing discussions with tribal comanagers

FISH WATCH — WILD FISH NEWS, ISSUES AND INITIATIVES

New Map Shows Mine Pollution Threats in BC

Last month, SkeenaWild, one of *The Osprey*'s partner organizations, and the BC Mining Law Reform Network released a new map pointing to over a hundred known and potentially contaminated mine waste sites that threaten to pollute waters, fish habitat and communities across the province.

Concerns over mining have been growing since the 2014 Mount Polley disaster (*The Osprey*, January 2015) and 2016 Auditor General report calling for significant reforms to protect BC's waterways and communities. The new map highlights the massive scale of the problem and provides information that has not been made available by the Ministry of Energy & Mines.

Mining poses risks of water contamination from acid mine drainage and heavy metal and pollutant leaching. At times this can result in the need for water treatment in perpetuity, which can cost taxpayers millions, as with the Britannia Mine that has cost $40 million for clean-up to date and an additional $3 million annually to reduce acid mine drainage and heavy metals from entering Howe Sound.

The map highlights dozens of mine sites that are polluting or putting our waters and communities at risk of contamination and the need to reform mining laws in B.C. to put safety and clean water first.

Maps and additional information are available at:
https://skeenawild.org/new-map-shows-dozens-of-mine-pollution-threats-in-bc/

Court Ruling Protects N. Umpqua Water Quality

In early February, an Oregon administrative law judge ruled that the Winchester Water Control District's operation and maintenance of the Winchester Dam on Oregon's North Umpqua River was not exempt from state water quality laws. This ruling delivered advocates another victory in their ongoing campaign to end harm caused by the Winchester Water Control District's operation and maintenance of the Winchester Dam. The ruling struck down the arguments of the district's former president and current resident and director, who claimed that their dam repairs should be exempt from state water quality laws. The ruling is the latest development in an ongoing state-level contested case over a $53,578 fine issued by the Oregon Department of Environmental Quality (DEQ) against Basco Logging, Inc., the longtime primary contractor for repairs at the 450-foot wide, 17-foot tall, 130-year-old dam. WaterWatch of Oregon, Steamboaters, Native Fish Society, Umpqua Watersheds, and Oregon Wild intervened in the case on behalf of the river, water quality, fish, and wildlife, and are represented by Crag Law Center.

According to state investigators, pollution from an October 2018 repair at the dam degraded aquatic habitat, killed fish, and harmed the primary drinking water source for the City of Roseburg and the Umpqua Basin Water Association. Investigators also found that dam repairs were conducted without following known best management practices, even after authorities provided the dam owners with information in advance on how to protect water quality and fish. Winchester Dam lies entirely within state designated Essential Salmonid Habitat and federally designated critical habitat for Oregon Coast coho salmon protected under the federal Endangered Species Act.

The case will now proceed to a formal hearing in July.

According to the Oregon Department of Fish and Wildlife, Winchester Dam impedes access to 160 miles of high quality habitat for salmon and steelhead.

THE OSPREY

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