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April 22, 2026

Filed Electronically

Ms. Debbie-Anne A. Reese
Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

**Re: Carmen-Smith Hydroelectric Project, FERC Project No. 2242:
Petition for Improvement of Temporary Fish Passage at Trail Bridge Dam;
Petition for Cost-Benefit Analysis of Volitional Fish Passage at Trail Bridge Dam**

Dear Secretary Reese:

Pursuant to FERC Rule 207(a)(5),¹ Cascadia Wildlands, Native Fish Society, and Willamette Riverkeeper (collectively, “Petitioners”), submit two requests to FERC relating to the Trail Bridge Dam within the Carmen-Smith Hydroelectric Project (“the Project”) on the McKenzie River in Oregon. The Eugene Water and Electric Board (“EWEB”), owner and operator of Trail Bridge Dam, is far behind schedule for achieving permanent fish passage at the dam, required by its FERC license and to comply with the Endangered Species Act. On December 31, 2025, EWEB asked for yet another extension of time to comply with its license, filing a “Notice of Intent to File License Amendment Application to Implement Resolution for Permanent Trap-and-Haul Fish Passage,” seeking new deadlines, again modifying fish passage requirements and further delaying compliance. If approved, the amended license would result in a ten-year delay from the current license deadline for permanent trap-and-haul fish passage, as required by the 2019 Final License Order, and more than a fifteen-year delay from the deadline in the original 2008 agreement that required permanent volitional fish passage at Trail Bridge Dam. EWEB has continued to produce hydropower the entire time despite failing to provide permanent fish passage at the dam, which has harmed, is harming, and will continue to harm Upper Willamette River (“UWR”) Chinook salmon and bull trout, both listed as ‘threatened’ species under the Endangered Species Act (“ESA”).

EWEB’s attempt to mitigate for the delay in permanent fish passage by installing a temporary trap-and-haul system to collect and move fish above the dam has been unsuccessful.

¹ 18 C.F.R. § 385.207(a)(5) (“Rule 207”).

Not only has it moved very few returning Chinook salmon (in some years none) above the dam, but it has actually harmed and killed listed fish. If FERC accepts EWEB's proposal to push completion of permanent upstream passage to 2032, then EWEB must be required to improve its interim measures, including the temporary system aimed at reducing the harm to threatened Chinook and bull trout resulting from the lack of passage at the dam. An expert fish biologist retained by Petitioners has offered recommendations for a new temporary trap that would likely increase the number of Chinook collected for transport upriver above the dam.² Our organizations request that FERC work with the Fish Working Group ("FWG") and direct EWEB to implement a new trap for its temporary fish passage beginning this summer.

Second, EWEB's notice of intent to file a license amendment application states that it plans to move forward with permanent trap-and-haul as the solution to upstream fish passage at Trail Bridge Dam. Given EWEB's history of noncompliance with passage deadlines and the resulting harm to listed species from those delays, it should complete a more robust analysis of alternatives for its license amendment. As explained in more detail below, Petitioners submit that a system allowing for volitional fish passage—i.e., a fish ladder, as was originally agreed upon—is a better solution because it will allow more fish to move upriver and cause less injury and stress to those fish, and will require much less money and resources to operate and maintain over the 50-year term of the license. It will also allow for continuous passage when human access is not possible, such as during wildfires and the associated forest road closures of the only road providing access to the dam, which have proved a serious impediment to temporary trap-and-haul efforts to date. Accordingly, Petitioners request that FERC direct EWEB to conduct a new cost-benefit analysis of a fish ladder compared to permanent trap-and-haul facilities as part of EWEB's license amendment process to assess the efficacy and cost of each under current and future conditions, including ongoing operational and personnel costs for each option.

Staff, members, and supporters of Cascadia Wildlands, Native Fish Society, and Willamette Riverkeeper care deeply about Chinook salmon and bull trout in the McKenzie River.³ Our organizations and our members have long-standing professional, recreational, scientific, and aesthetic interests in these fish and have spent significant time working to preserve and protect these imperiled populations. Our organizations intend to participate in EWEB's license amendment and accompanying processes and will move to intervene in the administrative process at the appropriate time. We believe the two issues raised in this petition warrant immediate attention from FERC.

Background on Trail Bridge Dam

Trail Bridge Dam is part of the Carmen-Smith Hydroelectric Project on the Upper McKenzie River, which is a tributary of the Willamette River in western Oregon. EWEB owns and operates the Project, which was first licensed by FERC in 1958. The McKenzie River contains important populations of Chinook salmon and bull trout, which are listed as threatened species under the ESA. Since 1963, when Trail Bridge Dam was constructed, the dam has stood

² See generally, Exhibit 1-Declaration of Kirk Schroeder.

³ Exhibit 2-Declarations of Bethany Cotton, Joshua Laughlin, Jennifer Fairbrother, Josh Moody, Michelle Emmons, Chris Daughters, Andrew Archer, David Thomas.

as an absolute barrier to migrating salmon and bull trout, harming these important fish species and impairing the recovery of these populations.

Chinook salmon returning from the ocean to spawn are unable to get to the high-quality spawning habitat upstream of Trail Bridge Dam, which is designated as Chinook critical habitat under the ESA. Access to this high-quality cold-water habitat is important for recovery of the McKenzie River population of Chinook, particularly as climate change continues to warm downriver habitat. Additionally, bull trout from the population located above Trail Bridge Dam are hindered from migrating downriver to find better foraging habitat, the population downriver is unable to access high-quality spawning habitat above the dam, and the different populations are unable to interbreed to maintain and improve genetic diversity and resilience. The National Marine Fisheries Service (“NMFS”) and U.S. Fish and Wildlife Service (“FWS”) have concluded that, by impeding passage upriver and downriver, Trail Bridge Dam is seriously harming Chinook salmon and bull trout because it significantly impairs their reproduction, feeding, and genetic diversity.⁴ Additionally, fish trying to migrate downriver by passing through the dam are often injured or killed.⁵ Permanent fish passage at the dam is essential for the recovery of these imperiled populations.

EWEB’s initial license for the Carmen-Smith Project expired in 2008. Recognizing the serious harm to Chinook and bull trout from Trail Bridge Dam, EWEB’s relicensing process included measures to address impacts to imperiled fish. Parties to the relicensing process, including EWEB, FERC, state and federal wildlife agencies, Tribes, and conservation organizations, including Cascadia Wildlands, reached an agreement in 2008 that contained terms to improve conditions for fish.⁶ These measures included the installation of volitional up- and downstream fish passage facilities at Trail Bridge Dam within six years of license issuance. Specifically, EWEB was required to construct a volitional fish ladder to provide upstream passage past the dam, and construct a fish screen and bypass system for downstream passage past the dam.⁷ NMFS and FWS supported this approach because fish ladders “permit volitional fish migration . . . , require far less maintenance than trap-and-haul . . . , operate reliably throughout the year with little human intervention required, operate year round regardless [of] the number of fish present, and operate continuously to pass large numbers of fish without delay, crowding, and injury.”⁸ The fish agencies each issued a Biological Opinion for the new license, which discussed the benefits to Chinook salmon and bull trout from an upstream fish ladder at Trail Bridge Dam as well as from the downstream screen and bypass system.⁹ These changes would allow fish to

⁴ National Marine Fisheries Service 2018 Biological Opinion for Carmen-Smith Project (“NMFS 2018 BiOp”) at 87-88, 117, issued on April 12, 2018 (Accession #: 20180412-5132); U.S. Fish and Wildlife Service 2018 Biological Opinion for Carmen-Smith Project (“FWS 2018 BiOp”) at 37, 40, 59, 75-76, issued on August 3, 2018 (Accession #: 20180803-5006).

⁵ National Marine Fisheries Service 2011 Biological Opinion for Carmen-Smith Project (“NMFS 2011 BiOp”) at 83-84, 123, issued on May 3, 2011 (Accession #: 20110503-5133); FWS 2018 BiOp at 76, 80-83.

⁶ 2008 Settlement Agreement for Relicensing the Carmen-Smith Project (“2008 Settlement”), filed on October 24, 2008 (Accession #: 20081024-5101).

⁷ 2008 Settlement at 84-87 (Articles 30 & 32).

⁸ Letter from NMFS to EWEB Re: Fish Passage at Trail Bridge Dam at 6, filed on October 12, 2007 (Accession #: 20071018-0030)

⁹ NMFS 2011 BO; U.S. Fish and Wildlife Service 2010 Biological Opinion for Carmen-Smith Project (“FWS 2010 BiOP”), issued on December 13, 2010 (Accession #: 20121214-5008).

naturally migrate up and downstream without human intervention. NMFS and FWS required that construction of these passage facilities occur within six years of license issuance (which would have been by 2018 had the license order followed and ultimately included those Biological Opinions) for EWEB to avoid liability for unlawful “take” of the listed species.¹⁰

History of Fish Passage Delays

FERC issued EWEB yearly interim licenses starting in 2008 until it issued the final license 11 years later (2019). The delay largely centered around EWEB’s resistance to conservation measures and initial economic concerns about the cost of volitional fish passage. In 2015, at EWEB’s request, FERC permitted EWEB to reanalyze the economics of volitional passage. In 2016, following that analysis, EWEB claimed that the volitional passage requirements made the Project uneconomical. In that filing, EWEB proposed replacing the upstream fish ladder with a trap-and-haul system and replacing the downstream fish screen and bypass system with modifications to the spillway and the gate and hoist system. These changes were incorporated into a new 2016 Settlement Agreement, which required that the passage facilities be completed within three years of license issuance.¹¹ NMFS and FWS stated that trap-and-haul systems are typically less effective than volitional passage, often significantly less so, but agreed to the changes because of the “expedited” three-year timeline.¹²

In 2018, the fish agencies issued revised Biological Opinions for the Project that incorporated the new fish passage requirements and deadlines.¹³ FWS and NMFS noted that although the trap-and-haul system would provide upstream fish passage, it would cause numerous negative effects to fish compared to a volitional fish ladder, including stress, physical injury, and/or mortality from being captured, held, transported by truck, and released into the river upstream; injury or mortality if the trapping or transport equipment malfunctions; and delayed migration from the trapping and transport process compared to swimming up a fish ladder.¹⁴ The Biological Opinions expressly required EWEB to complete the new fish passage requirements within three years of license issuance to be exempt from the “take” prohibition of the ESA.¹⁵

In May 2019, FERC issued the new license to EWEB.¹⁶ It incorporated the fish passage requirements from the 2016 Settlement and 2018 Biological Opinions, as set forth in Articles 29, 30, and 33 of the license. Specifically, Article 29 required EWEB to, within six months, submit to FERC a plan and schedule for the design and construction of the trap-and-haul facility; complete construction of the facility within three years (by May 2022); and monitor the facility

¹⁰ NMFS 2011 BiOp at 190-94; FWS 2010 BiOp at 174-76, 180-84.

¹¹ 2016 Settlement Agreement for Relicensing of the Carmen-Smith Project (“2016 Settlement”) at 84-87 (Articles 29 & 33), filed on November 30, 2016 (Accession #: 20161130-5174).

¹² See Letter from NMFS to FERC Re: Status of ESA Consultation for Carmen-Smith Project at 2, filed on Dec. 13, 2023 (Accession #: 20231213-5173).

¹³ NMFS 2018 BiOp; FWS 2018 BiOp.

¹⁴ FWS 2018 BiOp at 75; NMFS 2018 BiOp at 113; Exhibit 1 ¶¶ 36-37.

¹⁵ NMFS 2018 BiOp at 132, 136; FWS 2018 BiOp at 147.

¹⁶ 2019 FERC license for Carmen-Smith Project, issued on May 17, 2019 (167 FERC ¶ 61,152).

for ten migration seasons.¹⁷ If results showed that mortality rates from the trap-and-haul exceeded standards identified in the license, EWEB would have to develop a plan and schedule for volitional passage (a fish ladder).¹⁸ Article 33 of the license required EWEB to, within six months, submit to FERC a plan and schedule for the modification of the spillway, gate and hoist system for downstream passage, and complete construction within three years (by May 2022).¹⁹

Despite the change in passage requirements pursuant to EWEB's economic preferences, EWEB has failed to even begin constructing the upstream and downstream passage facilities, now more than six years after license issuance and several years past the license-required deadline for construction and implementation. Specifically, after EWEB repeatedly requested extensions of the passage deadlines—which were consistently disfavored by FWS and NMFS and denied by FERC—EWEB filed a self-report of license noncompliance in May 2022.²⁰ In that noncompliance report, EWEB estimated completion of a trap-and-haul facility by December 2027, and completion of spillway and gate modifications by December 2029.²¹ In fall 2023 through the beginning of 2024, NMFS and FWS filed a series of letters stating that, because EWEB failed to comply with its license, the conclusions in the 2018 Biological Opinions were no longer valid, dispute resolution processes for fish passage issues had failed, and a new solution was required.²² Given EWEB's delays, both agencies stated a return to volitional passage was warranted.²³

NMFS and FWS's initial letters described EWEB's pattern and practice of delaying progress at every turn and bad faith efforts in license compliance and fish passage requirements, and that the economic justification for the change to trap-and-haul had proven false.²⁴ Meanwhile, the delay in passage had led to significant harm to Chinook salmon and bull trout.²⁵ Because the 2018 Biological Opinions "relied on faithful implementation of the [fish passage] measures as a way to drastically reduce the otherwise ongoing injury and mortality caused by [Trail Bridge Dam], as well as its blockage of . . . habitat," the continuing adverse impacts from the dam meant "the conclusions of the biological opinions are no longer accurate."²⁶ The fish agencies requested that FERC order EWEB to return to a volitional fish ladder for fish passage and complete it on the fastest possible timeline. NMFS and FWS explained that volitional fish passage was the most appropriate path forward because of:

¹⁷ *Id.* at 144.

¹⁸ *Id.* at 97.

¹⁹ *Id.* at 144-155.

²⁰ FERC Noncompliance Order to EWEB Re: Trail Bridge Dam, Fish Passage, issued on Oct. 28, 2020 (Accession #: 20201028-3035); EWEB Report of Deviation from Trail Bridge Dam Fish Passage, filed on May 16, 2022 (Accession #:20220516-5096).

²¹ EWEB Report of Deviation at 7.

²² Letter from NMFS to FERC Re: Noncompliance with License for Carmen-Smith Project, filed on Oct. 17, 2023 (Accession #: 20231018-5033); Letter from FWS to FERC Re: Noncompliance with License for Carmen-Smith Project, filed on Oct. 26, 2023 (Accession #:20231027-5015).

²³ Letter from NMFS to FERC at 5, filed on Oct. 17, 2023; Letter from FWS to FERC at 3, filed on Oct. 26, 2023.

²⁴ Letter from NMFS to FERC at 2, 3, 9-15, filed on Oct. 17, 2023; Letter from FWS to FERC at 1, filed on Oct. 26, 2023.

²⁵ Letter from NMFS to FERC at 4, filed on Oct. 17, 2023; Letter from FWS to FERC at 2-3, filed on Oct. 26, 2023.

²⁶ Letter from NMFS to FERC at 4, filed on Oct. 17, 2023.

- The record of superior performance by volitional passage systems compared to trap-and-haul;
- The fact that EWEB has already studied volitional passage and produced initial designs for structures, which means that they could begin implementing this plan quickly;
- The changing project economics that now support volitional passage structures;
- The lesser obligations required to operate volitional passage structures to ensure safe, timely and effective passage, compared to a trap-and-haul system;
- Their lack of confidence in EWEB faithfully implementing any system, let alone a more onerous operation such as trap-and-haul that must continue indefinitely; and
- The need for the most robust action on passage, including best performing facilities and fastest possible implementation, to make up for the almost 15-year delay in passage facilities since the original settlement agreement was signed.²⁷

NMFS and FWS found that a long-term solution that required EWEB to construct and maintain volitional passage at Trail Bridge Dam for juvenile and adult bull trout and Chinook salmon was warranted.

Subsequent letters by FWS and NMFS stated that FERC and EWEB could no longer rely on the 2018 Biological Opinions due to the continued delays in implementing fish passage that prolonged harm to the species, and that NMFS and FWS were withdrawing from the 2016 Settlement Agreement.²⁸

FERC then issued a noncompliance order to EWEB in April 2024, finding EWEB out of compliance with license Articles 29, 30, and 33, and noting EWEB's lack of regard for its commitment to expedite construction and implementation of fish passage measures.²⁹

Despite its long pattern and practice of delays and unlawful inaction, EWEB again seeks further extensions of its license deadlines to avoid liability and civil penalties for its noncompliance. It is also requesting a license amendment process that would incorporate into its license a new plan for trap-and-haul and new deadlines that would delay downstream passage until December 2030 and upstream passage until December 2032.³⁰ All the while, threatened

²⁷ Letter from NMFS to FERC at 5, filed on Oct. 17, 2023; Letter from FWS to FERC at 3, filed on Oct. 26, 2023.

²⁸ Letter from NMFS to FERC, filed on Dec. 13, 2023 (Accession #: 20231213-5173); Letter from NMFS to EWEB Re: Withdrawal from 2016 Settlement Agreement, filed on Dec. 13, 2023; Letter from FWS to FERC Re: Status of ESA Consultation for Carmen-Smith Project, filed on Jan. 26, 2024 (Accession #:20240126-5176); Letter from FWS to EWEB Re: Withdrawal from 2016 Settlement Agreement, filed on Jan. 26, 2024 (Accession #: 20240126-5231).

²⁹ FERC Noncompliance Order to EWEB Re: License Articles, issued on April 11, 2024 (Accession #: 20240411-3032).

³⁰ See *infra* at pg. 12, "Ongoing License Amendment Process and Need for Updated Cost-Benefit Analysis."

salmon and bull trout continue to suffer, putting the Upper McKenzie River populations at risk of extinction.

Flaws with the Temporary Trap-and-haul System

EWEB has implemented a temporary fish passage system for bull trout and Chinook salmon as supposed mitigation for the delay in providing permanent fish passage at Trail Bridge Dam. Bull trout are moved above the dam primarily through a “hook and haul” system, whereby they are caught below the dam by a person using hook and line, loaded into a truck and driven above the dam, and released into the upper river. For Chinook, EWEB constructed a temporary trap in a human-made side channel of the river below Trail Bridge Dam in 2023 with the aim of trapping and collecting Chinook (and bull trout that enter the channel), then transporting them by truck above the dam. Multiple problems with this temporary system exist.

Using hook and haul methods, EWEB, supported by state and federal agency wildlife staff and volunteers, has been able to move as many as 50 bull trout annually above Trail Bridge Dam in recent years.³¹ However, this method can injure and stress the fish when they are hooked, netted, handled for collection, and released back into the river.³² Additionally, the fish may experience predation, transmission of disease and pathogens, and stress when they are enclosed with other fish before and during transport. FWS estimated that the temporary hook and haul method would “take” 15% of the adult bull trout handled each year.³³ Hook and haul also requires human presence during spawning season, an expensive and time intensive requirement. And a big problem when the dam is inaccessible due to wildfires and associated road closures.³⁴

The trap-and-haul of Chinook salmon has been unsuccessful, largely because very few Chinook have actually entered the trap. Expert salmon biologist Kirk Schroeder explained in court filings the many flaws with the current temporary trap, including its design, location, and operation.³⁵ Chinook have not entered the trap because of (1) poor design (small entrance and holding tube, little attraction flow, entrance perpendicular to natural direction of flow); (2) improper location in the stream channel (located in a deep pool with little natural current); and (3) the trap’s small size, which can hold only one fish at a time so personnel must be able to check the trap and remove the fish shortly after it enters.³⁶ Since the trap’s construction in 2023, only one Chinook has entered the trap in the three years combined (0 in 2023, 0 in 2024, 1 in 2025) despite efforts to improve capture before the 2024 and 2025 seasons.³⁷ EWEB has claimed

³¹ EWEB 2023 Annual Report for the Carmen-Smith Project at App. G-H, filed on October 15, 2024 (Accession #:20241015-5141); EWEB 2024 Annual Report for the Carmen-Smith Project at App G, filed on August 12, 2025 (Accession #: 20250812-5004).

³² Exhibit 1 ¶ 40; Exhibit 2, Declaration of Josh Moody ¶¶ 7-8.

³³ FWS 2018 BiOp at 83, 140.

³⁴ *See infra* (“Wildfire Impacts on Fish Passage in the Upper McKenzie River Watershed”).

³⁵ Exhibit 1 ¶¶ 39, 48; Exhibit 3-Second Schroeder Decl. ¶¶ 9-11.

³⁶ Exhibit 1 ¶¶ 39, 48; Exhibit 3 ¶¶ 9-11.

³⁷ Quarterly Fish Passage Progress Report at 12-13, filed on April 30, 2025 (Accession #: 20250430-5527); Quarterly Fish Passage Progress Report at 12-14, filed on Aug. 1, 2025 (Accession #: 20250801-5160); Quarterly Fish Passage Progress Report at 5, filed on October 31, 2025 (Accession #:20251030-5309); Quarterly Fish Passage Progress Report at 5-6, filed on Jan. 30, 2026 (Accession #20260202-5012).

that there were not large numbers of Chinook returning to the channel in those years, but multiple Chinook were seen in the channel on several occasions in 2024 and 2025, and only one entered the trap.³⁸ Establishing Chinook spawning above Trail Bridge Dam is critical for increasing the number of fish using that high-quality habitat in the future.

The current trap is a permanent fixture in the artificial channel, and thus, there are limited changes that could be made to the existing trap to improve Chinook capture. As noted, changes before the 2024 and 2025 seasons did little to entice more Chinook into the trap. However, Mr. Schroeder has provided expert recommendations for a simpler and less expensive trap that could be installed in a better location within the channel, which would attract and hold multiple fish that could enter on their own and be removed later in the day.³⁹ Mr. Schroeder has decades of experience with the Oregon Department of Fish and Wildlife, conducting research on UWR Chinook salmon, and is familiar with many types of fish traps.⁴⁰ He explained that a cage trap could be installed in a location where the current is faster and flows through the trap to provide attraction flow, a weir would guide fish to the trap, and a special entrance would lead fish into the holding area of the trap.⁴¹ With the entrance on the downstream end of the trap in the natural path of the current, fish naturally enter the trap as they migrate up the channel (often at night). The trap is then to be checked daily to retrieve any fish collected.⁴² A trap like this is relatively inexpensive and simple to construct and install.⁴³ Given the current trap's lack of success in capturing Chinook, and EWEB's prediction that it will be at least another six years until permanent upstream passage facilities are completed, it is imperative that the current trap be replaced by a more effectively designed trap placed in a different location in the channel as soon as possible before the upcoming spawning season.

Wildfire Impacts on Fish Passage in the Upper McKenzie River Watershed

Another key factor hindering the transport of bull trout and Chinook salmon above the dam is the occurrence of wildfires in the area. Wildfires have frequently closed OR-126, the only road providing access to the dam and available to transport fish around it. Wildfire impacts on the efficacy of trap-and-haul have been significant and largely ignored by EWEB, federal and state agencies, and FERC. These issues warrant serious study and should inform any reconsideration of fish passage measures at Trail Bridge Dam, especially now as EWEB seeks to reopen the license and revisit its fish passage requirements.

Wildfires in the Upper McKenzie Basin have restricted access to Trail Bridge Dam in at least three of the past six years (2021, 2023, and 2024).⁴⁴ In each of these instances, wildfire led to the closure of OR-126, preventing access to the dam during peak migration and spawn timing

³⁸ Quarterly Fish Passage Progress Report at 13, filed on Nov. 1, 2024 (Accession #: 20241101-5087); Quarterly Fish Passage Progress Report at 5, filed on Nov. 1, 2025 (Accession #:20251031-5035); Exhibit 3 ¶¶ 10, 28-29.

³⁹ *Exhibit 3* at ¶¶ 13-16, 35.

⁴⁰ Exhibit 1 ¶¶ 3-10; Exhibit 3 ¶¶ 4-5 & Exs. 1-3.

⁴¹ *Exhibit 3* ¶ 13.

⁴² *Id.*

⁴³ *Id.* ¶¶ 15-16, 22.

⁴⁴ Northwest Interagency Coordination Center. (n.d.). Northwest Large Fire Interactive Web Map. <https://gacc.nifc.gov/>. <https://gacc.nifc.gov/nwcc/firemap.php>

for UWR Chinook salmon and bull trout in the McKenzie.⁴⁵ Understandably, during these closures, the safety of staff, contracted employees, and volunteers assisting with trap-and-haul efforts is prioritized.⁴⁶ These fires and associated road closures have resulted in an inability to staff the temporary trap-and-haul system and conduct bull trout hook-and-haul, when Chinook and bull trout migration are at their peak and the fish are preparing to spawn.⁴⁷ When analyzing a long-term passage solution, EWEB and FERC must consider the reasonableness of pursuing a system that requires human access and participation during peak wildfire season. The increasing frequency of wildfires in late summer and early fall, which overlaps with the critical period of fish movement past the dam, suggests that volitional passage or dam removal may be the only viable options. Especially, given the fact that fires anywhere in this watershed and often the greater Willamette National Forest routinely result in forest-wide closures and prevent access to OR-126, and thus the Carmen-Smith/Trail Bridge facilities, during these critical months.

Since 2017, eight significant wildfires have burned parts of the McKenzie River Basin upriver from the community of Walterville.⁴⁸ Each of those fires occurred between August and October, which coincides with peak migration and spawning of UWR Chinook salmon and bull trout in the Upper McKenzie.⁴⁹ At least three of these wildfires have restricted access to Trail Bridge Dam since 2020. Specifically, the Holiday Farm Fire in 2020, the Lookout Fire in 2023, and the Boulder Creek Fire in 2024 each resulted in closures of OR-126 during August and September.

In August 2017, the Rebel and Avenue fires burned in the Upper McKenzie Basin. The human-caused Rebel Fire burned 8,700 acres on the South Fork McKenzie River above Cougar Reservoir.⁵⁰ This fire burned approximately 17 miles from Carmen-Smith Project facilities.⁵¹ The Avenue Fire burned 3,800 acres in the Horse Creek drainage, a tributary to the McKenzie, just south of OR-242. This fire burned approximately eight and a half miles from Project facilities. Both fires smoldered through August, corresponding with the beginning of migration and spawn timing for UWR Chinook salmon and bull trout.⁵²

⁴⁵ Lane County Board of Commissioners, Lane County Holiday Farm Fire Update - Board of County Commissioners Situation Report as of Tuesday, September 29, 2020. Retrieved February 17, 2026, from https://cdns5hosted.civiclive.com/UserFiles/Servers/Server_3585797/File/Government/BCC/2020/2020_AGENDAS/092920agenda/T.7.A.pdf; Dios, A. D. (2023, August 26). *As weather cools in Oregon, firefighters make progress battling blazes*. Oregon live. <https://www.oregonlive.com/wildfires/2023/08/as-weather-cools-in-oregon-firefighters-make-progress-battling-blazes.html>; McDonald, R. (2025, February 3). *Highway 126 reopens with delays after fire caused closure*. KLCC. <https://www.klcc.org/transportation/2024-09-13/highway-126-reopens-with-delays-after-fire-caused-closure>.

⁴⁶ Exhibit 2, Moody Decl. ¶ 11 (fires during the 2023 migration season prevented any meaningful fish passage because trap-and-haul and hook-and-haul personnel could not access the area due to safety issues and road closures).

⁴⁷ Northwest Large Fire Interactive Web Map.

⁴⁸ *Id.*

⁴⁹ Exhibit 1 ¶¶ 5-6, 10.

⁵⁰ Northwest Large Fire Interactive Web Map.

⁵¹ Google. (n.d.). Google Maps: Measure Distance Tool, Rebel/Terwilliger--CSTB. Google maps. https://www.google.com/maps/@44.2608864,-122.0537563,13.66z?entry=tu&g_ep=EgoyMDI2MDIxMC4wIKXMDSoASAFQAw%3D%3D

⁵² Northwest Large Fire Interactive Web Map.; Exhibit 1 ¶¶ 5-6, 10.

In August 2018, the Terwilliger Fire burned 11,500 acres along the South Fork of the McKenzie River above Cougar Reservoir.⁵³ This fire burned through the month of August and was immediately adjacent to the burn scar of 2017's Rebel Fire.⁵⁴ This fire burned approximately 13.5 miles from Project facilities.⁵⁵

In September 2020, the Holiday Farm Fire burned over 170,000 acres of the McKenzie River corridor between the communities of Leaburg and McKenzie Bridge from September 7th until late October.⁵⁶ This was the largest fire in the drainage's recorded history. OR-126 was closed from September 7 to September 25, 2020, coinciding with the peak spawning period for UWR Chinook salmon in late September.⁵⁷ This fire occurred prior to installation of the temporary trap-and-haul system but likely would have prohibited operations for most of the season if the system had been in place.

In August 2021, the lightning-caused Knoll Fire burned 544 acres immediately along the McKenzie River above Belknap Springs.⁵⁸ This fire burned through August and was only a mile from the Carmen-Smith Project.⁵⁹

In the late summer of 2023, several fires ignited in the Upper McKenzie. In August and September 2023, the naturally-caused Horse Creek Fire burned 755 acres in the Horse Creek drainage, approximately eight and a half miles from the Project.⁶⁰ Additionally, the Lookout Fire burned nearly 26,000 acres immediately east of Trail Bridge Dam.⁶¹ This fire began on August 5th and was not fully contained until October 11th, two full months later. The Lookout Fire resulted in the closure of OR-126 on August 30th and caused an evacuation order for the Trail Bridge Dam area from August 18th until at least August 26th.⁶² According to EWEB's fish

⁵³ Darling, D. (2019, July 23). Terwilliger fire not quite out. *The Register Guard*.
<https://www.registerguard.com/story/news/2019/07/22/terwilliger-fire-not-quite-out/4633215007/>

⁵⁴ Northwest Large Fire Interactive Web Map.

⁵⁵ Google. (n.d.). Google Maps: Measure Distance Tool, Rebel/Terwilliger--CSTB. Google maps.
https://www.google.com/maps/@44.2608864,-122.0537563,13.66z?entry=tту&g_ep=EgoyMDI2MDIxMC4wIKXMDS0ASAFQAw%3D%3D

⁵⁶ *Willamette National Forest | Holiday farm fire*. U.S. Forest Service. (n.d.).

<https://www.fs.usda.gov/r06/willamette/fire/info/holiday-farm-fire>

⁵⁷ Lane County Board of Commissioners, Lane County Holiday Farm Fire Update - Board of County Commissioners Situation Report as of Tuesday, September 29, 2020. Retrieved February 17, 2026, from https://cdnsm5-hosted.civiclive.com/UserFiles/Servers/Server_3585797/File/Government/BCC/2020/2020_AGENDAS/092920agenda/T.7.A.pdf.

⁵⁸ Northwest Large Fire Interactive Web Map.; Exhibit 1 ¶¶ 5-6, 10.

⁵⁹ Google. (n.d.). Google Maps: Measure Distance Tool, Knoll--CSTB. Google maps.
https://www.google.com/maps/@44.2608864,-122.0537563,13.66z?entry=tту&g_ep=EgoyMDI2MDIxMC4wIKXMDS0ASAFQAw%3D%3D

⁶⁰ Northwest Large Fire Interactive Web Map; Google. (n.d.). Google Maps: Measure Distance Tool, Horse Creek--CSTB. Google maps. https://www.google.com/maps/@44.2608864,-122.0537563,13.66z?entry=tту&g_ep=EgoyMDI2MDIxMC4wIKXMDS0ASAFQAw%3D%3D

⁶¹ Northwest Large Fire Interactive Web Map.

⁶² Dios, A. D. (2023, August 26). *As weather cools in Oregon, firefighters make progress battling blazes*. Oregonlive. <https://www.oregonlive.com/wildfires/2023/08/as-weather-cools-in-oregon-firefighters-make-progress-battling-blazes.html>

passage report, the Lookout Fire directly interfered with trap-and-haul operations and contributed to the lack of success that season.⁶³ Contractors reported the same; trap-and-haul efforts were unsuccessful that season.⁶⁴

In 2024, the Boulder Creek Fire burned 544 acres immediately adjacent to OR-126 between Belknap Springs and the Trail Bridge Dam. This lightning-caused wildfire burned from September 7th until late October.⁶⁵ It caused the closure of OR-126 from September 10th to 13th,⁶⁶ and areas between Trail Bridge Dam and Belknap Springs were under evacuation orders from September 10th to 16th.⁶⁷ This fire interfered with ODFW's trap-and-haul efforts for the second year in a row, inhibiting EWEB's temporary fish passage measures.⁶⁸

Snowpack and drought conditions over the 2025-2026 winter and spring are predicted to result in high wildfire risk this summer. Record-low snowpacks throughout the western United States, including in the western Cascades, are unlikely to recover to even average levels, creating serious concerns for an early and persistent fire season.⁶⁹ Most of our region is unlikely to even reach 25% of typical snowpack (see image below).⁷⁰

⁶³ EWEB April 2025 Quarterly Fish Passage Report at 12.

⁶⁴ Exhibit 2, Moody Decl. ¶ 11

⁶⁵ *Boulder Creek Fire*. Watch Duty: Wildfire Maps & Alerts. (n.d.). <https://app.watchduty.org/i/33554>

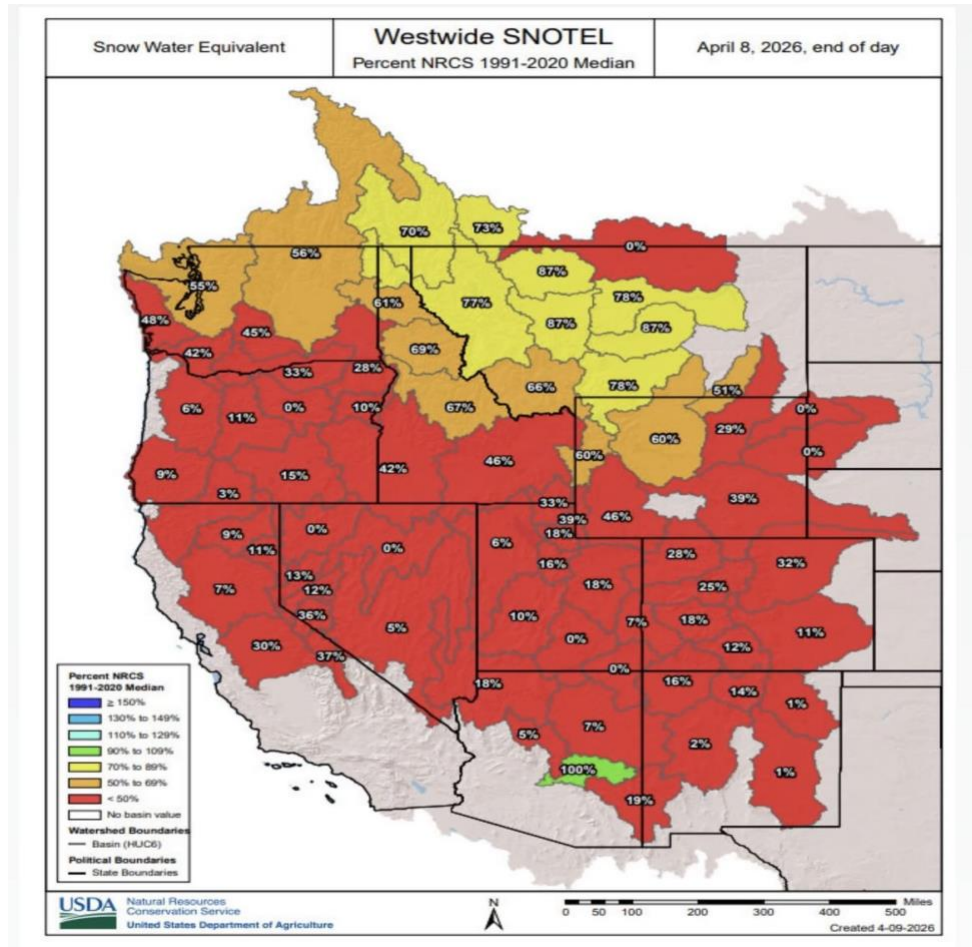
⁶⁶ McDonald, R. (2025, February 3). *Highway 126 reopens with delays after fire caused closure*. KLCC. <https://www.klcc.org/transportation/2024-09-13/highway-126-reopens-with-delays-after-fire-caused-closure>

⁶⁷ *Boulder Creek Fire*. Watch Duty: Wildfire Maps & Alerts. (n.d.). <https://app.watchduty.org/i/33554>

⁶⁸ EWEB April 2025 Quarterly Fish Passage Report at 12-14.

⁶⁹ Figueroa, A. (2026, February 12). *Oregon's record low snowpack is not likely to recover, scientists say*. Oregon Public Broadcasting. <https://www.opb.org/article/2026/02/11/oregon-record-low-snowpack-is-not-likely-to-recover-scientists-say/>.

⁷⁰ USDA NWCC Interactive Map. NWCC IMAP. (n.d.). <https://nwcc-apps.sc.egov.usda.gov/imap/#version=2&elements=&networks=!&states=!&counties=!&hucs=&minElevation=&maxElevation=&elementSelectType=any&activeOnly=true&activeForecastPointsOnly=true&hucLabels=false&hucIdLabels=false&hucParameterLabels=true&stationLabels=&overlays=&hucOverlays=&basinOpacity=75&basinNoDataOpacity=25&basemapOpacity=100&maskOpacity=0&mode=data&openSections=dataElement,parameter,date,basin,options,elements,location,networks&controlsOpen=true&popup=&popupMulti=&popupBasin=&base=esriNgwm&displayType=station&basinType=6&dataElement=WTEQ&depth=-8¶meter=PCTMED&frequency=DAILY&duration=I&customDuration=&dayPart=E&monthPart=E&forecastPubDay=1&forecastExceedance=50&useMixedPast=true&seqColor=1&divColor=7&scaleType=D&scaleMin=&scaleMax=&referencePeriodType=POR&referenceBegin=1991&referenceEnd=2020&minimumYears=20&hucAssociations=true&relativeDate=-1&lat=43.381&lon=-114.382&zoom=5.0>



The low snowpack will exacerbate the persistent drought that is affecting our region.⁷¹ These conditions create an increased likelihood of a long and intense wildfire season and corresponding forest and road closures that may again interrupt or entirely prevent trap-and-haul operations in 2026.

Wildfire impacts on the success of trap-and-haul operations warrants serious reconsideration of current and future fish passage measures at Trail Bridge Dam. The increase in fire prevalence and severity raises alarms about the efficacy of using trap-and-haul as a solution to fish passage at Trail Bridge Dam, particularly because the area immediately surrounding the Carmen-Smith Project is at a greater risk of burning than any other area in the Upper McKenzie River Basin.⁷²

⁷¹ See e.g., National Significant Wildland Fire Potential Outlook-Outlook Period - February through May 2026 (2026). Retrieved February 17, 2026, from https://www.nifc.gov/nicc-files/predictive/outlooks/monthly_seasonal_outlook.pdf; see also NOAA. (2026, February 5). *Snow drought current conditions and impacts in the west: February 5, 2026*. Drought.gov. <https://www.drought.gov/drought-status-updates/snow-drought-current-conditions-and-impacts-west-2026-02-05>.

⁷² See Oregon State University. *Our science*. Climate Impacts Research Consortium. (2019, June 14). <https://pnwcirc.org/science/wildfires>; Oregon State University. (n.d.). *Oregon Community Wildlife Protection Map Tool*. VertiGIS studio apps. <https://oregon-explorer.apps.geocortex.com/webviewer/?app=fccd4dfc5a974213aa1fa6a01b9c07e1>.

Volitional Passage is Safer, More Effective, and Better Equipped to Pass Fish in a Fire Prone Area

Based on the history of fires in the last ten years and increasing risk in the future given climate change impacts, it is likely that fire will continue to significantly impede trap-and-haul efforts at Trail Bridge Dam. It is clear that volitional passage is a substantially more effective method of fish passage in a fire prone area, as it does not require human facilitation to be successful.⁷³

Broadly, volitional fish passage provides UWR Chinook salmon and bull trout an effective means of passing Trail Bridge Dam with little or no delay and little risk of injury or mortality during the passage process.⁷⁴ Furthermore, it requires no human assistance to operate, which is an important factor in the fire-prone Upper McKenzie.⁷⁵ Even from the start of the relicensing process in 2007, NMFS cited several reasons why volitional passage (in the form of fish ladders) is preferred to trap-and-haul.⁷⁶

- Volitional fish migration results in less delay, injury, and stress;
- Fish ladders require far less maintenance than trap-and-haul and other mechanical devices;
- They operate reliably throughout the year with little human intervention required; and
- They operate continuously to pass large numbers of fish without delay, crowding, and injury⁷⁷

Each of these benefits suggests that volitional passage is preferable at Trail Bridge Dam. Moreover, they also highlight why volitional passage is a more resilient and effective means of passing fish in an area so clearly prone to wildfire and access problems associated with wildfire-caused road closures. Notably, in two of three years of operation, trap-and-haul efforts were restricted for part of the migration and spawning season due to wildfire and associated forest road closures. The likelihood of future fires in the McKenzie watershed means that any trap-and-haul system, whether temporary or permanent, will be limited in effectiveness compared to a volitional passage system like a fish ladder that fish can swim up without any human assistance. As NMFS and FWS explained in their prior letters to FERC, a volitional fish ladder will pass more fish and will do so without the injuries and stress caused by a trap-and-haul system; requires no human intervention to operate it and little maintenance; and would not be affected by road closures due to wildfire. Moreover, because of the extensive delays in permanent passage, it is all the more critical to implement the most effective passage system possible.

⁷³ Exhibit 1 ¶¶ 27-28.

⁷⁴ NMFS 2007 Letter “Biological Benefits of Fish assumed equivalent.”

⁷⁵ *Id.* at 5.

⁷⁶ *Id.*

⁷⁷ *Id.*; see also Letter from NMFS to FERC (highlighting similar benefits), filed on Oct. 17, 2023.

Ongoing License Amendment Process and Need for Updated Cost-Benefit Analysis

On December 31, 2025, EWEB filed with FERC a notice of intent to file a license amendment application and requests to approve extensions of its fish passage deadlines and modifications to its quarterly fish passage progress reporting obligations.⁷⁸ The license amendment would impose new deadlines for upstream and downstream fish passage facilities and change the plan for the upstream trap facility.

EWEB explained the need to change the upstream trap-and-haul facility due to hydraulic modeling that revealed more complex conditions in the tailrace of the dam than originally anticipated.⁷⁹ It worked with NMFS and FWS to identify a new location for the trap several hundred feet downstream of the dam, rather than at the base of the dam, and a new tailrace barrier that would be immediately upstream of the trap entrance. EWEB stated it would design and construct this new facility and barrier and place them into use by December 31, 2032. It would modify the spillway and gate and hoist system for downstream passage by December 31, 2030.⁸⁰ EWEB is consulting with FERC's Division of Dam Safety and Inspections and EWEB's Board of Consultants to initiate the study and design process for the new upstream trap facility. Specifically, EWEB has "initiated efforts" to "identify the suite of studies that may be needed to design and construct" the new fish passage plan and has met with federal and state agencies to discuss the plan.⁸¹ It "must expend significant resources to study, analyze, and develop an entirely new fish passage proposal"⁸² EWEB admits that studies may reveal "a critical flaw with the anticipated new location" that would set back efforts even further.⁸³ EWEB also acknowledged that a license amendment to incorporate this change requires a new ESA consultation, a new Environmental Assessment under the National Environmental Policy Act (NEPA), a new Water Quality Certification from the State, and a Clean Water Act dredge and fill permit from the Army Corps of Engineers.⁸⁴

In other words, EWEB is essentially starting over from scratch on an upstream trap-and-haul facility without considering other alternatives, such as a fish ladder, or addressing key aspects of the problem. Such analysis is necessary because of EWEB's extensive delays in permanent fish passage, the lack of success with temporary trap-and-haul, and the increasing risk that wildfires will impede both temporary and permanent trap-and-haul efforts in the future. Moreover, as outlined by NMFS and FWS, and consistent with Petitioners' expert's findings, a volitional fish ladder will pass more fish without human intervention and will do so without the injuries and stress associated with a trap-and-haul system.⁸⁵

⁷⁸ EWEB Notice of Intent to File License Amendment Application to Implement Resolution for Permanent Trap-and-haul Fish Passage, filed on Dec. 31, 2025 (Accession #: 20251231-5457).

⁷⁹ *Id.* at 2.

⁸⁰ *Id.* at 3.

⁸¹ *Id.* at 4-5.

⁸² *Id.* at 9.

⁸³ *Id.* at 19.

⁸⁴ *Id.* at 5, 18, 21.

⁸⁵ Exhibit 1 ¶¶ 36, 54.

EWEB states that it would develop an alternative system, such as volitional passage, if the new upstream trap does not perform up to standards after six to eight migratory seasons.⁸⁶ EWEB should be analyzing the feasibility of this alternative *now*, given the superior performance and lower operational and maintenance burdens of volitional passage, as well as the serious questions about the effectiveness of trap-and-haul in an area that has a high risk of wildfire and corresponding forest and road closures. At a minimum, EWEB should complete a new cost-benefit analysis to compare a fish ladder with a trap-and-haul facility, including considering staffing and maintenance costs across the 50-year duration of the license. Indeed, this is an alternative action that EWEB should include in its new Environmental Assessment to compare with the proposed trap-and-haul facility. Rather than plowing full steam ahead with trap-and-haul, this is an opportunity to reevaluate whether volitional fish passage is now the better solution based on the benefits to the fish, the overall cost over 50 years, the lower human involvement and staffing requirements, and the serious likelihood of future fires continuing to hinder trap-and-haul success, whether temporary or permanent.

Requests

1. We request that FERC order EWEB to construct and install a new trap in the Carmen Smith spawning channel for temporary trap-and-haul that follows the recommendations of salmon expert Kirk Schroeder. EWEB has stated it does not intend to install a new trap lower in the channel but rather, attempt further adjustments to the current system.⁸⁷ The inherent flaws in the location and design of the current trap cannot be fixed with “adjustments.” Given the length of time that it will take for EWEB to complete permanent passage, it is imperative to have an effective temporary passage system for Chinook and bull trout as soon as possible. Therefore, FERC should order EWEB to install a cage trap lower in the spawning channel by August 2026, before the 2026 spawning season.
2. We request that FERC order EWEB to conduct a new cost-benefit analysis comparing the benefits and the costs of a volitional fish ladder to an upstream trap-and-haul facility over the course of the 50-year license, including ongoing human staffing costs, and the real risk of failure of a trap-and-haul system demonstrated by previous failures and the limitations imposed by frequent wildfires and associated forest road closures in the area. This analysis should be conducted immediately, before EWEB, FERC, federal and state agencies, and other interested parties spend significant time and resources on a new plan for an upstream trap-and-haul facility and should be incorporated into the updated Environmental Assessment for the license amendment.

Given the nature of this petition, submitted pursuant to Rule 207(a)(5), we formally request the opportunity to meet and discuss how FERC, federal agencies, and EWEB intend to address the longstanding fish passage issues and timely address Petitioners’ significant concerns raised herein.

⁸⁶ EWEB Notice of Intent at 20.

⁸⁷ *Id.* at 19-20; Quarterly Fish Passage Progress Report at 6, filed on Jan. 30, 2026.

Respectfully submitted,



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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Plaintiffs,

v.

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

Case No.: 6:25-cv-00446-MTK

**DECLARATION OF KIRK
SCHROEDER**

I, Kirk Schroeder, declare as follows:

1. I have personal knowledge of the facts set forth below and if called as a witness I would and could truthfully testify to these facts.

2. I was asked by the Plaintiffs in this litigation to provide my expert opinion on the impacts to threatened Upper Willamette River Chinook salmon and bull trout caused by Trail Bridge Dam, which is owned and operated by Eugene Water and Electric Board (“EWEB”). I was also asked to provide my expert opinion on interim measures that could be implemented to provide immediate and temporary relief.

Professional Qualifications and Experience

3. I received a Bachelor of Science (B.S.) from the University of Idaho in 1975 and have 40 years of experience conducting research and monitoring on salmon and steelhead, including 36 years with the Oregon Department of Fish and Wildlife (“ODFW”) conducting studies, evaluating management actions, and providing management recommendations. I served as the Research Project Leader on the Willamette Spring Chinook Research Project from 2004 to 2013 and was an Assistant Project Leader from 1996–2004. I retired from ODFW as a Research Project Leader in 2013 and continued to work part-time on advising the project and writing research papers. My principal job responsibilities at ODFW included the development and implementation of research on the life history and habitat use of spring Chinook in the Willamette and Sandy basins to provide information for protecting and recovering populations, analysis and writing of research results, coordination with ODFW management, presentation of research results at agency, interagency, and professional meetings, coordination with state and federal agencies, and collaboration with scientists from Oregon State University, University of Oregon, and Oregon Watershed Enhancement Board.

4. I have worked with spring Chinook salmon on numerous rivers including the Salmon and Middle Fork Salmon Rivers in Idaho and the Deschutes, Warm Springs, John Day, McKenzie, North and South Santiam, Clackamas, and Sandy Rivers in Oregon. My experience includes extensive spawning ground surveys, design and implementation of research studies, and development of management plans. I have conducted research and monitoring studies on numerous aspects including status and trends of natural populations, life history diversity and population stability, effect of catch-and-release fisheries on spring Chinook salmon, composition of hatchery-wild fish in spawning populations, strategies to reduce hatchery strays, and hatchery fish release strategies.

5. I coordinated efforts by the Oregon Chapter of the American Fisheries Society to gather and summarize information on the status of bull trout in Oregon and was the lead author in drafting a petition to list the Klamath subpopulation of bull trout under the Endangered Species Act (“ESA”) in 1993. I also was the lead author in drafting a document on critical habitat and viability assessment of the Klamath bull trout that was submitted to the U.S. Fish and Wildlife Service (“FWS”).

6. I helped design and implement a broad set of research activities for ODFW starting in 1996 that included intensive spawning surveys and collection of biological data, juvenile fish sampling and tagging in spawning tributaries and in the mainstem Willamette River to identify migratory behavior, a research study of the effects of catch-and-release fishing in the lower Willamette River, and a marking program that enabled fish managers to identify and manage wild and hatchery Chinook salmon (this included a hatchery-wide fin clipping program and thermal marking of otoliths to differentiate unclipped hatchery fish from wild fish in

carcasses collected on spawning grounds). The results of our work were used to help develop conservation and recovery objectives for Upper Willamette River (“UWR”) Chinook salmon.

7. The results of our surveys have been published in a series of annual reports and scientific papers. Our work was the basis for a comprehensive research paper on the diversity of life histories in juvenile Chinook salmon that demonstrated how diversity provides stability and resilience to smolt production in the Willamette Basin. We are currently working on a research paper about life history diversity in adult Chinook that also shows how diversity makes populations more stable. I have collaborated with university scientists to develop criteria and identify winter habitat for juvenile Chinook salmon in the Willamette River and adjacent floodplains. A selected list of publications includes:

- Schroeder, R. K., L. D. Whitman, and B. Cannon. In preparation. Life History Diversity and Contribution to Population Stability in Adult Chinook Salmon of the Willamette and Sandy Rivers, Oregon.
- Schroeder, R. K., L. D. Whitman, B. Cannon, and P. Olmsted. 2016. Juvenile life history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon. *Canadian Journal of Fisheries and Aquatic Sciences* 73:921–934.
- Whitman, L.D, R.K. Schroeder, and T.A. Friesen. 2017. Evaluating migration timing and habitat for juvenile Chinook salmon and winter steelhead in the mainstem Willamette River and major spawning tributaries. Final report to Army Corps of Engineers.
- Billman, E.J., L. D Whitman, R. K. Schroeder, C. S. Sharpe, D. L. Noakes, and C. B. Schreck, 2014. Body morphology differs in wild juvenile Chinook salmon *Oncorhynchus tshawytscha* that express different migratory phenotypes in the Willamette River, Oregon, USA. *Journal of Fish Biology*, 85:1097-1110.
- Lindsay, R.B., R.K. Schroeder, K.R. Kenaston, R. Toman, and M.A. Buckman. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. *North American Journal of Fisheries Management* 24:367–378.
- Schroeder, R.K. 2007. Rainbow trout in the Deschutes and White rivers, Oregon. Pages 65–75 in *Redband trout: resilience and challenge in a changing landscape*, R.K. Schroeder and J.D. Hall, editors. Oregon Chapter, American Fisheries Society, Corvallis.

8. I have also conducted research and assisted in developing management guidelines for winter and summer steelhead, fall Chinook salmon, and redband trout. I have served on science and professional society committees including the Clackamas Science Review Team to assess the effects of PGE dam operations on salmon and steelhead populations, Chair of Natural Production Committee for the Oregon Chapter of the American Fisheries Society (“AFS”), President of Oregon AFS, Snake River Review Committee for Western Division AFS, and Resolutions Committee for AFS at the national level.

9. I have received awards and recognition for my work including Oregon AFS awards of Fishery Worker of the Year (1998), Award of Merit (1993), and Past-president (1996–1997), as well as ODFW awards of Biologist of the Year (2011, Northwest Region) and Technical Achievement Award (1997, Northwest Region).

10. I served as an expert witness in a case against the Army Corps of Engineers regarding their dam operations in the Upper Willamette River basin and harm to listed spring Chinook salmon and winter steelhead. I filed several declarations on the merits of jeopardy and take claims that presented biological data and information regarding take and population harm of the Corps’ operations. I also submitted declarations addressing remedies that included specific measures and operational changes and was assigned by the court to an expert panel to develop the specific implementation details of the court-ordered injunction measures and to review progress in implementing the injunction measures. *See Northwest Env’tl. Defense Ctr. v. U.S. Army Corps of Engrs.*, No. 3:18-cv-437-HZ, ECF Nos. 37, 76, 97, 119, 144, 196, 208, 224, 228, 233, 238, 240, 249, 278, 293, 297 (D. Or., filed Mar. 13, 2018).

Upper Willamette River Chinook Salmon

11. Spring Chinook salmon is a native species of anadromous salmon found upstream of Willamette Falls.¹ These fish are listed as threatened under the ESA and critical habitat has been designated within the Willamette Basin, including the McKenzie River and tributaries. Chinook salmon native to the Willamette River basin return from the ocean as adults in late winter and early spring (spring run), the only season when passage was historically possible at Willamette Falls. Early run timing and isolation of the populations upstream of the falls resulted in a genetically divergent group among Columbia River Chinook salmon. Our research indicated a broad range of life histories in juvenile Chinook salmon and two primary smolt life histories: those that migrate to the ocean in their first year of life (subyearling) and those that migrate in their second year (yearling). The presence of two life histories is somewhat unique among spring Chinook populations and was first documented in the Willamette populations in the 1940s, before the construction of dams.

12. Willamette Falls historically restricted migration of adult spring Chinook into the upper Willamette River basin to periods of high spring flows. The run generally peaks at Willamette Falls from late April through May and can extend into late August and early September. Adult Chinook migrate to the McKenzie River and continue migrating past Leaburg Dam starting in late April with peak passage normally occurring in June through mid-July and continuing into mid-October. Adult salmon “hold” in the deep pools with cool water temperatures through the summer. The historic spawning period for UWR Chinook probably

¹ Anadromous fish are those that spawn in freshwater, migrate to the ocean to rear, and return to freshwater. Other native anadromous species found upstream of Willamette Falls are winter steelhead and lamprey.

extended from July through October, but spawning presently begins in late August and continues into late October, with peak spawning generally in late September.

13. Adult Chinook salmon deposit their eggs in the fall, and low water temperatures in fall and winter ensure that incubation is timed to allow fry to emerge the following spring when there is sufficient food for survival and growth. The exact timing of spawning varies with water temperature: fish in the upper watersheds with cold water spawn earlier than fish in the lower areas of the watershed. Because Chinook spawn in the fall and their offspring emerge from the gravel the following spring, spawning success is greatest where gravel substrate is fairly stable and does not scour out or shift during high flows. Water quality in the upper McKenzie River basin provides excellent spawning, incubation, and rearing habitat.

14. Currently, less than 10,000 wild Chinook salmon return each year to the UWR basin, which is a fraction of the several hundred thousand that historically returned each year. In addition, only the Clackamas and McKenzie subbasins have significant numbers of naturally produced (wild) fish. Seven independent populations of spring Chinook have been identified in the UWR Chinook evolutionarily significant unit (“ESU”)²: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette. The McKenzie population was identified as both a “core population” and a “genetic legacy population.” Core populations are those with high productivity and generally higher abundance, which are important for achieving recovery. Legacy populations represent historical genetic diversity and they generally have a larger abundance of wild fish within the population.

² An ESU is a group of populations that is substantially reproductively isolated from other populations, and represents an important component in the evolutionary legacy of the biological species. Listed bull trout are classified as a distinct population segment (“DPS”), which must be discrete from other populations, and it must be significant to its taxon. ESU and DPS are considered inclusive; i.e., an ESU constitutes a DPS.

15. Historical genetic diversity is important for conservation and recovery because it represents the adaptive capacity of populations to respond to environmental change. The emphasis of conservation and recovery efforts is on wild fish because hatchery-origin fish have been shown to have lower reproductive success and lower fitness (e.g., lower genetic and life history diversity). Viability analysis used for developing and monitoring conservation and recovery measures considers that hatchery-origin fish can contribute to spawners, but do not count as recruits; i.e., the return of first-generation hatchery adults does not contribute to the natural productivity and long-term viability of a population.

16. The estimated number of wild spring Chinook in the McKenzie River has averaged about 2200 adult returns from 2002–2023.³ The trend in wild fish, as measured with a 5-year moving average, declined from a return of >3500 in 2002–2006 to a low of <1500 in 2013–2017. The 5-year average has been relatively stable at around 2000 adults since 2015. The estimated percentage of hatchery fish in the population averaged >35% for the whole river in 2019–2024, but the average percentage of hatchery fish was 1.7% in the upper part of the basin (upstream of McKenzie Bridge including Horse Creek). Therefore, the vast majority of Chinook salmon affected by Trail Bridge Dam are wild fish.

17. The 2011 Conservation and Recovery Plan included two recovery goals: 1) achieve delisting from the federal ESA threatened and endangered species list, and 2) achieve ‘broad sense recovery’ defined by Oregon as having populations of naturally produced salmon that maintain self-sustaining populations while providing for significant ecological, cultural, and economic benefits. The plan further adopted four biological attributes that contribute to the

³ 2002 is the first year when all hatchery adult salmon had a fin clip and a thermal mark on their otoliths (ear bones) so that hatchery origin fish could be identified by fin clip in video counts at Leaburg Dam and by fin clip and thermal mark in carcasses recovered on spawning grounds.

viability of salmon populations: abundance, productivity, spatial distribution, and diversity. Viability is based on an assessment of biological or physical criteria that when met would indicate the target population or group of populations is unlikely to go extinct. The viability criteria consist of a measured parameter or metric (e.g., number of adults) and a value of the metric or threshold above which the population would be considered viable.

18. In general, the abundance and productivity criteria have been considered as a single attribute because they are closely related; that is, the abundance of salmon in a population is a reflection of the growth rate or productivity of that population (e.g., returning adults per spawner). A primary measure of abundance is time series of adult returns, but may also include information such as harvest rate, percentage of hatchery origin spawners, and age structure of the population. Spatial structure is a measure of how populations are geographically arranged based on their ability to disperse and the quality of habitats. Spatial structure can be assessed through measures such as the number and distribution of spawning areas and the proportion of the historical range presently occupied. Population diversity includes both the genetic makeup of the population and the life history characteristics that provide a foundation for the resilience and persistence of populations in the face of environmental change.

19. The 2011 Conservation and Recovery Plan identified “conservation gaps,” or the amount of improvement needed to achieve a desired status, which is defined generally as low to very low risk of extinction. The conservation gaps emphasized adult abundance because it is more easily measured and understood compared to other measures such as spatial structure and diversity. The desired status for individual populations was set to achieve an overall low risk of extinction for the entire Willamette River ESU, consisting of the aforementioned seven populations (*see* ¶ 13). The conservation gap for the McKenzie population was estimated at

about 3500 adults; that is, the average return would need to improve by 3500 adults to achieve the desired risk of extinction. Achieving this goal requires improvement throughout the McKenzie Basin, including providing upstream and downstream passage at Trail Bridge Dam to allow Chinook salmon to access this historic spawning and rearing habitat.

20. The 2024 status report for UWR Chinook salmon found that the McKenzie population “remains well below its recovery goals” and that the population is at low to moderate risk of extinction over a 100-year time frame. Access to upper watershed habitats was identified as a key element for reducing risk to populations, and the area upstream of Trail Bridge Dam was identified for the McKenzie population (along with that upstream of Cougar Dam). Providing effective passage at dams and access to historical spawning and rearing habitat is one of the “greatest opportunit[ies] to advance the recovery of UWR Chinook.” However, long delays by EWEB in addressing passage at Trail Bridge Dam resulted in the National Marine Fisheries Service (“NMFS”) writing a letter to the Federal Energy Regulatory Commission (“FERC”) on the noncompliance of EWEB: “...we have no confidence that EWEB will implement the license as issued, particularly with respect to protections for Upper Willamette River (UWR) Chinook salmon...”⁴

Upper Willamette River Bull Trout

21. Bull trout are a native species of the Willamette Basin and they were listed as threatened under the Endangered Species Act in 1998 as part of the greater Columbia Basin listing. Bull trout in the McKenzie River were included as part of the Upper Willamette core area. Designated critical habitat includes all of the McKenzie River including the river and

⁴ Letter from NMFS to FERC re: noncompliance with license, dated October 17, 2023, attached to opening preliminary injunction brief as Exhibit 8; *see also* letter from U.S. Fish and Wildlife Service to FERC re: noncompliance with license, dated October 26, 2023, attached as Exhibit 9.

tributaries upstream of Trail Bridge Dam. Historically, bull trout in the McKenzie River functioned as a single population and likely had interchange with populations in the Middle Fork Willamette River. Construction of dams and degradation of water quality resulted in the fragmentation and isolation of populations. Currently, bull trout in the McKenzie Basin are composed of three subpopulations that include South Fork McKenzie upstream of Cougar Dam, McKenzie upstream of Trail Bridge Dam, and the McKenzie River downstream of these dams.

22. Bull trout can express both resident and migratory life histories and both life histories can co-occur within populations. Migratory bull trout spawn in tributary streams or small mainstem rivers and may rear 1–4 years before migrating to a lake or reservoir (adfluvial form) or to a larger river (fluvial form). Adult bull trout migrate within the McKenzie River corridor and tagged fish have been detected passing upstream at Leaburg Dam. Use of the mainstem river habitat allows bull trout to feed on a range of fish species and grow to large size (>30 inches), which increases the reproductive potential of individuals and contributes to an increase in the productivity of the population. Bull trout reach sexual maturity in 4–7 years on average and often live for 10 years and may live up to 20 years or more.

23. Bull trout have specific habitat requirements for spawning, incubation, and rearing. Preferred spawning habitat consists of loose, clean gravel patches with water temperatures of 39–51° F in August to November in stream reaches often fed by springs or cold groundwater. The optimum temperature for egg incubation is 35–39° F and egg incubation is usually 100–145 days, although it may exceed 200 days in water that is consistently cold. Fry will normally emerge in April and May, depending on water temperature. The upper McKenzie Basin, including the area upstream of Trail Bridge Dam, provides excellent habitat for bull trout

because of cold groundwater discharge originating from precipitation and snowmelt that percolates into fractured lava flows of the Cascade Mountains and collects in a large aquifer.

24. The goals of the 2015 Bull Trout Recovery plan were to: 1) achieve widespread geographic distribution across representative habitats and demographically stable populations in each recovery unit, 2) conserve genetic diversity and diverse life history forms, and 3) conserve and connect cold water habitats essential to bull trout. Among the measures identified in the plan were efforts to: 1) protect, restore, and maintain suitable habitat conditions, and 2) restore connectivity for genetic and life history diversity. Specifically, implementation and action plans for Upper Willamette bull trout identified upstream and downstream passage at Trail Bridge Dam as a key conservation and recovery action for connecting populations to conserve genetic and life history diversity.

25. The 2024 FWS species status report ranked the population trend for UWR bull trout as stable. Status of bull trout abundance is often assessed by surveying and counting nests made in gravel in which a female lays her eggs (redds). Counts for the area upstream of Trail Bridge in 2021–2024 have averaged about 45 redds in the McKenzie River and about 13 redds in Sweetwater Creek. For comparison, Anderson Creek (downstream of Trail Bridge Dam) has averaged about 75 redds in 2021–2024. Among the assessed threats to the UWR populations in the status report, impaired connectivity caused by fish passage issues at dams was ranked high to severe. Other threats included reduced prey base from lack of fish passage at dams resulting in loss of or reduced native fish populations upstream and downstream of dams (high threat) and altered water flows from dams that has reduced pools and complex habitats for juvenile and adult rearing (moderate to high threat).

26. The status report modeled the potential effects of climate change on bull trout spawning and rearing habitat and estimated that the available stream length would decrease from about 20 km at present to 13 km by 2050 and 9 km by 2090. Another assessment of the effects of climate change on bull trout estimated that the percentage of streams with optimal August temperatures would decrease from 17% that were available in the 1980s to <4% by 2080.⁵ In light of these expected climatic changes, the habitat in the upper McKenzie River, including the area upstream of Trail Bridge Dam, will likely be the stronghold for the continued persistence of the species.

Trail Bridge Dam Impacts

Lack of Passage

27. The primary impact of Trail Bridge Dam is that it serves as an absolute barrier that blocks access to historic spawning and rearing habitat for both spring Chinook salmon and bull trout. Habitat upstream of Trail Bridge Dam is important for both species because it contains good spawning gravel and cold water. As noted previously, bull trout have specific temperature requirements for spawning, incubation, and early growth that are found upstream of the dam (*see* ¶ 22). Chinook salmon also require cold water habitat during summer because they migrate to spawning rivers in spring and hold in pools until they spawn in late summer and fall. In addition, Chinook eggs that incubate in cold water develop slowly to enable fry to emerge in late winter or early spring when more food is available and winter floods have subsided.

28. These cold-water habitats will become increasingly important because environmental changes caused by climate change are predicted to result in increases in water

⁵ Penaluna, B.E., D. Horan, G.H. Reeves, D.J. Isaak, and J.C. Chatel. 2022. *Climate change effects on fishes of concern*. Chapter 4, pages 85–158 in General Technical Report PNW-GTR-1001, U.S. Forest Service, Pacific Northwest Research Station, Portland.

temperature and flows as precipitation in high elevation areas shifts from snow to rain in a warming climate.⁶ For example, the number of days with water temperature at suboptimal conditions for Chinook salmon and bull trout are projected to increase and high flow events are also predicted to increase. These changes will have a more pronounced effect on streams that originate in the rain-dominated Western Cascades, thereby increasing the importance of the upper McKenzie River for Chinook salmon and bull trout because of groundwater sources of cool water originating in the High Cascades. Thus, a major impact of Trail Bridge Dam is that it blocks upstream passage to the high-quality habitat upstream of the dam and hampers downstream migration of juvenile salmonids and adult bull trout.

29. Lack of passage has impacted the establishment of Chinook salmon upstream of Trail Bridge Dam. In addition to the effects on the recovery of Chinook salmon in the McKenzie Basin, and the consequent effect on the recovery of the Willamette ESU as a whole, the reduced population of Chinook salmon also affects bull trout because their prey base of Chinook eggs and juveniles has been reduced. A reduced prey base decreases the growth potential of adult bull trout, resulting in lower fecundity and reduced productivity of the population. Lack of upstream and downstream passage at Trail Bridge Dam results in the inability of Chinook salmon to reach and use historic spawning and rearing habitat upstream of the dam.

30. Trail Bridge Dam affects the ability of bull trout to connect with the population of bull trout that resides in the upper McKenzie Basin downstream of the dam. Downstream migration of adult bull trout is affected by the dam and bull trout that migrate through the

⁶ For example, see Tague, C. and G.E. Grant. 2009. *Groundwater dynamics mediate low-flow response to global warming in snow-dominated alpine regions*. *Water Resources Research* 45:W07421; Nolin, A.W. 2012. *Perspectives on climate, mountain hydrology, and water resources in the Oregon Cascades, USA*. *Mountain Research and Development*, 32(S1):S35-S46; Penaluna et al. 2022. *Climate change effects on fishes of concern*.

spillway are exposed to injury, stress, and potentially elevated levels of dissolved gases downstream of the spillway. Trail Bridge Dam has affected genetic exchange of bull trout upstream of the dam with those downstream of the dam. Genetic analysis of bull trout in 2017 found that: “Trail Bridge Dam has formed a major barrier limiting gene flow and facilitating a low effective population size that has likely resulted in rapid genetic drift.”⁷ Gene flow is the transfer of genetic material when individuals migrate and spawn between areas and populations; thus barriers prevent the necessary connectivity between populations resulting in potential genetic and evolutionary consequences.⁸ Gene flow increases the genetic diversity of populations and can improve the adaptive capacity of populations to deal with environmental changes, and can be particularly important for maintaining genetic diversity in small populations such as UWR bull trout.

31. Effective population size (N_e) is the number of successful breeding individuals per generation and is usually lower than the census population. Low N_e can occur from factors such as small population size, fluctuations in population size, and unequal sex ratio; and can result in inbreeding, loss of genetic diversity, and increased risk of extinction from random environmental events. Genetic drift is the random fluctuation of the genetic makeup of a population due to chance events that leads to loss of genetic variation and can reduce the adaptability of small populations. Genetic drift in small populations can increase the chances of harmful mutations becoming fixed, which reduces fitness and makes populations more

⁷ Bohling, J.H., 2017. *Assessment of bull trout genetic diversity, population connectivity, and genetic introgression in the Upper Willamette Basin, OR*. U.S. Fish and Wildlife Service, Abernathy Fish Technology Center, Longview WA.

⁸ For example, see Zarri, L.J., E.P. Palkovacs, D.M. Post, N.O. Therkildsen, and A.S. Flecker, A.S. 2022. *The evolutionary consequences of dams and other barriers for riverine fishes*. *BioScience* 72:431-448.

vulnerable to being affected by random events. The difference between genetic drift and natural selection is that drift is random and can have negative effects on populations whereas natural selection is generally directional and influenced by changes in environmental conditions that results in positive change or adaptation to environmental change.

32. Trail Bridge Dam impairs downstream passage for Chinook salmon and bull trout. Unrestricted downstream passage is important in both species for the full expression of life history. Because the McKenzie River is the only subbasin upstream of Willamette Falls where historic spawning and rearing habitat in the upper watershed is still accessible, it can serve as a template for the rearing and migratory behavior of fish under historic conditions. Research on Chinook salmon in the McKenzie has revealed a wide diversity of rearing and migratory behaviors including long-distance migration of newly emerged fry to the lower McKenzie River and the mainstem Willamette River in winter through early spring, migration of juvenile fish in fall and winter, and migration of yearling smolts in the spring of their second year of life.⁹ Our research on juvenile Chinook salmon from the McKenzie River documented six primary migratory types and four secondary life histories, and near continuous downstream migration with seasonal peaks. Downstream migration enables juvenile salmon to occupy a wide range of habitat, grow at different rates, and migrate to the ocean at different times of year and different ages. This diversity in migration spreads risks across time and space that, in turn, increases survival. For example, if an environmental event (fire, landslide) caused high mortality in fish living at a certain place within a watershed, other fish from that same cohort would have migrated to a different habitat and would not be directly affected by the event.

⁹ Schroeder, R.K., L.D. Whitman, B. Cannon, and P. Olmsted. 2016. *Juvenile life history diversity and population stability of spring Chinook salmon in the Willamette River basin, Oregon*. Canadian Journal of Fisheries and Aquatic Sciences 73:921–934.

33. Bull trout are also affected by impaired downstream migration. Downstream migration of both juvenile and adult bull trout is important for genetic interchange within the McKenzie population (*see* ¶ 30). Downstream migration is also critical for the expression of the fluvial life history in bull trout whereby their migration to the lower watershed enables them to access habitat that offers food sources and rearing conditions to achieve higher growth than is possible in the upper watershed. Larger bull trout are an important component of population productivity and population recovery because of their increased reproductive potential.

34. In summary, Trail Bridge Dam is a barrier to the migration of Chinook salmon and bull trout. The lack of upstream passage and ineffective downstream passage at the dam has prevented Chinook salmon from becoming established and utilizing high-quality habitat upstream of the dam to contribute to the McKenzie population and the larger UWR Chinook salmon ESU. The dam has affected bull trout by severing the historic connectivity between those upstream of the dam and those in the upper McKenzie Basin downstream of the dam, resulting in a loss of genetic diversity and reducing the effective population size. The dam has also constrained the life history expression of fluvial bull trout because of impaired downstream passage that inhibits bull trout from accessing productive habitat in the lower McKenzie River watershed, achieving large size, and increasing their reproductive potential. Thus, Trail Bridge Dam causes harm to the McKenzie populations of listed Chinook salmon and bull trout, and continued operation of the dam without immediate improvements to provide safe and effective fish passage will impair the survival and recovery of these important populations.

Trap-and-Haul/Capture of Adults

35. Trail Bridge Dam has resulted in harm and mortality to individual Chinook salmon and bull trout in addition to the broader population harms. Currently, the only passage for

adult Chinook salmon and bull trout is to trap or capture fish and haul them in trucks to release sites upstream of the dam to allow a limited number of fish to reach their historic habitat. Trap-and-haul programs are a non-volitional passage solution that harms fish by increasing stress from handling and transport, and the practice at Trail Bridge Dam has caused injury and mortality.

36. Documented effects of trapping and transporting adult salmon in the Willamette River basin have included elevated stress, physical injury, disease transmission, delay in upstream migration, and mortality before fish have spawned (“prespawn mortality”).¹⁰ Trapping or capturing adult fish can cause physical injuries, including internal injuries that may not be obvious by cursory examination of the fish. Capture, trapping, or handling adult fish can result in direct physical injuries to fish and loss of the protective mucous coat that can lead to infections. The capture, handling, and transport of fish increases stress in adult fish and can result in mortality during each stage of capture and transport or in mortality after release.

37. Adult salmon are already immunocompromised during their spawning migration because they are undergoing stages of senescence; therefore, additional stress increases their vulnerability to disease and infections and may lead to lower reproductive success (e.g., females releasing fewer eggs) or mortality. In addition, adult salmon or bull trout that are trapped and transported can be exposed to disease transmission from other fish, even if exposed for short periods. Spring Chinook salmon are especially vulnerable to these impacts during capture, handling, and transport in late summer and fall because of the long time they have already been holding in freshwater and their late stage of gonadal development. Because spring Chinook salmon are predominantly wild fish in the upper watershed (<2% are hatchery fish, *see* ¶ 16),

¹⁰ For example, *see* Keefer, M.L., G.A. Taylor, D.F. Garletts, G.A. Gauthier, T.M. Pierce, and C.C. Caudill. 2010. *Prespawn mortality in adult spring Chinook salmon outplanted above barrier dams*. *Ecology of Freshwater Fish* 19(3):361-372.

stress or mortality caused by trapping and transporting adult salmon has a pronounced effect on efforts to recover this listed species.

38. At present, the efforts to capture adult fish have been, at best, inconsistent and inadequate. Adult Chinook salmon were netted downstream of Trail Bridge in 2022 and 22 fish were given radio tags, transported, and released upstream of the dam.¹¹ Although external injuries were not reported for the netted fish, this method of capture causes stress and can also result in internal injuries, especially in fish that are close to spawning. Of the 22 transported fish, 20 fell back downstream which would induce additional stress and potential injury. One fish was found dead downstream of the dam and the cause was determined to be a ruptured stomach from the insertion of a radio tag. During the 2023 construction of a temporary fish trap at the upstream end of the Carmen-Smith spawning channel, two bull trout were found dead in the construction area. Therefore, the present operations of capturing Chinook salmon and bull trout to transport them upstream of the dam has resulted in the direct mortality of individual fish of the listed species. As previously noted, the composition of adult salmon in the upper McKenzie watershed is predominantly wild fish (*see* ¶¶ 16, 37).

39. The temporary trap in the spawning channel has captured few fish despite fish observed holding in the vicinity of the trap and the use of an auxiliary pump to increase attraction flow. The design of the trap is such that fish must be enticed to enter the trap one at a time while someone is on-site operating the trap, most likely during daylight hours. However, adult fish tend to migrate during crepuscular and nighttime hours, which may also partially explain the poor performance of the trap (*see* ¶ 48 for more detail on ineffectiveness of trap).

¹¹ Information in this paragraph is from the quarterly report on Trail Bridge Dam fish passage, submitted by EWEB to FERC and dated April 30, 2025 (Attached to opening preliminary injunction brief as Exhibit 10).

40. Bull trout have been caught by hook and line downstream of Trail Bridge Dam and transported upstream. Use of hook and line can result in injury and mortality (immediate and delayed), stress from being caught and landed, and stress from handling and transport. Catching fish with hook-and-line can cause injuries to the mouth, eye, gills, or other body parts, which could decrease the ability of bull trout to effectively forage for prey, increase vulnerability to infections, and cause mortality from loss of blood (e.g., injury to gills). Hooking and landing bull trout causes elevated stress that increases with the amount of time it takes to land, handle, and transport the fish. As explained earlier, stress can result in increased vulnerability to infections and disease, can lower reproductive success, and can lead to mortality (*see* ¶¶ 36-37).

Other Effects

41. The tailrace barrier that is meant to prevent adult fish from passing upstream to the powerhouse tailrace is ineffective based on observations of adult fish upstream of the barrier. This results in adult fish unnecessarily expending energy and facing potential injury when they pass upstream to a dead end at the tailrace.

42. Juvenile salmon and bull trout produced upstream of Trail Bridge Dam will face difficulties in migrating downstream because of the lack of effective fish passage and the operation of the dam. Injury and mortality will likely occur as the juvenile salmonids attempt to migrate downstream through turbine or spillway routes. The spillway gate opening is limited at Trail Bridge Dam, which increases the potential for injury from collision with the gate as well as the spillway walls and chute. In addition, other hydraulic forces can cause injury (e.g., shear stress, pressure changes, acceleration) and often occur in conjunction with physical injuries from

collisions.¹² Larger fish such as adult and subadult bull trout are particularly vulnerable to injury and mortality from passage through turbine or spillway routes. Because these are the only available routes for downstream passage, fish are exposed to injury and physiological stress during passage that can result in instantaneous death or delayed mortality, which manifests itself as the fish continues to migrate downstream.

43. Juvenile salmonids can get stranded in shallow areas of the Trail Bridge Reservoir because of the operations of the dam. A study found that salmonid fry were stranded in interstitial spaces of cobble or potholes on gradual slopes and that stranding occurred during large and small fluctuations in the water level.¹³ Most of the stranded fish were dead, although some were alive in small, isolated pools.

44. The presence of brook trout in Trail Bridge Reservoir can impact bull trout through hybridization. Although the 2017 genetic analysis found a low percentage of brook trout alleles in sampled bull trout (~1.4%), it was noted that hybridization is nonetheless a concern because “the reduced effective size of the [bull trout] population suggests this is not a particularly large or robust population that can resist introgression.”¹⁴

45. In summary, the ongoing operation of Trail Bridge Dam continues to disrupt the life history of UWR Chinook salmon and bull trout because of lack of access to historic spawning and rearing habitat, and lack of effective and safe passage for juvenile fish through the dam. Deleterious effects of trapping and transporting adult fish negatively affect efforts to

¹² Cox, R.X., R.T. Kingsford, I. Suthers, and S. Felder. 2023. *Fish injury from movements across hydraulic structures: A review*. *Water*, 15(10):1888

¹³ Bell, E., Kramer, S., Zajanc, D. and Aspittle, J., 2008. *Salmonid fry stranding mortality associated with daily water level fluctuations in Trail Bridge Reservoir, Oregon*. *North American Journal of Fisheries Management* 28:1515–1528.

¹⁴ Bohling 2017. *Assessment of bull trout genetic diversity*.

conserve and recover the listed species. Effects on Chinook salmon are especially detrimental because they affect predominantly wild fish that are present in the upper watershed, and the wild salmon population in the McKenzie River is of critical importance for the recovery of UWR Chinook salmon.

46. All of the attributes considered critical for long-term recovery and continued viability of the UWR salmon and bull trout populations continue to be affected by the operations of Trail Bridge Dam. These effects include: abundance levels well below recovery levels; lack of spatial structure because of blocked access to historic habitats and loss of downstream passage for juvenile fish to disperse and migrate naturally; loss of genetic diversity because of low abundance of adults and lack of connectivity; and disruption to rearing and migratory life histories. Our research has shown that life history diversity of Chinook salmon in both the adult and juvenile stages provides stability and resilience to populations. Under projected effects of climate change in the Willamette Basin, protection of life history diversity will be critical for maintaining spring Chinook and bull trout populations, and access to high-quality habitat, such as that upstream of Trail Bridge Dam, will increase in importance.

Proposed Interim Measures

47. As discussed above, the prospects for the future survival and recovery of UWR Chinook salmon and bull trout are directly and materially harmed by the present operation of Trail Bridge Dam. To help alleviate this continuing harm to these species, I propose the following interim measures that should be immediately adopted and implemented by EWEB.

48. The trap in the Carmen-Smith spawning channel should be relocated and modified to overcome the shortcomings of the existing trap. The trap presently installed in the spawning channel is inadequate for the capture and transport of adult salmon and bull trout

because: 1) the trap is too small to accommodate more than one fish, 2) the trap is designed to be manually and occasionally operated (vs. a volitional entry design), which requires someone to be on-site during daylight hours, 3) the trap is located in a pool that is too deep for creating adequate flow to attract fish to enter the small trap (as evidenced by observations of fish holding in the vicinity of the trap but not entering), and 4) the entrance to the trap is on the side of the trap perpendicular to the flow (vs. on the downstream side and directional to flow), further confusing fish and preventing them from entering. In conclusion, the current location and design of the trap is insufficient for attracting fish to the trap entrance and for volitional capture of multiple fish.

49. To address these problems, a new fish trap should be immediately constructed and located to address the present inadequacies: 1) construct a trap box with capacity to accommodate multiple adult salmon or bull trout (e.g., 10–12 fish), 2) design the trap box with a fyke¹⁵ entrance so that adult fish can volitionally enter during their natural period of upstream migration (generally dusk to midnight), 3) construct the trap box with round aluminum or steel pipe to minimize sharp edges and with spacing between pipes narrow enough to prevent fish from getting their heads stuck (e.g., ≤ 1 inch¹⁶), 4) construct a lid for the trap box to provide shade and calm fish in the trap, 5) install guidance picket weirs (wings) to lead fish to the trap entrance, and 6) relocate the new trap downstream to take advantage of natural current for attraction flow; either at the tailout of the pool at the upstream end of the spawning channel or

¹⁵ A fyke is a V-shaped trap entrance that narrows toward the interior of the trap, with an interior gap that is wide enough for fish to comfortably enter the trap and ends with a narrow opening to prevent fish from easily exiting. The fyke entrance can be fitted with a gate that can be closed when processing trapped fish.

¹⁶ NMFS (National Marine Fisheries Service) 2022. NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual, NMFS, WCR, Portland, Oregon.

near the entrance of the spawning channel. Individual fish should be netted and processed (*see ¶ 50*) using methods to minimize stress such as a covered cradle inside the trap box or a removable gate at the upstream end of the trap box to move individual fish into a covered, V-shaped trough. Trap boxes and picket weirs are commonly used in streams to capture adult fish and their design and construction are relatively simple. Construction of a new trap box can be completed within a month and installation of the new trap box and weir can be completed in a day or two, therefore, a new trap should be ready for the majority of the 2025 adult migration period.

50. To monitor the success of these changes, and the trap-and-haul process generally, EWEB should implement the following: 1) install underwater cameras at the trap entrance to observe fish behavior and evidence of trap avoidance, 2) give each trapped fish a PIT (Passive Integrated Transponder) tag¹⁷ if it does not already have one (inserted into the dorsal sinus for Chinook salmon instead of into the body cavity) and use a covered cradle or V-shaped trough to keep fish calm and minimize handling or use a water bath with anesthetic, 3) install PIT tag antennas at the entrance to the spawning channel and at the tailrace barrier (flexible design) to collect data on fall back of fish transported upstream of the dam, and data on downstream movement of adult and subadult bull trout, and 4) collect tissue samples from all transported fish for genetic analysis.

51. Additionally, a team of biologists should be formed to investigate alternative trap designs or locations that could be implemented next year if the monitoring shows the spawning channel trap is still insufficient to meet objectives. Priority would be for methods that minimize

¹⁷ PIT tags are small (grain of rice) tags implanted in fish with unique alphanumeric codes for identifying and tracking individual fish. The tags are based on radio-frequency identification (RFID) technology and are activated when a fish enters the electromagnetic field of an antenna. The activated tag transmits the unique code to a receiver where it is recorded and stored.

handling and stress of adult fish. Alternative trapping sites should be investigated, such as in the vicinity of the velocity barrier downstream of the dam. One possibility would be to create a notch in the velocity barrier to create a single point of attraction and incorporate a passive adult trap upstream of the notch. If water velocity needs to be reduced through the trap, flow could be dissipated with additional notches in the barrier that would be blocked with a picket gate (or some other means of exclusion), and/or a velocity break could be installed upstream of the trap. Because these more significant changes for trapping require additional time for investigation, design, and implementation than the recommendations in ¶ 50, planning for these potential changes should begin immediately so they could be implemented by next summer, if needed.

52. Fish can fall back over a dam after being transported and released upstream of the dam, especially if fish transported were produced by adults that spawned downstream of the dam. Fall back rates of up to 25% were reported in a review of trap-and-haul;¹⁸ therefore, the reported fall back rate of 91% for the 22 Chinook transported above Trail Bridge Dam is excessive (*see* ¶ 38). Measures to reduce fall back mentioned in the trap-and-haul review include: 1) increase the distance between the release site and the dam, 2) release fish into free-flowing water rather than into a reservoir, and 3) release fish into a tributary. Because available release locations upstream of Trail Bridge Dam may be limited and prevent full implementation of these suggested measures, other measures may be needed to reduce fall back. A temporary weir could be used upstream of Trail Bridge Dam to keep transported fish in an area with

¹⁸ Kock, T.J., J. W. Ferguson, M.L. Keefer, and C.B. Schreck. 2021. *Review of trap-and-haul for managing Pacific salmonids (Oncorhynchus spp.) in impounded river systems*. *Reviews in Fish Biology and Fisheries* 31(1):53-94. It should be noted that fall back rates at fish ladders can be similar to that for trap-and-haul. However, the difference is that most of the fish that fall back will reascend fish ladders whereas those that fall back after transport are lost to the population upstream of the dam (unless they are trapped and transported more than once).

spawning gravel, thus progeny that returned would be inclined to home to the area upstream of the dam. A team of biologists would identify stream reaches that contain good spawning gravel where adult salmon could be released, and install a temporary weir at the downstream end to prevent fall back. The downstream end should include a pool area where fish could hold. Adult salmon released in the blocked area should be from the latter part of the run and close to spawning. The area would need to be closely monitored, especially shortly after fish are released, to observe fish behavior and to provide for downstream passage of any adult bull trout in the area. A weir has been installed upstream of Trail Bridge Dam in the past when bull trout were released upstream of the dam.

53. Improvements for downstream passage such as modifications to allow a larger gate opening should be implemented without further delay to facilitate downstream passage of juvenile salmonids and adult bull trout.

54. These measures should be considered a minimum to prevent further harm to the species while EWEB begins immediate work on permanent changes to remedy upstream and downstream passage. I concur with the conclusions of NMFS and FWS that "...an appropriate solution is for EWEB to design and construct facilities to allow for the *volitional* upstream and downstream migration of ESA-listed salmonids to be completed on the fastest possible timeline, with no further excuses for delay" (emphasis added).¹⁹ The long-term strategy must be for volitional and effective upstream and downstream passage at Trail Bridge Dam that includes, but is not limited to, construction of a fish ladder and modifications to dam operations and the spillway that will minimize harm to migrating Chinook salmon and bull trout (e.g., gate opening

¹⁹ NMFS letter to FERC, October 17, 2023 (Exhibit 8); FWS letter to FERC, October 26, 2023 (Exhibit 9) (*see supra* n. 4) (*see* footnote 6 in letters for reference to construction of a fish ladder).

improvements and epoxy coating to create smooth surfaces). A fish ladder at Trail Bridge Dam should be installed for the effective upstream passage of Chinook salmon and bull trout. An effective fish ladder would allow salmon and bull trout to naturally migrate upstream and would function volitionally, with less oversight, onsite personnel, and ongoing costs than that required to operate a trap-and-haul system. As evidenced by the disruption of recent wildfires, a fish ladder would continue to function if personnel could not be on-site as opposed to a trap-and-haul system that requires onsite human operation to remove fish from a trap, and handle and transport fish. A fish ladder would also eliminate the stress and physical injuries to fish caused by trapping, handling, and transport during trap-and-haul. Therefore, the design for a fish ladder should be finalized and construction should begin without further delay. As NMFS has noted: “...we have no confidence in EWEB complying with its license; and that EWEB must be ordered to construct and operate fish passage facilities immediately.”²⁰

Conclusions

55. Trail Bridge Dam is an absolute barrier for passage to historic spawning and rearing habitat for Chinook salmon and bull trout in the upper McKenzie River. Efforts to provide temporary upstream passage at the dam have been ineffective and have resulted in injury and mortality to salmon and bull trout. Downstream passage at Trail Bridge Dam is inadequate for juvenile salmon and bull trout and for adult bull trout. Therefore, the operation of Trail Bridge Dam prevents the expression of the natural migratory behaviors of adult and juvenile salmon and bull trout, resulting in a loss of life history diversity which has shown to provide stability and resilience to populations. Operation of the dam has resulted in the loss of

²⁰ NMFS letter to FERC, October 17, 2023 (Exhibit 8); FWS letter to FERC, October 26, 2023 (Exhibit 9) (*see* footnote 6 in letters for reference to construction of a fish ladder).

productivity for Chinook salmon and bull trout populations, thus causing harm to the populations and jeopardizing conservation and recovery efforts, as well as the future viability of these species.

56. In particular, injury and mortality caused directly or indirectly by Trail Bridge Dam operations, including the capture and transport of adults, has affected primarily wild spring Chinook salmon. Over 98% of the adult Chinook salmon in the upper watershed (upstream of McKenzie Bridge including Horse Creek) are wild (*see* ¶ 16), and this component represents about 50% of the wild population found upstream of Leaburg Dam based on the 2010–2024 average. Wild spring Chinook salmon are of critical importance for recovery of this species in the McKenzie River, therefore, the wild fish component in the upper watershed is essential not only for successful recovery of the McKenzie River population but for the UWR Chinook ESU as a whole. I concur with the conclusions of NMFS on the effects of the considerable delay and changes requested by EWEB (such as replacing a fish ladder with trap-and-haul): “...the changes requested by EWEB to the settlement agreement have led to significant harm to ESA-listed salmon.”²¹

57. Operation of Trail Bridge Dam has put hydroelectric production as a higher priority than conservation and recovery of the listed fish species, and EWEB has repeatedly delayed mandated changes to the dam. As noted by FWS: “EWEB’s actions have spoken louder than words—they simply have not prioritized timely completion of fish passage as intended in the settlement agreement and required by their license.”²² The result of this continued inaction is that Chinook salmon and bull trout are unable to fully utilize the historic spawning and rearing

²¹ NMFS letter to FERC, October 17, 2023 (Exhibit 8).

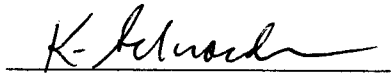
²² FWS letter to FERC, October 26, 2023 (Exhibit 9).

habitat upstream of the dam, which would contribute to recovery goals for abundance, distribution, connectivity, and genetic and life history diversity.

58. In my professional opinion, interim measures are imminently needed to prevent further harm, injury, and mortality of listed UWR Chinook salmon and bull trout caused by Trail Bridge Dam and the temporary efforts to capture and transport fish upstream of the dam. Operation of the dam should be prioritized for the downstream passage of juvenile salmonids and adult bull trout. Improved temporary trapping efforts should be initiated by August 2025 and alternative plans should be developed that could be implemented in 2026 at the latest.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Signed this 14th of May, 2025, in Philomath, Oregon.

A handwritten signature in black ink, appearing to read "K. Schroeder", is written over a horizontal line.

Kirk Schroeder

EXHIBIT 2

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UNITED STATES DISTRICT COURT
DISTRICT OF OREGON
EUGENE DIVISION

CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

DECLARATION OF BETHANY
COTTON

EUGENE WATER & ELECTRIC
BOARD,

Defendant.

I, BETHANY COTTON, hereby declare as follows:

1. I am a resident of the United States. I live in Eugene, Oregon.
2. My drinking water is sourced from the McKenzie River. I am a ratepayer of the Eugene Water and Electric Board (“EWEB”).
3. I am an attorney and hold a certificate in Environmental and Natural Resources Law with a specialization in Animal Law.
4. I am an active member of Cascadia Wildlands and have been since 2020. I am also the Conservation Director for Cascadia Wildlands.
5. Founded in 1998, Cascadia Wildlands works to protect and restore Cascadia’s wild ecosystems in the forests, in the courts and in the streets. Cascadia Wildlands envisions vast old-growth forests, rivers full of wild salmon, wolves howling in the backcountry, a stable climate, and vibrant communities sustained by the unique landscapes of the Cascadia bioregion. With over 15,000 members and supporters, the majority of whom live and recreate in the Cascadia bioregion, Cascadia Wildlands focuses our work on safeguarding the remaining mature and old-growth forests and protecting wild rivers in the Cascadia bioregion, and the species that call these special places home.
6. Cascadia Wildlands has engaged in McKenzie River conservation and management for many years, including participating in the Federal Energy Regulatory Commission (“FERC”) process for re-commissioning the Carmen-Smith Hydroelectric Project and Trail Bridge Dam in 2008. Cascadia Wildlands withdrew from the settlement process when EWEB pivoted from its commitment to install a fish ladder to a trap-and-haul plan, as we objected to this less effective approach to fish passage. We have also engaged in the public process about the future of the Leaburg dam on the McKenzie, supporting

EWEB's decision to remove the dam. A significant portion of our forest defense work has been and is on forests surrounding the McKenzie River, and its sub-watersheds, tributaries, and headwaters.

7. Cascadia Wildlands has a specific interest in the plight of wild fish species, including bull trout and Chinook salmon, and in defending the integrity of the Endangered Species Act ("ESA"). Cascadia further has a specific interest in ensuring that our public utility and federal agencies, including the FERC, U.S. Fish and Wildlife Service, and National Marine Fisheries Service, follow the mandates of the ESA. I have an interest in ensuring that dam operators, including the Eugene Water and Electric Board, comply with all federal laws, including the ESA. Cascadia Wildlands' and my interests are harmed when dam operators violate federal law, including the ESA.
8. Cascadia Wildlands and our members have an interest in ensuring that bull trout and Chinook salmon survive the threats posed by habitat loss and habitat fragmentation caused by dams and other barriers, habitat degradation, climate change impacts, increased temperature, and other impairments. Many of Cascadia Wildlands' members have a particular affinity for wild fish and their habitat, including the famed McKenzie River, and actively support our work to safeguard wild rivers and the species that call them home.
9. Cascadia Wildlands' staff have an annual McKenzie River raft day where we float a section of the river downstream of the Carmen-Smith Hydroelectric Project and Trail Bridge Dam. We swim, look for wildlife, including bull trout and Chinook salmon, identify native plants, picnic along the river, and generally find joy together recreating in an area the organization has long worked to protect. Last October, our staff hiked up the

river to the artificial spawning channel and the temporary trap-and-haul facility below the dam. We observed several Chinook salmon redds and saw several large adult bull trout in the shallow water upstream of the temporary trap-and-haul facility, but below the dam. I felt both thrilled at seeing bull trout up close in the wild and deeply sad knowing these fish could not access the pristine habitat above the dam. My sadness is magnified because I know that the current trap-and-haul system utilized below the dam is flawed and inadequate, even as a stopgap measure until permanent fish passage is achieved.



Fig. 1—Two adult bull trout upstream of the temporary trap-and-haul facility trapped downstream of Trail Bridge dam – the fish are the darker area underwater in the center left of the photo (still image taken from video shot October 14, 2024).



Fig. 2—Cascadia Wildlands’ staff, including executive director Josh Laughlin observing spawning bull trout trapped below Trail Bridge dam, October 14, 2024.

10. For many years, I have found solace in recreating in and around the McKenzie River and its tributaries. I regularly hike with my rescue dogs, camp, and forage near the river most of the year, and swim in and raft on the river during the warmer months. Several of my favorite hikes are along the river or with views of the river. One of my favorite camping destinations is the riverside Paradise Campground, operated by the Forest Service on the banks of the upper McKenzie River. I have camped there multiple times in recent years, hiking the famed McKenzie River Trail, watching wildlife, and swimming. I drive to Bend several times per year and stop along the McKenzie to observe the river and look for wildlife, including bull trout and salmon. I intend to continue to visit the McKenzie,

including this upcoming summer, to raft, camp, and hike. I hiked in the forest near the river most recently on May 10, 2025. I have plans to forage morel mushrooms and view wildflowers in the coming weeks in the forests near the river. I also pick blueberries at an organic farm on the banks of the river that sources its water from the river every summer, and regularly source my produce from this farm. I intend to do so again this coming summer.



Fig. 3—View of the McKenzie River from my Paradise Campground site, September 30, 2022.



Fig. 4—McKenzie River view from our campsite at Paradise Campground the evening before Cascadia Wildlands’ annual staff river float, August 7th, 2024.



Fig. 5—Cascadia Wildlands’ staff swimming in the McKenzie River during our annual float trip, August 1, 2023.



Fig. 6—McKenzie River hiking, foraging and camping trip October 10, 2021.

11. As an amateur photographer, I enjoy seeking the opportunity to photograph wild fish and their habitat. Press have used photos and videos I took of bull trout on the McKenzie in media coverage, and we have used these images in Cascadia Wildlands' social media and communications with our members. I also derive aesthetic and recreational enjoyment from looking for bull trout and salmon, viewing them in the wild, and simply knowing that they still exist. I feel better about our world knowing that we have made significant efforts to undo some of the harm humans have caused to species, including Chinook salmon and bull trout. I think a lot about whether my three-year-old niece and one-year-old nephew will similarly get to enjoy these species in the wild when they are my age.

12. My treasured encounters with bull trout and Chinook salmon were made possible by the conservation tools provided by the ESA. I was in high school when bull trout and Chinook salmon were added to the ESA list of imperiled species. No justifiable excuse exists for EWEB to not have adequately planned for fish passage at their dam. EWEB has had my entire adult life – over 25 years – to plan, design, construct, and implement adequate fish passage at Carmen-Smith and Trail Bridge dam. The harm caused by EWEB's ongoing delay is difficult to measure. We will never know how much achieving fish passage a decade ago could have helped struggling bull trout and Chinook salmon populations, but we do know that continued failure to accomplish this requirement of the ESA is untenable. I rely on the court system and our system of checks and balances to ensure entities like EWEB are held accountable for fulfilling their duty to comply with the ESA.

13. I believe in the ESA's foundational tenet that humans should not cause the extinction of other species, and that we should work to reverse previous damage and recover already imperiled species. This principle is not inherently partisan. In fact, the law was passed in a bipartisan manner, nearly unanimously, and was signed by a Republican president with significant fanfare. The authors of the law were wise enough to realize that the government might not always effectively enforce the law and included a citizen suit provision by which the public can ensure the purpose and intent of the law is followed and the letter of the law, including reliance on the best available science and consideration of historic range and remnant populations are required. Fundamentally, protecting species and their habitat also protects the ecosystems on which humans

likewise depend. As a downstream resident, I rely on the clean drinking water provided by the McKenzie River, just as bull trout and Chinook salmon rely on that same water.

14. I am very aware that one of the most important steps for ensuring that threatened and imperiled fish species, including bull trout and Chinook salmon, not only persist but also recover is removing barriers to fish passage. When species' populations are isolated from each other, genetic diversity is lessened over time, and events like wildfire, drought, climate change-induced increases in temperature, and habitat modification and destruction can be devastating. Cascadia Wildlands has long worked to reduce barriers to fish passage in the Cascadia bioregion and to improve protections for our remaining quality wild fish habitat, both for the rivers themselves, the surrounding forests, the species that call both rivers and forests home and the people who rely on the river's water. Every mile of high-quality stream habitat matters for these imperiled fish species. The ESA is designed to prevent death by a thousand cuts, whereby species decline bit by bit as habitat is degraded or destroyed. Cascadia Wildlands has an interest in ensuring isolated bull trout populations naturally connect and achieve genetic exchange. Cascadia Wildlands has an interest in ensuring Chinook salmon can reach the coldest, clearest, most pollutant-free reaches of their historic habitat on the McKenzie River. I have an interest as an Oregonian, recreationist, conservationist, and amateur photographer that these species can reach their historic high-quality habitat and achieve genetic exchange.
15. When Cascadia Wildlands became aware in early 2024 that EWEB had still not met its legal obligations and the promises it had made in settlements and binding agreements with federal agencies to achieve fish passage at Carmen-Smith and Trail Bridge, we conducted considerable research into the issue to understand exactly what had gone

wrong. We sent a detailed nearly 30-page memo to the EWEB Board of Commissioners as well as General Manager Frank Lawson in late April 2024 ahead of the May 2024 Commission meeting, outlining our concerns and EWEB's legal responsibilities. I, along with one of our summer law clerks, testified in my professional capacity and as a ratepayer at that meeting during the public comment period, which occurs at the start of EWEB public meetings. Testimony is limited to three minutes, so the testimony was brief, but we raised our concerns about EWEB's ongoing failure to achieve fish passage at Carmen-Smith and Trail Bridge. We received no response to our letter.

16. In the year since, EWEB has only made more excuses for its failure to achieve fish passage. At EWEB's April 2025 Board of Commissioners meeting, the Board approved an additional \$3,300,000 in ratepayer dollars for further design work on its long-overdue trap-and-haul facility. I am shocked that EWEB is doubling down on a plan that both expert federal fish agencies – the US Fish and Wildlife Service and National Marine Fisheries Service – have declared insufficient, further sinking extensive costs into a decidedly ineffective system to the peril of the listed species that depend on McKenzie River habitat and at the expense of ratepayers like myself. Nonetheless, I understand that Plaintiff's expert witness in this matter has proposed measures EWEB could immediately take to enhance the effectiveness of the trap-and-haul system until such a time that permanent fish passage is installed. I support these measures, which would both help the species that I care about as well as partially redress my own aesthetic and recreational injuries in the short term.

17. Over the past several summers, I have been unable to recreate in the McKenzie River corridor as much as I would have liked due to wildfires. Highway 126 was closed for

extensive periods due to fire in both summer 2023 and 2024. These closures occurred at the same time as Chinook salmon were migrating upstream to spawn, which is when trap-and-haul must occur. Highway 126 is the only road that a trap-and-haul truck can drive to bring fish around the dam; if the road is closed, trap-and-haul inherently fails. This significant risk to the viability of trap-and-haul as a means to achieving fish passage was demonstrated by the near-total failure of EWEB's temporary trap-and-haul efforts in 2023 and 2024. Given the increase in severity and frequency of climate-change-driven wildfires in the region and on the ground realities of the last few years, sinking rate-payer resources into a plan that is totally dependent on a single road being open during a specific time of year when wildfire is most likely is not a rational choice.

18. Both Cascadia Wildlands as an organization, working on behalf of our members, staff, board and supporters, and myself as an individual have a strong interest in ensuring that bull trout, Chinook salmon, and other wild fish receive the actual protections of the ESA, and that those safeguards are meaningful on the ground. Cascadia Wildlands' and my interests in the survival and recovery of bull trout and Chinook salmon have been harmed, and will continue to be harmed, by EWEB's failure to ensure adequate fish passage at the Carmen-Smith Hydroelectric Project and Trail Bridge dam. The relief requested in this litigation would redress and alleviate the injuries to my and Cascadia Wildlands' interests caused by EWEB's ongoing failure to comply with the ESA. The immediate relief requested in Plaintiff's preliminary injunction motion would also partially redress my injuries in the short term by enhancing the trap-and-haul process below the dam. That said, I feel strongly that permanent fish passage is the only way to

ensure the future viability and survival of bull trout and the Upper Willamette River
Chinook Salmon.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and
correct. Executed this 11th day of May 2025, in Eugene, Oregon.

A handwritten signature in cursive script that reads "Bethany Cotton".

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UNITED STATES DISTRICT COURT
DISTRICT OF OREGON
EUGENE DIVISION

CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

DECLARATION OF JOSHUA
LAUGHLIN

EUGENE WATER & ELECTRIC
BOARD,

Defendant.

I, JOSHUA LAUGHLIN, declare as follows:

1. The facts set forth in this declaration are based on my personal knowledge, and if called as a witness, I could and would competently testify thereto under oath. As to those matters which reflect a matter of opinion, they reflect my personal opinion and judgment upon the matter.

2. Cascadia Wildlands (“Cascadia”) is a tax-exempt, non-profit, membership organization with over 15,000 members and supporters headquartered in Eugene, Oregon. We have dedicated members who reside throughout western Oregon, including a large percentage who live within the McKenzie River watershed. Cascadia’s mission is to defend and restore Cascadia’s wild ecosystems in the forests, in the courts, and in the streets. We envision vast old-growth forests, rivers full of wild salmon, wolves howling in the backcountry, and vibrant communities sustained by the unique landscapes of the Cascadia bioregion.

3. Specifically, Cascadia focuses on protecting and restoring Upper Willamette River Chinook salmon and bull trout populations in the Pacific Northwest. These federally listed fish species are of particular interest to our membership as they are species that have undergone significant population declines as a result of overcutting our forests, water quantity and quality issues, and habitat loss, among other things. Dams, such as the Trail Bridge Dam on the upper McKenzie River, are one of the primary causes of continued harm to these species.

4. Cascadia Wildlands and its members derive substantial aesthetic and recreational benefits from the existence of Upper Willamette River Chinook salmon and bull trout, including through photography and hiking. Many of Cascadia Wildlands’ members and staff enjoy exploring the McKenzie River, and the prospect of seeing this species in Oregon is of great

value; conversely, knowledge that these species are in decline due to human influence, such as the presence of Trail Bridge Dam, lessens our membership's enjoyment of these activities.

5. I have worked with Cascadia since 2001. I am also a dues-paying member of Cascadia and have been for at least ten years.

6. Since 2015, I have been the Executive Director of Cascadia. I guide the organization in pursuit of its goals to protect and restore Upper Willamette River Chinook salmon and bull trout populations and their habitat within the Cascadia bioregion.

7. Cascadia has developed specific campaigns aimed directly at protecting these listed fish species. These projects include protecting threatened old-growth forests to maintain remaining viable habitat and clean water within the state, including several projects in and around the Upper McKenzie River, including the Robinson-Scott Timber Sale, the Certification Timber Sale, the Trapper Timber Sale, and the Flat Country Timber Sale, to name just a few. These projects involved field checking, commenting on, appealing, and litigating governmental actions that may harm Upper Willamette River Chinook salmon and bull trout as well as the watershed and intact ecosystem upon which they depend. We also support and encourage federal and private restoration projects in the upper McKenzie River that aim to improve their habitat and increase connectivity and health of rivers they depend on, including recent projects on Deer Creek, South Fork McKenzie, and the Finn Rock Reach on the mainstem McKenzie River.

8. Cascadia also seeks to preserve the interests of its staff, members, and board of directors in visiting areas where these species are present and observing or simply being in the presence of these imperiled species. Educating the public and our membership about Upper Willamette River Chinook and bull trout and their recovery is part of our effort to restore their populations in Oregon. We regularly feature these species in our public communications, like on

our website and newsletter, and our membership remains concerned and heavily involved in Upper Willamette River Chinook and bull trout conservation.

9. Cascadia Wildlands, its members, and I have been and will be further harmed by the Eugene Water and Electric Board's (EWEB) actions and inactions at the Carmen-Smith Hydroelectric Project, which includes Trail Bridge Dam, on the Upper McKenzie River. EWEB's operation of the Dam has harmed, harassed, and killed Upper Willamette River Chinook and bull trout. We will be harmed not only by the killing of individual fish and maintenance of a facility that functions as an absolute barrier to miles of pristine, upstream, cold-water habitat, but also by EWEB's careless disregard shown to this species, federal law, and the concerns of federal fish agencies, the Federal Energy Regulatory Commission (FERC), and the public. These activities harm my personal interests and the interests of Cascadia members not only in Oregon but throughout the broader Cascadia bioregion.

10. For nearly two decades, EWEB has been avoiding doing what it initially promised—providing volitional passage and net conservation benefits to listed fish species in the McKenzie River. Accordingly, as an organization focused on conservation and regularly using the law to hold government, corporations, and, in this case, our local utility, accountable, the implementation of functional volitional fish passage itself is valuable to our organization as well. The implementation of functional volitional fish passage is a necessary step toward recovery and would inspire and instill confidence within our membership and the broader community, many of whom are EWEB ratepayers. It would also send a message to the public that the conservation and recovery of Upper Willamette River Chinook salmon, bull trout, and other imperiled wildlife is a priority.

11. Cascadia formally engaged with the Carmen-Smith Hydroelectric Project in the mid-2000s, submitting comments on the relicensing process and eventual environmental assessment. Clear in these comments is the consistent concern for these species, advocacy in support of volitional passage, and the corresponding persistent disapproval of “trap and haul” that we maintain today, now approximately two decades later.

12. Cascadia has dedicated significant time and resources to this advocacy, participating, engaging, educating, and maintaining a position as a stakeholder throughout EWEB’s consistent delays and noncompliance with federal environmental laws. Accordingly, we are also adversely affected and aggrieved by EWEB’s multi-year failure to provide these fish with safe and functional volitional passage and ongoing injuring, harming, and killing of listed fish through their ill-informed and ineffective temporary fish passage measures.

13. As a member and Executive Director of Cascadia Wildlands, I, too, have a personal and professional interest in Upper Willamette River Chinook salmon and bull trout, particularly their populations in Oregon.

14. My family co-owns a cabin right off the McKenzie River on West Fork Horse Creek near McKenzie Bridge, Oregon. I have also rafted the McKenzie River dozens of times and, more broadly, have recreated, explored, learned from, and enjoyed this area for over 30 years.

15. I have a deep connection to this river and the surrounding watershed and have a strong passion, interest, and love for the listed fish species that call this river home. I have taken friends, colleagues, and my family members to the base of Trail Bridge Dam and the artificial spawning channel to attempt to observe spawning Upper Willamette River Chinook and bull trout over a dozen times. I am always amazed and inspired to see these powerful fish,

particularly the salmon, which migrate often over 200 miles from the Pacific Ocean to complete their life history in the clear, cool, forested upper reaches of the McKenzie River.

16. Since purchasing a share of our family cabin up the McKenzie, I have learned more about this area—the ecology and history. A large part of the decision to invest in a cabin here involved ensuring my family, specifically my children, could develop and maintain a connection to this watershed, this river, and the species that live and depend on this area, including Upper Willamette River Chinook salmon and bull trout. The tributary of the McKenzie that flows just off our porch, West Fork Horse Creek, likely has both salmon and bull trout in it. We hope to observe spawning and rearing activity in this creek at some point in the future as well as in the upper McKenzie River above Trail Bridge Dam.

17. Each time I lead a float down the McKenzie, in either my personal or professional capacity, I take time and pay close attention to the riffles for the chance to observe salmon and bull trout. I rarely make it much more than a mile into a float without commenting, sharing, or educating passengers in my boat about this river, the ecology, the history, the dams and developments, and the imperiled species that depend on these cold, clear, and clean waters. I always remind my passengers that we are floating in a habitat occupied by critically imperiled Upper Willamette Chinook salmon and bull trout, and we have a responsibility to help recover their ailing populations.

18. As recently as this last fall, I hiked to the artificial spawning channel below Trail Bridge Dam with other Cascadia Wildlands staff, where we observed redds, or recent spawning areas, as well as identified several bull trout circling riffles in two to four feet of water off the bank. That day, we saw no salmon—concerning and atypical for a mid-October day.

19. Beyond these experiences and connections, I have hiked, camped, and enjoyed this watershed, following miles of Pacific Crest Trail as it passes through the highest parts of the headwaters of the McKenzie, spending time on the McKenzie River Trail, and camping at various sites along the banks of the river with friends and family for the better part of 30 years.

20. I intend to float, hike, and explore as well as visit our cabin for as long as I am able. This river has defined large parts of my life and career, and will continue to do so. This area, my experience, and the health of this river depend on these fish. Without serious course correction, these two iconic species face real risks of extinction within my lifetime.

21. I think a lot about the health of this ecosystem and the species that depend on it, and am all too aware of what indicator species like salmon and bull trout—their health and population stability—say about the broader watershed. Bull trout depend on the cleanest and coldest waters available. The existence of bull trout in a watershed is the highest award for water quality standards. Salmon, including Upper Willamette River salmon, provide a vital component of the food chain for countless species and are the keystone for nutrient cycles that built the epic forests of the Pacific Northwest. Where salmon run in healthy numbers, the watershed and broader ecosystem thrive.

22. Cascadia, our members and supporters, and I are harmed by EWEB's actions and inactions associated with their operation and maintenance of the Carmen-Smith Hydroelectric Project and Trail Bridge Dam. The ongoing "take" of these species and the impacts on their recovery decreases our chances to observe, learn from, and enjoy Upper Willamette River Chinook salmon and bull trout. Our enjoyment of our recreational and aesthetic interests is materially impacted by EWEB's unlawful operations at the Trail Bridge Dam, which include acknowledged instances of take through mortalities incurred in the current, inadequate trap and

haul process. That fish are being harmed through the trap and haul process causes me further distress, as there are only so many members of the species remaining.

23. Cascadia, our members and supporters, and I are committed to the recovery of Upper Willamette Chinook salmon and bull trout and their habitat and are harmed by the ongoing violations of law, disruption of habitat and life histories, and harm, harassing, and killing of bull trout associated with the maintenance and operation of the Carmen-Smith Hydroelectric Project and Trail Bridge Dam. Our injuries and the harm to these species could be partially remedied by the employment of speedy conservation measures to reduce harm as soon as possible, and I understand Plaintiffs' expert in this case has proposed measures that the Court can and should require EWEB to immediately undertake that could enhance the current, temporary system in place. To fully address the ongoing harm to these species, however, will require the expeditious installation of volitional passage or the timely surrender or decommissioning, and removal of this project in the long term, such that the river and the fish that depend on it could once again run free.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on this 30th day of April 2025 in Eugene, Oregon.

Josh Laughlin

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Attorneys for the Plaintiffs

UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Plaintiffs,

v.

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

Case No.: 6:25-cv-446-MTK

**DECLARATION OF
JENNIFER FAIRBROTHER
WILDER**

I, Jennifer Fairbrother Wilder, declare as follows:

1. The facts set forth in this declaration are based on my personal knowledge. I could and would testify competently to these facts if called as a witness. As to these matters, they reflect my personal opinions, observations, and judgments.

2. I am a citizen of the United States and a resident of Canby, Oregon. I have been a resident of Oregon since 1986.

3. I joined and became an active staff member of the Native Fish Society in 2018 in order to support its efforts to protect native salmonid populations. The Native Fish Society is a 501(c)(3) non-profit organization whose mission is to advocate for the recovery of wild, native fish and promote the stewardship of the habitats that sustain them while being guided by the best available science. The Native Fish Society envisions a Pacific Northwest abundant in wild fish, free-flowing rivers, and thriving local communities.

4. Native Fish Society envisions a future for the McKenzie River and Willamette Basin in Oregon as one where abundant populations of wild spring Chinook salmon and bull trout return each year to their natal waters, which support the life history needs of these populations and sustain them into the future in the face of a changing climate.

5. In 1995, Bill Bakke, a renowned steelhead fly angler and wild fish advocate, and his supporters founded the Native Fish Society in Portland, Oregon, to create a space in culture for the appreciation of and advocacy for the Pacific Northwest's wild, native fish and their home waters.

6. Today, the Native Fish Society's work and mission are driven by three programs:
a) the River Steward Program, which supports and inspires a network of place-based volunteer advocates who work to build local support for the stewardship of their backyard rivers and native

fish; b) the Native Fish Fellowship, which is a multidisciplinary volunteer collaboration that elevates new perspectives, skills, and experiences in our community and environmental work; and c) the Women for Wild Fish Initiative, which is a movement focused on encouraging and supporting women who are joining together as advocates, activists, and leaders in the recovery of wild, native fish. By focusing on the beauty and importance of native fish, our staff, program volunteers, supporters, and members work collaboratively with partners across the region to improve the health and resilience of Northwest communities, landscapes, and rivers.

7. Through our programs and partnerships, Native Fish Society works to provide clean water, free-flowing rivers, abundant wild fish, sustainable consumptive and non-consumptive fisheries, and the benefits of a healthy environment to approximately 12.5 million people in British Columbia, Idaho, California, Washington, and Oregon. More than half of our volunteers, conservation campaigns, and staff are based in Oregon.

8. Native Fish Society Staff, River Stewards, and supporters have advocated for the protection and recovery of spring Chinook salmon and bull trout in the Willamette Basin, including the McKenzie River. Activities have included submitting comments to the recovery planning process, commenting on Hatchery Genetic Management Plans, conducting field trips with policy makers, participating in habitat protection campaigns, and working with habitat restoration practitioners.

9. Native Fish Society has been a leader in efforts to restore access to important historic habitats blocked by dams for native, wild fish populations in the Willamette Basin. In 2018, we participated as a plaintiff in a lawsuit against the United States Army Corps of Engineers for their failure to implement actions to improve upstream and downstream fish passage, water quality, and flows from the thirteen federally owned and operated dams in the

basin, including Cougar Dam in the upper McKenzie River watershed.

10. Native Fish Society has also worked to reform dam operations of the Willamette Valley Project through federal legislation under the Water Resource Development Acts of 2020, 2022, and 2024. These efforts have focused on policy change which can improve fish passage, water quality, and flows at the federal dams. Our staff have also worked to secure appropriations to implement measures to recover threatened fish under the Willamette River Biological Opinions.

11. Native Fish Society staff and River Stewards have engaged in numerous forums around the region related to upstream and downstream trap and haul facilities and programs. From this work, I am aware of the science and practice of adult and juvenile trap and haul programs, practices, and their impacts on individual fish and fish populations.

12. My family moved to Oregon before I was one year old, and I spent my childhood on a rural property in the Willamette Basin located between the towns of Philomath and Alsea.

13. During my childhood, I spent extensive time recreating, exploring, and learning in the McKenzie River, Middle Fork Willamette River, Coast Fork Willamette River, South Santiam River, North Santiam River, and Marys River watersheds. My family shared a passion for aquatic ecosystems and fish. Early morning weekend rituals included trips to our favorite fishing holes, followed by a pancake and hot chocolate breakfast. Summer weather meant frequent camping trips spent along the banks of these rivers. Rain or shine, the last day of the school year was always marked by a foray to one of these rivers.

14. I attended Philomath High School, where my passion for aquatic ecosystems led me to pursue a program in applied ecology. Within this program, we participated in stream restoration projects, Oregon Department of Fish and Wildlife (ODFW) fisheries surveys, and

sustainable forestry management projects around the Willamette Basin.

15. During my childhood, I witnessed the impacts of changing forest practices on federal lands with the implementation of the Northwest Forest Plan. This had a large impact on the timber economy of the region, which resulted in a profound social disruption in the community of Philomath and sparked my desire to study and work at the intersection of ecology and policy.

16. I attended Oregon State University in Corvallis, Oregon, where I focused my studies on philosophy, political science, and ecological science. I graduated in 2007 with a Bachelor of Science in Philosophy.

17. During my time at Oregon State University, I was employed on a joint project with the university and the United States Forest Service. The focus of the project was evaluating nitrogen cycling in forested, rural, and urban aquatic ecosystems in the Willamette Valley. It included extensive field research in the McKenzie River watershed, including fish surveying.

18. I pursued a graduate degree at The George Washington University in Washington, D.C., where I focused my studies on environmental policy with coursework covering environmental laws and regulations (including the Endangered Species Act) and natural resource economics. I graduated in 2009 with a Master of Arts in Philosophy and Social Policy.

19. Between 2009 and 2014, I returned to Oregon, where I lived in Eugene. During this time, my spouse and I spent nearly every summer weekend fishing, hiking, swimming, and camping in the McKenzie River watershed.

20. As an adult, I continue to frequent these rivers. In particular, I make several trips to the McKenzie, North Santiam, South Santiam, and Marys Rivers each year, both in the course of my employment and for personal enjoyment and recreation. I spend numerous summer

weekends connecting with Willamette Basin streams. These days and nights, often spent in the company of my spouse, my little boy, my family, and our friends, bring profound joy and well-being to my life. Days are spent probing swirling pools with fishing gear, hopeful that I will return to home or camp with a dinner of trout. Hot weather sees me plunging into emerald waters, feeling the energetic force of the river wrap around my body and carry me downstream. Light-filled days find me often spending countless hours perched atop a rock just watching the ebb and flow of water, sun, air, birds, and wildlife as they weave together to create something greater than their constituent pieces. Winter and spring regularly find me hiking along these rivers, breathing the deep, rich smell of decay and scouting for fleeting glimpses of fish holding in deep pools. My enjoyment of each of these activities in these watersheds is greatly enhanced when I encounter a wild salmon or trout, or even when I am aware they are present in the waters around me.

21. During my life spent along, upon, and in these waters, I have seen a marked decline in wild, native salmonids. The tangy, fecund scent of decaying carcasses no longer permeates the rivers each fall. The slap of strong tails breaching the surface, once part of the river symphony, has gone silent. When I step or plunge into these waters, I feel connected to the roiling life force that is all parts of a river flowing into one, and the loss of these beautiful creatures is a void that resonates through me and the landscape. The decline of wild spring Chinook and bull trout in the Willamette Basin has significantly impacted my experiences in these watersheds. My recreational, aesthetic, and spiritual interests are harmed when I visit these watersheds now and do not experience wild salmonids in abundance or do not experience them at all. My enjoyment of the activities listed above is diminished by the knowledge that wild salmonids, once so plentiful in these waters, have declined so significantly. However, I plan to

continue visiting these watersheds several times per year to fish, hike, swim, and camp, in the hopes of viewing or otherwise experiencing wild salmonids.

22. Given their precarious state, my family and I no longer fish for salmon in the rivers of the Willamette Basin. Yet I hope that someday, the native, wild fish of this region will be returned to abundance, enabling me and my family to once again know the lightning thrill of feeling one of these magnificent creatures at the end of a fishing line, to spend a moment face to face with an animal that has traveled the world, journeying where even humans can't follow, to gratefully, humbly, and with reverence take that life to sustain ours, and to bequeath to my son and future generations rivers surging with the cycle of life and death.

23. Of all the places I have traveled and lived, I have chosen to return here, to the Willamette Basin, to be near these rivers and spend as many of my days as possible with them.

24. Since joining the Native Fish Society, I have come to understand just how imperiled wild spring Chinook salmon and bull trout are in the Willamette Basin and McKenzie River watershed. I track their population status and trends by reviewing historic and current population data collected by ODFW. These populations are highly diminished from their historic abundance, and I believe current and past harms at the Carmen-Smith Hydroelectric Project have contributed to the decline of wild spring Chinook salmon and bull trout.

25. Attached hereto as Exhibit 1 is a true and correct copy of information provided to me by an ODFW colleague about the number of redds documented on the McKenzie River between 2022 and 2024, as well as fish passage numbers obtained from the Leaburg dam.

26. Based on reviewing research and surveys performed in the region, attending ODFW Commission and Army Corps of Engineers meetings and presentations, and discussions with state and federal fisheries biologists and managers, I understand that the root cause of

ongoing and continued decline of spring Chinook salmon and bull trout in the Willamette Basin is the ongoing operations of dams and their impacts on their habitats.

27. I understand that there are operational measures that the Eugene Water and Electric Board can and must take if we are to stem the decline and recover these fish before they go extinct. I believe these measures can directly remedy some of the harm caused to these wild salmonid populations and to me personally. Of critical importance is implementing effective fish passage both upstream and downstream at Carmen-Smith Hydroelectric Project.

28. I am gravely concerned about the harm caused by the existing upstream trap and haul facility. It distresses me to know that these fish have traversed thousands of miles and survived untold obstacles in their journeys through the years, only to be harmed or even mortally wounded at the doorstep of their historic spawning habitat.

29. If the Court does not grant Plaintiffs' requested relief, a precious piece of my life, my connection to these fish and rivers, my enjoyment of them for aesthetic, recreational, and spiritual purposes, will continue to be injured. This is a bereavement in my life that I experience most acutely when I journey to these rivers and experience the absence of wild salmon and bull trout. There is an irremediable grief that continues to grow deep within me as I observe the continued decline of these once-abundant creatures that form the backbone of a living river. The quality of my experience is irreversibly damaged each time I belly crawl over wet, mossy rocks to peak over the edge of a river bank in hopes of spotting a pool full of undulating spring Chinook salmon but instead find an empty void; each time I hike along the shores of these rivers, covered in the blazing color of fall leaves, and don't smell the sharp scent of rotting carcasses feeding the trees, birds, salamanders, and soil; each time I search for the subtle signs of redds marking the next generation of life only to find the cobble untouched and undisturbed; and each

time I see the latest year's data on pre spawn mortality, knowing how close those fish were to their final destination yet dying before their life's purpose could be fulfilled. I feel despondent knowing that the Eugene Water and Electric Board has the ability to ameliorate the harm to the species and has the directive to do so, but has failed to act. If the Eugene Water and Electric Board fails to immediately implement strong measures that will meaningfully reduce the harm to these species—I fear that they will slip closer to extinction and reach a point of no return. If I should ever live in this world devoid of these creatures, my grief will be sustained throughout my life.

30. I understand there are some immediate measures proposed by Plaintiff's expert that Eugene Water and Electric Board could take in the interim to help reduce the harm falling to the species at Trail Bridge Dam, including modifications and enhancements to the trap and haul process. I ask the court to give serious consideration to those immediate measures and require Eugene Water and Electric Board to take them, as the ongoing harm to these species must be mitigated and must occur expeditiously.

31. Although I am filled with sadness, I also maintain hope. A fishing legend in my family recounts a day when I was four or five, fishing with my father. We had spent the morning casting with nary a strike. My father asked if I was ready to call it a day when I responded, "Where there's life, there's hope." Likely lifted from some overheard idiom or media, the sentiment still resonates today. Wild salmonids are incredibly resilient. We have seen their populations make extraordinary comebacks after catastrophic events, like in the Toutle River after the eruption of Mt. St. Helens. There's even a success story in the making right here in the Willamette Basin. On the Clackamas River, effective upstream and downstream fish passage has been established at a series of three hydroelectric dams owned by Portland General Electric and

wild spring Chinook salmon are resurgent, the only Chinook population in the entire Willamette basin on the road to recovery. But I also know that the door is closing for spring Chinook salmon and bull trout in the McKenzie River. We have to make even more drastic changes now due to the Eugene Water and Electric Board's failures of the past decades.

32. And though I am often filled with a great grief for the state of the Willamette Basin's rivers and fish, I also envision a future of abundance. One in which I watch clear waters roiling from thousands of fish jockeying for space on spawning gravel and darting along the calm, winding stretches of Coast Range and Cascade Mountain streams. I dream of adipose fins cutting through the surface as I watch my son catch his first salmon. I see a river network reconnected and renewed where lamprey hang off the rocks in salubrious masses and giant logs wedge deep along verdant banks, creating a nursery where thousands of juvenile fish dart erratically about.

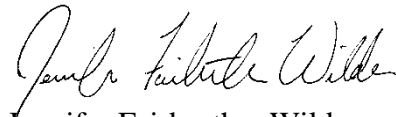
33. Native Fish Society and our partners share a vision of abundant, wild fish returning to a healthy and thriving Willamette Basin and McKenzie River that supports the many cultural, economic, social, and ecological needs of our communities and the landscape many of us call home. But we will only succeed if the Eugene Water and Electric Board takes seriously the important role they must play in achieving this goal. I believe that injury to the region's wild spring Chinook salmon and bull trout, and to me personally, can be lessened if the Court orders the Eugene Water and Electric Board to take the actions outlined in Plaintiffs' preliminary injunction to address the irreparable harm to spring Chinook salmon and bull trout they have caused and continue to cause.

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In accordance with 28 U.S.C. § 1746 and under penalty of perjury, I swear that the foregoing is true and correct.

Executed this 28th day of April, 2025.

A handwritten signature in black ink, appearing to read "Jennifer Fairbrother Wilder". The signature is written in a cursive style with a large initial "J".

Jennifer Fairbrother Wilder
Canby, Oregon

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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Case No.: 6:25-cv-446-MTK

Plaintiffs,

v.

**EXHIBIT 1 TO DECLARATION
OF JENNIFER FAIRBROTHER
WILDER**

EUGENE WATER & ELECTRIC BOARD,

Defendant.

Data on Number of Redds Documented in McKenzie River

| Reach | Redds | | |
|------------------------------|-------|------|------|
| | 2022 | 2023 | 2024 |
| McKenzie River - | | | |
| Below Leaburg Dam | 705 | 352 | 488 |
| McKenzie River - | | | |
| Leaburg – S Fork McKenzie | 120 | 228 | 134 |
| S. Fork below Cougar Dam | 140 | 107 | 82 |
| Above S. Fork Confluence | 489 | 277 | 278 |
| McKenzie River - | | | |
| S. Fork above Cougar Dam | -- | 15 | --- |
| Redds/km | | | |
| McKenzie River - | | | |
| Below Leaburg Dam | 21.5 | 22.4 | 19.3 |
| McKenzie River - | | | |
| Leaburg – S Fork McKenzie | 3.8 | 7.3 | 4.5 |
| S. Fork below Cougar Dam | 21.2 | 16.2 | 12.5 |
| Above S. Fork Confluence | 14.8 | 14.6 | 8.5 |
| McKenzie River - | | | |
| S. Fork above Cougar Dam | -- | 0.6 | --- |

Fish Passage Counts at Leaburg Dam, 2014-2024

| | Clipped | Unclipped | Total |
|-------------|----------------|------------------|--------------|
| 2014 | 448 | 1003 | 1451 |
| 2015 | 1092 | 1589 | 2681 |
| 2016 | 1360 | 1698 | 3058 |
| 2017 | 425 | 1479 | 1904 |
| 2018 | 469 | 1838 | 2307 |
| 2019 | 1859 | 2899 | 4758 |
| 2020 | 1154 | 1528 | 2682 |
| 2021 | 343 | 770 | 1113 |
| 2022 | 37 | 1843 | 1880 |
| 2023 | 26 | 1749 | 1775 |
| 2024 | 156 | 1292 | 1448 |

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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

**DECLARATION OF JOSH
MOODY**

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

I, JOSH MOODY, declare as follows:

1. The facts set forth in this declaration are based on my personal knowledge, and if called as a witness, I could and would competently testify thereto under oath. As to those matters that reflect a matter of opinion, they reflect my personal opinion and judgment upon the matter.
2. I have lived in Lane County, Oregon, for 19 years. I have spent much of my life on rivers pursuing, studying, observing, and learning about watersheds, aquatic and riparian ecosystems, fish species, and perfecting my presentation of flies, lures, and bait to fish. My primary occupation for the better part of those years has been that of a professional angler and guide. I have guided fishing trips in the Willamette Valley and Oregon's mid-coast. I have floated, fished, and guided trips on the Willamette, McKenzie, Umpqua, and many other coastal rivers as well as seasonally guided fishing trips in Alaska for over 20 years.
3. I have been a member and supporter of Cascadia Wildlands since 2017. I have donated guided fishing trips for Cascadia Wildland's annual fundraising events. I have taken members and supporters of Cascadia Wildlands as well as many friends, family, members of the local community, and clients down the McKenzie River showing them the beauty of the river, guiding them to and hopefully helping them catch local Redside rainbow trout, and educating them about the river and its ecology, including the amazing yet imperiled fish species that migrate, spawn, and inhabit this river such as bull trout and Upper Willamette River Chinook.
4. As a local, angler, boatsman, and guide, I have floated the McKenzie River more times than I could count. I have seen it in every season, at high flows and low flows, in full sun

and torrential rain. I care deeply about this river and have dedicated decades of my life to understanding its ecology, hydrology, and the biology of the fish that occupy it.



5. Beyond my work as a guide and pursuits as an angler, I worked for and volunteered with the Oregon Department of Fish and Wildlife (ODFW) for 2 years. I have assisted with habitat restoration, tagging and monitoring fish, assessing populations and habitat conditions, and moving migratory and/or anadromous fish species around dams in the

McKenzie and other Oregon rivers. Most recently, in 2023, I assisted with moving bull trout from the spawning channel and the reaches below Trail Bridge Dam to manually assist their migration and engagement with the upper river. I have also assisted in capturing and transporting fish around Hills Creek reservoir and assisted with the construction and maintenance of monitoring stations on the upper Middle Fork Willamette River.

6. This process, often called hook-and-haul, involves targeting bull trout with bait and artificial lures designed to imitate smaller fish to incite a territorial or predatory reaction, such that they bite, get hooked, and then can be netted and transferred to a truck and moved around the dam. Through this process and other efforts, I have spent considerable time working in and around EWEB's artificial spawning channel, temporary trap and haul facility, and generally below Trail Bridge Dam and Powerhouse, where most of the bull trout hook and haul is done.
7. Participation in this process left me with serious skepticism about the efficacy of trapping and hauling fish to mitigate the negative aspects of dam infrastructure in the McKenzie, namely at the Trail Bridge Dam. As someone who has spent as much time with these fish as I have, I am concerned about the sustainability and viability of fish passage that depends entirely on volunteers, angling, netting, transferring, trucking, and re-releasing federally protected fish, whether bull trout or Upper Willamette River Chinook salmon.
8. I know I, as well as others I have worked with, care deeply and try as much as possible to reduce stress, injury, and certainly avoid mortality of fish in this process, but the entire endeavor is an unnecessary risk to these fish. And, for Upper Willamette River Chinook salmon now at least 200 miles into their upstream journey to spawn and complete their

life cycle, the stress of this process is highly likely to impact their ability to successfully spawn and, at this stage of their life cycle, result in injury they are unlikely to recover from.

9. I have spent a lot of time trying to help move fish while working in and around the temporary trap and haul facility at the top of the spawning channel below the tailrace of Trail Bridge Dam. This facility, as it currently stands and operates, is a complete failure. It is based on a trap used in another system with different variables and with limited to no application here. It is overbuilt (above prime engineered), and its location in the river and placement at the top of the spawning channel do not make sense. There is such a limited flow at the mouth of the trap that there is almost no attraction. Salmon follow the flow of the river to navigate upstream. Without considerable flow output, there is no attraction to an area in the river for fish to identify a potential migratory route upstream. The entrance of the trap is also small and artificial. If a salmon decided to skip over all the artificial spawning opportunities as it made its way up to the top of the channel, it is hard to imagine they would then be intrigued to swim into the narrow mouth of the trap such that they could be penned, transferred, and moved around the dam by truck.
10. Additionally, I am generally pretty skeptical of the viability of any trap and haul system in this drainage because success depends entirely on the use and access to the two-lane highway during the months of August-October (spawning season). Those of us who live in Western Oregon know too well that these months are also peak season for wildfire. During the Holiday Farm Fire and subsequently the Lookout Fire, the highway was closed, and there have been some wildfire-related closures in this area almost every year in recent memory. When fire is present in the canyon, the road is closed. Because it is

fully dependent on trucking and hauling on this road at the height of fire season, which is also the height of Upper Willamette River Chinook migration, trap and haul is not practical.

11. For example, though I was contracted in 2023, we were limited in our efforts due to highway closures from the Lookout Fire. The first chinook in the spawning channel were observed on August 17, and the closure went into effect the next day. Trap and haul efforts cannot occur, and fish cannot be moved when there are wildfire/road closures in place. For bull trout, this means they are unable to interact and spawn with the upstream population. For both species, this means that they cannot access what is almost certainly the highest quality habitat in this basin.

12. Bull trout depend on cold, clear, and clean water and connected habitat. The Upper McKenzie is a wild, cold, and incredible piece of water. Bull trout also need to access the habitats of Sweetwater Creek. These upstream miles are essential for bull trout to connect their populations and increase connectivity in the river to aid in their recovery.



13. It is also important for Upper Willamette River Chinook salmon who are obstructed from reaching high-quality spawning areas and injured by structures and systems in place that harm them as they attempt to move upstream. Chinook need access to the McKenzie above the reservoir as well as the Smith River.
14. As water temperature and wildfire only worsen with climate change, this type of habitat becomes even more important for these species.
15. There are improvements to the temporary passage system and methods used that could reduce injury and prevent considerable harm. Improvements to the temporary system this season could likely reduce current and ongoing harms to these fish. However, almost all problems would be fixed by just allowing fish to move upriver, complete their life cycles, and engage in their normal behaviors without people in the way or risky handling along the way.
16. I worry about trap and haul specifically up here, where at least chinook are in their most fragile and energy-depleted state, having now traveled so far up the river and are reaching the end of their life cycle and preparing to spawn. In this state, at this point in the system, it is really not ideal timing and circumstances for handling protected fish. EWEB and others involved had this right the first round with their plans to install a fish ladder. A fish ladder would avoid unnecessary and risky handling of protected fish and allow unimpeded and more natural movement upriver to the high quality habitat above the dam.
17. Volitional passage is necessary to allow these fish to move on their own rather than rely on us, especially when we cannot always help due to public safety concerns. Volitional passage would also reduce the unnecessary stress associated with our manually catching, transferring, trucking, releasing, penning, and monitoring fish at a time when they are

particularly sensitive. I cannot imagine that the trap and haul system is more effective or inexpensive because it requires indefinite staffing and maintenance, yet it is less biologically and ecologically beneficial.

18. I have been disappointed and concerned for years about the decision to move to trap and haul. That concern was part of my motivation to work with ODFW and help do anything I could to make sure these efforts, though unideal, were as likely to succeed as possible and facilitated by people like me with deep love, care, and connection to these fish.

19. However, it has not succeeded, and without a serious change and some quick course correction, I am concerned it will be too late. There is a huge opportunity to get fish above the dam by their own means and drive some really meaningful conservation efforts that are highly likely to improve recovery and increase these runs, even in the short term, because of the high quality of the available habitat above Trail Bridge Dam. Additionally, when I think about Leaburg Dam downstream and its likely and not too distant removal, it is amazing to think about the potential of unimpeded river miles and greater numbers of fish pressing upriver to this area to ascend a series of tiered pools (fish ladder) to access cold, clear river miles above Trail Bridge Dam. There is real potential to free the McKenzie and give these resilient fish the chance to recover.

20. The fish themselves are only a focal point that gives us an objective to study the entirety of an ecological system. The observations tell us a great deal about the health of these systems. Fish counts allow us to see things that are happening upstream which goes far beyond the stream bank. An abundance of fish is a societal asset as well. These threatened and endangered species are not only indicators of the health of the environment but are significant to the health of the people who live and recreate here. I

understandably have not spent much time targeting salmon on the McKenzie given their status but when one of my anglers encounters chinook when trout fishing or sees a school of them pass under the boat, or when a large bull trout is slashing and charging after a trout on the end of the line leaving a boil of water that splashes them in the face, they experience something that changes them. Though those moments are rare and brief, they are left with a memory and a connection to the river, something they cherish and will look for again—something that they will share with those close to them—providing a source of hope that the generation to come will get to enjoy and see more of.



21. I cannot overemphasize the fish's cultural importance to the Mollala, Calapooya and other peoples who lived with and subsisted on these fish in the Willamette Valley for

1000s of years before colonization. The fish were far more than just sustenance; they were and are a part of the people themselves. It is heartbreaking to witness the foolishness of colonization and its effect on these people and these ecosystems. Even worse is that now we see what we have done and know at least some ways to mitigate, repair, and restore the damage that has been done, we are still not utilizing the best methods that we have available to attempt to fix the problems. We do a great disservice to these peoples, the ecosystem, and ourselves by not doing what we know is right by the fish and the river.

22. As someone whose livelihood depends on the health of this river and whose mental, emotional, recreational, and spiritual interests, health, and joy are deeply intertwined with the fish that occupy it, I will be irreparably harmed and my enjoyment diminished by ongoing harms to these species.
23. Specifically, without the installation of safe and effective fish passage at Trail Bridge Dam for UWR Chinook and bull trout, I am fully of the belief that these species will be at high risk of extinction in the McKenzie River in my lifetime. This will deeply impact the health of the river and diminish my ability to pursue my hobbies, interests, study, and connection to the river, fishing, floating, and guiding on the McKenzie River. The continued decline of UWR Chinook and bull trout due to the Trail Bridge Dam has and will continue to cause me irreparable harm, sadness, frustration, and concern as well as reduce my ability to learn, enjoy, and observe the fish I have spent so much of my life and career learning from, appreciating, and enjoying.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on this 7th day of May 2025, in Eugene, Oregon.

A handwritten signature in black ink, appearing to read "Josh Moody", is written over a horizontal blue line.

Josh Moody (May 7, 2025 20:17 PDT)

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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Case No.: 6:25-cv-446-MTK

Plaintiffs,

v.

**DECLARATION OF
MICHELLE EMMONS**

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

I, Michelle Emmons, declare as follows:

1. I am a resident of the United States and I live in Oakridge, Oregon. I have personal knowledge of all the facts stated below, and if called as a witness can and will competently testify to all of the matters contained herein. I submit this declaration in support of Plaintiffs Cascadia Wildlands, Willamette Riverkeeper, Oregon Wild, and Native Fish Society's suit in the above-captioned case against Defendant Eugene Water and Electric Board.
2. I am currently serving as a co-Executive Director for Willamette Riverkeeper. I have worked for the organization for over thirteen years, managing volunteer stewardship and paddling recreation events as well as leading strategic planning and financial operations. My professional work at Willamette Riverkeeper is highly focused on conserving and protecting ecosystems so that they can support various Oregon salmonid species.
3. Willamette Riverkeeper is a 501(c)(3) nonprofit corporation founded in 1996 with offices in Portland, Oregon, and Eugene, Oregon. Willamette Riverkeeper has over 8,000 members who are dedicated to the protection and restoration of the Willamette River and its tributaries and the species that rely on these waters throughout the Willamette Basin. The majority of Willamette Riverkeeper's members live and recreate in the Willamette Basin which contains essential fish habitat for fish species at issue in this lawsuit, Upper Willamette River Chinook salmon and bull trout.
4. In addition to Willamette Riverkeeper, I am also an outdoor educator and river guide with the City of Eugene River House Outdoor Center, and serve on the board of Oakridge Trails Alliance, providing leadership and advocacy to support accessibility and

maintenance capacity for trails in the Middle Fork Willamette district of the Willamette National Forest.

5. Prior to my current position at the Oakridge Trails Alliance, I worked as an Education Coordinator for the Middle Fork Willamette Watershed Council, a Volunteer Coordinator at Friends of Buford Park & Mt. Pisgah, and a District Outreach Administrator at Recreational Equipment Inc. I received a bachelor's degree in public relations from the University of Oregon in 1999. I use this degree to connect people to outdoor spaces and the species that make those spaces special, including our state's iconic salmonid species.
6. In both my professional and personal capacity, I travel along the McKenzie River, an iconic tributary of the Willamette River, four to five times a year. I hike and mountain bike the McKenzie River Trail and use the McKenzie River for flyfishing of salmonid species and paddling activities, where I regularly look for Upper Willamette River Chinook salmon. It is always exciting when I see bull trout in the river as well. The act of seeing fish during spawning season, underwater photography, and flyfishing has brought me great joy. Most of my activities regularly take me to the McKenzie River. The river plays a critical role in the existence of the salmonid species, which in turn, informs how I spend a great deal of my professional and personal time.
7. I also have moral and spiritual interests in the continued existence of these species. Salmon are often the subject of artwork for me through painting, drawing, theater, and participating in my family's culinary traditions. I use art to communicate to others the seriousness of the situation affecting the health of these species. I tell my communities about the seriousness of the losses of habitat and populations that threaten the continued existence of these species. I believe the loss of Chinook salmon speaks to the core of

human consciousness as it reflects our misunderstanding of the consequences of loss before it happens. Additionally, humans are dependent on water, as are most living species on the planet. This interconnectedness naturally extends to salmon and other aquatic species like bull trout. Based on that interconnectedness, it is distressing for me to know that Oregon salmonid species and their habitat are being harmed by dams making habitat inaccessible.

8. My concern for salmon survival has changed how I fish. Because of species decline, I fish as a catch-and-release activity. A disruption in one species can lead to cascading events throughout the food web and throw off the ecological balance. Therefore, other activities that depend on the salmon species thriving, like birdwatching and wildlife photography, are already being impacted in areas that do not see as much activity as they did in previous years due to declines in river health and a loss of salmonid species that are critical to the food chain. Additionally, some of the larger predators in areas close to my community are coming out of wildlife zones and into our communities in search of food. Removing yet another species integral to their food supply, like the salmon threatened in this case, will only exacerbate this issue.
9. The loss of Upper Willamette River Chinook Salmon and bull trout will negatively contribute to an already strenuous economic balance in the outdoor recreation industry. Given my roles in outdoor recreation, these losses will hinder the economic development of local communities, whereby fishing is a critical part of the outdoor recreation experience. The loss of these species will detrimentally impact the fish and game industry. These species' decline is due in large part to the continued lack of fish passage caused by dams.

10. Working and recreating in the McKenzie watershed is a vital ritual that I consistently participate in. I regularly share these experiences with others and plan to continue to do so. The McKenzie River is an integral part of my life.
11. My personal, professional, spiritual, and recreational interests in these fish and their rivers in Oregon are harmed by the barrier to habitat the Trail Bridge Dam causes and the Eugene Water and Electric Board's (EWEB) lack of action in following through with their fish passage obligations. If EWEB continues to fail to enact the fish passage measures it committed to do, my way of life will continue to be harmed.
12. I am also aware that EWEB's current ineffective trap and haul methods have resulted in harm and mortality. For me, this makes Plaintiffs' requested relief even more important to the continued viability of these species.
13. I ask for the Court to provide the relief sought by the Plaintiffs in this case, as it will help remedy the harm caused to me by EWEB's continued operation of Trail Bridge Dam without the required fish passage measures. I understand that there are immediate measures this Court could order EWEB to take that would partially alleviate the harm occurring to these species in a way that would help ensure the species' future survivability.
14. Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed this 13th day of May in Oakridge, Oregon.

A handwritten signature in black ink, appearing to read "Michelle Emmons", written in a cursive style. The signature is positioned above a solid horizontal line.

Michelle Emmons

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DISTRICT OF OREGON

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**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,**

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

**DECLARATION OF CHRIS
DAUGHTERS**

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

1. My name is Christopher Daughters, and I reside in Eugene, Oregon. I have personal knowledge of all the facts stated below, and if called as a witness can and will competently testify to all of the matters contained herein.

2. I submit this declaration in support of Plaintiffs Cascadia Wildlands, Willamette Riverkeeper, Oregon Wild, and Native Fish Society's suit in the above-captioned case against Defendant Eugene Water and Electric Board.

3. I am the owner of Caddis Fly Shop, located in Eugene, Oregon. Caddis Fly Shop aims to provide the best possible fly fishing experience to its customers across the United States. Caddis Fly Shop sells a wide variety of fly fishing gear, from flies to inflatable watercrafts. Caddis Fly Shop also offers a full-service fly fishing guide service for anglers seeking experiences with trout, steelhead, and salmon. Caddis Fly Shop offers guided trips in several areas, including trips on the McKenzie River and Willamette River. In addition to Caddis Fly Shop's fly fishing guide contractors, I also personally guide fly fishing trips locally and lead international fly fishing trips worldwide.

4. I have been an active member of Cascadia Wildlands since January 2020. I joined Cascadia Wildlands because the organization advocates in support of matters that are personally and professionally important to me, such as preserving the wild and scenic places of the Cascadia bioregion. Related to this case, Cascadia Wildlands' advocacy efforts to restore and protect the McKenzie River watershed are extremely important to me. As part of my continuing support for the organization, Caddis Fly Shop has donated fishing trips to Cascadia Wildlands.

5. I have been an active member of Native Fish Society since 2008. I joined Native Fish Society because I strongly believe that nature is the best fish hatchery and using science to determine the best conservation practices is best for our fisheries.

6. I have a lifelong passion for fly fishing and healthy river ecosystems. I travel extensively and often to fly fish recreationally and professionally.

7. I regularly visit the McKenzie River in my professional and personal capacity. I have always been drawn to the McKenzie River, which I deeply value for many reasons, including its proximity to community, quality of water, and quality of fish. The McKenzie River is one of the most intact watersheds around. I've explored countless stretches of the McKenzie River. Some of my favorite stretches include the upper reaches of the McKenzie River.

8. I have substantial aesthetic, recreational, economic, and professional interests in the McKenzie River. Some of my earliest memories are on the McKenzie River. I started fly fishing on the McKenzie River when I was 10 years old. Since then, fly fishing has been the biggest passion of my life. I went on my first guided fishing trip at 15 years old on the McKenzie River and have taken fishing and rowing trips on the McKenzie River ever since. I got married on the McKenzie River. I also taught my kids how to fish on the McKenzie River. Fly fishing in, recreating on, and experiencing the McKenzie River has brought me great joy.

9. For the last 40 years, I have also made a living off fishing trips on the McKenzie River. I am on the McKenzie River for at least 100 days every fishing season. Customers come into Caddis Fly Shop daily to experience the McKenzie River. As part of my professional – and personal – interests, I am always actively looking for ways to improve everyone's enjoyment on the McKenzie River. Our guides often find that the fishing opportunities are greater in parts of the McKenzie River that have had fish habitat restoration.

10. I intend to continue engaging in these business and recreational activities on the McKenzie River. I look forward to spending as many days on the River as possible.

11. The diversity and abundance of fish species on the McKenzie River are deeply important to me. The McKenzie River ecosystem requires healthy water quality and an abundance of fish.

12. I know that Trail Bridge Dam, associated with the Carmen Smith/Trail Bridge Hydroelectric Project on the Upper McKenzie River has prevented access to important habitat, obstructed migration, and caused physical injury and mortality to Upper Willamette River Chinook salmon and bull trout. It is my understanding that the loss of habitat due to dam blockages contributes greatly to the decline of these species. These fish are of extraordinary importance to me and the health of the McKenzie River ecosystem. While I cannot fish for Upper Willamette River Chinook salmon and bull trout, these species are integrally tied to the health of the McKenzie River, such that their absence would directly impact other fish species that I fish. The McKenzie River is most successful and productive when bull trout and salmon are abundant. I am concerned that Trail Bridge Dam is actively preventing fish populations from being successful. The loss of Upper Willamette River Chinook salmon and bull trout would detrimentally impact the fishing industry.

13. My personal, professional, economic, and recreational interests in these fish species and the McKenzie River are harmed by the absolute barrier that is the Trail Bridge Dam. Knowing that the Trail Bridge Dam is actively harming Upper Willamette River Chinook salmon and bull trout reduces my enjoyment as a fisherman and as a recreational user of the river. It would negatively affect my moral, professional, economic, and recreational interests if the Upper Willamette River Chinook salmon or bull trout go extinct. If Defendant continues to fail to enact fish passage measures at the Trail Bridge Dam, my way of life will continue to be harmed, and my economic livelihood will be injured. Furthermore, I am aware of the inadequacies of the

“trap and haul” system presently used at the Trail Bridge Dam. I understand that process has resulted in excessive handling, injury, and even mortality to fish. I am concerned that EWEB’s current approach to trap and haul is harming these species.

14. If volitional fish passage were provided at Trail Bridge Dam, I believe that other fish populations would become more successful, thereby directly benefiting my professional and recreational interests.

15. Defendant is likely to continue harming Upper Willamette River Chinook salmon and bull trout populations, with adverse and potentially devastating effects on the resources and values I cherish, if the court does not grant the relief sought by Plaintiffs. I understand there are some immediate measures that Defendant could implement that would lessen the harm suffered by these species this season and during this case, and that Plaintiffs are submitting a declaration describing those measures from an expert in the field. I ask the Court to require Defendants to implement those measures, because absent that relief, as well as the long-term relief Plaintiffs seek, my personal injuries as described herein will persist, and my recreational, aesthetic, and personal enjoyment of the McKenzie River and its species will be permanently damaged.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on this 12th day of May, 2025 in Eugene, Oregon.

A handwritten signature in black ink, appearing to read "Christopher Daughters". The signature is fluid and cursive, with a horizontal line drawn through the middle of the letters.

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**CASCADIA WILDLANDS;
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OREGON WILD; and NATIVE FISH
SOCIETY,**

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

**DECLARATION OF ANDREW
ARCHER**

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

I, ANDREW ARCHER, declare as follows:

1. My name is Andrew Archer, and I make the following statements on the basis of personal knowledge, and if called as a witness, I would and could truthfully testify thereto.
2. I have resided in Oregon for 29 of my 31 years. I grew up in Bend and received my undergraduate degree from the University of Oregon in 2015. Following graduation, I lived in Bend and Ashland for approximately seven years before returning to Eugene to attend law school. As of writing, I am in my final semester of law school, on track to graduate in May with a concentration in Environmental and Natural Resources Law.
3. I have been a member of Cascadia Wildlands since 2022. I have volunteered, attended events, and participated in field checking as well as completed two legal internships with the organization during law school. While working with the organization, I have assisted with ongoing litigation in federal court involving BLM timber sales. During my most recent internship with Cascadia Wildlands, I also assisted with various research and writing projects associated with the Trail Bridge Dam on the McKenzie River.
4. In addition to my work and involvement with Cascadia Wildlands, I also serve as the vice president of the local Trout Unlimited chapter within the Southern Willamette Valley. Established in 1998, our chapter is dedicated to healthy fisheries, cold water conservation, and education in the McKenzie and Upper Willamette River watersheds. In this role, I regularly facilitate partnerships with local organizations in the Eugene/Springfield area to host river cleanups and native tree plantings along the McKenzie River, including direct support to federal and private restoration work.
5. Growing up in Central Oregon, I began fly fishing over twenty years ago on the Deschutes and Metolius Rivers east of the Cascades. However, soon after a fly rod was

first placed in my hands, I began exploring the upper McKenzie River, as it is a short drive over the Cascades from Bend. I remember witnessing the first Green Drake mayfly hatch of my life on the upper McKenzie in June 2006. On that spring afternoon, I watched large, graceful mayflies suddenly emerge from the river and begin fluttering angelically over the crystal-clear surface of the McKenzie. Soon after their emergence, the insects were engulfed by feisty, open-mouthed native rainbow trout. The river truly came alive with activity. The hatch ended as quickly as it started, but that moment has stuck with me ever since and has continued to call me back to the banks of the upper McKenzie River year after year to fish and find solitude.



6. I have a strong, longstanding personal interest in the health, viability, and abundance of Upper Willamette River (UWR) Chinook salmon and bull trout on the McKenzie River. In 2011, I moved to Eugene and enrolled at the University of Oregon as an undergraduate student. At this time, I began fishing the McKenzie River more frequently because I was now living in the Willamette Valley. Between late March and November each year between 2011 and 2015, I would fly fish and/or float the McKenzie at least two days per month. While pursuing my degree in Environmental Science, I also worked at the local fly shop in Eugene, where I helped anglers in the community connect with the native fish populations of the McKenzie River. I would also educate customers about the unique ecosystem and amazing aquatic life on the McKenzie, including the salmon and bull trout that call the river home. Between my junior and senior years, I worked as an intern in the fisheries biology department with the US Forest Service in the Upper Willamette Ranger District. I spent the summer studying bull trout in the Upper Willamette River above Hills Creek Reservoir. While monitoring and maintaining PIT tagging stations was one of my primary roles as an intern, I also spent multiple days each week conducting snorkel surveys in search of bull trout. I can count on one hand how many bull trout I personally observed that summer, underscoring how few of these fish remain in their native range. However, being in the water with these incredible creatures during those few and brief encounters was deeply impactful and spiritual for me. In addition to my summer internship with the US Forest Service, my senior project at the University of Oregon involved assisting the US Forest Service collect baseline monitoring data for an ongoing floodplain enhancement project on the South Fork of the McKenzie River below Cougar

Dam. One of the primary goals of this project is to improve spawning habitat for UWR Chinook salmon and bull trout in the McKenzie basin.

7. Since my return to Eugene in 2022 to attend law school, I regularly fly fish, raft, and kayak on the McKenzie River again. In the spring and fall, I frequently fish the lower McKenzie River downstream of Hendricks Park. But during the summer months, I love to fish and paddle the upper river downstream from Olallie Campground. I am often joined on these days by my longtime partner and our friends in the local community.



8. I feel most at peace when I am on the river. Whether it is paddling a rapid or standing knee-deep in a riffle with my fly rod in hand, I experience immense spiritual benefits associated with my hobbies. I understand that these hobbies depend upon clean, healthy

waterways with intact habitats and sustainable fish populations, including Upper Willamette River Chinook and bull trout.



9. While I only target rainbow trout on the McKenzie, I regularly look for bull trout and UWR Chinook salmon when I am on the river, particularly in the fall when these species are spawning. I looked for UWR Chinook salmon and bull trout most recently while hiking along the Trail Bridge Hydroelectric Project Spawning Channel on October 14, 2024. While I witnessed five bull trout that day, I did not see a single salmon, despite it being the time of year when I have regularly seen them in this area during previous years. It was a stark reminder that despite the McKenzie River historically producing

approximately 40% of the UWR Chinook salmon spawning in the Willamette Basin upstream of Willamette Falls, their numbers have rapidly declined throughout my life.

10. I understand that one of the reasons for this decline is due to dams like Trail Bridge Dam on the McKenzie, which prevent UWR Chinook from accessing critical habitat upstream. The lack of fish passage on this dam makes it impossible for these fish to access some of the coldest, cleanest water in the entire basin, which has contributed to their precipitous decline.
11. Through my experience and education, I have learned that as the number of salmon returning to a river declines, the health of the river declines too. UWR Chinook significantly contribute to the health of the McKenzie River and the surrounding forest. After they spawn, salmon die, and their carcasses provide essential nutrients to the local habitat. These nutrients support soil health, plant growth, and also indirectly support the entire food web of local animals that depend on these plants for food, such as deer, birds, beavers, and otters. The importance of salmon to the health of rivers is well-documented, and its importance cannot be overstated.
12. While working as an intern with the Forest Service studying bull trout, I learned about “the four C’s” of bull trout habitat requirements: cold, clean, complex, and connected habitat. Trail Bridge Dam denies bull trout below the dam the ability to spawn and thrive in the coldest and cleanest water in the river, which lies in the miles of river above the dam. Moreover, the dam severs a crucial connection in their habitat, and in doing so, it has isolated populations of bull trout above and below the dam. This continues to deny the genetic exchange between populations, which is critical for their long-term fitness, and it denies the bull trout above the dam from the foraging habitat that lies beneath the

dam. Overall, as long as the Trail Bridge dam stands in the McKenzie River without effective fish passage, bull trout will continue to decline on this river for the reasons stated.

13. Since learning that my local public utility has been continuously exceeding their incidental take permit associated with the Trail Bridge Dam, I have become distraught and feel betrayed as a member of this community, especially given my significant personal and professional interest in the restoration of the McKenzie River and the viability of its native fish populations.
14. I plan to make Oregon my lifelong home. In the years ahead, I hope to start a family and share with my children the wonders of the McKenzie River – a place that has profoundly shaped me. I want them to experience the magic of a Green Drake hatch while trout fishing on the Upper McKenzie. I want them to witness the wonder of salmon spawning in their natal stream after journeying hundreds of miles from the Pacific Ocean. And I want them to observe bull trout swimming in the deep pools of the upper McKenzie River, and see them not only for the majestic fish that they are, but also understand the testament their existence provides to the greater health of the cold, clean, complex, and connected habitats that they reside in.



15. If effective fish passage is not installed at the Trail Bridge dam, UWR Chinook and bull trout will be put at grave risk of extinction in the McKenzie River. This will deeply impact the health of the river and diminish my ability to experience the recreational and spiritual benefits associated with my hobbies of fishing and fish viewing on the McKenzie River. Considering the importance of this area to me throughout my life, the continued decline of UWR Chinook and bull trout due to the Trail Bridge Dam has and will continue to cause me irreparable harm, sadness, and reduce my ability to learn, enjoy, and observe the fish I have dedicated so much of my life and education to study, observe, understand, and appreciate.

I declare under penalty of perjury that the foregoing is true and correct. Executed this 29th day of April of 2025 in Eugene, Oregon.



Andy Archer (Apr 29, 2025 15:28 PDT)

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CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,

Case No.: 6:25-cv-446-MTK

Plaintiffs,

v.

DECLARATION OF
DAVID THOMAS

EUGENE WATER & ELECTRIC
BOARD,

Defendant.

I, David Thomas, hereby declare:

1. My name is David Thomas and I make the following statements on the basis of personal knowledge, and if called as a witness I would and could truthfully testify thereto.

2. I am a resident of Eugene, Oregon, and a retired biostatistician with expertise in population biology and genetics.

3. I come from a family with a strong tradition of both conservation and fishing, and have fished in the Pacific Northwest throughout my life, and have a great respect for the iconic salmon and bull trout here.

4. I have been a member and supporter of the Native Fish Society since 2008, and I have been professionally and personally involved in efforts to conserve and recover salmon and bull trout in the Upper Willamette River watershed for over ten years.

5. The Native Fish Society is a 501(c)(3) non-profit organization whose mission is to advocate for the recovery of wild, native fish and promote the stewardship of the habitats that sustain them, guided by the best available science. The Native Fish Society envisions a Pacific Northwest abundant in wild fish, free-flowing rivers, and thriving local communities. I joined and became an active member of the Native Fish Society in order to support its efforts to protect native salmonid populations in Oregon, generally, and in the Upper Willamette River watershed, in particular.

6. I volunteer as one of the Native Fish Society's River Stewards for the McKenzie River. River Stewards advocate on behalf of the wild, native fish in a specific watershed and provide a watchdog presence for state/provincial, tribal, and federal agencies with management authority. River Stewards come from all walks of life, from mechanics to

lawyers to teachers to software engineers, but are united in their devotion to the particular watershed over which they have stewardship. The purpose of the River Stewards and the Native Fish Society itself is to make sure that fish-related governmental policies are adopted and implemented on behalf of native fish. River Stewards work on proposed policies with key officials, from legislators to agency leaders. Once such policies are approved, the River Stewards and the Native Fish Society closely monitor the implementation of policies and regulations to make sure wild, native fish benefit. River Stewards identify opportunities for change, prioritize advocacy activities, and use personal knowledge, experience, relationships, and the best available science to motivate stakeholders and agencies to improve conditions for wild, native fish.

7. In my volunteer work as a River Steward for the McKenzie River, I have been particularly invested in education and public outreach. For example, I help organize, through a program called SalmonWatch, annual field trips for Lane County schoolchildren to salmon spawning grounds on the McKenzie River, where the children conduct hands-on activities to understand salmon biology, including identifying macroinvertebrates (aquatic insects), conducting water quality monitoring, exploring riparian zones, and collecting field data. Since 2018, I have participated in many field trips in which we observed wild Chinook salmon spawning in the river, and I explained to the schoolchildren what they were seeing and answered questions. I also regularly took photographs of the spawning salmon. I plan to continue to participate in field trips to the McKenzie River as long as I am able. I have recently secured grants from several funding organizations to continue and expand this important work. I am also involved in organizing, participating in, and recruiting local citizens to join an annual

cleanup drive to remove trash and debris from the river sponsored by the McKenzie River Watershed Council.

8. I am familiar with the Carmen-Smith Hydroelectric Project on the upper McKenzie River, and Trail Bridge Dam in particular. Because the SalmonWatch program described above utilizes the man-made salmon spawning channel at the base of Trail Bridge Dam for some of its programs, I have seen the dam numerous times and observed salmon blocked from moving upstream to headwater habitat.

9. I am aware that Trail Bridge Dam has adverse effects on McKenzie River Chinook salmon, which largely relate to the lack of effective fish passage at the dam. The lack of fish passage at Trail Bridge cuts off spawning habitat for Chinook salmon. I have observed Chinook salmon migrating to the base of the dam, and it is clear that they are attempting to move higher in the watershed, but Trail Bridge Dam is a complete impediment to that movement. As climate change increases water temperatures throughout the Cascades, it is limiting the range of cold clean water that the resident salmon and bull trout require. As the water in the lower McKenzie River becomes warmer, we can confidently anticipate that the dam's lack of fish passage to colder upstream water will greatly inhibit effective spawning. The inability of Chinook salmon to access the high-quality spawning and rearing habitat above Trail Bridge Dam contributes to its lack of recovery in the McKenzie Basin.

10. It is my understanding that attempts at moving adult Chinook above Trail Bridge Dam have had poor success and caused injury and mortality to individual fish. This is not surprising, as this method of moving fish around barriers is known to have negative effects. For instance, salmon migrate mostly at night, when the fish traps are rarely manned. As a result, the fish may be held in the trap for extended periods, and injury or even mortality is known to

occur. When salmon are blocked from reaching an adequate spawning location they will often die without spawning. This is known as Prespawn Mortality and is typically measured by examination of the carcasses of mature salmon at or near spawning grounds. Also, the handling of these mature and highly stressed fish when they are captured and transported by truck around the dam will often result in injury, impeding their ability to spawn. Unfortunately, to my knowledge, none of these parameters are currently being monitored at Trail Bridge Dam.

11. In the Fall of 2023, I was writing a technical article on McKenzie River salmon conservation. When I attempted to obtain information from EWEB regarding fish passage at Trail Bridge Dam, which I assumed was an ongoing process, I was advised that this was a process under development, and no information was currently available. I later raised the same question with the Oregon Department of Fish and Wildlife (ODFW) fishery manager, Jeff Ziller, and was told that “we [ODFW] have helped them move a couple of fish above Trail Bridge Dam.” These statements indicated that there was not a serious or successful program underway to give salmon access to the headwaters of the McKenzie River.

12. The lack of fish passage at Trail Bridge Dam also negatively affects McKenzie River bull trout populations. Bull trout are recognized as being at great risk of extirpation from the entire Western Cascades. Because this species requires unusually cold water to reproduce, the appropriate habitat for them to thrive is quite limited and will become even more limited as climate change continues to impact water temperatures. At present, the largest number of these fish are located in the headwaters of the McKenzie River due to the cold clean water in these reaches, with populations above Trail Bridge and Cougar Dams.

13. Since the 1990s, efforts to recover these fish have focused on ways to expand the range of bull trout breeding populations to allow these once highly migratory fish to exploit

a greater variety of resources. Previous efforts to expand their range included moving bull trout to areas below Trail Bridge Dam in the hopes that other streams would support bull trout and that the various local populations would form larger breeding groups. However, recent studies of McKenzie River bull trout have shown that larger breeding groups are not forming.

14. When bull trout were being moved to streams below Trail Bridge Dam, it was assumed that effective fish passage at the dam would be implemented. Unfortunately, the failure to implement an effective fish passage process has been a major factor in blocking an expansion of the breeding size of the various isolated populations. It has also prevented genetic exchange between the existing populations above and below Trail Bridge Dam, injuring the future viability of these isolated populations.

15. While there has been some attempt to move bull trout above Trail Bridge Dam by a trap and haul operation, available reports indicate that this has involved only a few fish and is, therefore, unlikely to result in the desired effects. In addition, moving bull trout in this way is expected to result in harm, harassment, and injury from capturing, handling, and transporting fish. For example, one of the methods employed below the dam is to use hook and line to capture bull trout manually, which creates a serious risk of injuring the fish's mouth from the hook or damaging the fish's body from the ensuing struggle. As discussed above in the case of salmon, traps are also hazardous for large fish such as these, as injuries or even mortality can come from removing the fish from the trap, putting them in tanks, and hauling them in trucks above the dam, and releasing them back in the river.

16. In 2023, I began a discussion among a group of retired scientists concerning the use of the newly developed eDNA water sampling methods to see if we could contribute to an understanding of whether any of the past efforts to expand the range of Western Cascades bull

trout were effective and to find new opportunities that might support the species' expansion. Working in coordination with the United States Forest Service and ODFW, trained volunteers sampled headwater streams across several Willamette sub-basins, focusing on the McKenzie Basin. Among other things, the study results demonstrated that the range of McKenzie River bull trout had not expanded from what had been reported much earlier. Given the geography of the habitats in question, effective fish passage at Trail Bridge Dam is likely the best way to expand the range of bull trout and allow for interactions between populations, thereby increasing the breeding size and genetic diversity in what are now a number of isolated populations.

17. My advocacy, conservation, and educational outreach efforts are motivated by the important role that wild salmon in the McKenzie River watershed have played in my own life since I was young. I grew up on the West Coast of the United States and began fishing on the McKenzie River in 1954, before dams were placed on the river, and have fished on it nearly annually until I retired and moved to Eugene, Oregon, in 2006. Now, living in close proximity to the McKenzie River, I still visit it numerous times each year. I plan to continue fishing and just enjoying the river as long as I am healthy and able. I particularly enjoy fishing for Chinook on the lower reach of the McKenzie River above the confluence.

18. My enjoyment of native fish is not limited to angling. I also enjoy hiking along the McKenzie River and am an avid nature photographer. I have taken many photographs of salmon and bull trout migrating, spawning, and rearing in the river. Several of my photographs of native McKenzie River salmon are posted on the Native Fish Society's website. The presence of migrating and spawning wild salmon contributes to the biodiversity of the riparian ecosystem, and schools of spawning fish and spawned-out fish

carcasses can attract predator and scavenger species such as eagles, ospreys, foxes, coyotes, raccoons, and bears, which I also enjoy observing and photographing.

19. Even when I do not have a fly rod or a camera with me, seeing native Chinook salmon and bull trout and knowing that they are present in the river system gives me great satisfaction. Last October, I took my daughter and my two grandchildren up the McKenzie River to see this great river for themselves. We discussed the various ways that man has attempted to “civilize” the river and the consequences that resulted. This of course included the effects of dams on the river and how their ill effects can be reversed. I plan to continue taking these trips regularly as long as I am able.

20. In recent years, I have personally observed the decline of the wild salmonid population in the McKenzie River watershed. The decline since I began fishing in the 1950s has been somewhat gradual and characterized by annual variation, but ultimately downward. Now it has become increasingly clear to me, particularly in the last ten years, that the danger of losing this population is very real. Since approximately 2008, I have noticed that the number of areas in which I have been able to observe salmon spawning has been significantly reduced. Also, the number of salmon I see spawning in these locations has diminished during that time.

21. I have experienced and will continue to experience personal injury from the harm, harassment, injury, and mortality of Chinook salmon and bull trout caused by the operation of Trail Bridge Dam. The adverse effects of the dam, particularly its lack of fish passage, are impairing the natural spawning, rearing, feeding, and migratory behaviors of salmon and bull trout. The current trap and haul efforts are not effective at moving fish above the dam and are directly injuring or killing fish. This lack of passage and the impacts of the

current trap and haul processes are impairing the abundance and productivity of these populations.

22. I enjoy fishing, observing, and photographing in these rivers less when I encounter fewer wild fish, and my increasing concern for the future of wild Chinook salmon and bull trout in the McKenzie River interferes with my use and enjoyment of this watershed. These two species were listed as threatened in 1999 and have not recovered a quarter of a century later, and their keystone populations in the McKenzie River still have low abundance and productivity, which is a great disappointment and a matter of great concern to me.

23. The trap and haul procedure now being employed for fish passage at Trail Bridge Dam also injures my interest in seeing, enjoying, and protecting McKenzie River Chinook salmon and bull trout. Not only are the methods ineffective at passing many fish, and therefore have not improved abundance or productivity in the populations, but they actually cause stress, injury, and sometimes mortality of individual fish. Knowing that fish are experiencing stress and injuries from poor trap and haul processes is disturbing to me. My injuries would be reduced if EWEB immediately took actions to improve its trap and haul methods to reduce injuries and stress to the fish. I understand Plaintiffs are providing information to the court in this regard. Such improvements would also make it more likely that fish would successfully spawn above the dam.

24. Additionally, even though I have historically taken great pleasure in angling for Chinook, I have begun to ask myself whether I can continue to fish in the McKenzie watershed, given the stress that the Chinook population is under. This ethical dilemma is something I have discussed frequently with other anglers, and it has reduced my ability to enjoy this pastime. I know that many of my fishing friends feel the same way.

25. I believe that Trail Bridge Dam contributes to the low abundance and low productivity of Chinook salmon and bull trout in the McKenzie River; this belief is supported by numerous scientific and agency analyses, along with my own lifetime of observations of the River. I am deeply concerned that these wild fish will not be there for my grandchildren and future generations to enjoy in the way that my family and I have. I feel that I owe it to my grandchildren, whom I have introduced to the river and taught to respect what nature has provided, to do everything I can to prevent this decline. Thus, I spend a significant amount of my limited free time working on conservation, education, and advocacy efforts to protect native fish in the McKenzie River watershed instead of spending that time enjoying outdoor recreational activities in that area, which I would prefer.

26. If the Court provides the relief sought by the Plaintiffs in this case, it will directly, though not fully, remedy the harm caused to me by EWEB's continued funding, maintenance, and operation of Trail Bridge Dam, including its current trap and haul methods, in a manner that causes or contributes to the harm, harassment, injury, and mortality of Chinook salmon and bull trout.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed this 14th day of May 2025, in Eugene, Oregon.



David Thomas

EXHIBIT 3

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UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

EUGENE DIVISION

**CASCADIA WILDLANDS;
WILLAMETTE RIVERKEEPER;
OREGON WILD; and NATIVE FISH
SOCIETY,***

Case No.: 6:25-cv-00446-MTK

Plaintiffs,

v.

**SECOND DECLARATION OF
KIRK SCHROEDER**

**EUGENE WATER & ELECTRIC
BOARD,**

Defendant.

I, Kirk Schroeder, declare as follows:

1. I have personal knowledge of the facts set forth below and if called as a witness I would and could truthfully testify to these facts.

2. I was asked by the Plaintiffs in this litigation to provide my expert opinion on the impacts to threatened Upper Willamette River Chinook salmon and bull trout caused by Trail Bridge Dam, which is owned and operated by Eugene Water and Electric Board (“EWEB”). I was also asked to provide my expert opinion on interim measures that could be implemented to provide immediate and temporary relief.

3. I provided a previous declaration in support of Plaintiffs’ Motion for Preliminary Injunction. Declaration of Kirk Schroeder (ECF No. 14).

4. My First Declaration describes my professional qualifications and experience. Schroeder Decl. ¶¶ 3–8. In brief, I spent nearly 40 years researching and monitoring salmon, steelhead, and trout; 36 of which I was employed with the Oregon Department of Fish and Wildlife (“ODFW”). I have substantial experience with Willamette River salmonids, as I assisted and then led the Willamette Spring Chinook Research Project from 1996–2013. I have continued to work with the Willamette River research project, write research papers for professional journals, and interact with project personnel on various activities associated with the Willamette basin.

5. I have many years of experience trapping and sampling adult salmonids, and helped design, construct, and install numerous picket weirs and cage (or box) traps in tributaries of the Siuslaw River for the purpose of capturing and sampling adult steelhead. I also provided input on the design and installation of weirs and cage traps in tributaries of the Sandy River for

capturing adult Chinook salmon. I authored a comprehensive review of capture techniques for adult salmonids that was published in the peer-reviewed ODFW Information Report series.¹

Temporary Trap-and-Haul in Spawning Channel

6. The primary goals of providing passage at Trail Bridge Dam are to re-establish Chinook salmon in their historic habitat and to reconnect the above-dam and below-dam bull trout populations. These goals have been identified in recovery and action plans for both species.² For example, the conservation and recovery plan for Upper Willamette River (“UWR”) Chinook salmon specifically identified passage at Trail Bridge Dam as a recovery action with the assumption that passage would be provided by 2016 or 2017. Because of numerous delays, EWEB has yet to provide the required passage at Trail Bridge Dam for spring Chinook salmon and bull trout. Therefore, it has been necessary to implement temporary measures to provide passage for these federally listed species.

7. EWEB installed a facility in the spawning channel that was intended to trap adult salmon and bull trout (primarily salmon) and transport them to designated release sites upstream of Trail Bridge Dam. Declaration of Andrew Talabere ¶¶ 21, 28–30, Ex. 1 (ECF No. 33).

8. In my previous declaration I assessed the temporary trap and haul system in the spawning channel with a primary focus on the design and effectiveness of the trap in capturing adult salmonids. Schroeder Decl. ¶¶ 39, 48. As should be obvious, the first step in an effective trap-and-haul system is capturing the target fish. Therefore, my assessment of the temporary trap-and-haul system was specific to its effectiveness in capturing adult salmonids. I did not

¹ Schroeder, R.K. 1996. *A review of capture techniques for adult anadromous salmonids*. Information Report 96-5, Oregon Department of Fish and Wildlife. Attached as Exhibit 3 (the citation for this report was provided to Defendant’s counsel prior to my deposition).

² ODFW and NMFS. 2021. *Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead*.; Upper Willamette Bull Trout Working Group. 2010. *Upper Willamette Basin Bull Trout Action Plan 2010*.

assess or address details of trap operation, trap design history, or other details of the transport and release protocols because these specific details are irrelevant in evaluating whether or not the EWEB trap is effective in capturing adult salmon for transport. In addition, I assumed the details of the transport and release protocols (e.g., release sites) had already been established based on the premise that the EWEB trap would capture fish to transport and release.

9. The single specific detail that pertains to the temporary EWEB trap-and-haul system in meeting its obligation for providing temporary passage is the fact that the trap has failed to capture a single adult salmonid in two years of operation. As a measure of the effectiveness of attracting and passing fish, three metrics are used: a) *attraction efficiency* or the proportion of fish that are attracted to the vicinity of the entrance (within 3 meters); b) *entrance efficiency* or the proportion of the fish attracted to the vicinity that then enter; and c) *passage efficiency* or the proportion of fish that enter and successfully exit a fishway.³ The first two metrics would apply to the effectiveness of the temporary trap but formal evaluation is not possible without a marking program.⁴ However, general observations reported in quarterly progress reports can be used to approximate entrance efficiency.

10. The EWEB trap was first operated in 2023 and no adult fish were trapped and transported. The quarterly progress reports did not note the presence of fish within the vicinity of the trap for 2023. Operation in 2023 was interrupted by wildfires. For 2024, the April 2025 quarterly progress report noted a number of salmon observed in the vicinity of the trap: (“five salmon in the immediate vicinity of the trap” on September 3; “11 salmon...spotted around the trap” on September 10; no “more than nine salmon in the vicinity for the remainder of sampling

³ Cooke, S.J. and Hinch, S.G. 2013. *Improving the reliability of fishway attraction and passage efficiency estimates to inform fishway engineering, science, and practice*. Ecological Engineering 58:123-132.

⁴ Fish would need to be marked or tagged downstream of the trap location to estimate the proportion of marked fish actively attracted to the trap vicinity and oriented within the attraction plume.

season”).⁵ It cannot be ascertained if the salmon in the vicinity of the trap were actively attracted to the trap site or if they were merely continuing upstream migration and resting in the pool where the trap is located. However, if one assumes the salmon were attracted to the vicinity of the trap and no fish entered, then the entrance efficiency would be 0%. The poor performance of the EWEB trap is despite several modifications that were intended to increase its effectiveness. Mr. Talabere states that plans for 2025 include “refining and improving the temporary trap and haul methodology,” but no specifics are provided on what that might entail. Talabere Decl. ¶ 35. Given the natural behavior of adult salmon and the inherent deficiencies of the trap design, it is difficult to see what modifications could be made to improve the trap. Modifications of the trap to date have proven insufficient.

11. The preponderance of evidence indicates the EWEB trap is ineffective in capturing adult fish for transport upstream of Trail Bridge Dam. In my professional opinion, based on years of experience in trapping adult salmonids, there are multiple deficiencies with the trap including:

- a. Location in a deep pool. Traps for adult salmonids are generally located in the thalweg (main current) of a stream where fish tend to migrate as they move upstream. Traps are designed to intercept adult salmonids actively migrating upstream through a section of stream with current. The EWEB trap is located within a deep pool where a pump is used in an attempt to create current near the surface to attract fish. Talabere Decl. ¶ 33, Ex. 1. However, the natural current through the lower water column of the pool would likely continue in a general downstream direction. The natural behavior of adult salmonids in a pool is to hold

⁵ Quarterly progress report to FERC, May 1, 2025, Docket No. 2242-111, -112. Plaintiffs’ Ex. 10).

in the bottom portion facing upstream, usually accompanied by brief forays within the pool before returning to a resting position.

- b. Attraction flow. It is difficult to determine whether the trap is deficient because (1) attraction flow provided by pump is insufficient to entice fish to swim toward and enter the trap and/or (2) adult fish are reluctant to enter the relatively small trap entrance and tube (*see* ¶ 11c). Adequate attraction flow is affected by many factors including water velocity (both for the stream and attraction plume), cross-sectional flow of the stream and the proportion of flow within an attraction plume, turbulence (turbulent kinetic energy), and natural behavior of target fish species.⁶ Basically, the flow and velocity in the attraction plume should be high enough to induce rheotaxis in adult salmonids (orientation to flow) and match their swimming ability. The plume created by attraction flow should be strong enough to overcome natural flow and should extend far enough from the trap so that fish enter the plume and swim toward the trap entrance. Available information is insufficient to determine the effectiveness of the supplemental pump to provide an adequate attraction flow. However, fish behavior in the vicinity of the trap should provide an indication of whether or not fish are swimming within the attraction plume and are oriented toward the trap entrance.
- c. Small trap entrance. Even if attraction flow was sufficient so that fish were oriented and actively swimming toward the trap entrance, they would then have to swim into a relatively small diameter tube. Talabere Decl. Ex. 2. The EWEB trap is contrary to standard trap designs that provide a larger entrance area so that

⁶ For example, see Gisen, D.C., Weichert, R.B. and Nestler, J.M. 2017. *Optimizing attraction flow for upstream fish passage at a hydropower dam employing 3D Detached-Eddy Simulation*. Ecological Engineering 100:344-353.

under their natural swimming behavior fish are more likely to enter a trap. The EWEB trap requires an adult fish to orient perpendicular to the general downstream flow of the pool and then swim into an enclosed tube. It would also likely require an adult fish to use burst or darting swimming speed to swim against the velocity of water supplied by the pump in order to enter the confined space of the tube. In contrast, other systems involving a pneumatic tube to transport fish have incorporated entry chambers that are larger than the transport tubes to overcome the reluctance of fish to enter small diameter openings.⁷ The chambers usually have sides that are sloped and funnel toward the tube opening with water diffusers in the upstream ends of the chamber and tube. Such features are absent in the EWEB trap.

- d. Trap entrance on side. As noted previously, the entrance to the EWEB trap is on the side, perpendicular to the natural flow in the spawning channel. Talabere Decl. Ex. 1. The standard for traps designed to capture adult salmonids is to have the entrance on the downstream end of the trap to intercept fish as they migrate upstream, not on the side of the trap. (Photographs of adult salmonid traps are provided in Ex. 1 and 2). In addition, the trap entrance is near the surface of the deep pool where the trap is located. Talabere Decl. Ex. 1. To find the entrance to the trap would require adult fish to swim toward the surface and turn perpendicular to the general current within the pool, contrary to their natural upstream orientation and movement.

⁷ Harris, J.H., Peirson, W.L., Mefford, B., Kingsford, R.T. and Felder, S. 2019. *Laboratory testing of an innovative tube fishway concept*. Journal of Ecohydraulics 5:84-93.

e. Limited operation. The trap can only be operated when people are on-site because it is designed to capture a single fish within a relatively small tube that would then have to be lifted and transported to the tanker truck. Talabere Decl. Ex. 2. This restricts the number of hours and the time of day the trap can be run, which may not conform to the natural behavior and movement of fish. To date, the trap has apparently been operated only during daylight hours. Adult salmonids often move during crepuscular and nocturnal hours when migrating into spawning tributaries, possibly an adaptation to avoid predators.⁸ Similarly, adult salmon may also remain in the deeper part of a pool during daylight hours and spend more time near the surface during the night. For example, I was involved in operating a fish trap to sample adult fall Chinook salmon at Sherars Falls on the Deschutes River, and the optimal time for sampling was determined to be 4 pm to midnight based on the highest catch rate during periodic tests when the trap was run for 24 hours.

12. It should be noted that because no adult fish have been captured in the EWEB trap, there remains a degree of uncertainty about the efficiency of the remainder of the operation to transfer a fish to the transport truck. For example, how long it will take to raise the tube to the level of the transport cable, traverse the transport cable to the transport tank, lower the tube to the transport tank, and release the single fish into the tank. Talabere Decl. Ex. 2. In addition, it is unclear how a salmon that is surplus to transport goals would be handled and released after it has

⁸ Twardek, W.M., Knight, K.L., Reid, C.H., Lennox, R.J., Cooke, S.J. and Lapointe, N.W.R. 2022. *Insights into Chinook salmon (Oncorhynchus tshawytscha) movement ecology in the terminal reaches of the upper Yukon River during the spawning migration*. Canadian Journal of Zoology 100:561-573; Finlay, R.W., Poole, R., French, A.S., Phillips, K.P., Kaufmann, J., Doogan, A., Cotter, D., McGinnity, P. and Reed, T.E. 2020. *Spawning-related movements in a salmonid appear timed to reduce exposure to visually oriented predators*. Animal Behaviour 170:65-79; and Bentley, K.T., Schindler, D.E., Cline, T.J., Armstrong, J.B., Macias, D., Ciepiela, L.R. and Hilborn, R. 2014. *Predator avoidance during reproduction: diel movements by spawning sockeye salmon between stream and lake habitats*. Journal of Animal Ecology 83:1478-1489.

been captured in the tube. That is, even if the trap was effective in capturing the goal of 10 pairs of salmon (Talabere Decl. ¶ 27), it is very likely that more than 20 fish would need to be captured to ensure a 50:50 sex ratio, and surplus fish would need to be handled and released in some manner.

Proposal for New Cage Trap

13. As was proposed in my first declaration, a cage trap would be installed in the spawning channel in a location where adult salmonids migrating upstream would volitionally enter the trap. Schroeder Decl. ¶ 49. The trap would be incorporated within a picket or panel weir angled downstream to guide the fish to the trap entrance. As mentioned previously, these types of traps have been commonly used to capture adult salmonids and are relatively simple to construct.⁹ This type of trap would largely eliminate the deficiencies of the EWEB trap:

- a. The trap would be located in the tailout of a pool to provide depth for adult fish to hold once in the trap. A picket or panel weir would angle downstream into the downstream riffle to guide fish to the trap entrance.
- b. Stream current would flow through the trap to provide attraction flow; i.e., the entire stream current would be the attraction flow whether through the trap or through the guiding weir. This setup would ensure that the trap is located in the natural pathway of actively migrating adult salmonids.
- c. The cage trap would have a V-shape fyke entrance with a large opening on the downstream end that narrows gradually to a smaller opening leading into the trap. The fyke entrance is common in many fish traps and is successful in guiding fish

⁹ Schroeder 1996. *Capture techniques*. see pages 3–10 and 72–73 (Ex. 3); see also Exs. 1 & 2.

into the trap, and the opening within the trap is narrow enough to prevent fish from escaping. Exs. 1 and 2.

- d. The entrance of the cage trap is at the downstream end, which is found on almost all traps designed to capture adult salmonids migrating up streams and rivers. Exs. 1 and 2.
- e. The trap does not require people to be on-site in order to operate, therefore the number of hours and time of day the trap can be operated are not restricted. The trap would capture fish as they naturally migrate upstream. Fish would volitionally enter the trap once it was placed into operation, and it would continue to operate during crepuscular and nocturnal hours when fish are more likely to move. Because the number of Chinook salmon returning to the spawning channel has been low in recent years (Talabere Decl. ¶ 37; *see also* ¶ 28), the trap could be checked once a day.

14. A weir and cage trap design is relatively simple to construct and install. *See also* ¶ 22. Materials for these types of traps are often aluminum pipe and framing (e.g., channel or angle). For ease of transport and storage, the trap could be fabricated in panels (sides and bottom) that can be connected with simple hook and eye attachments and/or by band clamps.¹⁰ The upstream end of the trap would be fitted with a removable gate. *See* Ex. 2. Alternatively, the upstream end could be fitted with removable pipes to create an opening. An opening on the upstream end of the trap would be used to pass fish if not needed for transport, or to pass fish into a carrying tube for transport to the tanker truck. Fish would be gently guided to the opening

¹⁰ Schroeder 1996. page 73.

on the upstream end of the trap using a crowder (e.g., small weir panel or coated net material stretched between wooden poles). A locking hinged lid would be installed on the top of the trap.

15. Because flow entering the spawning channel is regulated with a flow control structure and because there is a trash rack to catch debris, the conditions in the spawning channel during the late summer to early fall sampling season would have little flow fluctuations and limited debris. Therefore, materials used for the weir and trap and its installation method do not have to withstand high flows, floods, or heavy debris as is common for weir and trap installations in larger rivers. For example, picket weir sections or weir panels can be installed vertically and supported by fence posts rather than angled toward the downstream end and supported by tripods as is necessary when dealing with high flows. In addition, alternative materials for weir panels could be considered such as pre-fabricated 4–6 gauge, powder-coated welded wire panels with small openings (e.g., 1 inch x 1 inch). The weir and trap can be completely or partially removed at the end of the sampling season, or after the target number of fish has been transported.

16. A cage trap with component panel sections can be assembled on-site and installed on the stream bed with minimal disturbance to the substrate. Irregularities in the stream bed such as individual rocks can be moved or wedges such as sand bags can be used to stabilize the bottom panel of the cage trap.

17. A transport goal of 10 pairs of Chinook salmon has been established for the temporary trap-and-haul. Talabere Decl. ¶ 27. To increase the probability of obtaining Chinook salmon for transport, the weir and trap should be sited in the lower part of the spawning channel. A sampling protocol would be established by the existing Carmen-Smith Fish Working Group (“FWG”) to determine a schedule for transporting fish and allowing fish to pass upstream. Fish may be passed upstream after capture (e.g., males or females in excess of needed transport pair

numbers) through an opening in the upstream end of the trap (§ 14) or the trap may be taken out of operation to allow all fish to pass upstream by pulling pickets of the weir or weir panels closest to the trap. In addition, the entrance to the trap could be blocked when the trap is temporarily taken out of operation. For example, the trap could be operated until a certain number of pairs have been transported, then taken out of operation until adult salmonids are observed in the spawning channel upstream of the trap location, after which the trap would be operated again to capture and transport additional fish.

Sampling of Adult Chinook

18. The highest priority for biological sampling of fish to be transported upstream of the dam would be to collect tissue samples for genetic analysis. Collecting tissue samples from adult salmon can be done with little handling. For example, once a salmon is in a transport tube with the tail facing the open end of the tube, a small piece of the caudal fin can be clipped and processed following standard protocols. Genetic information is critical for evaluating the reproductive success of transported fish. Such information can be used to: a) assign the origin of returning adults collected at traps or recovered on spawning grounds (carcasses) to either parents that were transported upstream of Trail Bridge Dam or parents that spawned downstream of the dam; b) determine the percentage of transported fish that produced progeny (adult offspring) for all fish or by sex; c) total lifetime fitness and predictors such as release date, release location, sex ratio; d) cohort replacement rate or the number of future spawners produced by a transported fish that spawned; e) effective number of breeders for the number of fish transported and released upstream of the dam; f) annual abundance and age structure of returning adults that are assigned

to transported parents using genetic parentage analysis.¹¹ In addition, reproductive success of transported fish can be estimated if juvenile salmon are sampled upstream of Trail Bridge Dam, which can include information on the effects of parentage on emigration timing.¹²

19. The proposal to PIT tag adult salmon that are transported upstream of Trail Bridge Dam was to assess fall back using PIT tag antennas at the entrance to the spawning channel and/or on the sill that spans the river just upstream of the spawning channel entrance. Schroeder Decl. ¶ 50. However, if a weir is installed where transported salmon are released above the dam to prevent fall back (Talabere Decl. ¶ 50), then PIT tagging adult salmon would not be needed to assess fall back. If PIT tagging is conducted, any handling of adult salmon can be minimized with use of a hammock cradle, fish bag, or V-shaped sampling cradle.¹³ In all cases the fish would remain in well-oxygenated water and their head would be covered to help calm them. For example, in a study on the effects of catch-and-release on spring Chinook salmon, a control group was trapped within a fishway and fish were tagged with Floy tags at the base of the dorsal fin using a V-shaped cradle with hood to cover the anterior portion of the fish to keep them calm.¹⁴

¹¹ O'Malley, K.G., Dayan, D. I., Fitzpatrick, C.K., Couture, R. 2023. Evaluating spring Chinook salmon releases above Cougar Dam, on the South Fork McKenzie River, using genetic parentage analysis. Prepared for U.S. Army Corps of Engineers, Portland District.

¹² Banks, M.A., Sard, N.M., O'Malley, K.G., Jacobson, D.P., Hogansen, M., Schroeder, K., and Johnson, M.A. 2014. *A genetics-based evaluation of the spring Chinook salmon reintroduction program above Cougar Dam, South Fork McKenzie River, 2007-2013*. Prepared for U.S. Army Corps of Engineers, Portland District.

¹³ For example, see Donaldson, M.R., Raby, G.D., Nguyen, V.N., Hinch, S.G., Patterson, D.A., Farrell, A.P., Rudd, M.A., Thompson, L.A., O'Connor, C.M., Colotelo, A.H. and McConnachie, S.H. 2013. *Evaluation of a simple technique for recovering fish from capture stress: integrating physiology, biotelemetry, and social science to solve a conservation problem*. Canadian Journal of Fisheries and Aquatic Sciences 70:90-100; and Lawrence, M.J., Raby, G.D., Teffer, A.K., Jeffries, K.M., Danylchuk, A.J., Eliason, E.J., Hasler, C.T., Clark, T.D. and Cooke, S.J. 2020. *Best practices for non-lethal blood sampling of fish via the caudal vasculature*. Journal of Fish Biology 97:4-15.

¹⁴ Lindsay, R.B., Schroeder, R.K., Kenaston, K.R., Toman, R.N. and Buckman, M.A. 2004. *Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery*. North American Journal of Fisheries Management 24:367-378.

Talabere Declaration

20. I have reviewed the Declaration of Andrew Talabere. (ECF No. 33).

21. Mr. Talabere asserts the weir and trap being proposed cannot be implemented by mid-August because of “regulatory restrictions and approvals needed to modify the current system.” Talabere Decl. ¶¶ 42-44. He uses as an example that installation of the proposed trap can only be done during the ODFW in-water work window that ends August 15, 2025. However, it is my understanding that the in-water work window applies to activities that cause ground disturbance within stream beds and banks of streams. An example of a project where the work window would apply would be culvert replacement that requires excavation of the stream bed and/or re-routing of water. Installation of the current EWEB trap involved major excavation of the stream bed and dewatering a section of the spawning channel. In contrast, the proposed weir and cage trap would result in minimal ground disturbance to the substrate or banks of the spawning channel and no dewatering of the channel. The trap sets on the substrate and any irregularities in the stream bed that prevents the trap from sitting flush would involve either moving a few rocks or using sandbags under the trap. Depending on specifics of the weir installation, fence posts might be used to support the weir and would be set into the substrate resulting in very minor disturbance to the substrate.

22. Mr. Talabere asserts that it is “not possible to design, fabricate, and install a new trap” before the work window ends, although he provides no detail on how he arrived at that conclusion, other than regulatory restrictions and approvals. Talabere Decl. ¶ 43. These types of traps are commonly used and do not require an extensive design process; the main decision is on dimensions of the trap. Likewise, fabrication of a trap does not have to be elaborate. For example, an ODFW colleague and myself constructed similar traps in a few weeks; working

part-time on the project with a few tools such as metal saw, oxy-acetylene torch, drill press, and arc welder. These types of traps and weirs can be easily installed in a day, especially because the hydrologic conditions in the spawning channel are rather benign compared to installations done in larger streams with higher flows.

23. If a weir and trap using aluminum pipe and framing cannot be fabricated in time, alternative materials could be used in 2025 that require little to no fabrication to allow time for a more durable trap to be built. The hydrologic environment of the spawning channel is controlled and the size of the channel is small; therefore, construction of the weir and trap would not have to withstand high flows or large flow fluctuations.

24. Because the trap and weir could be installed outside of the ODFW in-water work window and because salmon have apparently been arriving later in recent years (Talabere Decl. ¶ 37), installation of the trap could occur in early September and likely meet the objective of capturing adult salmon for transport upstream of Trail Bridge Dam.

25. Mr. Talabere states that the proposed trap would require handling every fish, but use of a removable gate or removable pipes would allow fish to be passed. Schroeder Decl. ¶ 49; *see also supra* ¶ 14. Use of a hammock cradle or V-shaped cradle can also be used to minimize handling of fish. *Supra* ¶ 19. In addition, netting individual fish within cage traps either to release them or transfer them to a cradle is common, including with listed species. For example, in a consultation letter regarding the operation of a trap for bull trout in the Clackamas River basin, NMFS stated: “The operation of a picket weir and box trap will also capture adult ESA-listed fish. The adult trap is only in operation for a short time, during peak bull trout migration, usually during September. Any adult salmon or steelhead caught in the adult trap will be dip-

netted, and immediately released upstream.”¹⁵ These conditions are similar to how the proposed trap would operate in the spawning channel.

26. Mr. Talabere states: “The trap proposed by Plaintiffs is also designed to capture more fish than the current trap, resulting in the handling of more fish than in the current trap and haul system. Transporting more fish also conflicts with the Mitigation Group’s instruction to capture and transport only 10 pairs of Chinook salmon each year.” Talabere Decl. ¶ 46. He further states: “Mr. Schroeder proposes to transport more fish above the Trail Bridge Dam to spawn but there is currently limited habitat for spawning above the dam.” Talabere Decl. ¶ 48. First, I did not propose any specific numbers of adult salmon to be transported above the dam or released upstream of the trap to maintain a viable population. As stated above, the number of salmon captured and transported can be controlled by letting fish pass through the trap, closing the trap and letting fish pass through a weir opening, or removing the trap once the appropriate number of fish have been transported. Second, the EWEB trap has captured and transported *zero* salmon in two years, therefore capturing even a single fish would be more than what the current trap has achieved. The objective of the temporary trap-and-haul is to capture Chinook salmon for release upstream of Trail Bridge Dam to re-establish a spawning population until permanent passage is completed, but this “temporary” measure can only be successful if fish are actually captured.

27. Mr. Talabere initially criticized the proposal to install a weir in a stream section upstream of Trail Bridge Dam to prevent fallback of transported adult salmon, primarily because of the potential complications of providing downstream passage for post-spawn bull trout. Talabere Decl. ¶ 49. However, I had proposed that a “team of biologists would identify reaches

¹⁵ Consultation letter dated June 27, 2022, NMFS to FWS on trap operations, Pinhead Creek, Clackamas River, NMFS reference no. WCRO-2022-01425

that contain good spawning gravel where adult salmon could be released” Schroeder Decl. ¶ 52. Mr. Talabere subsequently acknowledged that a reach has been identified and installation of a weir is being “contemplated.” Talabere Decl. ¶ 50.

28. Mr. Talabere states that the numbers of Chinook salmon returning to the spawning channel have decreased in 2023 and 2024. Talabere Decl. ¶ 37. Presumably, this is an argument for why the EWEB trap has failed to capture any fish. I agree that the numbers have been low. For example, the average number of redds in the spawning channel was 29 in 2013–2022 compared to 15 in 2023 and 9 in 2024. Nonetheless, a number of adult salmon were observed in the vicinity of the trap in 2024, and some were noted as being in the “immediate vicinity,”¹⁶ yet no fish entered the trap. From this information, one can conclude that the inability of the trap to capture adult salmon is not merely a function of low numbers of fish returning to the spawning channel.

29. Another reason given for why salmon have not been captured is that they arrived later than usual, closer to time of spawning, and that this makes them “less likely to enter the trap.” Talabere Decl. ¶ 37. Even if one accepts this as an explanation for the failure of the trap to capture fish, rather than the inherent deficiencies of the trap design (*see supra* ¶ 11), a logical solution is to locate a trap farther downstream to intercept salmon as they migrate into the spawning channel.

30. The ineffectiveness of the EWEB trap to capture adult salmon for transport upstream of Trail Bridge Dam (as a temporary measure) and the delay in providing passage at the dam has implications for the overall recovery goals of the McKenzie River Chinook population. In particular, these factors jeopardize the goal of re-establishing a self-sustaining population of

¹⁶ Quarterly progress report to FERC, May 1, 2025. *See also* ¶ 10.

wild salmon upstream of the dam. To compensate for the inability of the EWEB trap to capture adult salmon, it is proposed that hatchery salmon be released upstream of the dam. Talabere Decl. ¶ 38. Adult salmon sampled in the spawning channel in recent years have been 100% wild (2021–2024), and salmon in the upper McKenzie River as a whole have been predominantly wild (98.5–100%). Wild fish generally have higher fitness and reproductive success than hatchery fish.

31. For example, O'Malley *et al.* (2023) found that natural origin Chinook salmon transported upstream of Cougar Dam on the South Fork McKenzie River had a total lifetime fitness that was 2.1-fold greater than that for hatchery origin salmon; i.e., the natural origin fish produced twice as many returning adults as hatchery origin fish.¹⁷ Similar results were reported for salmon transported upstream of Detroit Dam on the North Santiam River in 2015 when both natural origin and hatchery origin salmon were released. The total lifetime fitness of natural origin salmon was 1.8-fold that of hatchery origin salmon.¹⁸ Therefore, capture and transport of wild salmon would likely produce twice as many returning adults as hatchery salmon. That is, using hatchery fish to re-establish salmon upstream of Trail Bridge Dam is not a good substitute for capturing and transporting wild salmon that would have a higher likelihood of success in producing returning adults.

32. In addition to the lower productivity of hatchery salmon, releasing hatchery salmon in the upper McKenzie River basin where wild fish predominate could have negative genetic and ecological effects on the wild population. A large review of the effects of hatchery salmonids on wild salmonids found that the majority of studies reported some measure of

¹⁷ O'Malley *et al.* 2023. Genetic parentage analysis above Cougar Dam.

¹⁸ O'Malley, K.G., Dayan, D. I., Fitzpatrick, C.K., Bohn, S., and Grenbemer, G. 2023. Evaluating spring Chinook salmon releases above Detroit Dam and below Big Cliff Dam, on the North Santiam River, using genetic parentage analysis. Prepared for U.S. Army Corps of Engineers, Portland District.

adverse effects.¹⁹ The most common effect reported was adverse genetic effects on diversity, followed by adverse effects on productivity and abundance from genetic and ecological processes. Substituting hatchery salmon because of the failure of the EWEB trap to capture wild fish for transport carries genetic and productivity risks that could be averted if a more efficient trapping system is used, such as that proposed here.

Conclusions

33. Providing passage at Trail Bridge Dam is an important component in recovery of the spring Chinook salmon and bull trout populations in the McKenzie River and in the larger UWR population complex. Temporary passage measures are necessary because EWEB has failed to complete permanent passage for re-establishing Chinook salmon in their historic habitat and reconnecting the above-dam and below-dam bull trout populations. Thus, the objectives of the temporary measures are to capture wild fish for transport upstream of Trail Bridge Dam.

34. EWEB installed a trap in the spawning channel to capture and transport primarily Chinook salmon in order to provide a temporary solution to the lack of passage at Trail Bridge Dam. However, the trap has failed to capture a single fish in two years, despite adult salmon observed near the trap. The trap has multiple deficiencies that will be difficult, if not impossible, to remedy.

35. Therefore, I have recommended a different trap design and trapping location to meet the objective of capturing adult salmonids for transport upstream of Trail Bridge Dam. The proposed trap design has been proven over many years to capture adult salmonids (including listed species) across a wide variety of streams and rivers throughout the Pacific Northwest,

¹⁹ McMillan, J.R., Morrison, B., Chambers, N., Ruggerone, G., Bernatchez, L., Stanford, J. and Neville, H. 2023. *A global synthesis of peer-reviewed research on the effects of hatchery salmonids on wild salmonids*. Fisheries Management and Ecology 30:446-463.

Canada, and Alaska, and it overcomes the deficiencies inherent in the EWEB trap. Locating the trap farther downstream in the spawning channel would increase the probability of capturing adult salmon for transport. Provisions would be made to pass fish surplus to transport needs with minimal to no handling. The number of fish to be transported would not exceed the stated guideline of 10 pairs of Chinook salmon each year. Talabere Decl. ¶ 27. A sampling schedule would be adopted by the existing FWG to ensure a balance of capturing adult salmon pairs for transport above the dam and passing salmon upstream of the trap to spawn.

36. Wild salmon should be used to re-establish a population upstream of Trail Bridge Dam because wild salmon have been shown to have a lifetime fitness that is about twice that of hatchery salmon. In other words, a pair of wild salmon would be expected to produce twice as many returning adults as a pair of hatchery salmon. In addition to their lower productivity, the release of hatchery salmon upstream of the dam could have negative effects on the genetic diversity of wild salmon in the upper McKenzie River. The population of salmon in the upper McKenzie River has been almost exclusively wild fish in recent years (98.5–100%).

37. Installation of a weir at the downstream end of the stream section where adult salmon are released upstream of Trail Bridge Dam would prevent fall back. Plans for the weir should be finalized (not just “contemplated”) so that it can be installed prior to the first release of salmon. The weir should be monitored to observe the behavior of released salmon and to inspect the integrity of the weir to ensure its effectiveness in preventing downstream movement. Fall back of salmon released above the dam has been observed in the past when no provisions were made to prevent fish from moving downstream and out of the stream section where they were released.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Signed this 23rd day of June, 2025, in Philomath, Oregon.

A handwritten signature in black ink, appearing to read "K. Schroeder", is written over a horizontal line.

Kirk Schroeder

EXHIBIT 1. EXAMPLES OF WEIRS AND TRAPS IN PACIFIC NORTHWEST STREAMS USED TO CAPTURE AND SAMPLE LISTED SPECIES



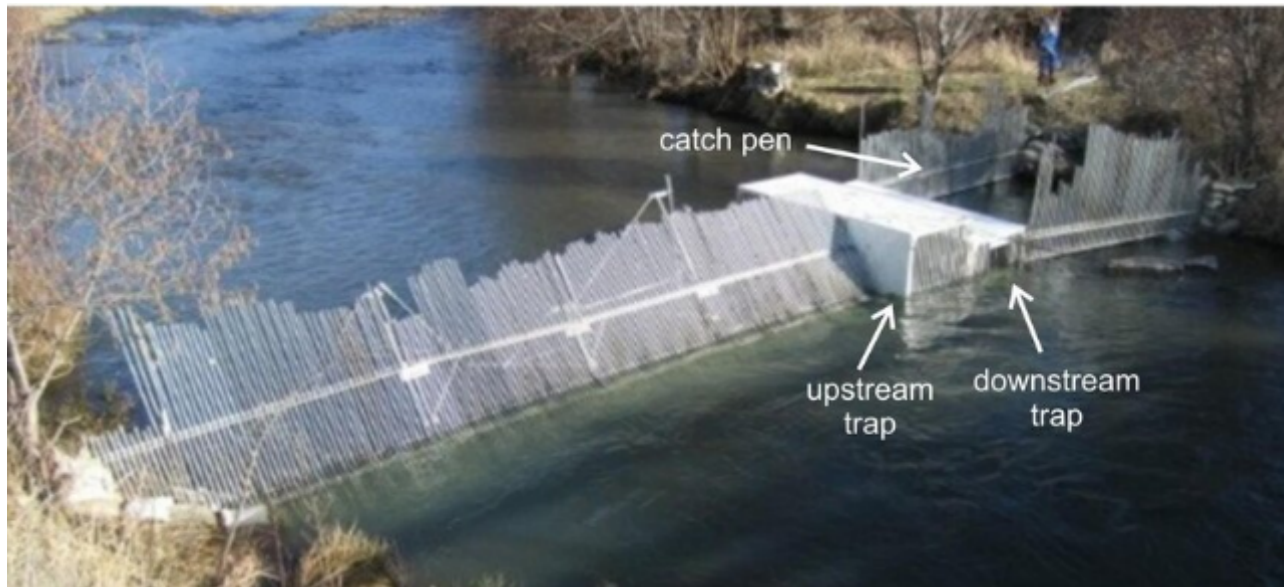
Weir and trap, Pinhead Creek, Clackamas River Basin, Oregon



Weir and trap on Salmon River, Sandy River Basin, Oregon



Weir and trap on Zigzag River, Sandy River Basin, Oregon

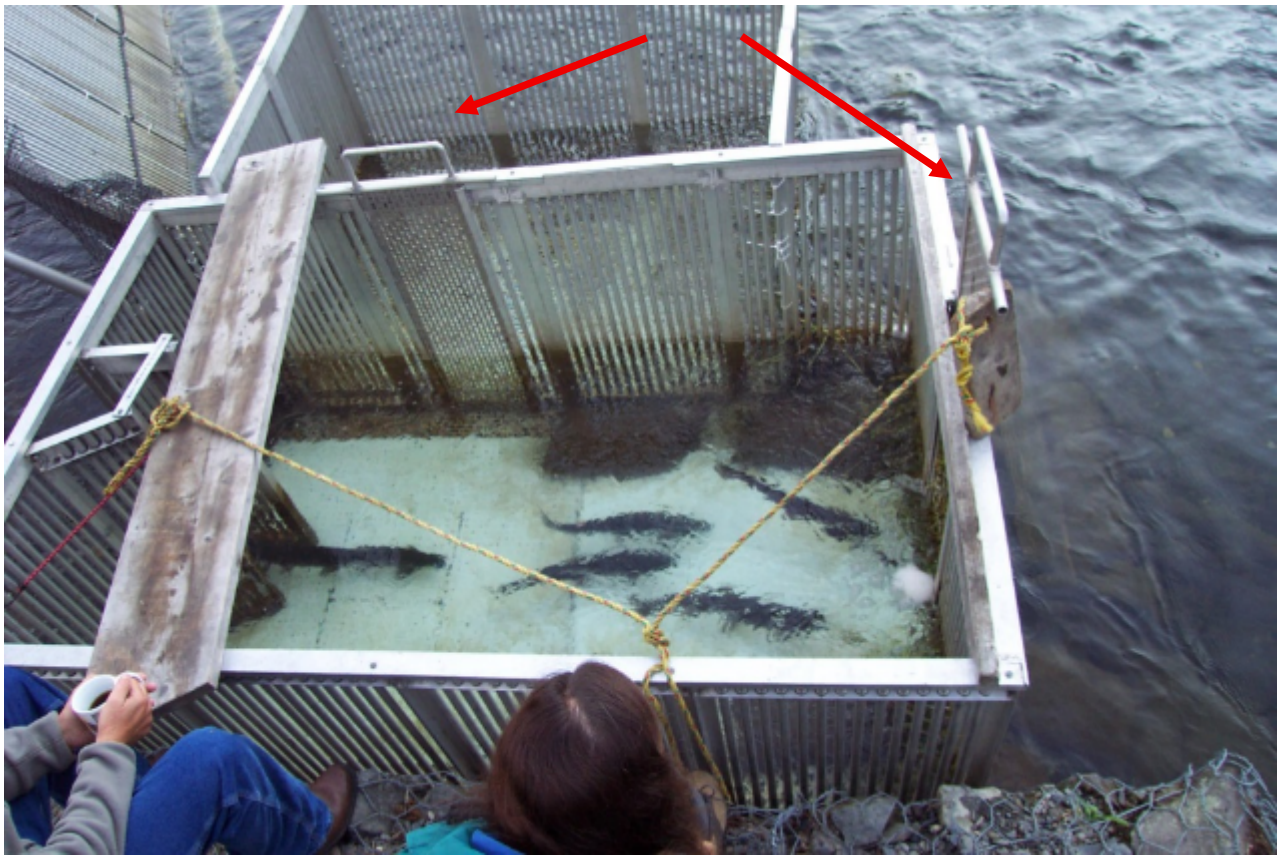


Weir and trap on Shitike Creek, Deschutes River Basin, Oregon



Panther Creek, Salmon River Basin, Idaho

EXHIBIT 2. EXAMPLE OF CAGE TRAP WITH REMOVABLE GATE

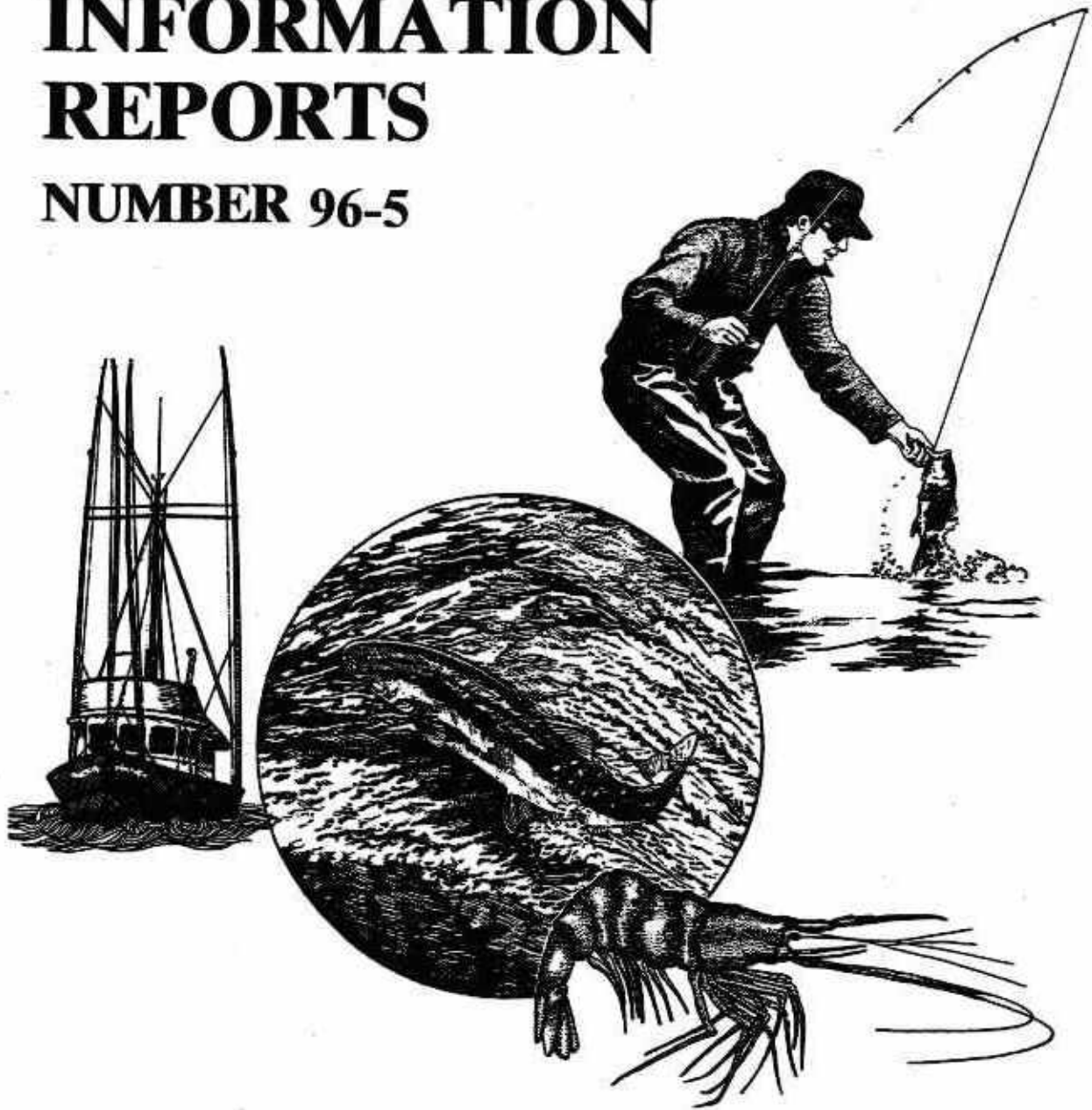


Cage trap used on Kenai River, Alaska. Note removal gates (red arrows); upstream side is raised.

Exhibit 3

INFORMATION REPORTS

NUMBER 96-5



FISH DIVISION

Oregon Department of Fish and Wildlife

A Review of Capture Techniques for Adult
Anadromous Salmonids

A Review of Capture Techniques for Adult Anadromous Salmonids

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March 1996

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SUMMARY

Many techniques for capturing adult salmon and steelhead have been tried in the Pacific Northwest. Capturing adult fish is necessary for monitoring run size, evaluating compliance with the Oregon's Wild Fish Management Policy, or developing and maintaining brood stock programs. The objectives of capturing salmon or steelhead should be identified before a technique is chosen. Differences among characteristics of streams (size, substrate) and among target species mean that no one method can be recommended for all streams. Therefore, the choice of a method will depend on factors such as duration of the project, expense, necessary capture efficiency, presence of existing structures (fishways or concrete sills), and stream conditions.

Management biologists should evaluate the potential for capturing adult salmon or steelhead in their streams. For example, streams with existing structures (such as fish ladders) can be modified to capture fish at a relatively low cost. These streams should be a high priority for capturing fish. In addition, streams with existing concrete sills, such as irrigation diversions or other types of low dams, can be converted into a trapping site using a horizontal picket weir.

A general overview of some capture techniques covered in this report is presented in Table 1. Measured costs and capture rates are given where available. Subjective estimates are also given and are based on information in the literature or from communication with experienced biologists. Because the effectiveness of a capture method depends on many factors such as the purpose of capturing fish, it cannot be measured solely by the capture rate. For example, if the purpose of capturing fish was to collect fish for a brood stock program, a method that had a low catch rate might be adequate.

INTRODUCTION

Fishery biologists often find it necessary to capture adult anadromous salmonids for data collection or for hatchery programs. Capture techniques vary from relatively simple means, such as angling, to construction of large, permanent structures. Some overviews of capture techniques exist in the literature, although they are generally specific to a purpose (such as escapement; Cousens et al. 1982) or they cover a broad array of general sampling techniques for many species (Cleary and Greenbank 1954; Welcomme 1975; Backiel and Welcomme 1980; Casselman et al. 1990). Although an attempt was made to provide a comprehensive review of techniques used to capture adult anadromous salmonids, some methods have undoubtedly been overlooked, especially given the ingenuity of biologists to devise new methods.

The purpose of this report is to compile current information on techniques for the capture of anadromous adult fish. Recent developments in Oregon will likely result in a greater need for capturing adult salmonids. Implementation of the Oregon Wild Fish Management Policy (OAR 635-07-525 through 529) will require collection of adult fish for development and maintenance of local brood stocks. In addition, compliance with the policy will require data on hatchery:wild ratios, which may necessitate capture of adult salmon and steelhead where fishery data are not available.

Table 1. Overview of cost and efficiency of capture techniques for adult anadromous salmonids.

| Method | Construction cost | Capture rate/efficiency | Other |
|---|----------------------------|--|---------|
| Picket weir (vertical, panel, horizontal) | \$40-100/ft | 25%; 60% ^a (90%+) ^b | c |
| Fish wheel | \$10,600-16,000 | 1-9% | d |
| Hoop trap | \$630-1,000 | 1-15% | d |
| Fishway trap -Denil steppass | \$500-1,500 \$49,000 | high (7-20%) ^e | c |
| Floating weir (commercial) non-commercial | \$500-3,250/ft \$110/ft | medium- high | d |
| Permanent picket | \$800-1,600/ft | high | f |
| Gabion barrier | low-moderate | medium- high | f |
| Concrete barrier | \$1,300-2,200/ft | high | f |
| Electric barrier | \$200-2,000/ft | medium- high | d, f, g |
| Boat electrofishing | -- | 1-39 fish/day | g |
| Gill nets | -- | 1-8% 1-18 fish/net | g |
| Seines | -- | 1-5% <1-60 fish/set | g |
| Angling | -- | 2-20 hrs/fish | g |

^a Average efficiency of picket and panel weirs in the Siuslaw River, Oregon, for basins >10 mi² (25%) and for basins <10 mi² (60%) - measured.

^b Estimated efficiency of horizontal picket weirs in the Siuslaw River, Oregon - not measured.

^c Specific structures required: sill with 3-4 ft drop for horizontal picket weir; fish ladder for a fishway trap.

^d Specific stream conditions required such as depth, velocity, gradient.

^e Measured efficiency of a Denil steppass trap for catching salmon and steelhead on the Deschutes River, Oregon.

^f Potential safety hazard: public safety or hazard to boat traffic.

^g Potential public relations problem with injury or mortality to fish.

The emphasis in this report will be on relatively low-cost methods, such as temporary structures or modified, existing structures. However, other more expensive methods that require construction of permanent facilities will also be discussed. The focus will be on techniques that have been used in the Pacific Northwest (including British Columbia and Alaska) to capture adult salmon or steelhead. Emphasis will also be on techniques that have the potential to capture adequate numbers of adult fish for development and maintenance of local brood stocks. Although costs of some methods are presented in Table 1 and in APPENDIX C, these costs should be considered in the context of the overall cost of a program and the effectiveness of a capture technique. In many cases, the cost of capturing fish is likely to be a small proportion of the total cost of a brood stock development program or a tag-recovery program to collect data on abundance, escapement, or migration.

Two basic types of capture techniques are "passive" methods in which fish swim into a trap on their own at some point during their upstream spawning migration, and "active" methods in which fish are pursued during their migration. Discussion of each technique is organized by a description of the method, areas where the method has been used (current and historic, where appropriate), effectiveness of the method in capturing adult fish, and advantages and disadvantages of the method. A list of contact persons or manufacturers is contained in APPENDIX B and is organized by capture method. Mention of manufacturers or products in this report does not imply endorsement by the Oregon Department of Fish and Wildlife.

PASSIVE METHODS

Low Cost or Temporary

Picket Weir

Description: Picket weirs are designed to diffuse water, yet block upstream fish passage. Fish are caught in an instream trap or are diverted into an off-channel trap. Picket weirs (also called fences or racks) have basic components of vertical weir supports, pickets that block the passage of fish while allowing water to pass, a trap, and an apron to provide a foundation for the weir or to prevent erosion and scour. These weirs have been made of netting (Blair 1956; Murray 1968), wire fence (Schaefer 1951), polyethylene fence (Noltie 1987), wood (Hunter 1954; Craddock 1958; Senn et al. 1984), metal tubing (Anderson and McDonald 1978), or steel (Kerswill 1971; Clay 1995). This report will concentrate on weirs that use steel pickets.

Good site characteristics for picket weirs are a solid stream substrate, either bedrock or compacted cobble or boulders, high banks that are not easily eroded, and a wide reach of stream. A wide reach of stream is generally shallower than a narrow reach. Given the same flow, a wide, shallow site will have a lower head difference between the upstream and downstream sides of a weir than a narrow, deep site. The head difference of a weir will increase when debris begins to clog the weir. Turbulence and erosion below the weir are reduced when the head difference is reduced (Clay 1995). Unless a weir is constructed on bedrock or large substrate, an apron is necessary to prevent erosion underneath the weir. Aprons can be hardware cloth or wire fencing

secured to the weir and stream bottom (Hill and Matter 1991), aprons of timber planks anchored by gabion baskets (Nelson 1976), or rock-filled timber cribs with sheet-piling on the upstream and downstream face of the apron (Clay 1995). The river bank can also be armored with rock-filled gabions (Nelson 1976), timber boxes filled with rock (Clay 1995), or fence material such as wire mesh. Armoring river banks can prevent erosion around the end of the weir and, if incorporated into the apron, can add stability to the weir.

In addition to the factors mentioned in the preceding paragraph, some design criteria can be used to reduce head difference and to secure a weir. Rounded pickets and the widest possible spacing of pickets will allow more water to pass through the weir. However, the spacing of pickets will depend on the size of the smallest fish targeted for capture. A short weir will allow flood water to more quickly crest the weir, which reduces scour around the end of the weir and reduces the maximum head difference that could develop during flood stages. The weir supports and trap should be cabled securely to trees on the bank, or to eyebolts or anchors set in bedrock, immovable boulders, or in the substrate. Turnbuckles can be used to tighten cables, which is important in preventing downstream shift of the weir or trap.

Vertical Picket Weir: The vertical picket weir is composed of horizontal railings attached to tripods or other supports, and vertical pickets of metal pipe or tubing that go through holes in the railings. An instream trap is incorporated into the weir (Figure 1). The more vertical a weir is constructed, the more the force of water will try to push the weir downstream during floods. The top of the weir should be angled downstream to transfer some of the force of water onto the leg supports. Additional construction details are presented in APPENDIX A.



Figure 1. Vertical picket weir on Nelson Creek (Siuslaw River), Oregon, 1995.

Panel Weir: As the name implies, pickets of these weirs are supported by preconstructed panel frames (Figure 2). Pickets within the panel frames can be oriented vertically (Kerswill 1971; Hill and Matter 1991; Clay 1995) or horizontally (Kenaston et al. 1990). Panels are attached together across the width of a stream and are supported with tripods, fence posts, or other methods. A panel weir can be vertical (Kenaston et al. 1990; Hill and Matter 1991) or can be angled (Sumner 1953; Hunter 1954) depending on the method used to support the weir. An instream trap is incorporated into the weir. Additional construction details are given in **APPENDIX A**.

Horizontal Picket Weir: A design using an existing concrete sill to attach a horizontal picket weir was described in Kenaston et al. (1990). The railings and pickets of this weir are similar to a vertical picket weir. The weir is supported on the upstream end by a punched rail bolted to stop logs on a concrete sill, and on the downstream end by monopod supports bolted to a second punched rail. A trap is installed on the upstream side of the concrete sill to one side of the horizontal weir (Figure 3). Additional construction details are given in **APPENDIX A**.

Traps: Fish traps used with picket weirs are usually a preconstructed cage placed on the upstream side of a picket weir (Figures 1 and 2) or a floorless cage whose sides are constructed of framing and pickets similar to materials used for the weir. Traps should be incorporated into the angle of the weir and should have V-shaped fyke openings to guide fish into the trap and to prevent escape. Traps should be placed in areas deep enough to hold fish during minimum flows, and where flow is sufficient to attract fish. During high flows, a resting area can be provided by placing a board or boulder on the upstream side of the trap. A panel of pickets and channel iron was cabled on the upstream side of a trap in Alaska to create an eddy between the panel and the trap during periods of high water velocity (Schmidt 1984). Additional description of trap design is in **APPENDIX A**.

Areas of use: Vertical picket weirs are the most common type of picket weir for trapping adult anadromous fish. They have been used recently in Oregon to sample adult winter steelhead in the Siuslaw Basin (Kenaston et al. 1990; Lindsay et al. 1994), and in the Mollala, Alsea, and Yaquina River basins. A vertical picket weir has also been used to sample adult steelhead and salmon in Elk Creek (Rogue River) and to sample chinook salmon in the Imnaha River (Messmer et al. 1992). These weirs have also been used in Idaho to capture steelhead (Senn et al. 1984; S. Rubin, U.S. Fish and Wildlife Service, Seattle, 1992, personal communication), in Alaska to capture salmon and steelhead (Merrell 1964; Jones 1984; Schmidt 1984; Elliott and Sterritt 1990), and in eastern Canada to capture Atlantic salmon (Anderson and McDonald 1978; Whelan et al. 1989; Mullins et al. 1991).

Panel weirs have been used in Oregon in the Siuslaw and Trask River basins to capture adult steelhead (Lindsay et al. 1989b; Kenaston et al. 1990), and in Sand Creek to capture salmon and steelhead (Sumner 1953). They have also been used in Northern California (Hill and Matter 1991), British Columbia (Schaefer 1951; Foerster 1953; Hunter 1954; Vernon et al. 1964; Clay 1995), and in eastern Canada (Hayes 1953; Kerswill 1971).



Figure 2. Panel weir on West Fork Indian Creek (Siuslaw River), Oregon, 1990.



Figure 3. Adult steelhead trap at a horizontal picket weir on Whittaker Creek (Siuslaw River), Oregon, 1992.

A horizontal picket weir was used to capture steelhead in Oregon (Kenaston et al. 1990) and a variation of this type of weir was used in British Columbia (Andrew and Geen 1960; Clay 1995).

Native Americans of the Pacific Northwest and indigenous people in other areas with migratory fish used weirs to capture fish (Ruggles 1980; Clay 1995). These weirs were made of brush or were constructed of branches lashed onto vertical posts that were driven into streambeds (Clay 1995). An early description of a weir used by biologists to study fish is provided by White (1939).

Effectiveness: Effectiveness of picket weirs depends on stream size and stream dynamics such as frequency and intensity of floods. Effectiveness also depends on the run size of target species and run distribution. Sumner (1953) reported that steelhead and sea-run cutthroat trout found the entrance of a trap more easily than did salmon. Effectiveness of weirs also depends on the primary purpose of capturing fish. For example, weirs that are under water for short periods during floods might be sufficient to collect fish for brood stock, but would be inadequate for a complete measure of escapement.

Picket weirs can be 100% effective in blocking fish passage and trapping fish. Picket weirs or fences have been the standard against which other estimates of escapement were measured in some streams in Alaska and British Columbia (Howard 1948; Schaefer 1951; Brett 1952; Vernon et al. 1964; Cousens et al. 1982). Mullins et al. (1991) reported that a vertical picket weir on a 25 mi² basin in Newfoundland remained fully operational for five sample seasons during Atlantic salmon migrations. Weir counts on some Alaska streams have also been considered complete (Nelson 1976; Schmidt 1984; Elliott and Sterritt 1990).

Picket weirs can fail during high water because of holes scoured beneath the weir or trap, erosion around the end of the weir, failure of the weir under the force of water, or water cresting the top of the weir. Operating weirs in some areas can present unique challenges, such as the case reported in Alaska where a brown bear partially destroyed a weir (Nelson 1976).

Based on tagging studies of adult winter steelhead in the Siuslaw River, the average capture efficiency of weirs was almost 60% for seven basins under 10 mi² and under 25% for two larger basins (Table 2). A picket weir on Sand Creek in Oregon (5 mi long with a maximum flow of 300-400 cfs) was estimated to be about 50% effective in capturing upstream migrants (Sumner 1953). Based on tagging and recovery studies in several southeast Alaska streams, the effectiveness of vertical picket weirs in capturing adult coho salmon has been estimated at 54% (Schmidt 1984), 79% (Elliott and Kuntz 1988), and 92% (Elliott and Sterritt 1990). A panel weir operated for two years in British Columbia captured 10% and 21% of the estimated run, with the difference attributed to the degree of flooding in the two years (Schaefer 1951). Horizontal picket weirs in two streams of the Siuslaw River were believed to be over 90% effective in capturing adult winter steelhead during two sample seasons. Effectiveness of these weirs could not be directly measured from tagging because no downstream trap was installed at the trap sites and downstream migrants were able to pass over the weir.

Table 2. Efficiency of picket weirs in capturing adult winter steelhead in the Siuslaw River, December–May, 1991–95.

| Stream | Year | Percent operational ^a | Percent efficiency ^b | Number trapped ^c | Basin size (mi ²) |
|-----------------------------|------|----------------------------------|---------------------------------|-----------------------------|-------------------------------|
| Vertical Picket Weir | | | | | |
| Fish | 1991 | 94 | 51 | 37 | 8 |
| Green | 1994 | 97 | 73 | 55 | 5 |
| | 1995 | 89 | 20 | 25 | |
| Greenleaf | 1993 | 91 | 21 | 18 | 12 |
| | 1994 | 98 | 39 | 47 | |
| Meadow | 1995 | 90 | 50 | 8 | 2 |
| Pataha | 1994 | 100 | 100 | 70 | 7 |
| | 1995 | 87 | 46 | 33 | |
| San Antone | 1994 | 100 | 82 | 51 | 4 |
| | 1995 | 88 | 62 | 29 | |
| Thompson | 1994 | 95 | 44 | 9 | 3 |
| | 1995 | 90 | 77 | 10 | |
| Turner | 1995 | 86 | 60 | 12 | 5 |
| West Fork Indian | 1995 | 69 | 16 | 15 | 14 |
| Panel Weir | | | | | |
| Turner | 1991 | 92 | 57 | 37 | 5 |
| West Fork Indian | 1991 | 89 | 14 | 63 | 14 |
| | 1992 | 81 | 7 | 58 | |

^a Percentage of days weir was operational during winter steelhead migration.

^b Number of marked steelhead captured above the weir or in downstream traps divided by the total number of steelhead captured above the weir or in downstream traps. Includes only the years in which three or more marked steelhead were recaptured.

^c Includes mortalities and fish kept for brood stock or transport.

Capture efficiency can be influenced by the size and flow of the stream, the amount of time the trap remains operational, and the run size and run timing of the target species. The capture efficiency of picket weirs in the Siuslaw River basin was negatively correlated with basin size ($r = -0.76$; $P = 0.02$) and positively correlated with the percentage of time the traps were operational ($r = 0.62$; $P = 0.01$; Table 2). However, with the exception of the Thompson Creek weir, the efficiency of the traps decreased by an average of 50% with only a small decrease (10%) in the amount of time a trap was operational during the sample season (Figure 4). Because migration of adult fish is not distributed equally through the season (i.e., short periods of peak migration usually correspond to high water flows), capture success will be increased by keeping a weir operational as much as possible during peak migration.

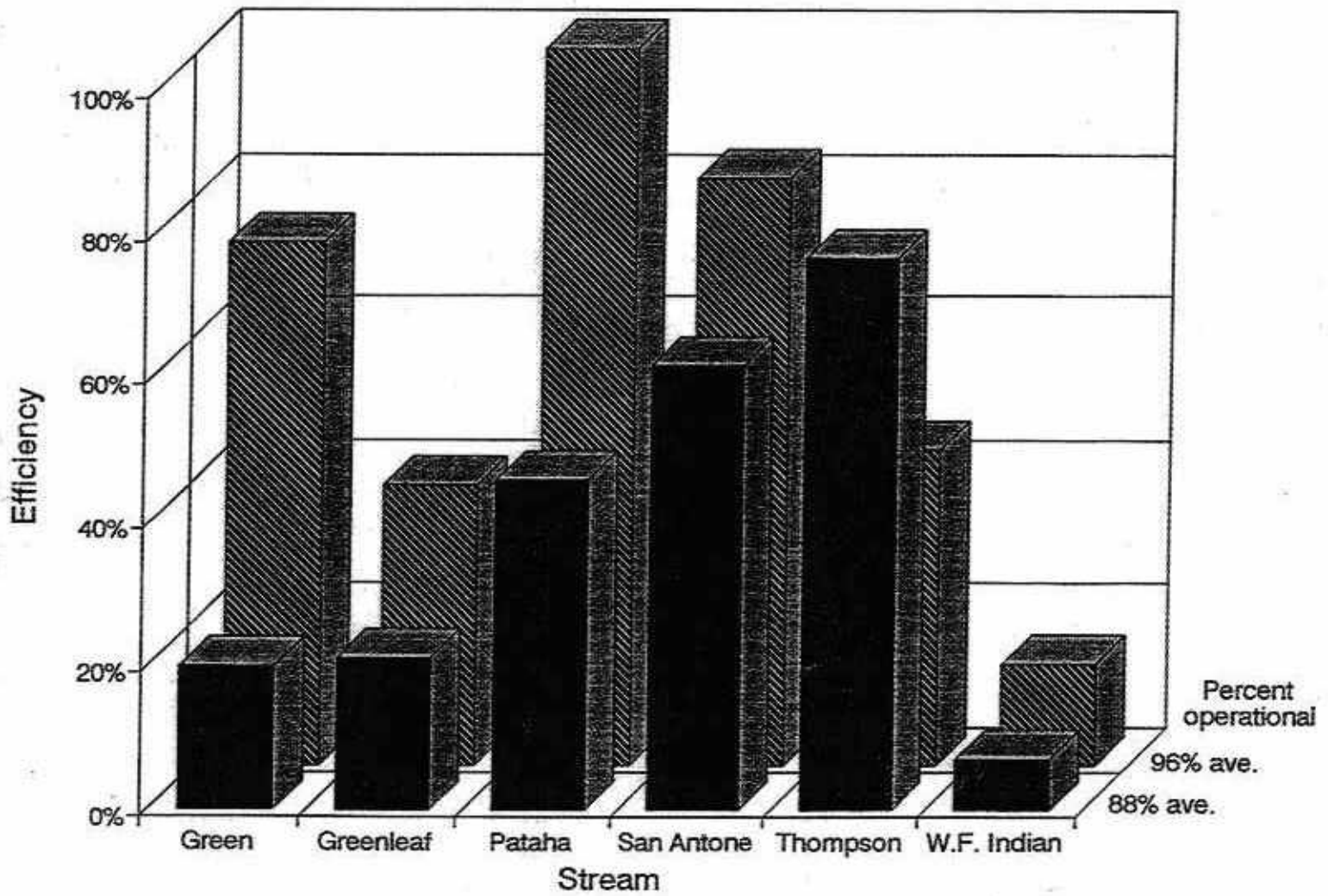


Figure 4. Capture efficiency of six weirs in two consecutive years under two levels of operational success, Siuslaw River, Oregon.

Advantages: Picket weirs can be very effective in capturing adult salmonids in certain streams and at certain sites. Sampling can be conducted over the course of a run, thus capturing all or a representative portion of the run, depending on the efficiency of the weir and variation in efficiency through the sampling season.

Most picket weirs are portable and relatively easy to set up. Assembly time for picket weirs has been reported as two hours for panel weirs to six hours for vertical and horizontal picket weirs with 4-6 people (Kenaston et al. 1990). Anderson and McDonald (1978) reported that a 100-ft vertical picket weir with three traps took an experienced crew two days to install. Hill and Matter (1991) described a design for a 30-ft panel weir that took one person eight hours to install. A relatively permanent panel weir in Alaska that measured 130 ft took six people about 20 days to construct and install, which included bank abutments and a rock shield apron (Nelson 1976). Portable weirs are relatively inexpensive to construct (APPENDIX C). Costs depend on the size, the design, and the purpose of the trapping facility.

Picket weirs and traps cause little injury or mortality to fish if adequate protection from high water velocity is provided in the trap. For example, the average mortality of 14 traps in the Siuslaw River basin was about 2% from 1990-95. Mortality was generally associated with floods. Schmidt (1984) reported some problems with mortality and injury at a vertical picket weir in Alaska because of high water velocity in the trap, and because of stress from tagging and handling fish.

Some types of picket weir have advantages over other types. The vertical picket weir can be built on uneven substrate because each picket rests on the stream bottom. Vertical picket weirs can withstand floods better than panel weirs, especially when constructed on a solid foundation of bedrock or another type of apron. Vertical picket weirs require fewer and less extensive repairs than panel weirs. The percentage of time vertical picket weirs were operational was slightly higher than that of panel weirs in the Siuslaw River basin (Table 2). Vertical picket weirs were generally inoperable because water crested the weir rather than from structural failure. Vertical picket weirs take less manufacturing time than panel weirs, although panel weirs can be installed in the stream somewhat faster than picket weirs because of their modular design. However, if a weir is fished for several years, the tripods and railing of a picket weir can often be left in place, thus the time required to reinstall the weir is significantly reduced. A horizontal picket weir is least susceptible to damage by floods. This type of weir remained operational a greater percentage of time in the Siuslaw River basin than the vertical picket or the panel weirs, and was believed to be highly effective in capturing adult winter steelhead.

Disadvantages: Although picket weirs can be quite effective in capturing adult salmonids, they are not usually suitable for trapping fish on large rivers. Picket weirs can require frequent maintenance during high flows and if damage is sustained, the weirs may remain out of operation for several days before stream levels recede enough to make necessary repairs. This can result in uncounted fish migrating past the weir during peak migration. Migration of fish can be delayed by picket weirs (as can be the case with any instream barrier), which could result in a redistribution of spawners to less

suitable spawning areas downstream of the weir or to another stream (Sumner 1953; Ruggles 1975). Adult fish may need to be passed downstream of a weir such as spawned steelhead (Jones 1984), early returning salmon that move between salt water and fresh water until they become physiologically adjusted to fresh water (Schmidt 1984), or fish that correct their migration. Unless picket weirs are built with upstream and downstream traps (Hayes 1953; Kerswill 1971; Anderson and McDonald 1978) or with a two-way trap (Whelan et al. 1989; Mullins et al. 1991), fish migrating downstream will need to be passed through an opening in the weir, or netted and passed downstream. If picket weirs are installed on large streams, they may pose a navigational hazard for boat traffic. As with any trapping technique, picket weirs should be operated throughout the run to representatively capture adult fish and are, therefore, somewhat labor-intensive.

Installation of vertical picket weirs may take more time than panel weirs, although vertical picket weirs usually withstand floods better. Horizontal picket weirs are the best design for withstanding high water, but a concrete sill with a 3-4 ft drop is necessary for attaching and suspending the weir. Generally, panel weirs are installed in smaller stream basins than are vertical or horizontal picket weirs, unless they are installed on an apron. Although the height of panel weirs could be increased to allow them to operate over a greater range of flows, the weight of such panels would make them difficult to install. A fairly even stream bottom or a constructed apron is needed for panel weirs because of the flat bottom edge of the panel.

Fishway or Fish Ladder

Description: Fishways or fish ladders can be modified to trap adult fish. Fishways built to aid or provide passage around waterfalls or dams are relatively common throughout the Pacific Northwest and offer opportunities to capture adult anadromous fish. Fishways are usually pool and weir type or vertical slot type (Andrew and Geen 1960; Bell 1986; Clay 1995). They can be open or enclosed.

Many fishways can be fitted with an adult fish trap or steps of the fishway can be converted into a trap. In cases where the inflow to the fishway cannot be controlled or the steps are too deep, a false floor (which can be raised) may be installed to more easily net fish. Most fishways are protected from debris, therefore the trap can be constructed of light gauge steel or aluminum.

A cage trap can be constructed similar to designs described under Picket Weirs (see *Traps* and APPENDIX A) and made to fit into a fishway step. Another method to trap fish is to convert a step into a trap. The trap entrance for a pool and weir fishway can be either a v-shape fyke fitted to the upstream side of the step opening (Figure 5), or a finger weir of metal or PVC tubing attached to the step (Figure 6; see also Clay 1995, Figure 4.8). The trap entrance for a vertical slot fishway can be a v-shape fyke bolted to the sides of the step. The fyke should be tall enough to hold fish at high flows. For both types of fishways, bar grates or screens are installed at the upper end of the step to prevent fish from escaping once they have entered the step.

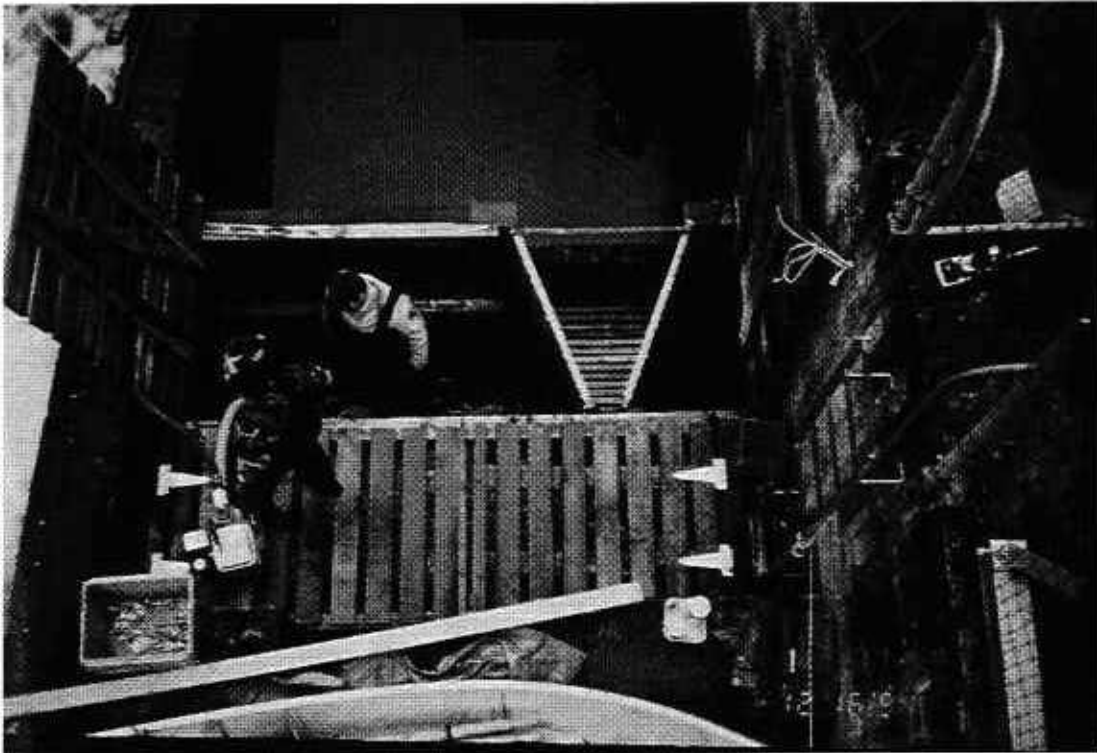


Figure 5. V-shape wooden fyke used to trap adult salmon and steelhead in a fishway step at Powerdale Dam on the Hood River, Oregon.



Figure 6. Finger weir in an adult fish trap in a fishway step, Powerdale Dam, Hood River, Oregon.

An alternative means of trapping fish at fishways was used on the Deschutes River with a Denil-type steppass (Jonasson and Lindsay 1988). Water was pumped from the river into the steppass. The entrance of the steppass was in the top step of the fishway (Figure 7). Fish ascending the fishway were blocked by grates at the top step and were diverted into the steppass where they swam up the steppass and into an anesthetizing tank. The trap was operated 6-8 hours per day, 5 days per week. When the trap was not operated, a gate in the stop step was raised to allow passage. Steppasses have been used in other locations to pass fish around natural or artificial barriers and could be fitted with a trap at the exit of the steppass. Descriptions and evaluations of steppasses can be found in Andrew and Geen (1960), Ziemer (1962), Slatick (1975), and Bell (1986).

Kupka (1964) described a fishway trap where fish jumped at a false waterfall and into an anesthetic tank. A sealed plywood trap was installed into a fishway step. Water was piped through a conduit and discharged beneath the sealed trap, which then welled up and over the fishway step, creating the false waterfall. Several types of discharge were used to find the best flow to attract fish and cause them to leap at the overflow.

Areas of use: Fishway traps have been frequently used in Oregon. Some streams where these traps have been used include the Rogue River (Everest 1973), South Umpqua River, Smith River, Tahkenitch Creek, Siuslaw River, Drift and Cascade creeks (Alsea River), Siletz River, Mill Creek (Yaquina River), Fishhawk Creek (Nehalem River), Clackamas River, North Santiam River, Hood River, Deschutes River, Walla Walla River, and Umatilla River.

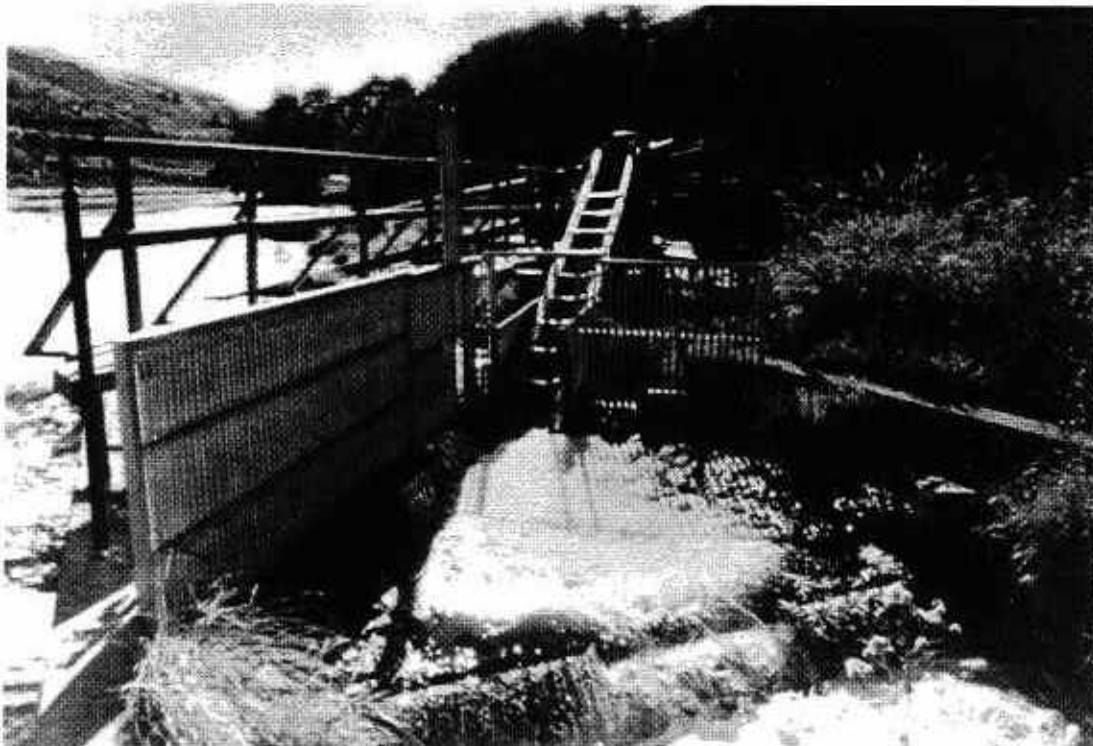


Figure 7. Denil steppass used to trap adult salmon and steelhead at the Sherars Falls fishway, Deschutes River, Oregon.

Effectiveness: Effectiveness of a fishway trap depends on whether alternative passage is available at the barrier. Some fishways provide the only means of ascent for migrating adults whereas other fishways provide an easier, alternate route over a waterfalls. In the former case, a fishway trap can be 100% effective in trapping the run if continuously operated. The effectiveness of a fishway trap where other passage is available depends on flow and on the attraction of the fishway to upstream migrants.

A steepass trap in the Deschutes River was more effective at low flow than at high flow, where alternative passage over the waterfalls was possible. The effectiveness ranged from 7% for spring chinook trapped in the spring (Lindsay et al. 1982) to 21% and 17% for fall chinook (Lindsay et al. 1982) and steelhead (Lindsay et al. 1980), respectively, trapped in the summer and early fall. Casselman et al. (1990) reported that fishways in Ontario had lower sampling variability than other passive methods of capture and were the most efficient means for capturing migrating fish in a large river system.

Advantages: The effectiveness of fishway traps makes them an attractive trapping method. Traps that are fitted into fishway steps can usually be constructed at a low cost and usually require a small amount of labor. Maintenance and repair of fishway traps are often minimal because flow into fishways can be controlled, or because the fishway can be protected with a trash rack to prevent large debris from damaging the trap. Fishways are relatively common on many rivers and streams in the Pacific Northwest, thus providing opportunities to capture adult fish and monitor fish runs.

Disadvantages: Fishway traps may require daily operation, depending on the size and temporal distribution of the run. Because some fishways are on waterfalls that are not a complete barrier, the effectiveness of the traps can vary with flow. If a trap is 100% effective, handling all of the run could be a problem with some species and stocks that are low in abundance. Knowledge of run timing and run size would be necessary to determine when to operate the trap, and when and how many fish to collect for brood stock. Another disadvantage is that the location of a fishway dictates where adult fish are trapped.

Hoop or Wire Fyke Trap

Description: The hoop trap (or wire fyke trap) consists of a framework of hoops covered with wire mesh or nylon netting (Figure 8). Two internal fykes or funnels direct fish toward a closed end (Figure 9). Most hoop traps described in the literature for catching adult salmon or steelhead are large; 8-10 ft in diameter and 18-20 ft long (Hallock et al. 1957; Morgan and Henry 1959; Tait et al. 1962). Adult fish enter the open downstream end of the trap and swim through two fykes or funnels until they reach the closed upstream end of the trap. Captured fish are removed from the closed end through an access door. The exit of the first internal fyke is larger in diameter (40-45 in) than the exit of the second or upstream fyke (20-26 in; Figure 9). The external frame of the traps is commonly constructed of five rings of metal pipe connected with metal or wood stringers. The external frame and the internal fykes are covered with wire mesh or netting.

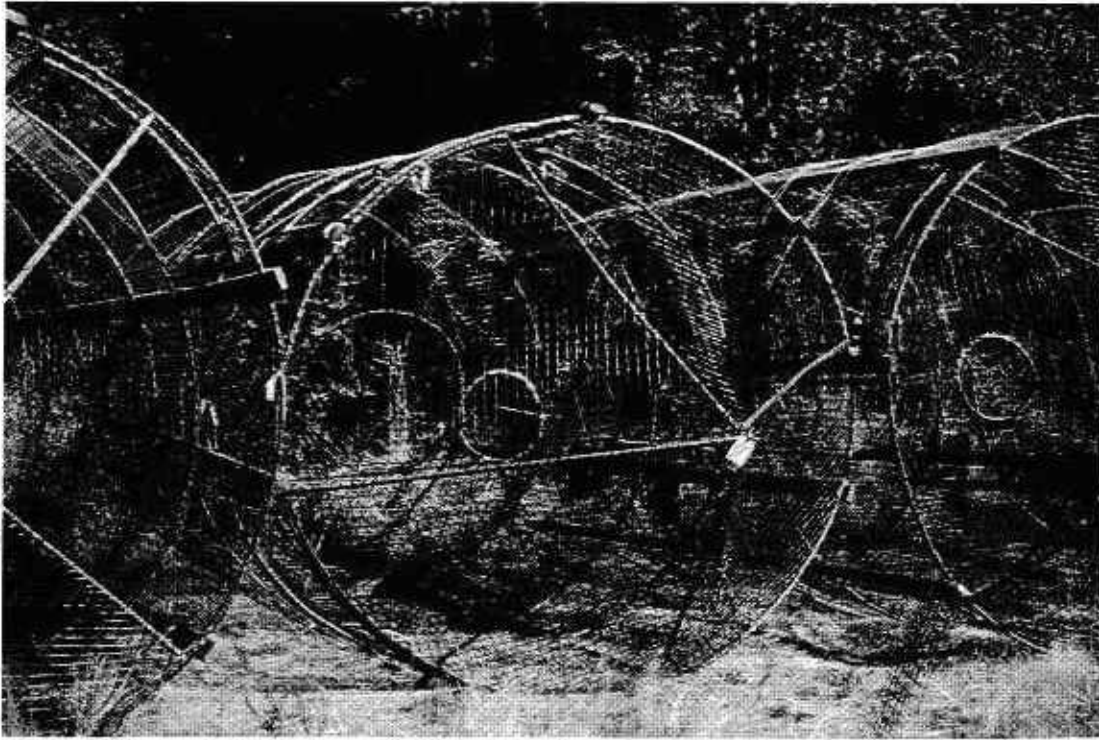


Figure 8. Hoop trap used to capture adult coho salmon in the Chehalis River, Washington.



Figure 9. Downstream (larger) and upstream (smaller) fykes inside a hoop trap used to capture adult coho salmon in the Chehalis River, Washington.

Hoop traps are fished in water that is generally as deep or deeper than the diameter of the trap opening. They are usually fished off steep banks (Figure 10), which facilitates raising and lowering the trap. Hoop traps in the Sacramento River were most effective where the river was 20 ft deep a few feet from shore and in velocities of 2-3 fps with flows of 5,000-10,000 cfs (Hallock et al. 1957). They also reported that the best fishing sites were on the deep side of the river where the river first straightened after a sharp bend. Usually several traps are fished in one location, either side by side or along the shore (Hallock et al. 1957; Seiler et al. 1992).

Hoop traps are held in place by a cable on the upstream end and by two cables (called runner wires) that run from the trap to the bank (Hallock et al. 1957). The two runner wires also keep the trap parallel to the current. When the trap is rolled up the bank, it is rolled onto these wires. A third cable (called the pull cable) is attached to the center of the trap and rolls up on the trap as the trap is lowered. At the same time, the runner wires unroll as the trap is lowered.

Areas of use: Hoop traps have been used recently in the Chehalis River of Washington to capture coho salmon (Seiler et al. 1992). They have also been used in Alaska (Tait et al. 1962) and California (Hallock et al. 1957). Hoop traps were used in Oregon to capture coho salmon in the Tenmile Lakes system (Morgan and Henry 1959). Hoop traps were fished for a while in the tidewater zone of the Siletz River, but were unsuccessful in capturing salmon (Morgan 1964), although they did capture numerous surf perch (Morgan 1961). Attempts to capture winter steelhead in the Sandy and Grays rivers with hoop traps were abandoned because of operational difficulties and because gill nets were more efficient in capturing adult fish (Wendler et al. 1956; Korn 1961). Small hoop traps (8-10 ft long) have been used in Oregon to capture cutthroat trout in tributaries of the Willamette River. Hoop traps have also been used to capture channel catfish (Gerhardt and Hubert 1989), burbot (Bernard et al. 1991), and striped bass (Hopkins and Cech 1992). Hallock et al. (1957) reported that hoop traps had been historically used by commercial fishermen in the Sacramento River before the traps were declared illegal.

Effectiveness: Two to three hoop traps fished at the mouth of Tenmile Lake captured 674 jack and 443 adult coho salmon, or about 2% and 1% of the jack and adult population, respectively (Morgan and Henry 1959). The hoop traps caught a higher number of jacks than a fixed trap one mile downstream. The efficiency of six or seven hoop traps used to capture coho salmon in the Chehalis River over a six-year period was about 3% (D. Seiler, Washington Department of Fish and Wildlife, Olympia, 1992, personal communication). For example, the efficiency at these traps in 1990 was 4% based on the ratio of 685 marked adult coho salmon to the estimated escapement (Seiler et al. 1992). Seven traps were fished constantly that year from early October through late December except for a two-week period of high water (after the coho salmon catch had tapered off). The traps also caught 452 jack coho salmon, 36 adult chinook salmon, 25 jack chinook salmon, 33 adult chum salmon, and 5 winter steelhead adults (Seiler et al. 1992). They also reported that the hoop traps appeared to capture a relatively constant proportion of the run past the trap site. Some tagged fish from the Chehalis traps were held to assess post-handling mortality and none was observed.

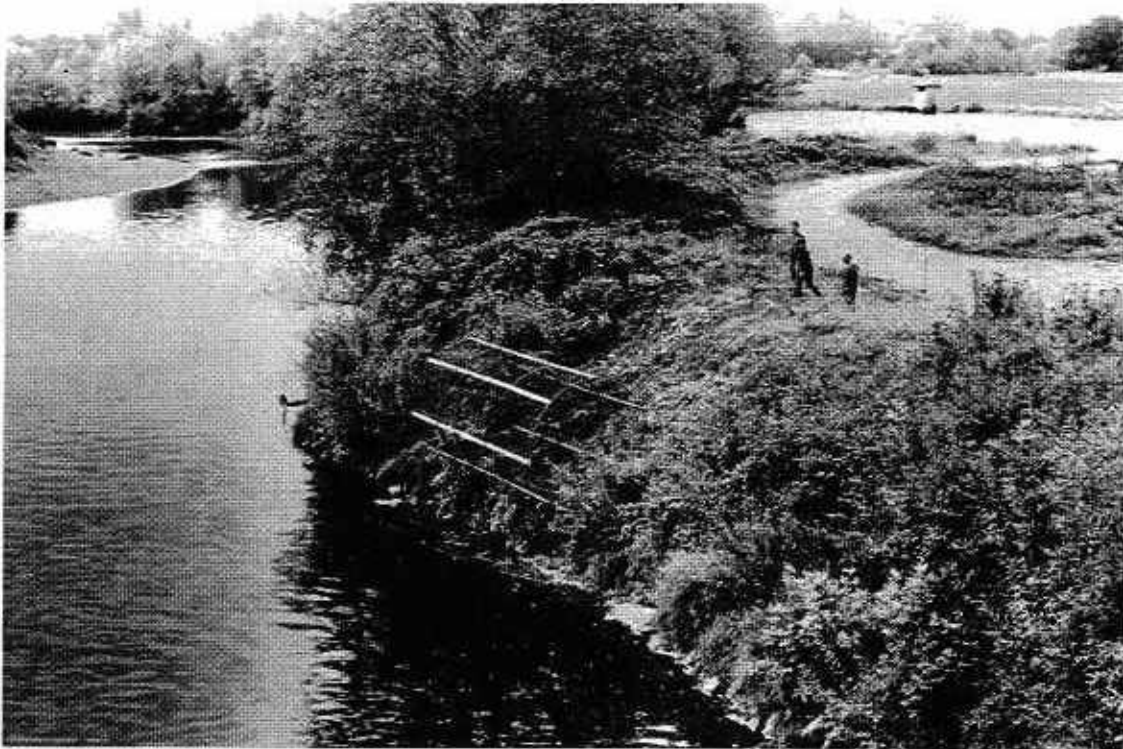


Figure 10. Hoop trap being rolled off a bank of the Chehalis River, Washington, into fishing position.

Hoop traps fished in the Sacramento River primarily captured steelhead, chinook salmon, coho salmon, striped bass, and shad (Hallock et al. 1957). The seven Sacramento traps captured 10–20% of an estimated run of 15,000–31,500 steelhead and 11% of the estimated run of 3,000 coho salmon. Only 1% of the estimated run of 124,000–446,000 chinook salmon were captured in these traps. The traps were somewhat selective in capturing smaller steelhead, but less so than with chinook salmon. Marked fish placed in the trap did not escape through the fykes. Trapped salmon and steelhead were in good condition and no mortality was observed.

Hoop traps used in Alaska appeared to catch sockeye salmon in direct proportion to their abundance without size selectivity (Tait et al. 1962). In addition to sockeye salmon, the Alaska traps also captured chinook, pink, coho, and chum salmon as well as Dolly Varden. These traps caught chinook salmon without size selectivity.

Advantages: Hoop traps are relatively inexpensive to construct and require little labor to operate or maintain. Several traps can be operated in a section of river without impeding boat traffic. Because the traps are submerged during high flow, they escape major damage from floating debris, although hoop traps in Washington were removed during high flow to prevent damage (Seiler et al. 1992). Depending on the size of the fish run, traps could be left in place for several days, thus reducing the time and labor needed to check them.

Although capture efficiency varies by site and by species, hoop traps probably catch enough fish for most brood stock programs. For example, the average catch in hoop traps in the Sacramento River was 3,266 chinook salmon, although the capture efficiency was just 1% (Hallock et al. 1957). Because hoop traps can be fished near the mouths of rivers, they representatively sample a fish run destined for various streams in the basin and throughout the duration of the run. Capture and tagging of fish from hoop traps can also be used to collect information on run timing, run size, migration, length and age distribution, or other life history characteristics (Seiler et al. 1992).

Disadvantages: Site characteristics for hoop traps include enough depth close to shore to submerge the trap (generally off a steep bank), access for installing and checking the traps, and adequate attraction flow. Several sites with these requirements would likely be needed to sample a river because several traps are usually operated. These criteria limit the number of streams that can be sampled with hoop traps. Daily cleaning of the traps may be required in some rivers during certain times of the year because of the amount of submerged debris such as algae or alder leaves. Some turbidity in the river would likely be required for effective trapping to prevent fish from avoiding the trap entrance. Although a submerged lead could be built to guide more fish toward the trap entrance, maintenance of this lead during high water would be time-consuming. Based on trapping in the Siletz River, hoop traps are not effective at capturing salmon in tidewater (Morgan 1964).

Fish Wheel

Description: The floating fish wheel has three basic components: the floating support structure or raft, the wheel, and the fish box (Figure 11). The raft is usually constructed of two parallel pontoon floats that are held together by crosspieces on the ends of the pontoons (Figure 11). pontoons must have enough flotation to support the weight of the wheel, the fish box, and workers. They can be made of large logs (Lynch 1979), foam-filled barrels (McGregor and Clark 1988), or foam-filled aluminum (Hammarstrom and Larson 1984). The wheels are attached to and revolve around a central axle. Wheels are composed of three baskets or of two baskets and two paddles (Figure 11). Framing for the baskets can be spruce or birch poles (Lynch 1979), metal pipe (Clay 1961), or lumber (Lynch 1979; McGregor and Clark 1988). The baskets are lined with nylon netting (Clay 1961; McGregor and Clark 1988), tarred mesh netting (Hammarstrom and Larson 1984), or wire mesh (Meehan 1961; Lynch 1979). At the bottom of the basket is an angled slide or chute that guides captured fish to a fish box, which is usually attached to the outside of the pontoons, although it can also be a live well in the middle of the pontoons (Meehan 1961). Chutes have been built of stovepipe (Meehan 1961), wood (Clay 1961; Lynch 1979), and foam-padded wood (Hammarstrom and Larson 1984). The fish box is approximately in line with the axle.

Fish wheels are placed in deep water, either in a fast slot or along the bank, generally on the outside of a meander and just upstream of an eddy (Clay 1961). They are attached to the shore with a cable on the upstream end of the fish wheel. A log boom or gin-pole is used to hold the downstream end of the fish wheel away from shore. A second cable is attached to the upstream end of the inside pontoon to keep the fish wheel parallel to the river current.

The force of water on the upstream side of the baskets and paddles turns the wheel. As each basket rises out of the water, it picks up fish that are in front of it. As the basket continues to rise out of the water and becomes more vertical, the fish slide down the basket, drop into the chute, and slide into the fish box. On models with two paddles and two baskets, the size of the paddles helps determine the speed at which the wheel turns. Boards may be added to or removed from the paddles to adjust the speed of rotation. The ideal rotational speed of fish wheels depends on the site and has been reported as 2.5 rpm (Hammarstrom and Larson 1984); 3-5 rpm (Donaldson and Cramer 1971), and 4 rpm (Meehan 1961). Fish wheels with two baskets and two paddles tend to move less smoothly than those with three baskets (T. Dress, NMFS, Auke Bay Laboratory, Juneau, 1993, personal communication).

Because fish wheels should be fished as close to the river bottom as possible, some are attached to an adjustable axle to allow the wheel to be raised or lowered with a change in water level (Lynch 1979; Bentz 1984; Hammarstrom and Larson 1984). The axle can be mounted on a bearing block that is raised or lowered on an axle stand (Hammarstrom and Larson 1984).

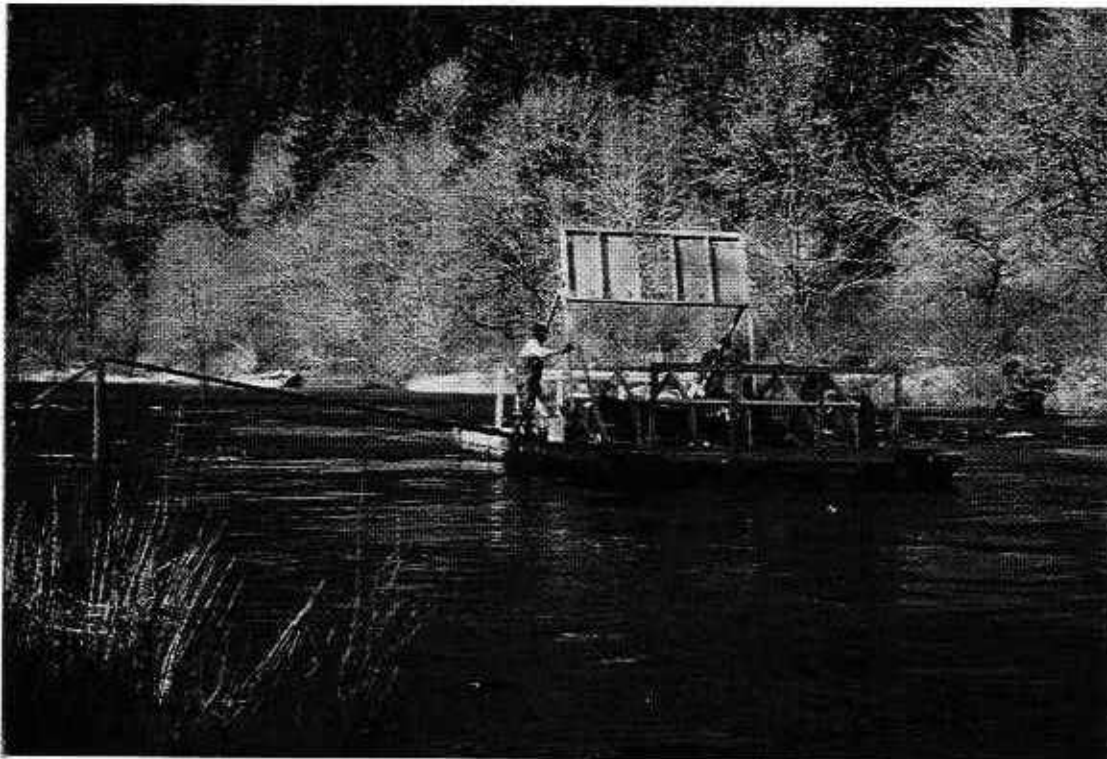


Figure 11. Fish wheel in the mainstem Siuslaw River (RM 26), Oregon, 1990.

Areas of use: Fish wheels have been used for commercial and subsistence fisheries, and for fish research and management in Alaska and British Columbia (Ward 1959; Clay 1961; Meehan 1961; Lynch 1979; Williams and Potterville 1983; Bentz 1984; Hammarstrom and Larson 1984; McGregor and Clark 1988; Eiler et al. 1992). They are generally used on large rivers.

The origin of fish wheels has been traced to 1829 in North and South Carolina and were principally used to catch shad (Donaldson and Cramer 1971). Most of these were fixed devices in rock dams, but some were attached to catamaran rafts. The most intensive use of fish wheels was on the Columbia River from 1887 until they were eliminated by law in 1927 (in Oregon) and in 1935 (in Washington; Johnson et al. 1948; Donaldson and Cramer 1971). Many of these were fixed wheels with picket fences to guide fish to the wheel, but some early wheels were attached to catamaran rafts. Later, fish wheels were built on twin-boom scows with the wheel section projecting beyond the scow so it could be fitted into an opening of a picket fence. These were often constructed so the wheel could be raised or lowered to fish at various depths.

Effectiveness: Fish wheels have been used principally to catch salmon. Salmon caught in an Alaska fish wheel were tagged and released in a quiet slough one mile below the fish wheel site (Meehan 1961). Based on recovery of these fish, the recapture rate was lowest for chinook and coho salmon (1% and <0.5%, respectively), higher for sockeye and chum salmon (2%), and highest for pink salmon (9%; Meehan 1961). McGregor and Clark (1988) estimated that 3% of a sockeye salmon run was caught in a fish wheel in the lower Taku River. Catch of coho salmon in two fish wheels in the Taku River was about 3% of the estimated escapement (Elliott and Bernard 1994; McPherson et al. 1994). Fish wheels in British Columbia rivers captured salmon and steelhead in roughly the same proportion as their abundance (Clay 1961). Meehan (1961) reported that the size of chinook salmon in fish wheels was smaller than the size of carcasses collected at a weir or on spawning grounds. He suggested that large chinook salmon avoided the fish wheel or migrated in swifter and deeper water than small chinook salmon. Selective capture of small coho in a fish wheel was also reported by Bentz (1984), although the sample size was small. Although the catch rate may be low for some species of salmon, the overall catch can be high because of run size and because fish wheels can be operated on large, mainstem rivers (Table 3).

Fish wheels operated on the Columbia River were the most efficient gear used to catch salmon (Johnson et al. 1948). However, because fish wheels were relatively few in number they accounted for less than 5% of the annual catch. For example, from 1928-1934, fish wheels accounted for 16% of the sockeye salmon catch, 2% of the chinook salmon catch, 1% of the steelhead catch, and <0.1% of the coho and chum salmon catch (Johnson et al. 1948). Picket fences were used on some Columbia River fish wheels to guide fish and to increase catch (Donaldson and Cramer 1971). A vertical picket weir was also used on a fish wheel in the Kenai River, but it interfered with the operation of the fish wheel because of debris on the weir and because the weir was attached to the pontoons and decreased flotation of the wheel (Hammarstrom and Larson 1984).

Table 3. Yearly catch of salmon and steelhead in fish wheels.

| River | Years | Weeks fished | Salmon | | | | | Steelhead |
|-------------------------------------|---------|-----------------|--------|---------|-------|---------|------|-----------|
| | | | Pink | Sockeye | Coho | Chinook | Chum | |
| British Columbia^a | | | | | | | | |
| Fraser | 1955 | 5 | 585 | 14 | 147 | 18 | 2 | 9 |
| Nass | 1959 | 6 | 1,050 | 1,075 | 13 | 451 | 3 | 1 |
| Wannock | 1960 | 8 | 50 | 1,750 | 25 | 5 | -- | -- |
| Alaska | | | | | | | | |
| Taku ^b | 1958-59 | 4- 8 | 7,591 | 308 | 403 | 1,273 | 971 | -- |
| Taku ^c | 1984-87 | 5-14 | 24,639 | 4,012 | 1,273 | 294 | 826 | -- |
| L. Susitna ^d | 1983 | 5 | 4 | 12 | 21 | 2 | 35 | -- |
| Copper ^e | 1982 | 3 | -- | e | e | e | -- | 32 |

^a From Clay (1961).

^b From Meehan (1961).

^c From McGregor and Clark (1988).

^d From Bentz (1984). Low clear water was thought to have reduced the catch.

^e From Williams and Potterville (1983). Sockeye, coho, and chinook salmon also caught, but no numbers were given.

Fish wheels appear to work best in rivers that are silty, such as glacial rivers, and where changes in flow are gradual. Fish avoid fish wheels in clear water (Clay 1961; Bentz 1984). However, fish wheels may be effective in clear streams at night. Catch of salmon in Columbia River fish wheels was higher at night (Donaldson and Cramer 1971). The catch of salmon in an Alaska fish wheel slowed with a rapid rise in the river, because of a reduction in fish migration (Meehan 1961).

Advantages: Fish wheels are an effective means to capture certain species of salmon when operated in a suitable location (Table 3). Fish wheels can be operated near the mouths of rivers, thus sampling a representative portion of the run throughout the migration. Fish wheels in Alaska were the least stressful to adult salmon, when compared to other large-river capture techniques, such as hook and line and gill nets (Bentz 1984). Little mortality was observed in salmon that were caught in an Alaska fish wheel, tagged, and released in a clear water slough (Finger 1958). In addition to collecting adults for brood stock, fish wheels could be used to estimate run size or escapement and to collect life history data.

Disadvantages: Fish wheels require certain site characteristics to operate efficiently, such as sufficient water depth, velocity, and turbidity, which makes them infeasible in many rivers. For example, because many of

Oregon's coastal rivers lack sufficient depth and velocity along shorelines, fish wheels would have to be placed in deep slots in the center channel, thus making them more susceptible to damage in high water. An attempt to use a fish wheel in the Siuslaw River was short-lived because the fish wheel was torn from its anchoring cable during a severe winter flood and suffered substantial damage (Kenaston et al. 1990).

Meehan (1961) and Bentz (1984) reported a selectivity toward smaller fish with fish wheels, which could affect brood stock collection, escapement estimates, and other life history data. The effectiveness of fish wheels can be reduced by large fluctuations in flow because fish migration may slow (Meehan 1961) or because fish may alter their migration routes. Also, a river with rapidly fluctuating flow would likely carry much debris, which would make the fish wheel susceptible to damage.

Construction, assembly, and launching of fish wheels is labor-intensive. Operation of fish wheels can also be fairly labor-intensive at times, depending on the number of fish captured and on repairs needed after high water. Although fish wheels on the Taku River, Alaska, need to be frequently repaired (8-12 times a season) because of damage from large debris, spare paddle and basket framing is kept on hand and repairs can be quickly completed (T. Dress, NMFS, Auke Bay Laboratory, Juneau, 1993, personal communication).

High Cost or Permanent

Floating or Resistant Board Weir

Description: A floating or resistant board weir blocks the upstream passage of adult salmonids much like picket weirs (Figure 12). The floating weir is attached to a cement sill or other attachment point on or near the bottom of the stream. The flotation of the closed PVC pipes in the weir panel and the force of water on a resistant board near the top of the panel keep the weir afloat. As the water rises or drops, the weir floats up or down on the bottom attachment point. At some high flows, the weir will sink beneath the surface of the water, but will float again when flow drops.

The minimum and maximum flow at which a floating weir will operate depends on the length of the weir, the placement and angle of the resistant board, water velocity, and water depth. A Washington Department of Fish and Wildlife (WDFW) weir on the Tucannon River operated between 20 cfs and 3,500 cfs (R. Bogden, WDFW, Olympia, 1992, personal communication). Efficient passage of water through the weir is achieved with streamlined PVC pipes, thus minimizing head difference between the upstream and downstream side of the weir. This reduces scouring on the downstream side of the weir and prevents water from backing up and washing around the ends of the weir during high flow. Debris on the weir panels washes off when the weir sinks below the water surface, either by high flows or by a person walking on the weir panels.



Figure 12. A floating weir at Aberdeen Hatchery, Washington, used to capture adult salmon and steelhead, 1992.

Several techniques for anchoring weir panels are a cable stretched across the stream bottom, railroad rails, a concrete sill in streams with relatively stable substrate, or a submerged sheet pile sill with a steel cap in streams with a soft, shifting substrate. Several methods have also been used to effectively cover steep or sloping banks, including vertical walls of sheet piling (covered with wood to allow the weir to raise and lower; see Figure 12), netting between the end weir panels and the bank, or an additional cable or sill running upslope to the high water line to which additional weir panels are attached. Detailed descriptions of two floating weirs, one commercially available through a Japanese manufacturer and the other built by Alaska Department of Fish and Game (ADFG), are provided in **APPENDIX A**.

Areas of use: Commercial floating weirs have been used in several locations in Washington (Chiwawa, Twisp, Skagit, and Tucannon rivers, Barnaby Slough in the north Puget Sound, and Van Wickel Creek near Grays Harbor) and Idaho (Lochsa River, Kooskia Hatchery, Blackfoot River). A floating weir was recently completed in 1993 at Lookingglass Hatchery in Oregon. The commercial product has been used extensively in Japan and along the east coast of Russia. The first commercial floating weir used in the United States was installed in Alaska in 1985. These weirs have been used in Japan since the early 1980s.

A floating weir built by Alaska Department of Fish and Game has been used in the Little Susitna River since 1988 (L. Bartlett, ADFG, Palmer, 1993, personal communication). Several others are currently in use, including one on the Anchor River near Homer. These weirs are used to capture adult salmon, steelhead, Dolly Varden, and other smaller fish.

Effectiveness: Little data were found on the efficiency of floating weirs. Efficiency depends on the ability of the weir to stay afloat during high water. Flotation of the weirs depends on panel length, water depth, and water velocity. For example, the limit of operation for a 16-ft long weir at a velocity of 3 fps is 6.5 ft of water depth, according to the manufacturer. Although a weir may become partially submerged at high flows, it may still operate to some degree if water passing over the weir does not form a wave and pool that would entice fish to jump over the weir. Some fish may pass above a weir if it is submerged by high flows, but the weir would float again when high flows begin to subside. Floating weirs may be operational much sooner after a flood than a picket weir that required repair.

A floating weir could potentially capture all upstream migrants under certain conditions. Floating weirs developed by ADFG have been highly effective in trapping and counting adult salmon and other species (L. Bartlett, ADFG, Palmer, 1993, personal communication). For example, although the Little Susitna River has rapid runoff and can carry much debris during the trapping season, a floating weir has been self-cleaning most of the time. Large logs usually wash over the top of the weir during floods.

Some floating weirs in the Wenatchee River drainage have been relatively inefficient in capturing adult chinook salmon (B. Hevlin, National Marine Fisheries Service, Portland, 1993, personal communication). Floating weirs on the Chiwawa and Twisp rivers allowed passage of large numbers of fish during high flow. For example, the Twisp River weir had a capture efficiency of about 25-35%. This efficiency was calculated from the number of fish trapped and the estimated run size to the weir site.

Advantages: Floating weirs appear to be highly adaptable to many streams and are effective for several species of salmonids. The biggest advantage over other methods of trapping an entire stream is that the floating weir operates during periods of peak migration on rising or descending flows. Debris that does not wash off the weir on its own can be removed by having one or two people walk on the panels to slightly sink the weir. In contrast, a fixed weir may be flooded or damaged during high flows and cannot be repaired until flows have substantially subsided. Unlike a fixed weir, a floating weir will allow upstream and downstream passage of boats by allowing boaters to partially sink some panels and drive or float over the top of the weir. In many large rivers, floating weirs may be the only feasible way of trapping the entire stream, short of major construction that could be an obstruction to boat traffic or may be esthetically undesirable.

Floating weirs can be easily installed once the sill is prepared. For example, a weir composed of 66 panels (about 200 ft) was installed in 3-4 hours by 7-8 people on the Lochsa River, and a weir of 42 panels (about 125 ft) took four people one day to install on the Chiwawa River. Individual weir panels weigh about 80-90 pounds.

Because floating weirs are relatively new in the United States, information is lacking on the life of weir panels. Several weirs have been operated for 3-4 years with little noticeable deterioration. The ADFG weir was operated from 1988-1992 before the PVC pipes became brittle and the weir panels needed to be rebuilt (L. Bartlett, ADFG, Palmer, 1993, personal

communication). Although the weir did require some maintenance during this five-year period, the PVC pipes were easy to remove and replace. Installation of these weirs is fast, even when installed in remote locations. A large advantage of the Alaska version over the commercial version is its lower cost. A 100-ft weir with sill attachment and trap cost around \$10,000 (L. Bartlett, ADFG, Palmer, 1993, personal communication).

Disadvantages: The floating weir is an evolving technology that is not yet perfected. Because floating weirs are relatively new in North America, questions remain about the durability of weir components such as the pickets, the lateral wood struts, the strap attachment to the lateral struts, and sill attachments. Some weir failures have occurred because of abrasion at the sill attachment or interference with the ability of the weir to pivot on the attachment point because of stream bedload movement during high flows.

Some commercial floating weirs have been relatively ineffective in capturing salmon. For example, a floating weir in the Twisp River was inefficient in spring flows because fish swam over the weir and because some fish worked through the pickets (B. Hevlin, NMFS, Portland, 1993, personal communication). Some fish also worked through the pickets at the Aberdeen Hatchery floating weir until additional lateral wood braces and attachment straps were added (B. Paulson, WDFW, Aberdeen, 1993, personal communication). Spawning distribution in the Twisp River was altered because a much higher proportion of fish spawned in downstream areas than had been previously observed (B. Hevlin, NMFS, Portland, 1993, personal communication).

Floating weirs cannot be adapted to all sites because they require certain stream characteristics to operate properly. They operate best where a stream is straight and wide with low gradient. Streams must often be confined within abutments to provide an even flow of water across the weir panels. The attachment sill must be horizontal and perpendicular to the flow to reduce uneven stress on the panels. However, some weirs in Alaska have been installed at an angle to the flow and have operated successfully by reattaching the resistant board so it remains perpendicular to the current (L. Bartlett, ADFG, Palmer, 1993, personal communication). Scouring can occur above and below the site unless an apron is provided. Damage to the PVC pipes can affect the operation of the weir and individual pipes are difficult to replace on the commercial weir. Therefore, most purchasers of the floating weir order extra panels.

A disadvantage of commercial floating weirs is cost, unless the weirs are planned for long-term use, such as at a hatchery or at a designated monitoring site. Weir panels 3 ft wide by 12-16 ft long cost around \$1100-\$1600 each from Mitsubishi. The total cost of a weir can be very high depending on the width of the stream and the amount of site preparation required, such as construction of an attachment sill and bank abutment work. For example, the total cost of a floating weir at Lookingglass Hatchery was \$185,000, which, in addition to the weir, included engineering, site construction, contractor, and agency oversight (P. Johnson, ODFW Engineering, Portland, 1995, personal communication).

Permanent Picket Weir

Description: Picket weirs that have been constructed at fish culture facilities are usually permanent structures consisting of concrete piers and a concrete apron. Clay (1995) described several structures in which picket panels are supported by steel beams and concrete piers. These structures require construction of a substantial apron to prevent scour and erosion underneath and downstream of the weir, and use of bank abutments to prevent scour around the shoreline. A permanent weir was constructed at the Sawtooth Hatchery in central Idaho to trap steelhead and spring chinook salmon. Concrete piers in the river support three rows of steel picket panels that are stacked on top of each other. A small crane mounted on a rail at the top of the structure is used to lift panels and to winch large debris off the panels. The piers are constructed with ports, which allow the lateral passage of fish across the apron. Fish at these permanent weirs are blocked at the weir and diverted into a fish trap or a fishway leading to a capture facility.

A trapping technique that combines features of panel, horizontal, and floating weirs was developed in 1993 to trap adult spring chinook salmon at Chiwawa Hatchery (B. Hevlin, NMFS, Portland, 1993, personal communication). The barrier was designed after a floating weir failed to block the upstream passage of chinook salmon for several years during high flows. Four to five panels (10 ft long by 20 ft wide) are constructed of heavy-duty ABS plastic pickets that are further reinforced by cross braces. The pickets are wing-shaped to increase the efficiency of passing water. The panels are attached with strong hinges to an existing sill that is about 12 in high. On the downstream end, the panels are supported by hydraulic lifters (two per panel) set on concrete pads 3-4 ft downstream of the sill. When the lifters are at their maximum height, the panels are about 60° to the stream bottom, and when they are lowered, the panels are dropped below horizontal. The hydraulic lifters use canola oil for fluid and are operated simultaneously by controls on the bank. The lifters are set to give when a certain amount of pressure is reached. Therefore, if a large tree or a large amount of debris collects on the panels, the lifters give way and the weir lowers to wash off debris.

Areas of use: Clay (1995) described several permanent picket weirs used in Canada and Scotland. Sawtooth Hatchery on the upper Salmon River in Idaho uses a permanent construction of concrete piers and steel picket panels to trap adult spring chinook salmon and steelhead. The panels are removed during the period when adult fish are not migrating. As mentioned previously, a new barrier design was recently used on the Chiwawa River to trap spring chinook salmon.

Effectiveness: Permanent picket weirs can be 100% effective in capturing adult salmonids. The Chiwawa barrier has performed well as a fish barrier, although attraction to the trap has been of concern (B. Hevlin, NMFS, Portland, 1995, personal communication). The barrier has been operated in flows up to 2,000-2,500 cfs. At these flows, the end of the weir panels was still 6 ft above the water surface. Because the pickets were efficient at passing water, little turbulence was created downstream of the panels and the fish tended to work along the barrier rather than jump at it. The new barrier was successful at capturing the entire run in its first year of operation,

which outperformed the 24-35% efficiency of a floating weir used previously at the site. However, because of problems with attraction to the trap, some spring chinook may have been displaced to downstream areas. The weir was lowered every fifth day in 1995 to let fish migrate past the weir site because of concerns about the low number of returning adults and the possibility of displacing spawners to less suitable areas.

Advantages: The size and construction of permanent picket weirs enables them to withstand floods much better than temporary structures. The picket panels diffuse water, which minimizes flooding upstream of the trap when compared to other techniques that use concrete or other material to block fish passage. Whether they are built to block fish at all flows or to allow flood water and associated debris to wash over them, permanent picket weirs should require little post-flood maintenance other than cleaning.

Disadvantages: The cost and construction of permanent picket weirs limit their use to areas where long-term sampling will be conducted. The Sawtooth Hatchery facility cost \$500,000 in mid-1980s dollars. The cost of the Chiwawa barrier was about \$100,000. Although the Chiwawa barrier has performed well, it has not been subject to high flows, which have previously occurred at the site. Also, the durability and performance of the barrier has yet to be tested. Impoundment upstream of the weir may be a disadvantage in some areas. Because these weirs may be 100% effective, capturing and processing all fish may be a problem in streams where fish runs are low.

Gabion Barrier

Description: An adult capture technique that has been used for several years on the Millicoma and Coquille rivers uses the combination of rock-filled gabions to block upstream passage and a concrete trap for capturing fish (Figure 13). The gabions are angled toward the trap, which is located on one side of the river. Before the gabions are filled with rock, a cable is woven through them and attached to large trees along the shore. After the gabions are filled, they are capped with cement to extend wear. To prevent fish from jumping over the gabions at high flow, short pickets of PVC pipe are attached to the top of the gabions and extend downstream (Figure 13). These pickets also help facilitate the passage of boats during high flows.

The trap is constructed of concrete with three vertical walls and a floor (Figure 14). Each wall has slots that allow the installation of stop logs, finger weir, or picketed panels. One side of the trap dissipates flow, and stop logs are placed on this side to maintain a velocity barrier for fish. The other side is converted into a trap by installing a picketed panel on the upstream side, stop logs to control the flow, and a finger weir (see Figure 6) on the downstream side. Flow through the trap can be controlled by installing or removing stop logs on the trap or the dissipation side of the structure, or by raising or lowering the finger weir.

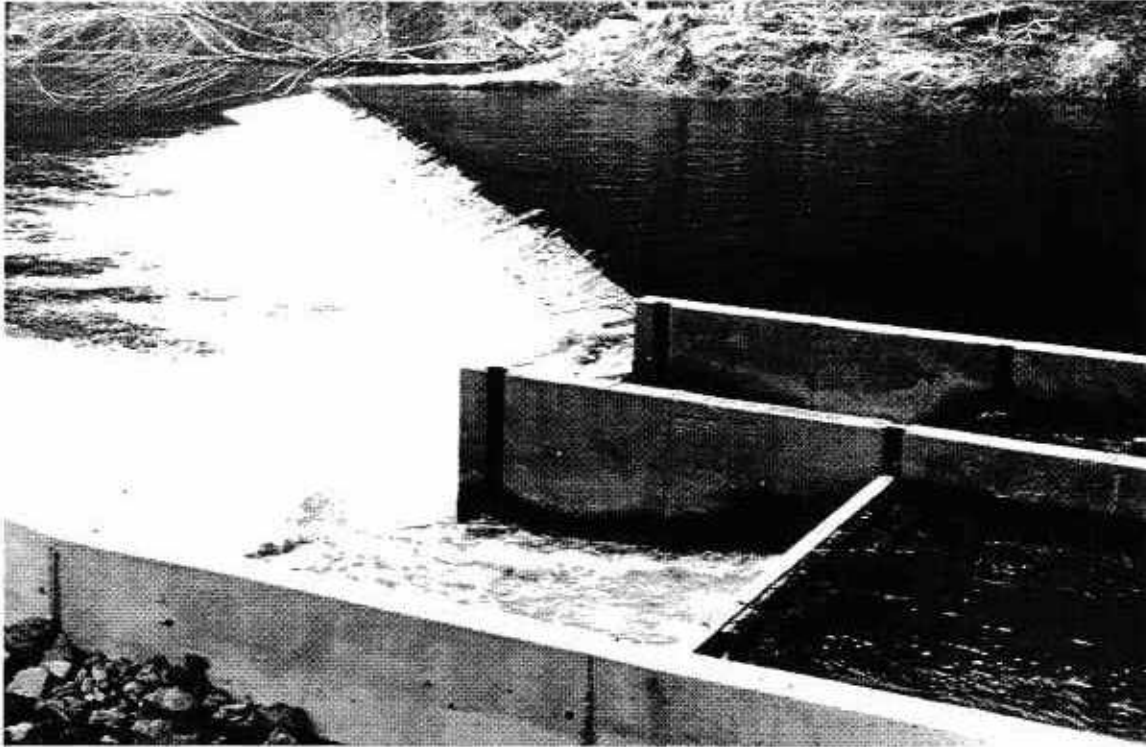


Figure 13. Barrier dam of rock-filled gabions for trapping adult salmon and steelhead, West Fork Millicoma River, Oregon (trap is in the foreground). Note PVC pipe extensions on top of the gabions to prevent fish from jumping over the barrier and to facilitate downstream passage of drift boats.

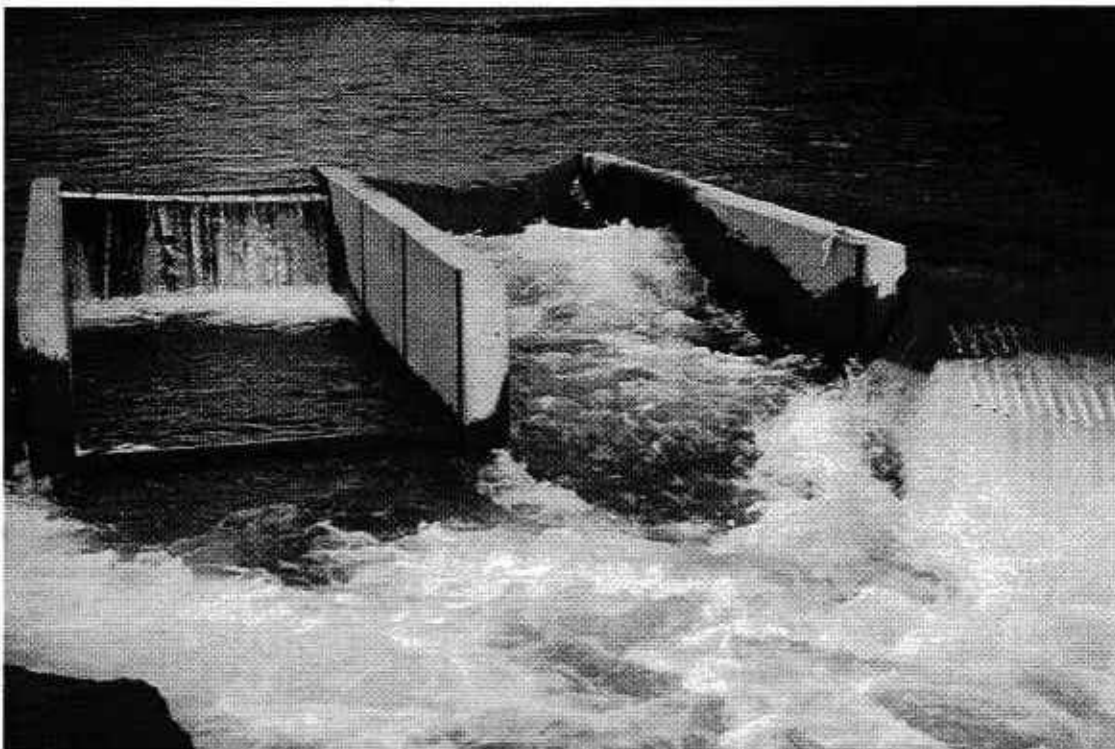


Figure 14. Adult trap at a gabion barrier dam, South Fork Coquille River, Oregon. Note that stop logs in photo are set to allow adult passage.

Fish ascending the river must swim into the trap because other passage is blocked by the vertical barrier of the gabion dam and by the velocity barrier of the dissipation side of the trap. During high flows, plywood is placed on the upstream side of the trap against the picketed panel to control the flow and to enable fish to be more easily netted. Fish can hold in the trap area for a couple of days, but the trap is generally checked twice during days it is operated.

Areas of use: Several of these traps have been built and operated on the Coos and Coquille systems. Their principal use is to collect salmon and steelhead for development of local brood stocks. Operation of these traps is coordinated by Coos-Coquille District of ODFW with much assistance from volunteers in the basin.

Effectiveness: Although no evaluation has been conducted on the effectiveness of these traps, they are generally believed to be highly efficient at most flows. During the highest floods of a year, some fish can pass over the gabions (T. Rumreich, ODFW, Charleston, 1993, personal communication). As long as the stop logs are properly adjusted, velocity on the dissipating side of the trap structure prevents upstream passage. Conceivably, these traps could be 100% effective at trapping fish during certain flows. However, the traps are generally operated only a few days a week to collect fish for hatchery programs.

Advantages: The principal advantage of these structures is that they can be used on large river systems where other traps might not be effective. Large debris washes over the top of the gabions during high flows, yet the gabions still have enough physical height on the downstream side to form a barrier to fish passage at most flows. Although the trap structure can be somewhat vulnerable to large trees, little damage has occurred to the traps (T. Rumreich, ODFW, Charleston, 1993, personal communication). The walls of the trap are low enough that they are submerged during highest flows and are therefore not exposed to large floating trees. Because gabion barriers can be installed on large river systems, they can be placed lower in a river basin than many other types of traps and can representatively sample throughout a run. Although the initial expense and labor is higher than with temporary weirs, the year-to-year costs may be less because of lower maintenance.

Disadvantages: The principal disadvantage of these structures is that they remain in place when not fishing, thus altering the appearance of the river. Such modifications may be unacceptable in certain rivers. Although these structures can be modified to allow passage of boats, they could create dangerous passage problems for boats at some flows and would require some warning and education of boaters. As with any structure that creates a height differential, these structures create a forebay and will flood some upstream areas, although the inclusion of a trap will minimize the flooded area at low flow. Over time the gabions will require some repair, which could be difficult because the structure is tied together.

Concrete Barrier

Description: Concrete barrier dams have generally been used to collect fish at fish culture facilities or to prevent upstream passage of unwanted fish species (Bulow et al. 1988; Clay 1995). These structures are usually expensive because they require extensive engineering and construction. Vertical barriers are built to create a height differential of 6-10 ft. A shallow sill downstream of the dam is built to prevent fish from jumping at the face of the dam. Clay (1995) and Senn et al. (1984) describe dams in which the face is sloped downstream (i.e., the bottom of the face is farther upstream than the top of the face - "Ambursen"-type dam). Fish that jump at the overflow go through the water and fall into a passageway beneath the sloped face rather than falling against the dam surface. Openings in concrete piers allow fish to move freely across the apron (see Clay 1995, Figure 3.1).

Velocity barriers are a variation of concrete barrier dams that use water velocity over a shallow surface, rather than height, to prevent fish passage. Water impounded by a small dam discharges onto a shallow sill below the dam or down a long slope face to create a velocity sufficient to prevent fish passage. Senn et al. (1984) reported desired water velocity as 16 fps, which exceeds the upper swimming ability of 10-13 fps for adult salmon and steelhead (Bjornn and Reiser 1991). The depth of water on the sill should be less than 6 in (Senn et al. 1984) and the flow should not exceed 8 cfs per linear ft of width to avoid an S-shape flow across the apron, which would allow fish to swim upstream. In some cases, adult fish might be able to maintain position or move laterally across the sill, but would not be able to swim the entire length of the sill or would not be able to jump at the impoundment face. A combination concrete barrier and velocity barrier is used at Warm Spring National Fish Hatchery to block upstream migration and to divert fish to a fish ladder and collection facility (Figure 15). Although fish at this site can sometimes jump onto the sill and swim up to the face of the impoundment dam, the shallow depth and velocity of water on the sill prevents fish from jumping at the second barrier and they eventually drop downstream.

Other variations of concrete barriers have been designed to prevent upstream passage of fish. A radial arm dam (a curved steel gate that pivots on two struts or arms) has been used in conjunction with a velocity barrier to prevent passage of adult salmon and steelhead on Little Sheep Creek, a tributary of the Imnaha River in northeast Oregon (Figure 16). This structure was built by the Army Corps of Engineers and is used as an adult collection and juvenile acclimation facility. Other concrete barriers are capped with adjustable crest gates on top of the concrete weir to control outflow (Clay 1995). Some crest gates are operated with hydraulic cylinders. Other crest gates use rubber bladders under the hinge of gates (Obermeyer gate), which can be inflated or deflated with air to raise or lower the crest gate.

Areas of use: Concrete barriers are fairly common throughout the Pacific Northwest and are generally constructed for use at a fish culture facility.

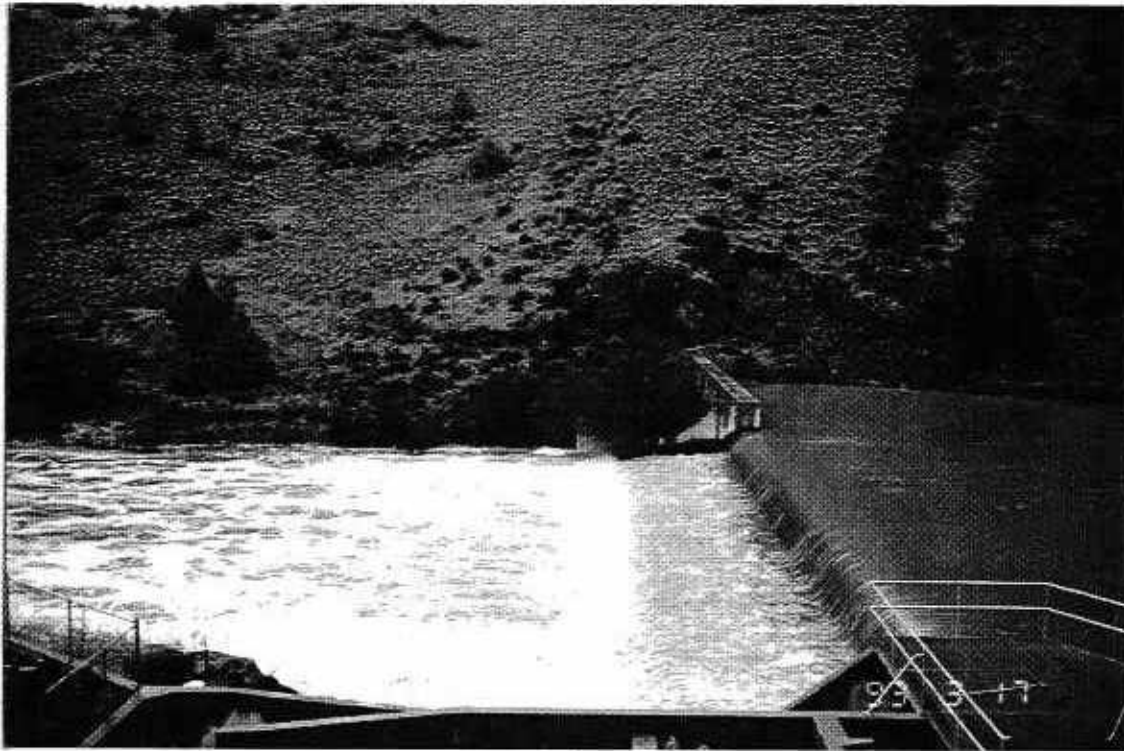


Figure 15. Concrete barrier used to divert adult salmon and steelhead into Warm Springs National Fish Hatchery, Oregon.



Figure 16. Radial arm dam and velocity barrier used to divert steelhead into adult steelhead trap, Little Sheep Creek (Imnaha River), Oregon.

Effectiveness: Theoretically, these structures should be 100% effective in preventing the passage of adult fish. Some designs may have temporary periods when passage might be possible, but most are highly effective in blocking passage and diverting fish into a capture facility.

Advantages: In addition to being highly effective in capturing adult fish, these structures withstand high flow and high debris loads. Some of the designs can be adjusted for varying flow, such as the radial arm dam and crest gate weir. Maintenance varies depending on the design; those with movable parts (such as hydraulic lifters) require more maintenance than designs such as the velocity barrier.

Disadvantages: The biggest disadvantage to these designs is the cost of engineering, materials, and construction. For these reasons, use of concrete barriers is confined to areas where long-term sampling will be conducted. Generally, these methods of fish capture have been constructed at fish culture facilities. Impoundment upstream of the barrier can be considerable and may be a disadvantage in some areas. Some of the designs, such as Obermeyer crest gates, are relatively new and have not been thoroughly tested. The hydraulic lifters used to operate some crest gates are positioned along the width of the apron and could pose injury risks to fish that jump through the outflow. Although crest gates can be operated individually to allow more flow at certain spots (thereby providing attraction flow), the effect of disproportionate flow moving over the gates and laterally under raised gates may affect passage of fish and may induce fish to jump at these areas. Finally, careful consideration should be given to any plan that calls for construction of a "small" dam to sample fish because of resultant changes in the river and possible effects on migration of non-target fish and on distribution of fish in the river.

Electric Barrier

Description: Electric barriers are used in conjunction with off-channel traps to capture adult salmonids. Fish swim into an electric field that is charged between suspended electrodes and a submerged ground. Once in the field, fish receive a mild shock and are prevented from continuing upstream. The adult fish eventually find their way into a fishway and trap, which are downstream of the electric field.

Clay (1961) and Senn et al. (1984) described similar setups for an electric barrier. A single row of electrodes, which are 1.5-in diameter galvanized pipe, are suspended from an overhead cable on 3-foot centers. They are located 15 ft upstream and parallel to a submerged ground. The barrier uses 110-volt, 60 cycle, single-phase alternating current (AC). The minimum barrier voltage should be 0.5 volts per inch over a 10-foot field length. Senn et al. (1984) reported that electric barriers have operated satisfactorily in streams as large as 200 ft wide and 8 ft deep. The velocity in the field should be at least 3 fps to wash stunned fish downstream and prevent mortality (Senn et al. 1984).

Other designs consist of submerged electrodes of metal strap that are mounted in a wooden platform, such as that used in Three Rivers, Oregon, to divert salmon and steelhead into Cedar Creek Hatchery. Because the electrodes are insulated, they do not ground to the substrate and the electric current flows through the path of least resistance in the water column. The field is evenly distributed in the water column from the submerged electrodes to the water surface. Electrodes are connected to individual pulsators to generate a pulsed direct current (DC) field. Pulsed direct current reduces stress on fish and minimizes the danger of electric shock to workers and the public. Each pulsator is adjusted differently to create a graduated field. Smith-Root, Inc. uses a similar design for an electric barrier, but the electrodes are encased in a special insulating cement that is poured as a sill on the stream bottom (Clay 1995).

The field from an electric barrier is oriented parallel to the stream flow, which is also parallel to a fish swimming upstream. This orientation transfers the maximum amount of power from the water into the fish as it swims upstream, which elicits a response in the fish ranging from fright to tetany (see Electrofishing). A fish receives minimal shock if it turns sideways to the current, but the velocity of water will sweep the fish downstream out of the field. The barrier offered by the Smith-Root, Inc. is a graduated electric field controlled by six or seven pulsators that are triggered simultaneously to create an additive electric field oriented with streamflow (Clay 1995). The graduated barrier allows fish that attempt to swim through the barrier at various speeds to be gradually slowed by the effects of electricity until they cannot keep their head into the flow and are swept downstream. This graduated field also affects fish of different sizes at different rates (because larger fish receive more voltage and are affected earlier than smaller fish). The graduated field helps prevent injury to fish.

Palmisano and Burger (1988) described a portable electric barrier that was used to divert adult chinook salmon into a small side channel where the fish were captured with a picket weir and trap. The barrier consisted of two galvanized cables (3/8 in) for electrodes that were connected to an electrofishing unit and a 4,000-W generator. The most successful setting was 168 V DC, 3.7 ms pulse width, 120 pulses/s, and 1 A current. The electrodes were secured to the stream bottom with sandbags with the cathode stretched across the river and the anode stretched upstream in shallow water parallel to the bank. The barrier was operated 50% of the time during the six weeks of operation to provide some unimpeded passage. The water velocity at the site was 2-5 fps.

Smith-Root, Inc. also offers a portable electric barrier that consists of electrodes made of stainless steel cables (5/16 in). The electrodes are held in a parallel array by sewn plastic netting on an insulated background of 18-oz reinforced vinyl. Insulated power cables from each electrode are attached to a pulsator unit and a power source. The array is secured to the stream bottom such that no water flows under the insulating vinyl. The mode of operation is like that for their permanent installations.

Areas of use: In Oregon, electric barriers have been at Bonneville, Salmon River, Nehalem River, and Cedar Creek hatcheries to divert adult salmon and steelhead into the hatcheries. Electric barriers have also been used in

Washington at Quinalt National Fish Hatchery (Senn et al. 1984). A Smith-Root, Inc. electric barrier has been used at Quilcene Hatchery, Washington, since 1989. A Smith-Root, Inc. barrier was also used in Minnesota to prevent upstream migration of common carp and bigmouth buffalo (*Ictiobus cyprinellus*) into a lake system (Verrill and Berry 1995). A portable electric barrier was used to divert adult chinook salmon into a fish trap in the Kenai River drainage in Alaska to estimate escapement (Palmisano and Burger 1988). Portable electric barriers made by Smith-Root, Inc. have been used to assess the feasibility of installing permanent electric barriers at irrigation diversions.

Holmes (1948, as cited in Andrew and Geen 1960) reported that the earliest use of an electric barrier to stop adult salmon was at Gold Ray Dam on the Rogue River, but it was subsequently removed because of mortality to fish. Other electric barriers were reported in the literature in the 1950s. They were often used in the Great Lakes region to stop spawning migrations of parasitic sea lampreys (Applegate et al. 1952). Because of excessive mortality of other fish species using alternating current, work was conducted with electric weirs operated by pulsed direct current (McClain 1956). Electric barriers in the Northwest were reported in the 1950s on the Entiat River to divert sockeye and chinook salmon into traps (Burrows 1957).

Effectiveness: The efficiency of electric barriers has not been extensively tested on adult salmon or steelhead. Andrew and Geen (1960) reported that although fish could be stopped at an electric barrier, the electric field was not very effective in guiding fish to a fishway. At the Three Rivers barrier, fish attempt to swim through the field, and at certain flows they school below the barrier rather than swim into the hatchery trap because of inadequate attraction flow (M. Traynor, ODFW, Cedar Creek Hatchery, 1993, personal communication). However, once flow increases from fall rains, the electric barrier is effective at diverting fish into the trap. Although electric barriers can be a complete barrier to upstream passage (Andrew and Geen 1960), some may be rendered temporarily ineffective during floods and during power outages. Because of the ability to pass debris, they should remain operational during most high water events, although debris can get tangled in suspended probes.

Smith-Root, Inc. reports in their literature that with uniform water velocity and depth, their barrier works well for adult salmon and steelhead in velocities ranging from 2-10 fps. A Smith-Root, Inc. barrier was effective in preventing upstream migration of common carp and bigmouth buffalo based on mark-recapture studies (Verrill and Berry 1995). A portable system used in Alaska was operated 40-90% of the week for six weeks and captured 157 adult chinook salmon or about 2% of the run (Palmisano and Burger 1988). This barrier caused some injury and mortality. Estimates of relative mortality were made by comparing counts of dead fish below the electric barrier to fish tagged at the trap. Relative mortality averaged 47% using AC when the barrier was operated 72% of the time, and dropped to an average of 7% using DC when the barrier was operated 40% of the time. The percentage of fish killed by the electric field under DC dropped from 12% to 3% when the anode was placed perpendicular to the cathode.

Advantages: Some electric barriers have relatively low construction costs compared to most permanent barriers, but cost depends on the type of electric barrier and on characteristics of the site. Electric barriers described by Clay (1961) and Senn et al. (1984) can be easily installed and dismantled. Maintenance is low because most debris passes through suspended electrodes. Senn et al. (1984) reported the electric demand of a 100-ft electric barrier averaged approximately 300 watts per day, although electric demand varies with the number of electrodes and their submerged depth.

Submerged electric barriers do not catch debris or alter water flow through the site. They are not subject to damage from high flows or from ice flows. A graduated electric field using pulsed DC reduces injury and mortality to fish. Use of low frequency pulsed DC with very short pulse durations also increases the safety to workers and the public.

Disadvantages: Although construction costs at some sites may be low, other sites may require a large expenditure. Sufficient electric power must be available, which makes an electric barrier infeasible in some areas. Construction is generally needed to confine the stream as it flows through the electric field. For example, the Smith-Root, Inc. barrier requires laminar flow to ensure all areas of the barrier have equal and sufficient velocity from shore to shore and from top to bottom. Bank abutments are constructed to confine the stream and are built to handle 50-to 100-year floods.

Power outages and some flood conditions can render the electric barrier ineffective. Some maintenance may be needed with suspended electrodes to keep them adequately spaced and free of debris. Protective fencing and adequate warning signs and lights are essential to protect the public where an electric barrier is used. Because boat traffic must be kept from the area, electric barriers are not feasible in some streams. Electric barriers also pose potential hazards for personnel working in the area.

Electric barriers can injure or kill adult fish. An electric barrier at Nehalem Hatchery was discontinued because of injury and mortality to adult salmon (G. Yeager, ODFW, Nehalem Hatchery, 1993, personal communication). Flow at the barrier was believed inadequate to sweep stunned fish out of the electric field. Andrew and Geen (1960) reported similar problems at other sites. Injury to adult fish at the Three Rivers barrier has occurred during low flow in the fall. Little mortality has been observed or reported from anglers in an intensive fishery just downstream of the barrier (M. Traynor, ODFW, Cedar Creek Hatchery, 1993, personal communication). Pulsators used at the Three Rivers barrier require frequent adjustment to maintain a proper field, which is affected by alder leaves and branches collecting on the electrodes at low flow. Where natural spawning occurs upstream of the electric barrier, electric barriers should not injure juvenile fish or interfere with their downstream migration.

The Smith-Root, Inc. electric barrier addresses some disadvantages of electric barriers through a back-up system for power outages, submerged electrodes to reduce damage by debris, and graduated pulsed DC field to reduce injury to fish and to increase safety. However, the cost of construction, computer control system, pulsators, and auxiliary power source makes the system feasible only for permanent installations, such as at fish hatcheries.

ACTIVE METHODS

Electrofishing

Description: Electrofishing for adult salmonids can be done with boat-mounted or backpack electrofishing gear. Because backpack electrofishing is effective only in small streams and is labor intensive for capturing adult salmon or steelhead, this report will concentrate on boat electrofishing. Boat-mounted electrofishing gear can be operated from a motorized craft such as a jet boat, or from a non-motorized boat such as a drift boat. The gear usually consists of a power source (generator or battery), a variable voltage pulsator, two electrodes (anode and cathode), and a foot switch in the front of the boat to activate the electrical field. The boat is equipped with a live box to hold captured fish.

Various materials and shapes of anodes have been used including copper cables, metal rings (Newberg 1973; Fessler et al. 1976), aluminum rings with steel dropper electrodes (Novotny and Priegel 1974), flat plates (Kolz 1993), and metal cylinders or spheres (Martinez and Tiffan 1992; Kolz 1993). Kolz (1993) evaluated 18 electrode types and found that vertical plates projected the farthest electric fields. However, he cautioned that the choice of an electrode type is dependent on a variety of electrical and biological factors such as size of the power source, desired size and intensity of the electric field, electroshock response of the target species, and working conditions of the sample area. On aluminum boats, the electrofishing unit is sometimes grounded to the boat, which then acts as the cathode (negative electrode).

Because size of the electric field is determined in part by the distance between electrodes, the anode for boat electrofishing is usually suspended from a boom as far as possible from the boat (usually 3-5 ft) while still allowing the person in the front of the boat to reach stunned fish. Gear descriptions for boat electrofishing can be found in Newburg (1973), Novotny and Priegel (1974), Hooton (1978), and Reynolds (1983). Sharber and Carothers (1987) described a suspended live box for use with a catamaran electrofishing raft that shields fish from electric shock. Information on electrofishing equipment can be obtained from manufacturers (see APPENDIX B).

Two people are usually involved in electrofishing from a boat. One person rows or steers the boat and the other operates the foot switch and nets fish from the water with a long-handled dip net. The boat is maneuvered so that sampling is done perpendicular along the shore or over likely holding water. If adult salmon or steelhead are being captured for brood stock, additional people may be needed to help transfer fish from the live box of the boat to a tanker truck. Alternatively, fish can be temporarily held in PVC tubes or collapsible cloth tubes (see Angling), secured along the shore, then picked up with a tanker truck at the end of the sampling run.

Electrofishing units use either alternating current (AC) or direct current (DC) to create an electrical or power field in the water. Generally, DC is more effective in attracting fish to the anode at the least harm to the fish. Electrical power disrupts internal neural responses in the fish and elicits a muscular response (Kolz 1989). Fish respond by voluntary and involuntary reactions including a fright response, galvanotaxis (attraction to the anode), galvanonarcosis (stunned immobility with slack muscles), pseudo-

forced swimming (cramped swimming with the fish on its side), and tetany (rigid immobility; Vibert 1963; Kolz and Reynolds 1989). These responses can cause injury in fish (see *Disadvantages*), but injuries may be reduced by adjusting properties of an electric field such as pulse frequency (McMichael 1993; Sharber et al. 1994).

Areas of use: Electrofishing with boats to capture adult salmon and steelhead has been conducted on several rivers in Oregon including the Rogue (ODFW 1990); Applegate (Fustish et al. 1989); Deschutes (Fessler et al. 1976); Siuslaw, Yaquina, and Coos (Hooton 1978); Trask (Lindsay et al. 1989b); and the Siuslaw (Kenaston et al. 1990).

Early reports of electrofishing in the United States were by Burr (1931) and Haskell (1940). Electrofishing has been fairly common as a sampling technique since the 1950s. Early accounts of electrofishing from a boat were reported by Larimore et al. (1950), Meyers (1951), and Rollefson (1958, as cited in Novotny and Priegel 1974).

Effectiveness: Several factors affect electrofishing efficiency including factors related to gear (type of current, waveform, amount of power, size, shape, and number of electrodes), properties of water (resistance or conductivity, electrolytes, temperature), physical characteristics of the stream (velocity, depth, and clarity), and size and species of fish (Novotny and Priegel 1974; Heidinger et al. 1983; Novotny 1990; Kolz 1993). Burkhardt and Gutreuter (1995) suggested that standardizing the power output of electrofishing (adjusted for differences in water conductivity and water temperature) can reduce the variability in catch of fish. Detailed information factors affecting electrofishing on fish is given in **APPENDIX A**.

Electrofishing can be effective for capturing salmon and steelhead, although salmon appear to be more susceptible to injury than steelhead (Fessler et al. 1976). The efficiency of capturing adult salmon and steelhead must take into account injury to the fish (see *Disadvantages*). Fredenberg (1992) and Snyder (1992) presented recommendations for electrofishing that balanced efficiency of capture and minimal injury to the fish. The catch and catch rate of electrofishing in Oregon to capture adult salmon or steelhead is given in Table 4.

Catch efficiency or capture probability with electrofishing gear generally increases with size of the fish (Zalewski 1985; Schroeder and Smith 1989; Thurow 1990; Anderson 1995) because large fish are more susceptible to electric shock than small fish (Taylor et al. 1957; Flux 1967; Ellis 1975). Although electrofishing gear is selective for large fish, little data have been reported on selectivity within the size range of adult anadromous fish. The mean length of adult steelhead in the Siuslaw River captured by electrofishing was not significantly different ($P < 0.05$) from those captured in traps, although the electrofishing sample size was low (Table 5).

Table 4. Catch and catch rate (fish/day) of adult salmon and steelhead with boat electrofishing gear in Oregon.

| Species | River | Years of sampling | Average sample days | Average catch | Fish/d | Source ^a |
|------------------|-----------|-------------------|---------------------|---------------|--------|---------------------|
| Winter steelhead | Rogue | 3 | 15 | 398 | 28 | 1 |
| | Applegate | 5 | 12 | 156 | 16 | 2 |
| | Trask | 1 | 4 | 9 | 2 | 3 |
| | Siuslaw | 1 | 11 | 10 | 1 | 4 |
| Summer steelhead | Deschutes | 2 | 48 | 1,567 | 33 | 5 |
| | Deschutes | 2 | -- | 335 | -- | 6 |
| Spring chinook | Deschutes | 2 | -- | 88 | -- | 6 |
| Fall chinook | Yaquina | 1 | 26 | 187 | 7 | 7 |
| | Siuslaw | 1 | 14 | 97 | 7 | 7 |
| | Coos | 1 | 5 | 61 | 12 | 7 |

^a 1. ODFW 1990; 2. Fustish et al. 1989; 3. Lindsay et al. 1989b; 4. Kenaston et al. 1990; 5. Fessler 1972; 6. Fessler 1974; Fessler et al. 1976; 7. Hooton 1978.

Table 5. Mean length (cm) and range of adult winter steelhead captured by traps, electrofishing gear, and angling gear in the Siuslaw River, 1990.

| Method | Mean length | Standard deviation | Range | Sample size |
|----------------|-------------|--------------------|-------|-------------|
| Traps | 67.6 | 4.7 | 59-82 | 151 |
| Angling | 67.0 | 6.7 | 56-76 | 9 |
| Electrofishing | 66.6 | 7.1 | 57-78 | 10 |

Advantages: Because electrofishing gear can be adapted for various sizes and types of boats, it could be used on a variety of streams. Voltage, pulse shape, and pulse frequency can be adjusted to help compensate for differences in stream characteristics. Sampling can be conducted near the mouth of rivers, thus capturing a representative portion of the run destined for various streams in the basin. Sampling can also be conducted throughout the run. Electrofishing can be used to collect information on run timing, migration patterns, contribution to fisheries, run size or escapement, length and age distributions, or other life history characteristics. Because

electrofishing does not require obstruction of the river channel, it can be conducted on fairly large systems during variable flows without impeding boat traffic. With adequate background information on holding pools, flow, and run timing, electrofishing can be conducted for short periods of time in select sections of a river.

Disadvantages: Electrofishing can be labor-intensive. For example, collection of chinook salmon on three Oregon coastal streams required an average of 60 person-days for each stream to collect an average of 86 fish per stream (Hooton 1978). An additional 22 person-days were required for maintenance and repair of equipment. In addition to the time required to collect fish, a minimum of two vehicles would be needed for a shuttle at the end of the sample section. Electrofishing in popular angling water could lead to public relations problems, especially if fish are accidentally killed or are perceptibly injured.

Electrofishing can kill or injure fish. Snyder (1992) contains an overview of studies on injury and mortality, and an extensive bibliography. Another extensive bibliography on electrofishing is by Burrige et al. (1990). When direct current is used, it causes spasmodic swimming toward the anode (galvanotaxis). Effective capture with electrofishing gear requires some level of galvanotaxis to enable samplers to net fish. However, spasms in the musculature of the fish can cause hemorrhage in the muscle tissue and dislocated or splintered vertebrae (Northrop 1967; Sharber and Carothers 1988; Fredenberg 1992; McMichael 1993; Sharber et al. 1994). Other less noticeable effects can be stress responses and behavioral changes (Horak and Klein 1967; Bouck and Ball 1966; Schreck et al. 1976; Mesa and Schreck 1989). Additional information on electrofishing injury is given in **APPENDIX A**.

A change in river conditions can reduce the effectiveness of electrofishing. For example, highly turbid water during freshets decreases the ability of the sampling crew to see and net fish. Also, the distribution of fish can change with increased flow, thus decreasing the ability to capture fish (Pierce et al. 1985). The efficiency of capturing chinook salmon in the Coos River declined sharply after fall rains began because fish no longer concentrated in holding pools (Hooton 1978). Although electrofishing can be conducted low in a river system, tidal influence may decrease electrofishing success because of fluctuations in depth and flow (Hooton 1978) and because of changes in water conductivity.

Gill Net

Description: Monofilament or multifilament gill nets have been used to capture adult salmon and steelhead in the Pacific Northwest for brood stock and for escapement estimates. A gill net is a single wall net with a float line at the top and a lead line on the bottom. The choice of mesh size, depth of net, and amount of flotation depends on the target species and on the physical characteristics of the stream. Mesh size is measured as the internal size of one side of the square (square mesh, bar, or half mesh) or as the internal length along a stretched square (stretch mesh or extension; Garner 1968; Lagler 1969). Hanging a net to the float and lead lines determines the

degree of looseness of a net when it is fished. Gill nets are usually hung with mesh openings vertically elongated in a diamond shape rather than in a square shape (Garner 1968). Some net manufacturers are listed in **APPENDIX B**.

Gill nets capture fish that swim partway through the net and are unable to back out or that entangle themselves in the net by their teeth, operculum, or fins. Gill nets can be fished in a fixed manner (set) or in an active manner (drift). Set nets depend on the active movement of fish. Set nets are usually attached to the bank on one end and anchored offshore on the other end (Baranski 1980). Generally, nets are set in an eddy where the current is low (Johnson et al. 1948; Baranski 1980). In small coastal streams of Oregon, gill nets were hung in holding pools between two block nets and fish were scared into the gill net by divers (T. Unterwegner, ODFW, Gold Beach, now John Day, 1993, personal communication).

Drift nets can be fished on the surface (floater) or on the stream bottom (sinker; Craig and Hacker 1940; Lagler 1969). They are usually drifted perpendicular to the current and can be attached to two power boats (Baranski 1980), to a buoy on one end and to a power boat on the other end (Craig and Hacker 1940), or to a power boat on one end and free on the other end (Hammarstrom 1980). A technique similar to seining has also been used in Oregon to capture adult salmon and steelhead (T. Unterwegner, ODFW, Gold Beach, now John Day, 1993, personal communication). One end of a gill net is attached to a power boat and the other end is walked downstream along a gravel bar. At the lower end of the gravel bar, the boat end of the net is brought ashore and the net is bagged. The gill net is kept loose during the drift to entangle fish and to prevent fish from breaking through the net. Casselman et al. (1990) described a method where a gill net was attached to a power boat and drifted parallel to the bank about 15-20 ft offshore while a second boat was rowed between the bank and the net. Fish were scared into the net by splashing the water surface with oars. Biggins and Cressey (1973) described a method using both a drift net and a stationary net at the downstream end of a hole. The drift net was moved downstream by two people, while a third person in mask and snorkel kept the net free of snags. Fish were crowded between the two nets and became entangled.

Areas of use: Gill nets have been used recently in Oregon to collect steelhead and salmon for brood stock (Chetco, Coos, Coquille, Siltcoos rivers, and Hunter and Tahkenitch creeks). Drift gill nets have been used to collect brood stock in Washington (Baranski 1980) and Alaska (Jones 1981; Wallis and Balland 1984). Gill nets have been used to capture and tag adult fish for escapement estimates in Oregon (Morgan and Cleaver 1954a, 1954b; Korn 1961; Henry 1964; Morgan 1964), Washington (Wendler et al. 1956), and Alaska (Bentz 1984; Wallis and Balland 1984; Sonnichsen and Alexandersdottir 1991).

Effectiveness: Effectiveness of gill nets depends on the purpose of capturing fish, such as brood stock collection or abundance estimate, and on the variability of the target species, such as fish size and run timing. Effectiveness of gill nets is affected by characteristics of the stream and the abundance of the target species (Washington 1973). The efficiency of gill nets also depends on location in the river, the proper mesh size, the proper hang of the net, and the skill in setting the net (Johnson et al. 1948; Hamley

1975). Baranski (1980) found the effectiveness of drift gill nets was most affected by the rate at which fish moved into the area being netted. However, he also reported that effectiveness was reduced by high flow (nets moved too quickly) and by low flow (nets moved too slowly), and was increased with high turbidity. Effectiveness of gill nets in lower reaches of coastal rivers can be decreased by tidal fluctuations (Johnson et al. 1948; Peterson 1954).

The selectivity of gill nets is related directly to size of fish (Peterson 1954; Lagler 1968; Hamley 1975) and to factors associated to size such as girth, state of ripeness, and behavior (Lagler 1968; McCombie and Berst 1969; Hamley 1975; Rudstam et al. 1984). Gill nets can also be selective for sex of fish, especially if sexual dimorphism is pronounced (Peterson 1954; Ward 1959; Hammarstrom and Larson 1984). The degree of selectivity is affected by mesh size, visibility of the net, elasticity of the mesh, thickness of the mesh, net construction, and method of fishing (Washington 1973; Hamley 1975; Collins 1979; Henderson and Nepszy 1992).

Evaluating effectiveness must also consider injury and mortality (Thompson and Hunter 1973). For example, of the three mesh sizes of drift gill nets used to capture chinook salmon in Alaska (5 1/8 in, 7 in, 8 in stretched), the 8-in mesh was most effective in capturing large adult salmon, but was more harmful to the fish than smaller sizes (Hammarstrom and Larson 1984). The 5 1/8 in net entangled rather than gilled most chinook salmon, but was selective to males and gilled other species of salmon. Measures of effectiveness (catch, catch rate, injury rate, etc.) for capture of adult salmon and steelhead in the Pacific Northwest are given in Table 6.

Korn (1961) felt that a set net was best for capturing winter steelhead in the Columbia River because fish could be removed from the net immediately without pulling the entire net and fewer fish were killed by seals in set nets than in drift nets. However, Baranski (1980) reported that drift nets were more efficient in capturing adult chinook salmon in the Skagit River. Drift nets captured about 11 fish per net per day compared to a catch of under two fish per net per day in set nets. Set nets rely on the movement of fish through specific areas whereas drift nets are actively fished in several areas of a river. Drift nets can fish more water and effort can be easily relocated to find concentrations of fish. Costs were higher for drift nets than for set nets because of frequent replacement of damaged nets and because of increased use of gas and oil in the power boats (Baranski 1980). However, the increased catch and efficiency of drift nets offset the higher costs.

Advantages: Gill nets can be fished near the mouths of rivers, thus representatively sampling fish below spawning tributaries. Adequate representation of the run can be ensured if sampling is conducted throughout the run. Capture of fish for brood stock or for tagging can be quite effective with gill nets once good sampling areas are located. Information on life history, run timing, length, age, harvest, abundance, and escapement can be obtained. Gill nets do not obstruct the river channel and can be fished in large river systems and during variable flows. Gillnetting may provide an alternative means of capture where construction of traps or electrofishing is unacceptable. The cost of sampling with gill nets is relatively low, especially when compared to other methods.

Table 6. Gill net catch and other statistics of salmon and steelhead captured for brood stock or tagging in the Pacific Northwest.

| Location ^a | Year | Species ^b | Catch | | Catch/ day/net ^d | Mortality rate (%) | Injury rate (%) |
|-----------------------|---------|----------------------|------------------|------------------|--------------------------------|-----------------------|--------------------|
| | | | Number | (%) ^c | | | |
| Drift | | | | | | | |
| Alsea | 1951 | Co | 1,142 | (1.3) | -- | 1.3 | 13 |
| | 1951 | Ch | 153 | (3.2) | -- | -- | 21 |
| Columbia | 1954-55 | StW | 655 | -- | -- | 5.2 | -- |
| | 1955-56 | StW | 1,481 | (0.7) | -- | 7.2 | -- |
| Tillamook | 1953 | Ch | 491 | (3.2) | 2.4 | -- | 32 |
| | | Co | 255 | (1.2) | 1.1 | -- | 25 |
| | | CS | 325 | (0.6) | 2.5 | -- | 14 |
| | | StW | 62 | (0.8) | 0.5 | -- | 24 |
| Siletz | 1954 | Ch | 194 | (4.1) | 2.3 | -- | 34 |
| | | Co | 445 | (2.9) | 5.3 | -- | 37 |
| | | CS | 58 | -- | 0.6 | -- | -- |
| | | StW | 63 | -- | 0.6 | -- | -- |
| Grays ^e | 1954-55 | StW | 164 | (2.1) | 2.1 | -- | -- |
| | 1955-56 | StW | 185 | (4.6) | 1.9 | -- | -- |
| Skagit | 1976-79 | Ch | 102 ^f | -- | 11.0 | 1-2 | -- |
| Kenai | 1983 | Ch | 1,535 | (5.0) | 18.3 | -- | -- |
| Anchor | 1983 | St | 133 | (7.9) | 3.0 | -- | -- |
| Set | | | | | | | |
| Columbia | 1954-55 | StW | 182 | -- | -- | 9.3 | -- |
| | 1955-56 | StW | 1,775 | (0.8) | -- | 6.0 | -- |
| Skagit | 1975 | Ch | 116 | -- | 1.8 | 6.0 ^g | -- |
| L. Susitna | 1983 | Co | 49 | (0.8) | 2.4 | -- | -- |

^a References by location: Alsea - Morgan and Cleaver (1954a, 1954b); Columbia River - Korn (1961); Tillamook Bay - Henry (1964); Siletz River - Morgan (1964); Grays River - Wendler et al. (1956); Skagit River - Baranski (1980); Kenai River - Hammarstrom and Larson (1984); Anchor River - Wallis and Balland (1984); Little Susitna River - Bentz (1984).

^b Species codes: Ch=chinook salmon; Co=coho salmon; CS=chum salmon; St=steelhead; StW=winter steelhead.

^c Catch as a percentage of the estimated population.

^d Estimated from information in "Methods" section of reports when not directly reported.

^e Combined for drift and set nets.

^f Average catch for period.

^g Mortality when netting late in the run and after moving upstream. Mortality from netting and handling was much higher downstream and earlier in the run.

Disadvantages: Collection of adult salmon and steelhead with gill nets can be labor-intensive, especially during initial efforts. Gill nets must be attended to remove fish immediately upon capture to minimize injury and mortality. Gill nets can be injurious or fatal to fish, even if fish are immediately removed from the nets (Table 5). Thompson and Hunter (1973) reported the mortality of sockeye salmon that became enmeshed and then disentangled from gill nets was about 55-65% when compared to a control group. About half of this mortality occurred on the first day. In this experiment, fish were exposed to gill nets overnight, therefore it was not known how long the fish were actually tangled in the net. In several Oregon tagging studies, salmon and steelhead that had been injured or stressed from gillnetting and handling were recovered at a lower rate than netted fish that had been uninjured, but the difference was not significant (Morgan and Cleaver 1954a, 1954b; Henry 1964). However, seriously injured fish were not always tagged and some mortality occurred in the nets. Korn (1961) reported that a disadvantage of gill nets was because fish became tangled and suffered damage to fins and gills as well as loss of scales. Stress in salmon or steelhead caught in gill nets has not been evaluated, but Hopkins and Cech (1992) reported that striped bass caught in gill nets exhibited a greater stress response than those caught in hoop traps.

Gill nets are selective for size and sex of fish, thus sampling may be biased depending on the target species and on the size range of the run (Hamley 1975). Although gill nets can be used low in a river system, unacceptable rates of injury and mortality may occur if the fish are not adequately acclimated to fresh water (Baranski 1980).

Gill nets may not be very effective in large rivers that flood frequently because of the difficulty in fishing nets during high flows and the difficulty in finding adequate areas to net. Baranski (1980) reported that driftnetting was not effective in a large, broad river that did not have well-defined slots, runs, and holes. Gill nets may not be effective where run timing is extended over several months, where run size is relatively small, or where fish do not congregate in any discernible areas of the river. Use of gill nets to capture fish may also lead to public relations problems, especially if fish are killed or perceptibly injured upon release.

Seine

Description: A seine is a vertical net that is pulled through the water to encircle and capture adult fish. Seines used in rivers are called beach, drag, or haul seines. These seines are used where fish congregate in numbers that are high enough to meet the objectives of capturing fish, such as collection of brood stock or tagging for escapement estimates. The best sites for seining are holding pools with a relatively smooth bottom that is free of debris, with current slow enough to not collapse the bag or lift the lead line, and with a shallow riffle downstream of the hole to confine the fish.

The characteristics of a proper seine depend on the target species and on the physical nature of the sample site. A seine must have enough weight to keep the lead line on the bottom and enough buoyancy to keep the float line on the water surface when it is pulled at the maximum force. However, a seine

that is weighted too heavily will be hard to pull through the water and will hang up if the bottom is irregular. The seine should be about one-third longer than the width of the seining area and about one-third deeper than the deepest part of the hole. The extra length and depth assures that the seine is loose as it is pulled through the water and that a good bag is formed. A beach seine is hung with varying degrees of looseness to obtain a bag, with the wings stretched more along the float and lead lines than the center so the center pouches when the seine is fished (Garner 1968). Proper mesh size is important because mesh that is too small is harder to pull through the water, thus increasing the opportunity for fish to escape.

A 300-ft. seine used to capture adult salmon and steelhead on the Rogue River in Oregon varied from a 2-in stretched mesh in the bag to a 5-in stretched mesh on the wings (ODFW 1991). The depth of this seine also varied from 18 ft in the bag to 9 ft on the outside edge of the wing panel (ODFW 1991). The seine was coated with a black net tar to decrease wear, to reduce water absorption of the net, and to reduce injury to fish by making the net surface smoother. Some net manufacturers are listed in APPENDIX B.

Seining encircles fish, leading them along the sides or wings and into the center of the seine as the net is bagged. Seines are laid out from the upstream end of the sample site, usually with a boat. The net is first laid out perpendicular to the bank and is then swept downstream to form a crescent, with the opening downstream. After the net is brought to shore, both ends are brought together and the net is drawn in until the lead line is on the shore. Fish move along the sides of the seine and into the center bag as the net is brought onto shore. The seine must be brought in quickly enough to maintain a bag, but not so fast as to the lift lead line off the bottom.

A variation of seining that also combines properties of electrofishing is the electric seine. Electric seines have been used principally in eastern and midwestern United States (Bayley et al. 1989; Angermeier et al. 1991). These seines have been used on relatively small streams for species composition or population densities of fish assemblages (Bayley et al. 1989; Angermeier et al. 1991). No reports were found on the use of electric seines to capture adult salmon or steelhead.

Areas of use: The principal areas where seines have been used recently in Oregon to capture adult salmon and steelhead are in the Rogue River (ODFW 1991; ODFW 1992; ODFW 1994) and in the Chetco River. Seining was previously used to capture steelhead in the Deschutes River (Fessler 1971) and in the Rogue River (Everest 1973). Seining has also been used to capture adult salmon and steelhead in British Columbia (Ward 1959; Vernon et al. 1964) and in Alaska (Jones 1981; Wallis and Balland 1981; Bentz 1984).

Native Americans used a type of seine to capture adult salmon in the Columbia River below Celilo Falls (Craig and Hacker 1940). Commercial seining for salmon and steelhead occurred historically on the Columbia River, where teams of horses were often used to land the seines (Johnson et al. 1948; Donaldson and Cramer 1971).

Effectiveness: The effectiveness of seining depends on stream and site characteristics, proper mesh size and hang of the net, skill in setting and retrieving the seine, and abundance and run timing of the target species. Seines work best when fish can see the net and are led along the wings into the bag. Consequently, seines are most effective when the water is fairly clear (Johnson et al. 1948). Seining efficiency for coho salmon in the Rogue River was negatively related to flow above 1,700 cfs (ODFW 1991). Catch of adult salmon and steelhead in several rivers of the Pacific Northwest is given in Table 7.

Based on a comparison of commercial seine catch in the Columbia River to gill net catch, seines appeared to be most effective in capturing steelhead (accounting for 40% of the combined gill net and seine catch), moderately effective for chinook, coho, and sockeye salmon (accounting for about 20% of the catch), and least effective for chum salmon (accounting for 7% of the catch; Johnson et al. 1948). The efficiency of seine catches in the Columbia varied because of changes in migration routes of fish and changes in physical characteristics of seine sites (Johnson et al. 1948). The efficiency of seining was also least effective during spring because of high flows. Therefore, seining was less effective for spring chinook and sockeye salmon than for fish migrating in summer and fall (Johnson et al. 1948).

Table 7. Capture of salmon and steelhead with beach seines for brood stock or tagging in the Pacific Northwest.

| River ^a | Years | Species ^b | Catch | | Catch/ set |
|--------------------|------------|----------------------|--------------------|----------------------|------------------|
| | | | Number | Percent ^c | |
| Fraser | 1957 | PS | 12,910 | 0.5 | 52 |
| Fraser | 1959 | PS | 10,356 | 1.0 | -- |
| Glendale | 1961 | PS | 1,856 | 1.1 | -- |
| Rogue | 1969-70 | StS | 8,810 ^d | 5.3 ^d | 4.4 ^d |
| Rogue | 1976-91 | Co | 120 ^d | 2.9 | 0.4 |
| Rogue | 1976-91 | ChF | 963 ^d | 2.2 ^d | 1.4 |
| Rogue | 1976-91 | StS | 420 | 2.2 | 0.7 |
| Deschutes | 1969-70 | StS | 103 | -- | 0.3 |
| Chetco | late 1980s | ChF | -- | -- | 30-200 |

^a References by river: Fraser 1957 - Ward (1959); Fraser 1959 and Glendale - Vernon et al. (1964); Rogue 1969-70 - Everest (1973); Rogue 1976-91 (coho) - ODFW (1991), Satterthwaite (1992); Rogue 1976-91 (chinook) - ODFW (1992), Satterthwaite (1992); Rogue 1976-91 (steelhead) - data from Tom Satterthwaite, ODFW, Grants Pass; Deschutes - Fessler (1971); Chetco - personal communication, Timothy Unterwegner, ODFW, Gold Beach (now at John Day).

^b Species codes: ChF = fall chinook salmon; Co = coho salmon; PS = pink salmon; StS = summer steelhead.

^c Catch as a percentage of the estimated population.

^d Estimated from data in the report.

Advantages: Adult salmon and steelhead can be seined below spawning tributaries, therefore the entire run can be representatively sampled if seining is conducted throughout the migration. Seining effectively captures fish for brood stock or for tagging if good sampling areas are available. Information on life history, run timing, length, age, harvest, abundance, and escapement can also be obtained. Cousens et al. (1982) reported that beach seines have minimal selectivity for size or sex of fish. However, factors such as size distribution of the species and variability in flow at the seining site might increase size selectivity. Seining does not obstruct the river channel and can be conducted on large river systems. Seining may provide an alternative means of capture where construction of traps or electrofishing is unacceptable. Under the right conditions, the cost of seining can be relatively low, especially when compared to other methods.

Disadvantages: Seining can be labor-intensive, particularly when conducted over the span of the run or during initial efforts. However, use of volunteers has reduced the cost of collecting chinook salmon brood stock in the Chetco River (T. Unterwegner, ODFW, Gold Beach, now John Day, 1993, personal communication). Variable environmental conditions, including flow and physical characteristics of a seine site, can alter the effectiveness of capturing fish (Johnson et al. 1948; ODFW 1991; Satterthwaite 1992). Seining can be selective for segments of a run if seining efficiency varies with flow. For example, adult chinook salmon congregate at a seining site on the Chetco River only until the first major freshet (T. Unterwegner, ODFW, Gold Beach, now John Day, 1993, personal communication).

The effectiveness of seines depends on river characteristics and run size of the target species. Seines may not be effective in large rivers that flood frequently because of difficulty in seining during high flows and because of inadequate areas to seine. Seining may not be effective where run timing is extended over several months, where run size is relatively small, or where fish do not congregate in any discernible areas of the river. Use of seines to capture fish may also lead to conflicts with anglers.

Angling¹

Description: Angling with conventional sport fishing gear to capture adult salmonids has been extensively used in British Columbia to collect steelhead for brood stock. Most of these programs require less than 50 fish. Use of professional guides generally provides the best results and fishery agencies occasionally contract with a few guides to collect a specified number of fish. Other volunteer anglers also assist in collecting fish. When contracted guides are used, they work directly with hatchery personnel after fish have been caught, thus minimizing the time biologists spend on the collection program. Most of the sites in British Columbia are accessible by boat or road, although some are reached by helicopter.

¹ Unless otherwise cited, information on angling is from personal communications, June 1993 with Rick Axford (Nanaimo) and Robert Hooton (Smithers), Ministry of Environment and Parks, British Columbia.

After fish are caught, they are temporarily held in the river or are put directly into a transport tanker. Fish held in the river are placed in a holding tube or holding pen. Holding tubes can be made of soft material or PVC pipe. Zippered, collapsible tubes made of soft material have been used for steelhead in British Columbia. A stainless steel ring and knotless netting is sewn into each end to maintain the shape of the tube and to ensure a good flow of water. The zipper runs lengthwise to provide easy access. These tubes have been made by project personnel or are available commercially (see APPENDIX B). Tubes of PVC pipe (Figure 17) have also been used to hold and transport fish in Oregon (Kenaston et al. 1990), Washington (Mongillo 1984), and British Columbia (Mongillo 1984; Senn et al. 1984). The length and width of the tubes varies according to the size of the fish. A 6-in diameter x 40-in long tube was used to hold adult winter steelhead on the Siuslaw River in Oregon (Kenaston et al. 1990). Squares of clear acrylic were used as gates on the ends of the tube, and were drilled with several 1-in diameter holes to allow water to flow through the tubes. One gate was removed to place fish in the tubes. Captured fish have also been tethered by passing a cord along the inside of the operculum, through the mouth, and tied to the lower jaw (Baranski 1980; Senn et al. 1984). The tethers are made of braided nylon line and have a section of rubber spliced in the center to allow play in the line (Baranski 1980). Fish are tied in quiet water to an overhanging branch.

Fish can be held in a hatchery trough in bundled tubes (Senn et al. 1984) or they can be held in individual tubes suspended from a floating rack (Figure 17; Kenaston et al. 1990). Fish can also be held in net pens, which are floated to a spot where fish are loaded in a tanker (Senn et al. 1984).

Areas of use: The most extensive use of angling to capture steelhead has been in British Columbia. In addition to brood stock collection, steelhead have also been captured for tagging by using conventional angling gear (Caverhill 1977; Hooton and Lirette 1986). Angling for brood stock has been recently used in Oregon on the Necanicum River and on the Walla Walla River to collect steelhead. Angling was also tried briefly in the Hood and Siuslaw rivers to collect steelhead, but was dropped because of high mortality and because more efficient means were available. Angling for brood stock has also been used in Washington (Mongillo 1984). Angling has been used in Alaska to tag steelhead (Jones 1981; Wallis and Balland 1981; Begich 1992) and coho salmon (Bentz 1984), and in Idaho to tag steelhead (Thurrow 1987).

Effectiveness: The effort required to capture fish by angling varies with fishing conditions, such as flow and turbidity. Flow affected the catch of steelhead and chinook salmon in the Rogue River (Cramer et al. 1985; ODFW 1990; ODFW 1992), winter steelhead in the Applegate River (Fustish et al. 1989), and winter steelhead in the Grays River, Washington (Wendler et al. 1956). When fishing conditions are good, some guides in British Columbia have been able to fish a single day each week for a few weeks to capture enough fish for brood stock. To collect 40 adult steelhead in the Cowichan River, British Columbia, a two-person crew spent 150 hours angling, plus 53 hours in travel and 8 hours in transport of fish. Capture of 40 fish in the Nanaimo River, British Columbia, required 140 hours of angling and 13 hours of travel for two people. A brood stock collection in British Columbia that required a helicopter took four people two days to catch 20 steelhead.

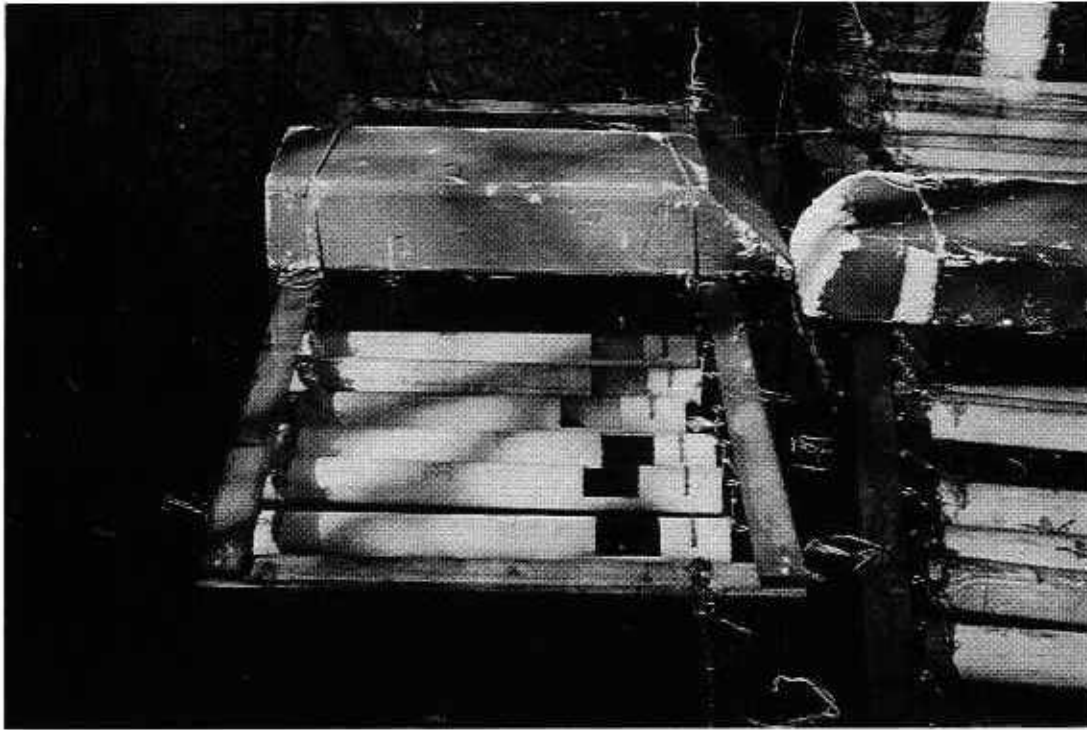


Figure 17. PVC tubes to hold adult steelhead for brood stock in the Siuslaw River, Oregon. Tubes are suspended from a wooden frame in a holding pond.

In addition to flow, the effectiveness of angling gear in capturing adult salmonids is influenced by the abundance of fish. Catch of adult salmonids and angler success increased with increased abundance for spring chinook and summer steelhead on the Rogue River (Cramer et al. 1985), for winter steelhead on the Rogue River (ODFW 1990), and for spring and fall chinook on the Deschutes River (Jonasson and Lindsay 1988; Lindsay et al. 1989a). Shardlow (1993) also reported that catchability of salmon increased with increased abundance. However, others have reported that the catchability of fish decreased as abundance increased (Peterman and Steer 1981; ODFW 1992).

On some rivers in British Columbia more effort was required to capture wild steelhead for brood stock after a hatchery run was established. Success in catching wild steelhead decreased because they represented a small percentage of the run. The catch of wild steelhead for two anglers was just one fish for every two days of angling on some rivers with large hatchery runs.

Effectiveness of angling to capture adult salmonids must consider injury and mortality. Hooking mortality of steelhead captured in British Columbia has been 3-5%, and sometimes no fish are lost even when they are held for several months before spawning. Hooton (1987) reported that mortality was under 4% for over 3,700 steelhead caught and held for brood stock. In another detailed study of hooking mortality on the Keogh River, the mortality for combined types of terminal gear was 5% (Hooton 1987). The survival through spawning of steelhead that were caught and released was 5% lower than that of steelhead captured at a weir (Hooton 1987). The holding mortality of summer

steelhead caught in the Coquihalla River, British Columbia, and held for up to five months averaged 1% (Caverhill 1977). Mortality of chinook salmon caught and released in the Kenai River, Alaska, ranged from 4% to 11% over three years, with small males having the highest mortality compared to large males and all females (Bendock and Alexandersdottir 1993).

In a review of hooking mortality studies on salmonids, Mongillo (1984) found that mortality of wild salmonids hooked with artificial lures was under 10%, and that wild fish had a higher rate of mortality than hatchery fish. Taylor and White (1992) reported that the overall hooking mortality in 18 reviewed studies was about 12%, and decreased to under 3% with use of barbless flies or lures. Mortality of steelhead caught with angling gear and tethered before transport was higher than for steelhead that were caught and placed in tubes (Mongillo 1984). Reingold (1975) found that hooked and released steelhead returned to a hatchery site in numbers roughly equal to a control group. Pettit (1977) reported that the reproductive success of caught and released steelhead was similar to a control group.

The above data indicate a relatively low mortality of fish caught and released by anglers, however mortality may be a problem in some areas. Although the sample size was small ($n=9$), the holding mortality of winter steelhead caught by anglers in the Siuslaw River was almost 70%, and was much higher than a small sample of fish ($n=5$) collected by electrofishing (0%) or a large sample of fish ($n=73$) collected in traps (8%; Kenaston et al. 1990). The angler-caught fish died after an average of 17 days. The holding mortality of winter steelhead caught by anglers in the Hood River was over 70% ($n=18$) and occurred from five days to several weeks after capture, although poor water quality of the holding pond may have affected survival (S. Pribyl, ODFW, The Dalles, 1993, personal communication).

When fish are injured from angling, most mortality appears to occur within 1-6 days. Most mortalities of chinook salmon caught and released in the Kenai River, Alaska, occurred within 72 hours (Bendock and Alexandersdottir 1993). Mortalities of hatchery rainbow trout played to exhaustion and released occurred within 2-6 days and increased with increasing water temperature (Dotson 1982). Fish that are exhausted or less seriously injured may die in a week to 10 days (Mongillo 1984). Ferguson and Tufts (1992) reported that exposure to air presented an additional stress to exhausted rainbow trout and led to increased mortality after 12 hours, when compared to a control group or to fish that were exhausted, but not exposed to air. Taylor and White (1992) examined several studies on hooking mortality and reported no significant relationship between mortality and water temperature, but a significant relationship between mortality and average size of the fish (the longer the fish, the higher the mortality), although data on fish size was limited. Most studies on hooking mortality of salmonids with conventional angling gear have been conducted on fish smaller than adult salmon and steelhead (for reviews see Wydoski 1977; Mongillo 1984; Taylor and White 1992).

Little data have been reported on selectivity of conventional angling gear as a capture technique for adult salmonids. The mean length of adult steelhead captured in the Siuslaw River was similar among three methods of capture, although some of the sample sizes were small (Table 5). Warner and Johnson (1978) reported that land-locked Atlantic salmon caught by angling

were somewhat smaller than fish caught in a fishway trap. Warner (1978) reported no significant difference in lengths of Atlantic salmon between those caught by angling and those caught by trap nets. Schroeder and Smith (1989) found the mean length and length distribution of rainbow trout ≥ 31.0 cm was not significantly different between captures by angling and electrofishing. However, Favro et al. (1986) reported that more brown trout over 33 cm and more rainbow trout over 25 cm were caught by angling than by electrofishing.

Selectivity of angling gear depends on the range and the variability of fish size in the target population. Selectivity may be reduced when sampling adult anadromous fish because even small fish are relatively large. Some of the largest individuals in a population may not be representatively sampled by angling because of difficulty in landing these fish. Size-selectivity of fishing gear has been reported by Leclerc and Power (1980), Ralston (1990), and Kenchington (1993). However, others found no selectivity of fishing gear (Pope et al. 1975; Ralston 1982).

Advantages: Conventional angling gear can be used low in a river system, thus sampling a representative portion of the run. In some cases, a small amount of effort over a short period of time may be sufficient to capture adults. Use of volunteers, guides, or contracted individuals can reduce the amount of time and expense that agency personnel must spend on brood stock collection programs. If fish are handled properly and catch rate is sufficiently high, angling is a good method of collecting fish for small brood stock programs. Involvement of the public can increase the awareness of an agency's goals and provide opportunities for good public relations.

Disadvantages: Angling for brood stock has been used mainly to capture steelhead for small brood stock programs. Most brood stock programs that rely on angling to capture steelhead are conducted over a relatively short period of time. Effort would increase if fish were captured over the course of a run to representatively sample the population. Supervision and reliability of volunteers could pose a problem in some cases. Although most studies report low rates of injury and mortality caused by angling, these could be a problem in some cases and should be monitored. The effort required to collect wild fish may increase if they represent a small percentage of the run or if fishing pressure is high and wild fish are caught and released by anglers before they are collected for brood stock. Success of angling is highly dependent on water conditions and on the size of the run. Angling can be selective for fish size, run timing, and sex and should be evaluated before this technique is chosen.

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APPENDIX A

Detailed Information on Some Capture Techniques

Vertical Picket Weir

Tripods are the most common support for vertical picket weirs. The single leg of the tripod is angled upstream from the pivot point. This leg can be wood, such as 4 x 4 in lumber, square steel tubing, or a metal pipe (Anderson and McDonald 1978). The horizontal railings of the weir are attached to this single leg. The two rear or downstream legs connect to the top of the front leg such that the legs can be collapsed or removed for easier transport. The legs can be constructed of wood, and can be a single piece or two pieces to allow better adjustment to the stream bottom (Anderson and McDonald 1978). Usually wood stringers are attached between the three legs of the tripod to provide stability.

Adjustable rear legs were used on tripods of a vertical picket weir to trap steelhead in the Siuslaw River basin. The legs were constructed of two sizes of drilled square steel tubing with the shorter, smaller tubing fitted inside the larger (stationary) tubing. The legs were pinned in place with a bolt after they were adjusted to the stream bottom (Appendix Figure A-1). The upper sections of both legs were welded at the top onto a short piece of angle iron. The front leg of the tripod was 4 x 4 in lumber, 8 ft long, which rested on the angle iron and was held in place by a lag screw (Appendix Figure A-1). A metal strap was welded between the two legs to provide additional stability. Tripods have been further modified by using 2 x 2 in metal tubing for the front leg and welding the rear legs directly to the front leg (Appendix Figure A-2).

Several means have been used to secure the weir supports and prevent downstream movement. Cables can be attached to the weir at each tripod and attached to large trees on the bank. Chain or cable wrapped around each tripod can also be attached to hooks or anchors set in the substrate upstream of the weir. The latter method reduces debris buildup on the cables and provides attachment points that are directly upstream of the weir. Platforms can be constructed between the tripod legs on which rocks or sandbags are piled to provide counterweight to the force of floodwater (Anderson and McDonald 1978). Boulders or sandbags can also be placed against the rear legs to keep them from sliding. The leg supports may be attached to an apron, although an apron is not constructed with most vertical picket weirs. Where bedrock is present, timbers (e.g., 4 x 6 in) can be pinned to the stream bottom by drilling into bedrock, setting a threaded rod with special glue (e.g., Hilti glue), and bolting the timber to the stream bottom to form an attachment sill. The single, upstream leg of each tripod support is attached to the sill with a bracket and lag bolt, which provides an anchor for the weir.

Railings are attached to the upstream leg of the tripod and are drilled or punched to accept metal bars or tubing. Railings are attached to the tripod with lag bolts (for wood legs) or with U-bolts (for metal legs);

Anderson and McDonald 1978). Railings can be angle iron, channel iron, or channel aluminum (Schmidt 1984). The holes should be oversized to allow pickets to be inserted and removed with ease. Railings should be as level and as parallel as possible to make installation of the pickets easier (Appendix Figure A-3). The number of railings used in the vertical plane depends on the length and the flexibility of the pickets. The bottom railing should be relatively close to the stream bottom (e.g., 6-12 in) to minimize the side-to-side play of individual pickets, thereby minimizing the chance that an adult salmon or steelhead can push through the pickets. Additional railings are spaced above the bottom railing such that the pickets cannot be easily spread by the force of water or by fish trying to squeeze through the weir. For example, Schmidt (1984) reported that some adult coho were gilled in a picket weir at high water because fish were jumping at the midpoint between two railings where the pickets had enough play to be spread apart by the fish.

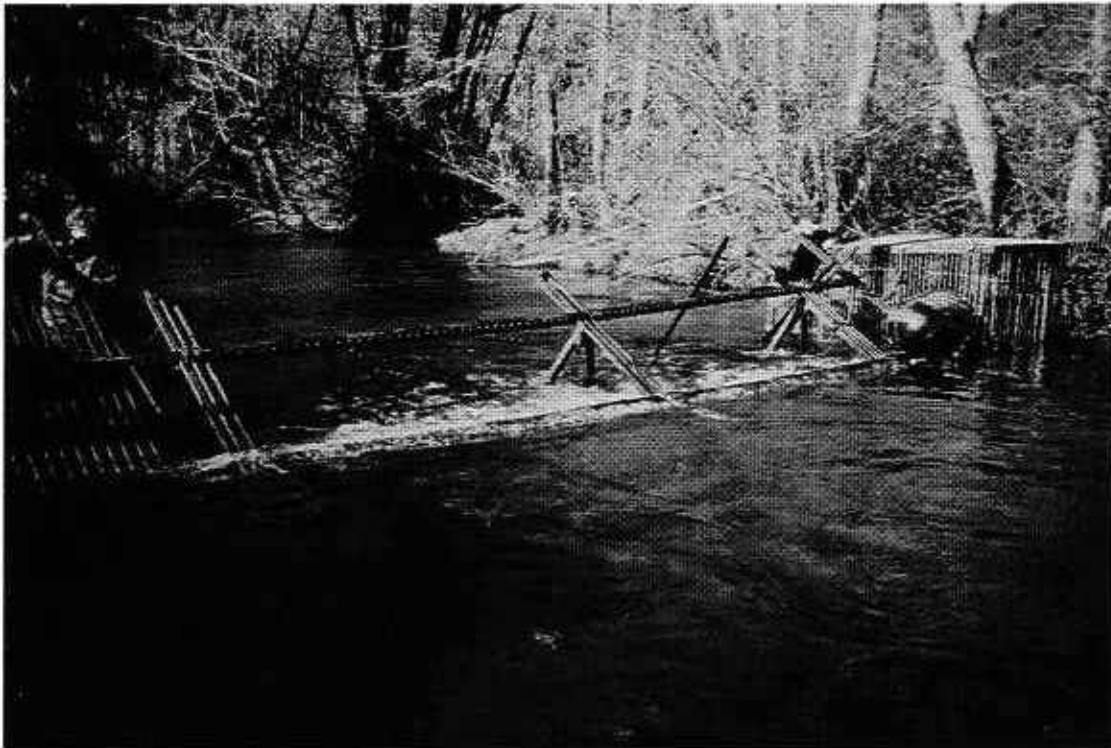
After railings are attached to weir supports and cables are attached, pickets are inserted through the holes in the railings. Care should be taken to ensure the pickets are on the bottom and that no pickets have been bent at the bottom. Wire mesh fencing or similar material may be needed to seal the area between the end of the weir and the shore.



Appendix Figure A-1. Metal tripod with adjustable rear legs and wood front leg used with vertical picket weirs in the Siuslaw River, Oregon, 1993.



Appendix Figure A-2. Metal tripod with adjustable rear legs and metal front leg used with vertical picket weirs in the Siuslaw River, Oregon, 1995.



Appendix Figure A-3. Vertical picket weir on Nelson Creek, Oregon, with punched channel iron rails and metal tripods, 1995.

Panel Weir

Supports for panel weirs can be vertical, such as pipe (Hill and Matter 1991) or fence posts driven into the substrate at each end of the panel. Supports can also be sloped downstream such as tripods or A-frames. These sloped support structures can be wooden tripods (Summer 1953), steel tripods (Nelson 1976), freestanding wooden A-frames joined by stringers (Kerswill 1971), or wooden A-frames attached to an apron platform (Clay 1995; see also Hunter 1954; Craddock 1958).

Panel frames can be wood or angle iron, and pickets for weir panels have been constructed of steel pipe, steel rod (Kerswill 1971; Clay 1995), aluminum tubing (Nelson 1976); electrical metal conduit (Hill and Matter 1991), wooden dowels (Senn et al. 1984), or wooden slats (Hunter 1954; Clay 1995). Pickets are usually attached to the panel frame (welded or nailed). Hill and Matter (1991) described a panel design in which pickets made of tubing were slid into holes in the wooden panel frames after the frames were installed in the stream.

A panel weir used to trap adult steelhead in the Siuslaw River, Oregon, was constructed of 1 x 1 in angle iron frames with pickets of 3/4-in diameter metal pipe flattened on the ends and welded horizontally to the inside of the frame (Appendix Figure A-4). Two metal straps were welded vertically on the outside of the frame and the pickets to reduce play in the pickets (Appendix Figure A-4). The panels measured 3.5 x 6 ft.

Individual panel frames can be held together by cables (Hill and Matter 1991), attached directly to the supports (Hunter 1954), or attached to stringers that run between the supports (Kerswill 1971; Nelson 1976; Clay 1995). Individual panels of the weir used on the Siuslaw were joined by welding two offset sections of tubing (3 in) on each end of the panel (Appendix Figure A-4). When the panels were abutted, a rebar pin was passed through the offset tubing to hold the panels together. Weir panels were attached to the trap in a similar manner.

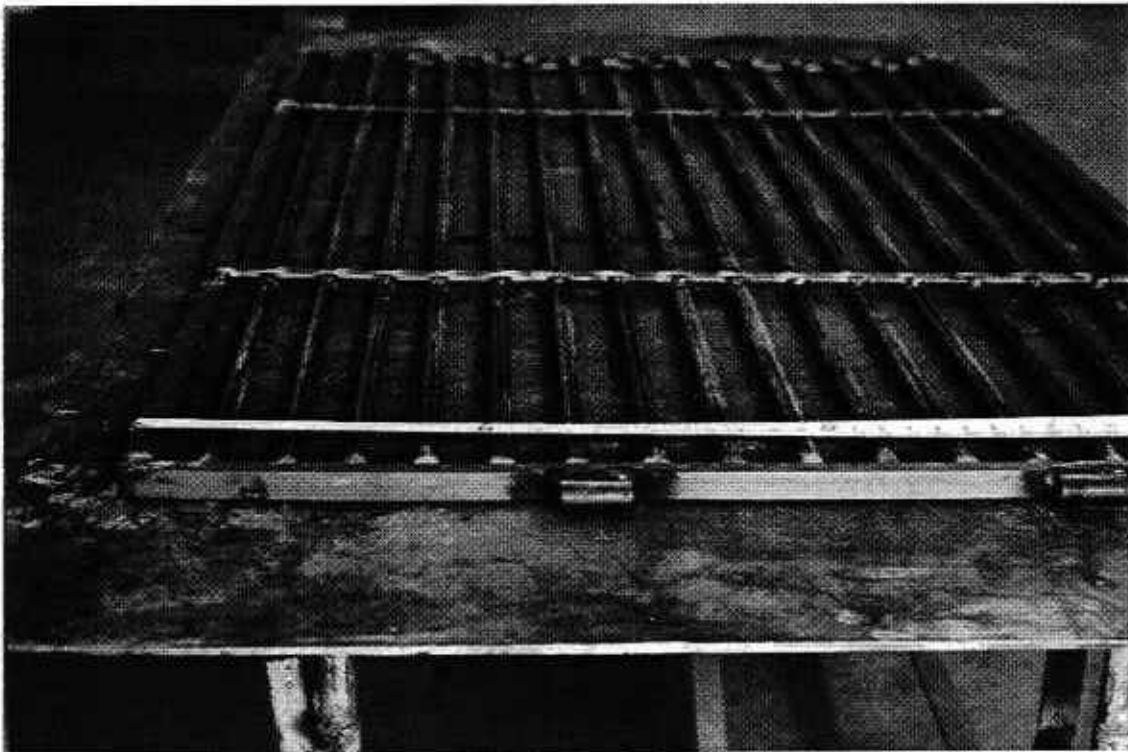
Clay (1995) described a trapping method that combined features of a panel weir and a horizontal weir. Vertically oriented panels constructed of steel bars were supported by concrete piers and steel beams between the piers. In addition, horizontal panels extended from the top of the vertical panels and sloped slightly downward in a downstream direction. These horizontal panels prevented fish from jumping over the vertical panels as the water approached the top. When water crested the vertical panels, much of the debris was swept off the horizontal panels. This design resulted in less cleaning than if taller vertical panels had been used.

Horizontal Picket Weir

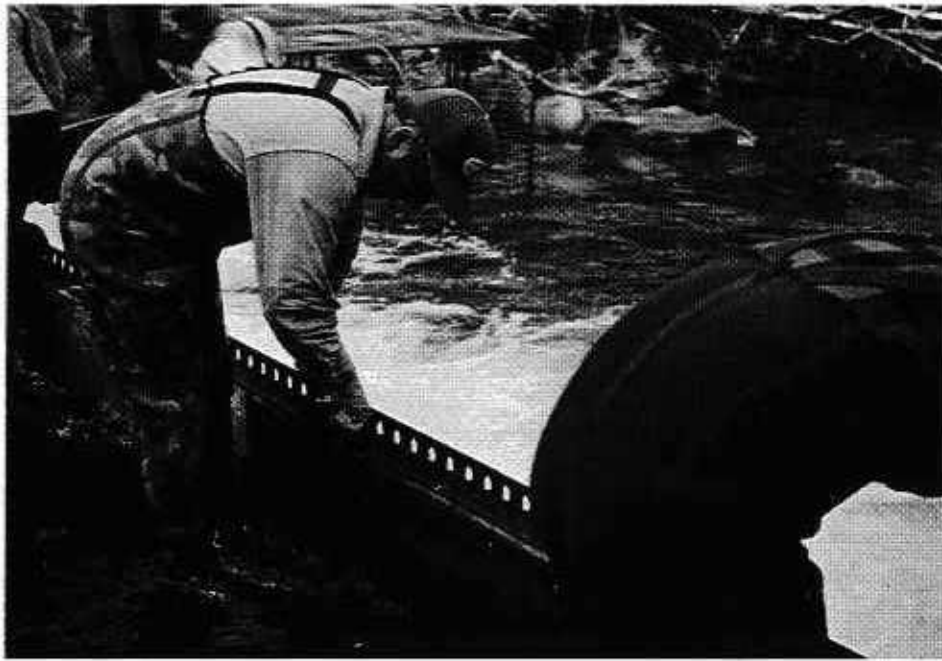
A horizontal picket weir used on the Siuslaw River was constructed of two punched rails, metal pickets, and supports for the downstream rail. The upstream rail of the weir was bolted to stoplogs that were installed on a concrete sill (Appendix Figure A-5). The downstream rail was initially suspended horizontally above the stream by cables. The weir was later supported by several monopods bolted to the underside of the downstream rail. The monopods were adjustable and were similar in construction to the

adjustable rear legs of tripods used for vertical picket weirs (see **Vertical Picket Weir**). Advantages of the monopods over cable were that debris was more readily swept off the weir rather than caught in cables and the monopods were easier to install than cables. Steel pipe was slid through holes in the railings to form a barrier. The pipes were flattened on the upstream end to prevent them from sliding through the upstream railing.

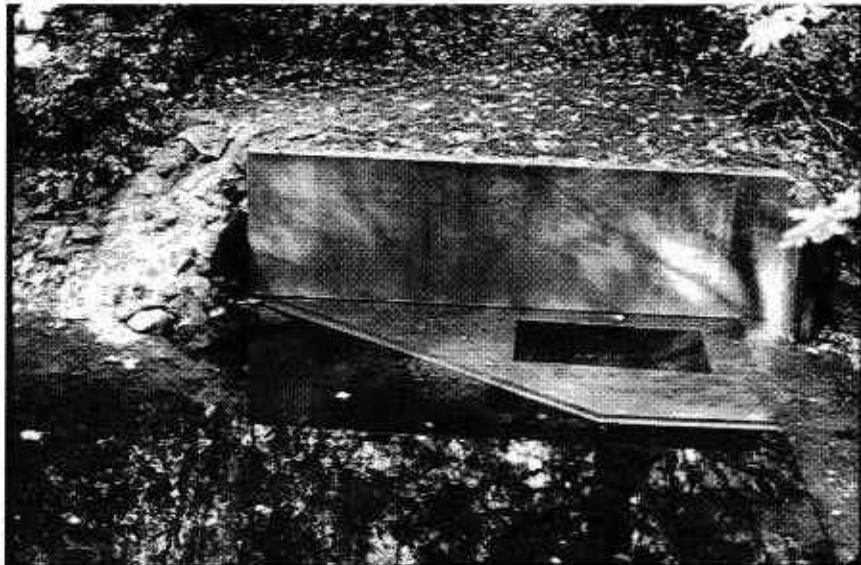
Several modifications have been made to the horizontal weir since 1991. The overall length of the weir was shortened from 20 ft to 7 ft, the railings were changed from angle iron to channel iron, and the trap was moved to the upstream side of the sill. With the help of volunteers, a concrete platform and retaining wall was constructed on the upstream side of the sill to serve as the floor and one side of the trap (Appendix Figure A-6). A trap of steel panels was constructed and held in place by horizontal braces attached to the top of the panels and to the concrete retaining wall (Appendix Figure A-7). The downstream set of panels included a V-shaped fyke in the middle. The panels set into a preformed channel in the concrete floor (Appendix Figure A-6). A locking lid of 3/4-in plywood covered the trap.



Appendix Figure A-4. Detail of panel for panel weir showing welded sections of tubing used to attach panels together.



Appendix Figure A-5. Horizontal picket weir on Whittaker Creek (Siuslaw River), Oregon, showing attachment of upstream railing to stoplogs on top of the concrete sill, 1990.



Appendix Figure A-6. Concrete pad and retaining wall for floor and side wall of adult steelhead trap on Whittaker Creek, Oregon, 1992. Note deeper section in floor to retain more water in low flow and channel along outside edge of floor for setting picket wall panels (see Appendix Figure A-7).



Appendix Figure A-7. Adult steelhead trap on Whittaker Creek, Oregon, with picket wall panels and metal framing for wall support and plywood lid, 1992.

Traps

A common design of a trap used in conjunction with a picket weir is a square or rectangular box cage with a V-shaped fyke leading into the trap. These traps can be constructed of wood (Craddock 1958; Mullins et al. 1991; Clay 1995), wood frame and wire mesh (Anderson and McDonald 1978), wood frame and steel rod (Kerswill 1971), or metal (Whelan et al. 1989). The walls of the trap are usually constructed of prefabricated panels. Trap designs can be found in Craddock (1958), Anderson and McDonald (1978), Whelan et al. 1989), Mullins et al. (1991), and Clay (1995). A lead from the sloped vertical picket or panel weir to the trap can be constructed of wire mesh screen (Craddock 1958; Anderson and McDonald 1978), fencing material, or material similar to the weir pickets (Clay 1995). The floor of the trap can be constructed of boards (Kerswill 1971), wood laths (Anderson and McDonald 1978), steel grating (Whelan et al. 1989), or wood straps (Mullins et al. 1991). Unless the weirs have persons on site, a locking lid is usually installed on the trap to prevent poaching of adult fish.

Traps for vertical picket weirs in Alaska are often 8 x 8 ft enclosures constructed of railings and pickets that extend upstream from the vertical picket weir (Schmidt 1984). The stream bottom acts as the floor of the trap and the trap has no lid. In areas where the stream substrate is erosive, erosion cloth (Mirafi brand) is used as a floor (F. Burgander, ADFG, Commercial Fisheries Division, Juneau, 1993, personal communication). A triangular lead of 2 x 6 in framing covered with wire mesh is attached to the tripod and the downstream corner of the trap. In streams with fast water velocity, a few pickets are removed to create the opening into the trap, but where water velocity is slow, a V-shape fyke is constructed (F. Burgander, ADFG, Commercial Fisheries Division, Juneau, 1993, personal communication).

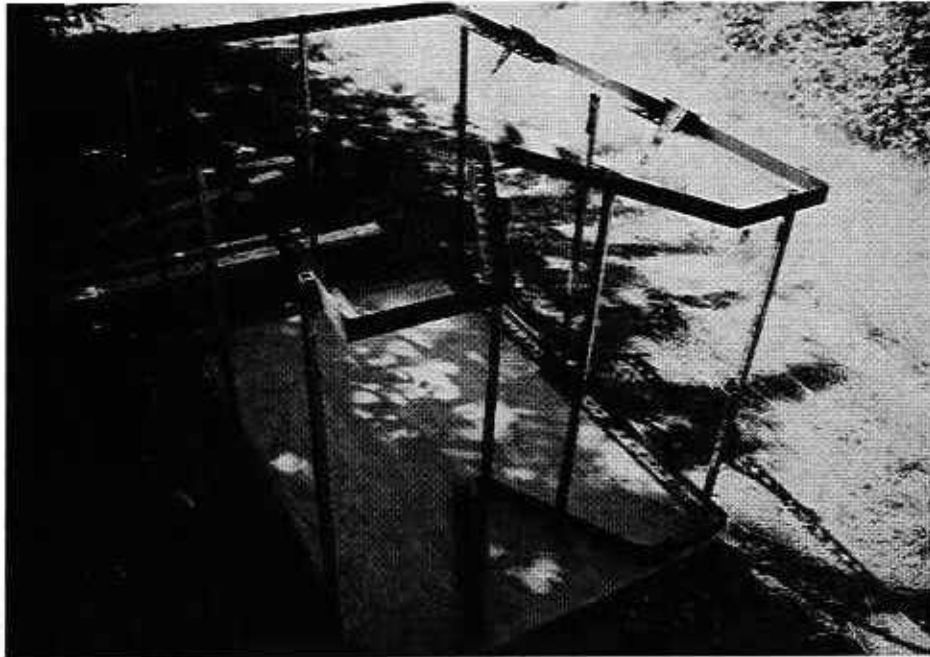
A metal trap with interlocking panels was used in conjunction with both vertical picket and panel weirs to capture adult winter steelhead in the Siuslaw River basin. Angle iron (1 x 1 in) was bent and welded to form 6 x 3 ft wall frames and a 6 x 6 ft floor frame. The floor can be either solid, such as plywood bolted to the angle iron framing, or picketed similar to the walls. The walls were the same construction as weir panels with tubing flattened on the end and welded horizontally to the angle iron frame (Appendix Figure A-4). Four short sections (3 in) of metal tubing were welded to the outside of the floor frame on the upstream and downstream sides (two per side), and to the outside framing of the side walls (Appendix Figure A-4).

Eight-inch pieces of steel rod were bent into U-shapes and one arm of the "U" was welded to the bottom and to the sides of the upstream and downstream wall frames (six per frame). The free arm of the "U" hooks welded on the sides of the frames pointed upward. These "U" hooks were welded so they lined up with the tubing on the floor frame and the side walls. Installation in the stream first required finding a fairly level area for the floor. The upstream and downstream walls were then attached to the floor by inserting the free arm of the "U" hooks on bottom of the walls into the corresponding tubing on the floor frame. Then the side walls (with tubing welded on the outside framing) were slid onto the free arms of the "U" hooks on the outside framing of the upstream and downstream walls. The walls were secured to each other with hose clamps and a hinged lid was bolted to the top of the side walls and the upstream wall.

A second design used to trap adult winter steelhead in the Siuslaw River was constructed of two 1 x 1 in angle iron frames that were welded to 4-ft sections of 1-in square tubing to form the top and bottom frames of the trap (Appendix Figure A-8). Additional angle iron was welded halfway between the top and bottom frames on the sides and on the upstream side to provide strength. The angle iron was punched to accept 1-in metal tubing. The tubing was inserted through the angle iron after the trap had been placed and cabled in the stream (Appendix Figure A-3).

Floating or Resistant Board Weir

A commercially available floating weir is manufactured in Japan and sold in the United States through Mitsubishi International (see APPENDIX B). This weir is composed of individual panels that are about 3 ft wide and 12-16 ft long depending on the size of the stream (Appendix Figure A-9). The panels are composed of pickets made of hollow PVC pipes. The PVC pipe has a slick surface and has a bullet-like shape that efficiently passes water. The PVC pipes are connected to wood braces by steel straps. The steel straps, which maintain the spacing of the pickets, are attached with wood screws to the wood frame on the underside of the panel (Appendix Figure A-10).



Appendix Figure A-8. Trap frame for vertical picket weir used in the Siuslaw River, Oregon. Angle iron is punched to accept metal tubing pickets.



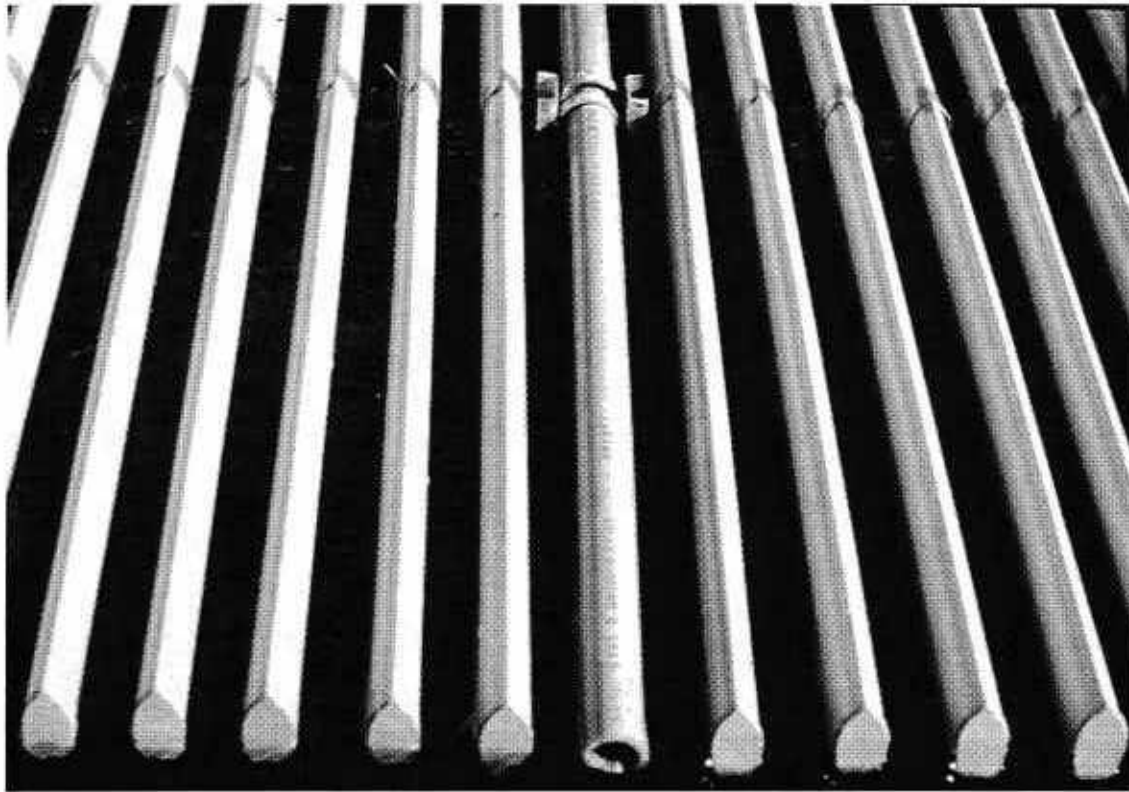
Appendix Figure A-9. Floating weir panel showing resistant board with extra flotation and attachment clamps (right side of photograph).



Appendix Figure A-10. Underside of a floating weir panel showing resistant board in the foreground (without extra flotation) and wood framing, Aberdeen Hatchery, Washington.

C-shaped shackles on the upstream end of the weir panels are used to attach the panels to a cable or to a sill (Appendix Figure A-9). Panels of a Washington Department of Fish and Wildlife weir are attached to the top of a submerged sill with a stainless steel rod that is pinned to the shackles. The rod is then inserted into C-shaped steel holders that are welded on the sill cap. The open ends of the C-shaped holders face upstream and the force of the water helps hold the steel rod in place. Other floating weirs are attached to a steel cable on the stream bottom or on top of a sill. Panels are attached to the cable by a C-shaped shackle or can be attached with a climbing carabiner clipped to the cable and to the shackle, which allows the weir to more easily pivot. In the latter case, rubber conveyor belt is used to seal between the end of the weir panel and the cable. Weir panels are connected to each other by inserting a round PVC pipe through offset rings on the side of the panels and securing it with set screws (Appendix Figure A-11).

A resistant board, which floats the panel, is attached near the top of the panel and is roughly 1 ft wide (Appendix Figures A-9 and A-10). The board is attached to the panel with hinges and then hooked in place with a wire extending back to the next lateral wood crosspiece. Water filters through the PVC pipes and pushes against the resistant board until the wire is taut. The angle of the resistant board to the weir is set by the length of the wire, and this angle plus the placement of the board along the length of the panel determines the range of flows at which the weir will float.



Appendix Figure A-11. Attachment of two floating weir panels with round PVC pipe inserted through offset rings and held by set screws.

A floating weir developed by Alaska Department of Fish and Game¹ is similar to the Japanese model, but uses round PVC pipe and flexible plastic strap to attach the pipe to the lateral wood braces. The panels measure 4 x 20 ft and the braces are 2 x 2 in. The upstream end of the panel is a steel plate attached to a 2 x 4 in brace. Pickets are Schedule 40, round PVC electrical conduit (1 in diameter), are filled with foam, and are capped on both ends. The pipes are spaced at 1.5 in for chinook salmon and are held in place by plastic straps that are attached to the lateral wood braces with hex-head screws. Panels are attached to each other in a manner similar to the Japanese model and a resistant board is attached toward the downstream end of the panel. The boards are generally set at 45° to the panel and are about 3 ft from the end of the panel. Weir panels are attached to a steel cable with hooks on the upstream end of the panels. Cable is strung through eye bolts welded on top of railroad rails or set on top of a concrete sill. Wire hardware cloth or sandbags on the upstream and downstream side of the railroad rail prevents scouring.

Traps used with floating weirs are generally off-channel and fish are diverted there by the floating weir. However, traps have been incorporated into the Alaska floating weir on the upstream side. A 6 x 6 x 4 ft steel trap is set about midstream and a weir panel is removed at this point. Two weir panels and heavy netting are attached on either side of the trap. These bridge the gap between the weir and the trap to prevent passage of fish. The trap is cabled to duckbill anchors set into the substrate.

¹ From personal communication, 23 July 1993, Larry Bartlet, ADFG, Palmer.

Electrofishing

Electrofishing relies on the reaction of fish to electrical power in water. Most electrofishing units use direct current that is supplied from a power source either directly or through a convertor built into a pulsator unit. Power from a generator or battery is routed through the pulsator, where pulse frequency, voltage, and pulse shape are adjusted. An electrical or power field is created in the water when electricity travels between the anode and the cathode. How much of the power is transferred to the fish depends on the conductivity of the water and of the fish (Whitney and Pierce 1975). Only when the two are equal will all the power be transferred into the fish.

Electrical power must first be transferred from electrodes into water, then from the water into fish (Kolz and Reynolds 1989; Kolz 1993). Electrofishing systems create electrical power in water through submerged electrodes. An electrical circuit is completed between a positive electrode (anode) and a negative electrode (cathode), although multiple electrodes are sometimes used (Novotny and Priegel 1974). The distribution and intensity of an electrical field in water is dependent on several factors including amount of electrical power; water conductivity; and size, shape, and spacing of electrodes (Novotny and Priegel 1974; Kolz 1993). Electrode design should consider the capacity of the power source, water conductivity, and working environment such as water current, water clarity, and maneuverability of the boat (Novotny and Priegel 1974; Kolz 1993). The design and placement of electrodes directly affect the shape, size, and distribution of electrical power in water (Kolz 1993). Electrodes with more surface area expose more metal to water, thus reducing the initial resistance and increasing the amount of voltage (and the electrical field) farther from the electrode (Kolz 1993). Aluminum boats can act as the cathode by grounding direct current electrofishing units to the boat. Because the surface area of the boat hull is large compared to that of the anode, little resistance will be associated with the cathode (Kolz 1993). Anode design should produce maximum current densities close to the surface of the water where fish will be attracted (Novotny and Priegel 1974), while maintaining voltage at a sufficient distance from the anode to extend the electrical field (Kolz 1993).

Conductivity of the water (or resistance) affects the efficiency of power transfer into the water and thus into fish (Whitney and Pierce 1957; Flux 1967; Kolz 1989). The conductivity of the water is affected by water temperature and the amount of electrolytes in the water (Novotny and Priegel 1974; Whitney and Pierce 1975; Novotny 1990). Kolz (1989) demonstrated that an increase in power could compensate for the inefficiency of power transfer into the water due to changes in conductivity. When resistance of water increases (i.e., conductivity is low), the efficiency of electrofishing gear decreases, as measured by the voltage gradient (V/cm) required to shock fish (Flux 1967). An increase in efficiency of the gear can be achieved by increasing the voltage output of the power source or by increasing the surface area of the anode. Alternatively, water that has very low resistance also requires high voltage because the current is dissipated within the electrolytes of the water. However, in this case more voltage output rather than anode size is needed to increase the size of the electrical field. Kolz (1993) stressed that on-board electrical measurements are no substitute for in-water measurements because fish respond only to the electrical field actually produced in the water.

Effectiveness of electrofishing also depends on factors such as physical characteristics of the water, the concentration of fish in the sample stream, and the experience of the crew. Casselman et al. (1990) reported that efficiency of electrofishing decreased markedly with deeper water, with faster water velocity, and with lower water transparency (because of difficulty in seeing and netting fish). Fustish et al. (1989) reported that electrofishing for steelhead was most productive at 500-1,800 cfs and turbidity of less than 6.0 JTU. Electrofishing for chinook salmon was two to three times more effective in the Coos River than in the Yaquina or Siuslaw rivers partially because fish were more concentrated at low flow (Hooton 1978). Hardin and Connor (1992) reported significant differences in the efficiency of two crews, which was attributed to variations in technique.

Electrofishing can injure or kill fish, thus this technique has been of concern to biologists. Adverse effects of electrofishing can be direct such as broken backs, hemorrhages, and respiratory failure, or indirect such as stress or behavioral changes. Spinal injuries and hemorrhages in electroshocked fish have been widely reported. Early detailed descriptions of electrofishing injuries in large rainbow trout was reported by Hauck (1949). Brands on fish have been associated with electroshocked fish (Horak and Klein 1967; Schroeder and Smith 1989; Holmes et al. 1990; Fredenberg 1992) and are believed to be discolorations of the skin indicating possible damage to the nervous system or hemorrhages associated with spinal injury.

Several investigators have reported spinal injuries in fish, although injury rates have varied. Fessler et al. (1976) reported an average injury rate of 21% in adult steelhead captured in the Deschutes River with various electrofishing gear using pulsed DC (60 Hz). Injury rates were based on necropsies of apparently injured and uninjured fish. Injury rates of adult steelhead electroshocked in hatchery ponds were 7% for DC, 28% for pulsed DC (5 Hz and 60 Hz), and 59% for pulsed DC (100 Hz; Fessler et al. 1976). They also reported that 2-3% of these fish died during a holding period of at least two weeks and that the mortalities usually had one or two severe breaks in the spinal column and extensive hemorrhage in muscle tissue. Fessler et al. (1976) also reported injury rates of about 80% in adult chinook salmon captured in the Deschutes River with pulsed DC (60 Hz) and 36% with DC.

Sharber and Carothers (1988) reported injury rates of 44-67% in adult rainbow trout (30-56 cm) captured with pulsed DC (60 Hz), with exponential and square pulse shapes producing the lowest injury rates. Sharber et al. (1994) reported injury rates of 43-65% with pulsed DC (60 Hz) using three different types of anodes. They also reported that rates of spinal injuries increased from 3% to 62% with pulse frequencies of 15 Hz to 512 Hz, respectively, and that complex pulse patterns also produced a low injury rate of 8%. Rainbow trout captured in three Montana rivers had spinal injury rates of 65-90% with pulsed AC, 78-98% with pulsed DC (60 Hz), 18% with smooth DC, and 31-54% with complex pulsed DC (Fredenberg 1992). McMichael (1993) found spinal injuries in 4-17% of rainbow trout captured seven days apart with DC, and in 35% and 53% of rainbow trout captured with pulsed DC at 30 Hz and 90 Hz, respectively. McCrimmon and Bidgood (1965) found spinal abnormalities in 8% of rainbow trout electroshocked with AC or DC, but they also found naturally occurring abnormalities in fish. Hudy (1985) found that 77% of rainbow trout and brook trout with swimming abnormalities had spinal injuries from electrofishing with AC, but that only 21% of fish examined immediately after capture had injuries.

Because the severity of the voltage gradient along the length of a fish increases with length (Taylor et al. 1957; Flux 1967; Ellis 1975), large fish may be more susceptible to injury than small fish. Schroeder and Smith (1989) reported that the average annual rate of electrofishing injury increased with size of fish. However, Fredenberg (1992) found no difference in the injury rate between fish 8-15 in and fish 15-22 in.

Although these studies have demonstrated that electrofishing can cause injury and mortality in individual fish, Schill and Beland (1995) point out that no studies have been conducted on the effect of electrofishing on fish populations. They presented estimates of electrofishing mortality for salmonid populations ranging from 0.1%-0.3%, with a high of 4.5%.

Tetany can cause cessation of respiration or long recovery time to normal respiration (Chmielewski et al. 1973, as cited in Synder 1992; Schreck et al. 1976). Schreck et al. (1976) reported increases in blood concentrations of plasma corticoid, lactic acid, and glucose as indicators of stress response to electrofishing. Bouck and Ball (1976) also reported that plasma protein concentrations in rainbow trout were affected by electrofishing (as well as by seining and hook and line). Handling can also lead to stress and mortality in electroshocked fish (Hudy 1985). Mesa and Schreck (1989) reported behavioral changes in electrofished wild trout including decreased activity and lack of feeding from electrofishing or from handling and marking of captured fish. Decreased swimming performance of electroshocked rainbow trout was reported by Horak and Klein (1967).

Dwyer and White (1995) reported that electroshocked adult rainbow trout had significantly lower growth than control fish over a 35-day period after only a 10-second exposure. However, others have reported no adverse effects on growth after a single electrofishing event (Maxfield et al. 1971; Kynard and Lonsdale 1975). Gatz et al. (1986) reported that average growth rates of wild rainbow trout and brown trout were lower for fish that had been electroshocked two to seven times within a 12-month period than for control fish of the same age and species. Marriott (1973) reported that electrofishing mature pink salmon caused a significant increase in egg mortality. Others have reported an effect of electrofishing on fertilized eggs, deposited eggs, or embryos (Godfrey 1957; Marriott 1973; Dwyer et al. 1993). The mortality of cutthroat eggs exposed to electric shock was significantly higher than control groups when higher voltages were used (≥ 225 V), regardless of pulse rate or wave form (Dwyer and Erdahl 1995). However, Sorensen (1974) reported no effect of electroshock on spawning behavior of sexually mature brook trout and goldfish.

APPENDIX B

Contacts and Manufacturers

Vendors

Floating or Resistant Board Weirs

Mitsubishi Canada
2800-200 Granville St.
Vancouver, British Columbia V6C 1G6
Mariko Lo (604) 654-8127

Electric Barrier

Smith-Root, Inc.
14014 NE Salmon Creek Ave.
Vancouver, WA 98686
(206) 573-0202

Boat Electrofishing Pulsators

Smith-Root, Inc. (see above)

Coffelt Manufacturing
1311 East Butler Ave., Building B
Flagstaff, AZ 86001
(602) 774-8829

Dirigo Electronics Engineering
1307 NW Buchanan
Corvallis, OR 97330
(503) 752-5337

Gill Nets/Seines

Nichols Net and Twine
RR 3- Bend Road
East St. Louis, IL 62201

Memphis Net and Twine Co., Inc.
P.O. Box 8331
Memphis, TN 38108
(800) 238-6380

Nylon Net Co.
P.O. Box 592
Memphis, TN 38101
(800) 238-7529

Sterling Net and Twine Co., Inc.
18 Label St.
Montclair, NJ 07042

Erosion Control Cloth

Mirafi, Inc.
P.O. Box 2258
Redmond, WA 98073-2258
(206) 881-8806

or

Oregon Culvert Co.
P.O. Box 398
Tualatin, OR 97141
(503) 692-0410

Collapsible Fish Tube

Eric's of Nanaimo, Ltd.
General Delivery
Crofton, British Columbia
V0R 1R0
(604) 246-4977

Contacts

Picket Weirs

Oregon Dept. of Fish and Wildlife
28655 Highway 34
Corvallis, OR 97333
Ken Kenaston (541) 737-7626
email: kenastok@ucs.orst.edu
Kirk Schroeder (541) 737-7627
email: schroedk@ucs.orst.edu

Alaska Dept. of Fish and Game
Commercial Fisheries Division, Juneau
Fred Burgander (907) 465-4250

Fish Wheel

National Marine Fisheries Service
Auke Bay Laboratory, Juneau
Tom Dress (907) 789-6044 (construction)

Alaska Dept. of Fish and Game
Commercial Fisheries Division, Juneau
Andy McGregor (907) 465-4250 (operation)

Permanent Picket Weir

- hydraulically operated; Chiwawa River, WA
National Marine Fisheries Service
Portland
Bill Hevlin (503) 230-5407

Floating or Resistant Board Weirs

Lookingglass Hatchery
(503) 437-9723 (operation)
Paul Johnson (engineering) (503) 229-5400 ext. 523

Washington Dept. Fish and Wildlife
Engineering Section, Olympia
Roger Bogden (206) 753-5700

Angling

British Columbia Ministry of Environment and Parks
Nanaimo
Rick Axford (604) 751-3224
Craig Whightman (604) 751-3232

Hoop or Wire Fyke

Washington Dept. of Fish and Wildlife
Olympia
Dave Seiler (206) 586-1994

Oregon Department of Fish and Wildlife
Corvallis
Stan van de Wetering (541) 737-7635

APPENDIX C

Costs of Some Capture Techniques

Appendix Table C-1. General cost of eight types of techniques used to capture adult salmonids in the Pacific Northwest.

| Features | Size (ft) | Cost ^a | | Source ^b |
|--|--------------|-------------------|----------|---------------------|
| | | Total | Per foot | |
| Vertical Picket | | | | |
| conduit pickets | 40 | 1,650 | 41 | 1 |
| black pipe pickets | 60+ | 5,860 | 98 | 1 |
| black pipe pickets, metal tripods | 40 | 2,470 | 62 | 2 |
| temporary w/o trap | -- | -- | 95 | 3 |
| Fish Wheel | | | | |
| w/ aluminum pontoons | -- | 10,600-16,000 | -- | 4 |
| Hoop or Wire Fyke | | | | |
| Oregon, 6 ft diam./15 ft length | -- | 630 | -- | 2 |
| Washington, 10 ft diam./20 ft length | -- | 1,000 | -- | 5 |
| Fishway Trap | | | | |
| Denil | -- | 47,000 | -- | 3 |
| Cage trap in ladder step | -- | 500-1,500 | -- | 2 |
| Floating or Resistant Board | | | | |
| Commercial (Mitsubishi) | | | | |
| Idaho, w/ cement sill | 200 | 94,000 | 470 | 6 |
| Wash., w/ cement sill | 140 | 67,000 | 480 | 7 |
| Oregon, w/ site preparation | 60 | 195,000 | 3,250 | 8 |
| Alaska - weir, w/o site work | 100 | 11,150 | 112 | 9 |
| Permanent Picket | | | | |
| Permanent w/o trap | -- | -- | 1,560 | 3 |
| Weir w/ hydraulic lifters, cement sill | 140 | 110,000 | 786 | 7 |
| Concrete Barrier | | | | |
| Velocity barrier | 30 | 39,000 | 1,300 | 3 |
| Vertical barrier | 30 | 66,000 | 2,200 | 3 |
| Electric Barrier | | | | |
| Power on site, w/o bank work | <75 | -- | 360 | 3 |
| | >75 | -- | 215 | 3 |
| Smith-Root, Inc. | | | | |
| small-scale, little site work | -- | 30,000 | >1,000 | 10 |
| large-scale, excavation, bank | -- | 300,000 | >2,000 | 10 |

- ^a *All costs are in 1995 dollars based on: Economic Report of the President, Annual Report of the Council of Economic Advisors, U.S. Government Printing Office, Washington, D.C.*
- ^b
1. *Fred Burgander, Alaska Department of Fish and Game, Commercial Fisheries Division, Juneau.*
 2. *Kirk Schroeder, Oregon Department of Fish and Wildlife, Research Section, Corvallis.*
 3. *Senn et al. (1984).*
 4. *Tom Dress, National Marine Fisheries Service, Juneau.*
 5. *Dave Seiler, Washington Department of Fish and Wildlife, Olympia.*
 6. *Grant Christenson, Idaho Department of Fish and Game, Engineering Section, Boise.*
 7. *Paul Johnson, ODFW, Engineering Section, Portland.*
 8. *Bill Hevlin, NMFS, Portland.*
 9. *Larry Bartlett, ADFG, Palmer.*
 10. *Dave Smith, Smith-Root, Inc., Vancouver, WA.*

Appendix Table C-2. Detailed cost of a 40 ft vertical picket weir used to trap adult winter steelhead in the Siuslaw River, Oregon (1995 dollars).

| Component (number) | Material | Size | Number | Unit | Cost |
|------------------------------------|---|-------------------------------|--------|--------|-------|
| Tripods (5) | square tubing | 2 x 2 x 3/16 in | 2 | 20 ft | 78 |
| | square tubing (for adjustable legs) | 1.5 x 1.5 x 3/16 in | 1 | 20 ft | 41 |
| -wood leg | lumber | 4 x 4 in | 5 | 8 ft | 42 |
| -metal leg | square tubing | 2 x 2 x 3/16 in | 3 | 20 ft | 118 |
| Rails (6) | channel iron | 3 x 3/16 in | 6 | 20 ft | 157 |
| | U-bolts (for attaching rails to tripods) | 7 x 2 x 3/8 in | 30 | -- | 50 |
| Pickets (200) | black pipe | 3/4 in Schedule 40 | 67 | 21 ft | 535 |
| Traps (2) (132/trap) | angle iron | 2 x 2 x 1/8 in | 5 | 20 ft | 53 |
| | conduit pipe | 3/4 in, .065 in thick | 53 | 20 ft | 297 |
| | square tubing (for vertical framing) | 1 x 1 x 1/8 in | 5 | 20 ft | 110 |
| | CDX plywood | 4 x 8 ft x 3/4 in | 4 | -- | 94 |
| | strap hinge | 5 in | 4 | -- | 8 |
| Holes punched | channel iron | 1 3/16 in on 2 1/2 in centers | | | 225 |
| | angle iron | 13/16 in on 2 in centers | | | 150 |
| Securing weir | Eyebolts | 5/8 x 6 in | 17 | -- | 170 |
| | Turnbuckles | 3/8 x 6 in (forged) | 20 | -- | 240 |
| | Quick links | 5/16 in | 40 | -- | 40 |
| | Chain | 3/16 in | -- | 60 ft | 42 |
| | Cable | 3/8 in | -- | 150 ft | 60 |
| Total (with 1 wood leg on tripods) | | | | | 2,392 |
| Total (with all metal tripods) | | | | | 2,468 |

Appendix Table C-3. Costs of a 60 ft resistant board weir at Lookingglass Creek Hatchery, Oregon (1995 dollars). Does not include agency costs for engineering oversight.

| Component | Cost |
|--|----------------|
| Weir panels (19, includes one extra) | 26,000 |
| Engineering consultant | 31,000 |
| Civil engineering (excavation, concrete, etc.) | 138,000 |
| Total | 195,000 |

Appendix Table C-4. Detailed costs of a hoop or wire fyke trap built in Oregon. The trap is 6 ft diameter, 15 ft long, with two fykes of 30 in and 12 in (source: S. Van de Wetering, ODFW, Corvallis, 1995, personal communication)

| Component (number) | Material | Size | Cost |
|--------------------|----------------------|---------------------------------|------------|
| Hoops (4) | rolled square tubing | 1 x 1 x 1/8 in 6 ft diameter | 325 |
| Runners (6) | square tubing | 1 x 1 x 1/8 in 12 ft long | 75 |
| Fyke (2) | square tubing | 1 x 1 x 1/8 in | 65 |
| Covering | wire fencing | 1 x 1 in 100 ft | 120 |
| Fasteners | | | |
| -screws (200) | self-tapping | 5/16 in | 45 |
| -washers (200) | fender | 1 1/4 in diameter | |
| Total | | | 630 |

