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UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF OREGON

NORTHWEST ENVIRONMENTAL DEFENSE CENTER, **WILDEARTH GUARDIANS**, and **NATIVE FISH SOCIETY**,

Plaintiffs,

v.

U.S. ARMY CORPS OF ENGINEERS and **NATIONAL MARINE FISHERIES SERVICE**,

Defendants.

CITY OF SALEM and MARION COUNTY,

Intervenors.

Case No. 3:18-cv-00437-JR

Declaration of Richard A. Domingue In Support of Plaintiffs' Motion for Preliminary Injunction

I, Richard A. Domingue, 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 of the Willamette Project on threatened Upper Willamette River Chinook salmon and steelhead. I was also asked to provide my expert opinion on the feasibility and likely impacts of the interim measures that are requested in the Plaintiffs' Motion for Preliminary Injunction.

Professional Qualifications and Experience

3. I earned a Bachelor of Science in Forest and Watershed Management from Colorado State University in 1979.

4. I worked at the National Marine Fisheries Service ("NMFS") from 1998 to 2017 as a Hydrologist in the Hydro Division of the Northwest Region. In that role, I analyzed federal water development and hydroelectric project actions for hydrologic effects and how such actions may affect anadromous fish species listed under the Endangered Species Act ("ESA"). I composed correspondence, including biological opinions, and agency-recommended terms and conditions for actions being taken by other federal agencies (e.g., FERC licensing). I negotiated settlements to conform federal agency actions with the requirements of the ESA. One of my major projects at NMFS was working on the ESA consultation and related work regarding the Federal Columbia River Power System ("FCRPS"), which addressed the likely future impacts that the proposed operation and configuration of 13 hydroelectric and water storage dams operated by the U.S. Army Corps of Engineers ("the Corps") and the U.S. Bureau of Reclamation ("Reclamation") would have on imperiled salmonids.

5. While at NMFS, I also worked on the ESA consultation for the Corps' Willamette Project. I was one of the two senior NMFS employees who worked on the consultation when it started around 2000. It was clear from the beginning of that process that fish passage was the major problem to be addressed, because the Corps' dams blocked access to a large fraction of the historically accessible spawning habitat for Upper Willamette River ("UWR") Chinook salmon and steelhead in the affected watersheds. I was involved in drafting the 2008 Biological Opinion ("BiOp") and the Reasonable and Prudent Alternative ("RPA"). I was primarily responsible for developing water release patterns necessary to meet fish habitat and passage needs in the rivers downstream from the dams while meeting other authorized project purposes. I was also involved in the construction and finalization of the entire RPA.

6. After completion of the 2008 BiOp, I was involved in the day-to-day operation of the Willamette Action Team for Ecosystem Management ("WATER") that was required under the BiOp. My role on the WATER team was in-season operations. This required me to participate in regular meetings (often weekly) with representatives from the Corps, reservoir operations team. As part of that team, I considered requests from the Corps to reduce the minimum flows or alter other RPA requirements as conditions might warrant (e.g. low inflow, mechanical failure). To analyze such requests, I considered the feasibility and need of the Corps' operation, along with the impacts the deviation would have on fish habitat and the species. I participated in meetings in which conflicts over the Corps' maintenance and outage schedules arose. I reviewed the Corps' annual Willamette Project water quality reports of ongoing temperature monitoring and modeling efforts. Overall, I worked on a wide range of technical, scientific, and biological issues, and considered how the Corps' operation of the Willamette Project affects fish habitat and fish in the watershed. This required me to develop an

expertise and strong understanding of the fish habitat/flow relationships and the array of fish needs throughout the Upper Willamette River watershed.

7. Prior to my service at NMFS, I began my professional career in 1986 as a temporary employee with the U.S. Forest Service, and the U.S. Geological Survey, and stints working in mined land reclamation and land development, all in Colorado. In March 1986, following a short period of volunteer service, I was hired to work with the U.S. Fish and Wildlife Service's Instream Flow Group in Ft. Collins, CO. Over the next 18 months, I took all of the courses offered by the group and began helping to teach the group's instream flow assessment models to others. This led to an opportunity to be the technical expert in developing an instream flow program for the state of Minnesota, where I was employed by the Department of Natural Resources, Division of Waters as a hydrologist/instream flow specialist from Sept. 1987 through May 1990. In developing this program, we conducted numerous field instream flow surveys for streams throughout the state, developed stream flow vs fish habitat functions for dozens of species and life stages in our study streams, identified streamflow metrics that correlated well with good fish habitat conditions, and submitted a completion report to the DNR.

8. Subsequently, I took a job with Stone & Webster Engineering, Englewood CO in 1990 as hydrologist/instream flow coordinator. My initial assignments were to conduct instream flow assessments for several hydroelectric projects in Michigan's upper peninsula. Following development of the streamflow/fish habitat functions, I developed project operations models and operating plans designed to meet fish needs in the river reaches downstream from the projects while minimizing the loss of potential power. In 1992, Stone & Webster was awarded a contract to assist the Federal Energy Regulatory Commission (FERC) in conducting all hydropower relicensing process actions, from public hearings, to study requests and plan reviews, application

adequacy, NEPA review of its licensing actions, and writing license orders. I participated in all these actions, focusing on streamflow related issues (fish habitat, recreation, water quality). Under this contract I worked on several hydroelectric projects in the Pacific Northwest including: the Cushman Project, the Nisqually Project, Snoqualmie Project, and the Leaburg-Walterville Project where I served as Deputy Project Manager.

Willamette Project Impacts

9. In the 2008 BiOp, NMFS concluded that the Corps' proposed operation and maintenance of the Willamette Project would harm critical habitat for UWR Chinook salmon and steelhead and jeopardize their continued existence, and issued a Reasonable and Prudent Alternative ("RPA") that, if implemented, would avoid jeopardy.[1] The Corps has failed to implement key RPA measures, particularly modifications to dam configurations to facilitate fish passage, and to control water temperature and dissolved gas loads downstream. Rather than implementing the RPA in a timely manner, the Corps has spent much of the intervening years arguing about the need for the RPA actions. In large measure, following issuance of the biological opinion in 2008, the Corps has implemented the proposed action from its 2007 biological assessment that NMFS determined would jeopardize the species and adversely modify critical habitat. By failing to implement the RPA in a timely manner, the Corps has extended the Project's adverse effects on fish survival, further risking their survival and potential for recovery.

10. The Corps has taken insufficient action to arrest or reverse the decline in status of UWR Chinook salmon and steelhead affected by the Project. Indeed, both have recently further declined in abundance. This decline is not entirely attributable to the Project as Chinook salmon

[1] NMFS 2008 Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat Consultation. Consultation on the "Willamette River Basin Flood Control Project".

and steelhead populations have recently declined throughout the Pacific Northwest. However, the decline in salmon populations in Project-affected tributaries of the upper Willamette River has been more severe than the decline observed in the Mollala River, another nearby river in the upper Willamette basin that lacks Willamette Project dams and thus is less affected by the Project. This ongoing decline in fish abundance, combined with the increasing risks posed by global climate change warrants aggressive implementation of protective measures.

11. The construction, and ongoing operation and maintenance of Project dams are largely responsible for the dramatic declines in the abundance of both species since the dams were built in the 1940s, 1950s and 1960s. There are three key ways the Project harms fish: 1) cutting off access to a large fraction of the species' historical and high-quality spawning habitat upstream of the dams and failing to operate the system in a way that provides adequate passage; 2) modifying the timing and quality of water released in a way that adversely effects downstream fish survival; and 3) creating large reservoirs that provide good habitat to predators and pathogens, and extending residence times for juvenile salmon above dams and thereby increasing their exposure to predation and infection. The Corps often has some discretion to make operational or maintenance decisions that could reduce the impacts of these problems, but prioritizes other uses, like hydropower or recreation, instead.

12. As I explain in further detail below, the Corps' operation and maintenance of the Project continues to negatively impact UWR salmon and steelhead. I base my professional opinion on scientific research in Project-affected reaches and elsewhere, and my professional experience with and knowledge of the Project and the fish.

Blocked Passage

13. The Project blocks adult salmon from returning to their natal streams to spawn by their own volition. A limited number of adult salmon reach their natal streams above some dams through non-volitional means—trapping adult fish at fish facilities downstream from the dams and trucking them to release locations above the dams. High rates of loss and pre-spawning mortality have been observed in these transported adult fish. Traps at Big Cliff (Minto trap), Foster, and Cougar dams have all been rebuilt or substantially modified over the past decade to reduce these effects, but trap and haul operations still reduce both the fish's likelihood of survival to spawning and the number of eggs laid.

14. From those adults that survive relocation to upstream areas and successfully spawn, the resulting juveniles face low survival odds when migrating through Project reservoirs and dams on their way to the sea. Most juvenile fish perish in the reservoirs, never locating an outlet to pass the dams. Even when the fish do find an outlet, overall dam passage survival is generally poor. The majority of juveniles that do pass the dams do so during the late fall and winter, long after reservoir entry, interfering with normal migratory behavior. This lack of safe, timely, and effective downstream passage severely limits the potential to increase productivity and abundance of both species. This has resulted in low productivity for upstream habitat even though it is high-quality and more secure from Project effects and ongoing climate change than currently accessible habitat downstream from the dams. Current poor juvenile passage conditions limit the potential for survival and recovery of both species, a primary cause for NMFS concluding that the project adversely modifies critical habitat for both species.

Unnatural Flow Regime

15. The Corps' operation and maintenance of the dams in their current configurations causes highly unnatural flow and habitat conditions throughout the year that harm UWR Chinook salmon and steelhead. This largely stems from the Corps' operation of the dams to hold back water flows and maintain high reservoirs during parts of the year, which presents problems for fish habitat and fish.

16. The agency generally draws down system storage reservoirs in the fall (beginning in September), after the summer recreation season, to make room for heavier precipitation in the winter and spring. This requires the Corps to discharge more water than would naturally occur when Chinook salmon are spawning, leading to fish spawning in less secure locations. The Corps also often spills water during this drawdown in an attempt to remain on the Corps' rule curve,[2] causing total dissolved gas and gas bubble disease issues.

17. During the peak flood control season, from November through January, the Corps keeps Project reservoirs at low levels that allow continued power production while meeting flood storage obligations. Reservoir water levels rise and fall to attenuate downstream peak flows as needed to conform to the Corps' rule curve throughout the winter and spring.

18. In the spring, the Corps begins to "refill" reservoirs, following the Corps' rule curve attempting to refill the reservoirs by early May while meeting downstream flow demands. This requires the Corps to discharge less water from dams than would normally flow downstream, and to largely hold back peak flows during precipitation events that historically provided an important out migration cue to juvenile salmon. The spring refill greatly reduces

[2] Rule curves, or storage reservation diagrams are design storage levels to meet flood damage reduction and water storage goals.

downstream flows from what would normally occur. From early May through August, the Corps attempts to maintain high water levels in Project reservoirs to serve reservoir recreation while attempting to meet downstream flow needs. These high reservoirs also cause unnaturally low downstream flows and generally lead to water temperature problems described below.

19. These general operations substantially reduce peak flows (floods), which contributes to channel simplification in both the Project-affected tributaries and the Willamette mainstem. This prevents the tributary stream reaches and mainstem Willamette from displaying wider active floodplains and more frequent side-channels. This is harmful to fish because side channels and wider floodplains provide important habitat for fish migrating up and down the rivers, and for some adults who spawn downstream of the dams. Dam operations also prevent natural high flows from moving channel substrates around, which would increase suitability for use by spawning fish. By reducing the magnitude and frequency of peak flows, the Project reduces the quality of migrating and spawning habitat in the affected streams..

20. Operational changes impact flows and can cause sudden changes in flow rates. This influences where adults spawn and whether eggs survive.

21. The RPA included flow objectives and ramping rates but the Corps does not always meet these. These deviations occur due to forecasting error, the Corps' perceived limited operational discretion, equipment failures, and natural hydrologic conditions (e.g. floods and droughts). Undesirably low flows can impede migration and can lead to increasing the rate of warming as the water flows downstream. Unusually high flows, particularly during Chinook salmon spawning in the fall, reduces spawning success.

High Total Dissolved Gas Levels

22. High Total Dissolved Gas ("TDG") levels are created when water falls from dams before hitting the river at a lower elevation below. The force from falling water entrains air which becomes dissolved in the water at concentrations in excess of the equilibrium saturation concentration (i.e. supersaturation). Exposure to supersaturated water is harmful to all life stages of salmon and steelhead by causing gas-bubble trauma ("GBT"). GBT is a severe disease, similar to 'the bends' divers may experience when rising too fast. When the excess gas comes out of solution in the fish's blood stream the gas bubbles can stop blood flow, leading to loss of equilibrium, skin lesions, and death. Juveniles are particularly susceptible to GBT. High TDG is reduced by exposure of supersaturated water to the atmosphere and generally declines in a downstream direction. Turbulence accelerates degassing.

23. The Oregon State Water Quality Standard for TDG is 110% of the saturation concentration. The susceptibility of Chinook salmon and steelhead to GBT varies between species and their life stages with juveniles being most susceptible and steelhead juveniles showing greater susceptibility than Chinook juveniles. Incidence of the disease is associated with both the percent of supersaturation and the duration of exposure. Chronic exposure can cause GBT at very low levels (less than 110%). Episodic, short-term exposure to TDG levels greater than 120% can cause GBT. Frequent and prolonged exposure to high TDG for fish that use Project-affected reaches is a serious problem, especially after concentrations exceed 120% of saturation.

24. High TDG can occur when water is routed through spill gates that are located higher on dams. The Corps' operation of nearly all Project dam spillways causes very high levels of TDG downstream. Substantial juvenile salmon mortalities have been observed

downstream from Project dams due to GBT following spills. Adverse TDG conditions decline rapidly in the downstream direction as shallow water and turbulence degas the river. However, these near-dam high TDG areas are generally the most densely used areas for salmon and steelhead spawning downstream from the dams, meaning that recently emerged fry and juveniles in these heavily used spawning areas are susceptible to GBT caused by project operations. Due to the overlap between emergence timing and spill operations, this mostly affects juvenile Chinook salmon, but may also affect juvenile steelhead that rear in these areas.

25. Operational and structural solutions are available to reduce TDG levels below project dams. Operationally, the Corps may "spread" spill, meaning discharge spill from multiple spillways rather than just one. The Corps can keep reservoirs low so spillways are not available, or prioritize use of other discharge outlets—like turbines or regulating outlets—to avoid spill. Structural options include a flip lip, which avoid the creation of high TDG by discharging water more horizontally, reducing the plunging water effect common to most spillways. Despite these available options, the Corps has not readily or consistently taken available operational measures to reduce TDG, and is not moving forward with structural solutions to the best of my knowledge.

Unnatural Water Temperatures

26. The Corps' reservoir operations cause water temperature problems by taking in cool water during the spring and storing it. The temperature of water affects its density, which leads to stratification of water in reservoirs, with different temperatures at different depths. Cold water is denser and tends to drop to the bottom of the reservoir, while warmer, less dense water is pushed to the top. Water is released from reservoirs through outlets in dams—regulating outlets, spillways, and turbines—that are located at specific heights. The outlet used and timing

of the water released by the Corps determines its temperature. Under current general operations and configurations, abnormally cold water is released by the dams in summer, and abnormally warm water is released in fall (see Figure 1 below). Because fish rely on temperature to cue certain behaviors, this impact to fish habitat harms fish.

27. In the fall/early winter, warm water released by the dams can lead to early emergence of Chinook salmon fry, putting them in the river when there is little to eat and large risk of high flows and high turbidity events that can injure or kill salmon fry. Early emergence thus contributes to poor juvenile survival. Warm water temperatures during the fall can also delay spring Chinook salmon spawning. Delayed spawning can harm fish by increasing their likelihood of dying before spawning. Salmon die soon after spawning because they have used up all stored energy in their bodies. If spawning time is delayed, they may use up those resources, or succumb to disease and die before being able to spawn. High levels of pre-spawning mortality ("PSM") is a concern throughout the Willamette basin and Project operations contribute to this adverse effect. The direct causes of PSM vary widely, but high water temperatures and delayed spawning are strongly correlated to the effect.

28. During spring and summer, the Corps operates Project dams to discharge water that tends to be cooler than it would be absent the project. This can delay the emergence of steelhead fry, leading to smaller fish going into the winter, which reduces their likelihood of survival. Cool water releases in spring and summer also delay upstream adult migration. ODFW personnel have observed that Chinook salmon reach the Minto fish trap faster when the upstream Detroit Dam spills in the spring, bringing warmer reservoir surface water downstream. But under current operations, such spring spill is uncommon. In general, the quicker adult Chinook salmon reach the trap, the greater their chance of survival to spawning.

29. At Cougar dam, the Corps recently installed a selective withdrawal system that captures water at selected depth to meet downstream water quality criteria. This system works well and mostly keeps downstream water temperatures within water quality standards. Other projects do not have such a system and the issues described above persist. In coordination with the Oregon Department of Environmental Quality, NMFS, and the U.S. Fish and Wildlife Service, the Corps has adopted target water temperature regimes, based on the Cougar dam regime, for its operational efforts to control discharge water temperatures at the Detroit/Big Cliff and Middle Fork developments. These efforts have had limited success and discharge water temperatures often fail to meet these targets, particularly in the fall.

Reservoir Conditions

30. Reservoirs cause several problems for fish and fish habitat. Fish passage through reservoirs is a key problem. Reservoirs harm fish by dramatically increasing travel time to the dam face. This increases exposure to problematic conditions, including higher water temperatures, predators, and disease. At present, only a small fraction of juvenile salmon and steelhead that enter the Project's large reservoirs from upstream areas survives passage.

31. Reservoirs contribute to warmer temperatures because they have greater surface area that is far less shaded than the narrower river, increasing the absorption of solar energy. They also trap incoming sediments and woody debris, leaving downstream reaches starved for spawning-sized gravels and coarse woody debris, an important component of juvenile salmon and steelhead habitat. The severity of these effects varies but occur below each dam.

Prioritization Problems

32. There are no harmless ways to operate the dams. There are limitations imposed by the structures themselves, by the Corps' perceived limits on discretion, by environmental regulation, and by Corps policy. However, the Corps often places other Project objectives ahead of its obligation to protect fish.

33. The existence, configuration, and operation of the Project dams create highly unnatural habitat conditions in affected reaches of the UWR basin that harm salmon and steelhead. The effects of dam operations are not limited to the tributary on which they are located nor are they independent of the impacts of other Project dams. Because flows from each tributary on which the dams are located combine in the Willamette River, the Corps must coordinate the operations of dams to meet the minimum flow targets for the Willamette River downstream. Thus, the Corps' decisions to operate one dam can affect how another dam must be operated. As a result, the Corps at times meets mainstem flow needs by augmenting flows heavily in one tributary by releasing stored water, while releasing as little water as possible at a dam in another tributary in order to maintain a high reservoir level for flatwater recreation. Because the rate of flow is among the environmental cues for fish migration, such substantial deviations from natural flow regimes likely has adverse effects on fish survival.

34. It is not uncommon for operators to face operating decisions that may be beneficial to one life stage of salmon or steelhead while being potentially adverse to another. For example, spilling water to avoid turbine passage may offer the safest route of downstream fish passage at certain times and at certain dams. Yet, despite the potential fish passage benefits from using project spillways at times, they tend to produce high concentrations of total dissolved gas, which are harmful to fish survival downstream. Moreover, the high reservoir elevations

required to use the spillways exacerbate the habitat, temperature, and flow problems associated with reservoirs that are described above.

35. In recent years it has been common for key facilities at Project dams to be inoperable, or performing poorly for extended periods of time. These operational limitations can have severe consequences for fish. For example, when a spillway gate is out of service, the Corps is forced to concentrate spill at the remaining gate(s), thereby increasing the TDG downstream. When a regulating outlet, key to attempting to manage discharge water temperatures, becomes inoperable, temperatures can increase rapidly. Issues like these have plagued the Corps' efforts at meeting RPA water quality goals with existing Project works and have harmed fish and their habitats.

Project Specific Harms to UWR Chinook Salmon and Steelhead

North Santiam River: Detroit and Big Cliff dams

Passage

36. A large portion of the historically accessible spawning and rearing habitats for UWR Chinook salmon and steelhead in the North Santiam River lies upstream of the dams (Detroit and Big Cliff dams) or is inundated by their reservoirs. The habitat upstream of Detroit Lake is unaffected by Project operations, is largely suitable for fish spawning and rearing, and is more secure from the adverse effects of ongoing global climate change than the river downstream from Big Cliff dam. But fish that return to the North Santiam may only access this high-quality spawning habitat if they are trapped and trucked past Detroit and Big Cliff dams. Of the limited number of fish that are trucked and released above Detroit Dam, some successfully spawn. While the new Minto trap has improved fish collection and handling, high

rates of PSM continue to plague the North Santiam population of UWR Chinook salmon, both above and below the dams.

37. Downstream passage survival for juveniles resulting from outplanted adults, is very low. Because they cannot easily detect the downstream direction due to lack of flow, fish that enter Detroit Lake in the spring display both upstream and downstream movement in the reservoir, extending their passage time. By spending additional time in Detroit Lake, juvenile salmon and steelhead are exposed to stressors and mortality vectors, including parasitic copepods which can cause death. While the majority of juveniles from the watershed upstream of Detroit Lake enter during the spring and early summer, studies have shown that the largest fraction of juvenile salmon and steelhead that pass the two dams pass during the fall and winter months when the Detroit Lake is at its lowest level. Passage through Detroit Lake and Big Cliff reservoir generally kills a large number of the juvenile salmon and steelhead that enter Detroit Lake. Passage survival through the Detroit powerhouse is poor but passage survival through the regulating outlet (RO) and spillway is generally better. However, project operations—primarily refilling the reservoir in the spring and holding it high until the fall—largely preclude use of the regulating outlet to pass fish, except during the winter.

Water quality

38. TDG is a particular problem in the reach of the North Santiam River below Big Cliff dam because spilling water over the Big Cliff dam spillway can cause very high concentrations of TDG. Spills are infrequent, but generally occur during the fall drawdown and during the winter when high inflows force spills. Following the peak of the flood event, spills in excess of those that occurred during the flood are sometimes used to bring Detroit Lake down to its rule curve elevation quickly, thereby further increasing TDG downstream from Big Cliff dam.

This is a particular problem because the four-mile river reach between the Minto trap and the base of Big Cliff Dam—referred to as a "sanctuary"—provides spawning habitat free from the risks of competition and other survival effects posed by hatchery fish.[3] Near total mortality has been observed in juvenile fish collected downstream due to GBT following a spill event. These were test fish, confined to a trap and thus could not escape the effect so it is possible that if not confined, the fish would have made an effort to avoid the high TDG by swimming deeper, or heading downstream where the effect is lessened. Nevertheless, the fact is that high rates of spill at Big Cliff create very high concentrations of TDG and render downstream habitat harmful to fish.

39. TDG problems in the reach of the North Santiam River below Big Cliff are an ongoing issue because the Corps has not taken adequate operational or structural actions to reduce these problems. Operationally, the Corps has not reduced the rate of Detroit Lake drawdown by beginning earlier in the fall to avoid undesirably high rates of spill, or drafted the reservoir deeper during the fall and winter to avoid the perceived need to spill to conform to the Corps' rule curve. Nor has the Corps developed plans to modify the Big Cliff spillway to reduce the production of high concentrations of TDG.

Temperature

40. Operation of Detroit dam strongly affects the water temperature regime in the N. Santiam River downstream from Big Cliff dam, as demonstrated in Figure 1. Figure 1 illustrates the typical temperature regime of the North Santiam River under Corps operations, which includes warmer than normal temperatures in the fall and colder than normal temperatures in the

[3] This is important because hatchery salmon pose genetic risks to the wild population (wild x hatchery progeny are less likely to survive to adulthood than wild x wild offspring), and can serve as disease vectors.

summer. The biological effects of this change in the temperature regime are discussed in paragraphs 27 and 28 above.

41. The Corps conducts operational measures intended to reduce temperature problems by using different outlets to blend water from different reservoir elevations. These measures have had some success controlling temperatures during the spring and summer, but in late summer, when Detroit Lake falls below the spillway crest, all discharge takes place through the powerhouse or regulating outlets that are much deeper, causing a sudden drop in water temperatures downstream followed by gradual warming as the reservoir drops and warmer near-surface water becomes entrained in the discharge stream. Review of the Corps' annual water quality reports makes clear that these operations have not solved the problem and downstream temperatures still fail to meet targets at certain times of the year, particularly in fall and winter when temperatures exceed spawning and incubation targets.

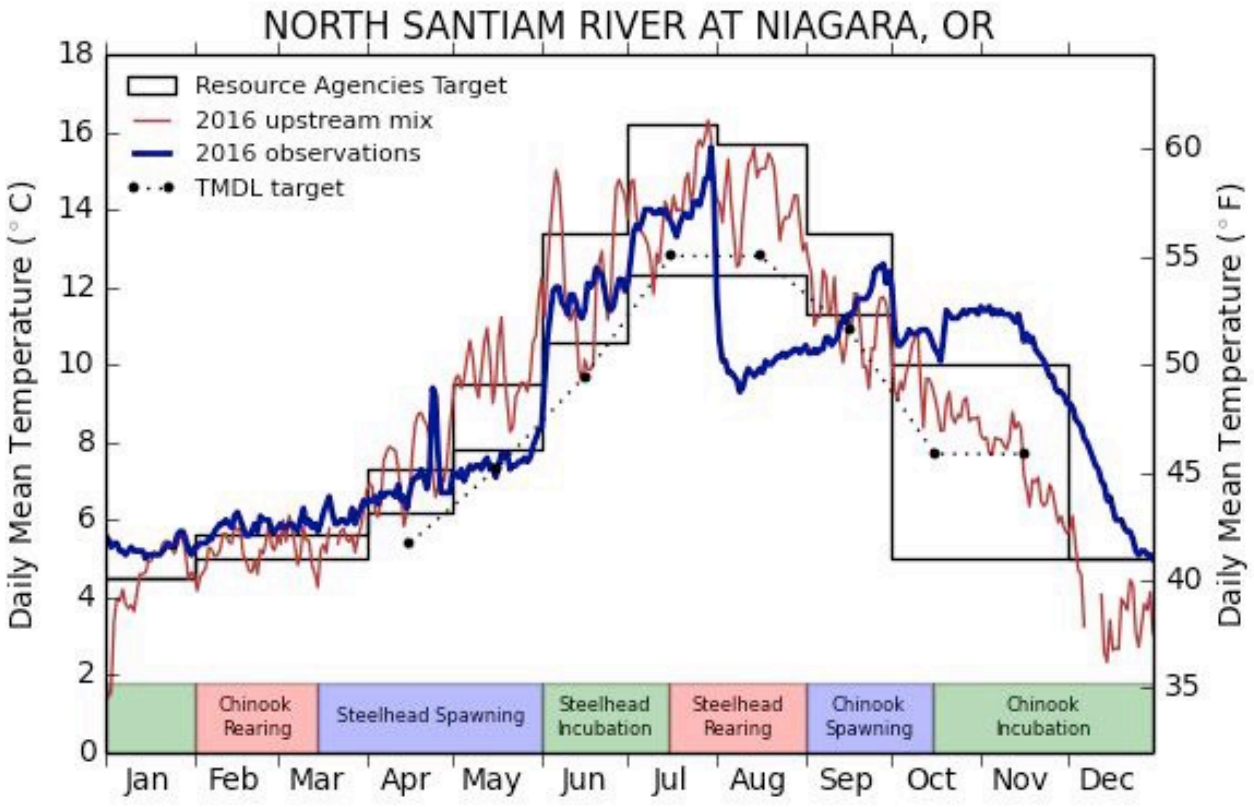


Figure 1 Daily average water temperature measured in the North Santiam River below Big Cliff dam in 2016 compared to estimated natural conditions (upstream mix), showing ODEQ's TMDL and resource agency target temperatures and the seasonal salmonid life stage of primary concern. Source: Corps 2017. Willamette Basin Annual Water Quality Report for 2013

South Santiam River: Foster and Green Peter dams

Passage

42. Foster and Green Peter dams block access to and inundate spawning and rearing habitat in the upper South Santiam subbasin, an area that historically produced about 70% of the steelhead and an estimated 85% of the spring Chinook in the South Santiam River. Volitional upstream fish passage in the South Santiam subbasin ends at Foster Dam. Some returning adult salmon and steelhead are collected at the Foster fish facility, sorted and the wild fish trucked to release sites upstream. Currently, no adults are released upstream of Green Peter reservoir due to poor juvenile passage survival through the reservoir and dam.

43. ODFW personnel operating the new Foster trap have observed reduced numbers of Chinook salmon entering the trap, where they would be sorted and wild ones trucked upstream, and an increased level of spawning in the river immediately downstream. This observation causes concern as it suggests a problem with fish attraction to the new trap that would place a larger fraction of salmon reproduction into the South Santiam downstream from Foster dam where fish would be exposed to Project-caused adverse water quality effects.

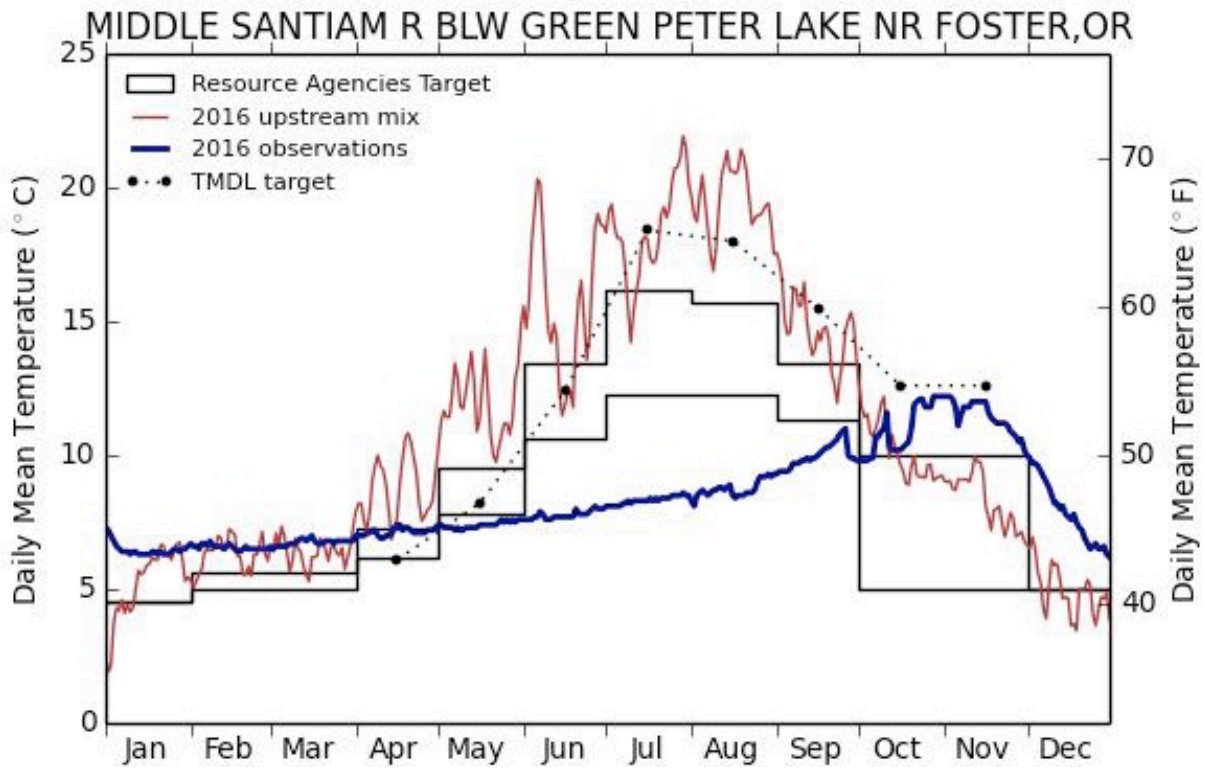
44. Research shows very poor survival for juvenile salmon and steelhead that rear in habitat upstream of Green Peter reservoir and try to pass downstream through the reservoir and Green Peter dam. Because of this, transporting adult fish past the dam was discontinued in 1988, leaving this habitat and its potential productivity unused today. NMFS has required the Corps to begin outplanting Chinook salmon above Green Peter to investigate passage options and inform passage measures in the next biological opinion. The Corps has thus far refused, so no adult fish spawn above that dam.

45. Research on juvenile passage survival at Foster dam has yielded somewhat conflicting results indicating excellent to poor performance, depending on the time of year and route of passage taken through the dam. Passage times through the reservoir vary, with very short passage times (a few days) under low reservoir levels in the winter to several weeks when water levels are high. Even though travel times through Foster reservoir are fairly low, about half of the fish that pass Foster dam are infected with parasitic copepods.

Water quality

46. Foster dam causes high TDG in the river downstream when it spills, adversely affecting juvenile survival. As project discharge is often increased following a flood event to return to the rule curve as fast as possible, high TDG persists longer than the flood event itself. Thus, following passage, juvenile fish may be exposed to adverse TDG conditions in the river downstream caused by spill at Foster dam. The river immediately downstream from the dam is the most impacted. Further, salmon spawning downstream from Foster dam is concentrated in the first 2 miles below the dam, which exposes spawning fish, incubating eggs, and newly emerged fry to harmful levels of TDG.

47. Water temperatures below Green Peter and Foster dams also fail to meet targets during parts of the year. Water temperatures in the Middle Santiam downstream from Green Peter dam are strongly affected by the dam, being much colder than normal during the spring and summer, with a sudden increase in the fall as the reservoir is drawn down, entraining warmer near-surface water. This results in Middle Santiam water temperatures cooler than desired in summer and warmer than desired in fall and winter. These effects are lessened downstream from Foster dam, but continue to cause cooler than desired water temperatures in the spring and summer and elevated temperatures in the fall and winter (See Figure 2). No temperature control actions occur at either of these dams.


MIDDLE SANTIAM R BLW GREEN PETER LAKE NR FOSTER,OR
Resource Agencies Target
2016 upstream mix
2016 observations
TMDL target
Daily Mean Temperature (°C)
Daily Mean Temperature (°F)
0
5
10
15
20
25
40
50
60
70
Jan
Feb
Mar
Apr
May
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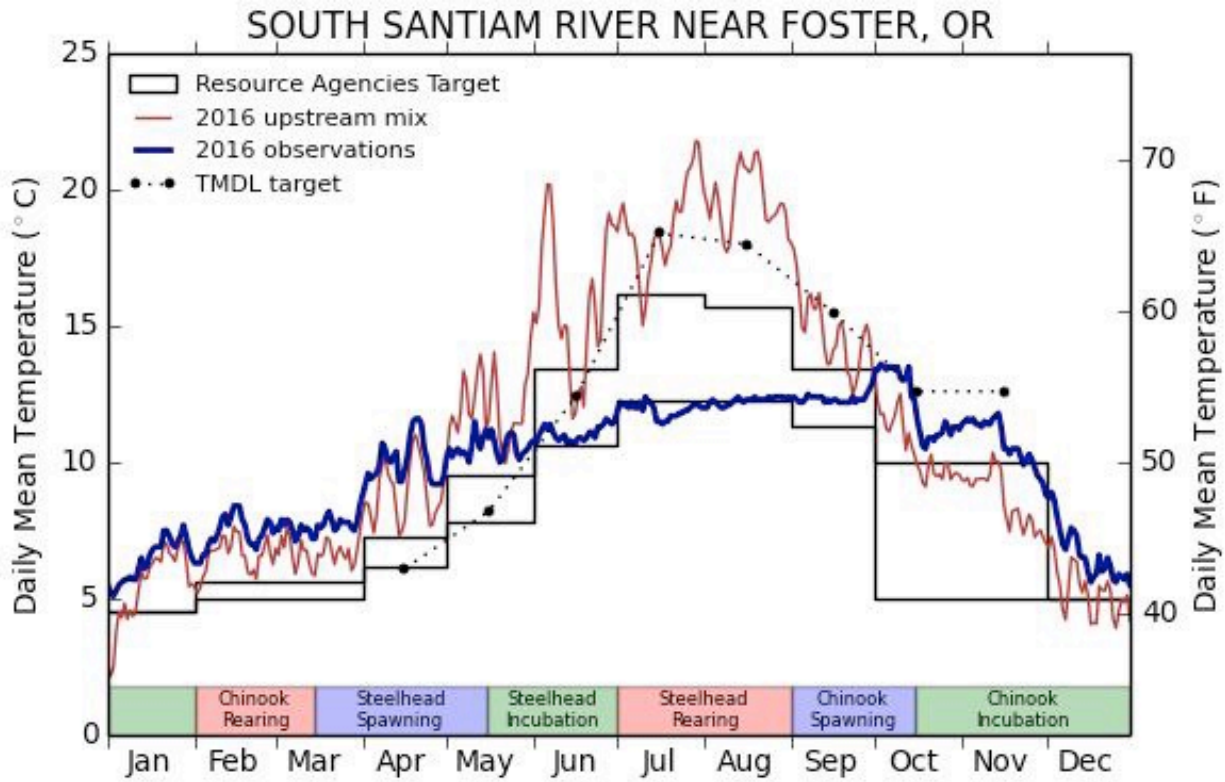
SOUTH SANTIAM RIVER NEAR FOSTER, OR
Resource Agencies Target
2016 upstream mix
2016 observations
TMDL target
Daily Mean Temperature (°C)
Daily Mean Temperature (°F)
0
5
10
15
20
25
40
50
60
70
Chinook Rearing
Steelhead Spawning
Steelhead Incubation
Steelhead Rearing
Chinook Spawning
Chinook Incubation
Jan
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Nov
Dec

Figure 2. Green Peter (top) and Foster (bottom) reservoirs daily mean outflow temperatures in 2016 compared to upstream mix, showing TMDL and resource agencies' target temperatures, and seasonal salmonid life stage of primary concern. Source: Corps 2016 Water Quality Report.

South Fork McKenzie River: Cougar dam

48. Cougar dam is the highest dam in the system (519 feet), and its reservoir the deepest. An important fraction of historical spawning habitat for the McKenzie River population of UWR Chinook salmon was inundated or cut off by Cougar dam. The primary issues at Cougar are the lack of adequate downstream passage through the reservoir and dam, and armoring and simplification of the South Fork McKenzie River channel downstream of the dam by capturing sediments and woody debris in the reservoir.

Passage

49. As at other large storage dams in the Project, juvenile passage timing is strongly associated with the reservoir water level, with most passage occurring during the fall and winter at or near minimum reservoir pool. Because the majority of outmigrating juvenile salmon enter the reservoir in the late-winter and spring, juvenile salmon spend months (or longer) in the reservoir, looking for an outlet. Delayed passage through the reservoir reduces juvenile salmon survival. High mortality rates due to copepod infections have been observed in tagged juveniles in Cougar reservoir with mortality increasing with time spent in the reservoir. At lower reservoir levels, flow velocity is increased, helping to orient the fish, and dam outlets are shallower and easier for the fish to find. The lowest reservoir levels under current operations occur during the winter and this is when the majority of juvenile passage currently occurs, even though this not when the fish would naturally migrate. Most juvenile passage occurs at night, through the regulating outlets, where survival is relatively high. Passage survival through the powerhouse, the other route available, is very low.

Water quality

50. Although the regulating outlets provide fish passage benefits, they produce elevated TDG over a wider range of discharges. While TDG from operation of the regulating outlet sometimes exceeds state water quality standards of 110% immediately below the dam, that effect diminishes in the downstream direction and meets state standards within 2.7 miles of the dam. Production of high TDG is a lesser issue at Cougar dam than at Big Cliff or Foster dams. Gas production is lower and the regulating outlet flows through a short shallow channel before entering the river, allowing degassing before entering the South Fork McKenzie River.

51. The intake tower was recently reconstructed to selectively collect water from various depths and temperatures to discharge water that mimics natural temperature conditions. This system generally functions well, although temperatures often continue to exceed targets during several weeks in the summer.

Middle Fork Willamette River: Lookout Point, Hills Creek, Fall Creek, and Dexter dams

Passage

52. Volitional fish passage ends at Dexter and Fall Creek dams where fish traps collect, and sort returning adults. Fall Creek enters the Middle Fork Willamette River below Dexter Dam, while releases from Hills Creek and Lookout Point are reregulated by Dexter Dam on the Middle Fork Willamette. Some adult salmon collected at the Dexter fish trap are trucked to release locations upstream of Lookout Point dam and Hills Creek dam. Fish that return to the Fall Creek fish trap are trucked to release locations upstream of Fall Creek reservoir. High rates of PSM reduce the effectiveness of this program. Much of the Middle Fork watershed upstream of Lookout Point, Fall Creek, and Hills Creek dams is suitable for salmon spawning and rearing.

53. No operations are performed at Dexter, Lookout Point, or Hills Creek to support juvenile downstream fish passage and measured passage survival is poor. In recent years, Fall Creek reservoir has been drawn down to its regulating outlet elevation from November through January, effectively draining the reservoir, to increase juvenile passage survival.

Water Temperature

54. Water temperature is a significant issue downstream from Dexter dam. Dexter dam is fairly low in the watershed, where water is naturally warmer than higher elevation areas. Project operations compound this effect as discharged water temperatures fall far outside of targets below Dexter, especially in fall and winter during salmon spawning and incubation periods. Salmon reproductive success downstream from Dexter dam—where salmon spawning is largely confined—is very poor due to Project effects on water temperatures.

Total Dissolved Gas

55. Spill at Dexter dam creates high levels of TDG, frequently well in excess of Oregon state water quality standards. This effect appears to persist downstream somewhat further than at other Project dams, likely due to lower turbulence in this lower gradient stretch. This likely increases GBT in incubating eggs, fry and juveniles exposed to these conditions, decreasing their likelihood of survival.

Plaintiffs' Proposed Interim Measures

56. There are several interim operational measures that are feasible for the Corps to take that would reduce harm to threatened salmonids from water quality and flow problems. The Corps produced a document in November 2012 entitled Operational Measures Evaluation Report ("OMET") that analyzed dozens of operational actions the Corps could take to improve water quality and downstream fish passage. Many measures were feasible, and able to be implemented within the short-term. Plaintiffs have proposed several interim measures that are similar to those analyzed in the OMET. As explained in more detail below, these measures are feasible and would likely improve fish passage and water quality conditions on three key tributaries.

57. As part of the interim measures, it is imperative that the Corps and NMFS develop and implement a monitoring plan to evaluate the effects these measures have on fish passage survival, reservoir refill, and downstream water quality. This is important because the information gathered would provide a greater understanding of these effects and support thoughtful adaptive management.

58. However, these interim measures are not enough to stop jeopardy of and recover UWR Chinook salmon and steelhead. These proposed measures will lessen the harm posed by the Project to the fish in the interim, but it is imperative that long-term solutions to the Project's adverse effects on fish passage and downstream water quality be implemented as soon as possible. Toward that end, the Corps and NMFS need to finish a new Biological Opinion as soon as possible that includes firm deadlines for completing permanent fish passage and water quality improvements to the system in a timely manner.

General Benefits of Reservoir Drawdowns

59. Drawing down project reservoirs can benefit fish habitat and fish passage depending upon the depth, season, and length of the drawdown. Available Project dam passage data generally show that the regulating outlets and spillways are the safest routes of downstream passage for juveniles. But regulating outlets are often located dozens or hundreds of feet from the surface of the reservoir, which is too deep for juveniles to sound to for passage. Reservoirs must be drawn down to lower levels to make regulating outlets safely accessible for juveniles. Recent work at the Fall Creek dam shows that deep reservoir drawdowns result in the shortest travel times and highest passage survival under current dam configuration. Reservoirs are generally drawn down in the fall to the minimum conservation pools to make room for winter and spring floods. But deeper drawdowns that take reservoir elevations below minimum conservation pools make passage routes much more accessible and thereby less harmful to fish.

60. Research has shown that juvenile fish often pass the dams during the fall and early winter when reservoirs are lower and regulating outlets are more accessible. However, this behavior is likely a result of the timing of the drawdowns and not natural preferences for the species. The largest fraction of juveniles enter the reservoirs during the spring and could pass quickly if reservoir levels were low enough to make safe passage routes accessible. Because remaining in the reservoir for months exposes juveniles to predators, disease, and water quality issues, the highest benefit of deep drawdowns to fish would occur if the drawdowns were in the spring, or year-round. By greatly improving juvenile passage survival, deep drawdown measures would allow managers to place larger numbers of adults into the more protected and high quality spawning and rearing habitats upstream of the dams, increasing the resilience of the populations.

Detroit and Big Cliff Dams

61. I have reviewed Plaintiffs' proposed interim measure to drawdown Detroit Dam to approximately 1,370 ft. from November 15 through December 15 each year, excepting as needed to avoid downstream flooding or to protect human health and safety, while prioritizing discharge through the dam's regulating outlet throughout this period. This measure is similar to OMET measure DET_04, but of a shorter duration. This measure would provide the following benefits.

62. It would provide outmigrating juvenile salmon and steelhead access to the safest means of passing Detroit Dam under current dam configuration (the regulating outlets) during the higher passage period of the year. This operation would reduce juvenile travel time through Detroit Lake by reducing the cross-sectional area of the lake, thereby increasing the flow velocity, and improve juvenile survival and condition. This travel-time reduction would be substantial for fish that enter the lake in the fall and modest for fish that enter the lake in the spring. This would also reduce the time that juveniles are exposed to parasitic copepods in Detroit Lake that can harm and kill juvenile salmon and steelhead.

63. DET_04 contemplated a longer period of drawdown (November 1, through January 31), but the Corps concluded it would also substantially reduce the likelihood of reservoir refill, reducing the likelihood of meeting summer flow and temperature objectives downstream from the project, and thus rejected the measure. The Plaintiffs' request for a shorter drawdown should have much smaller effects on reservoir refill than that presented in DET 04 as there would be more time during the winter wet season (December 15 through January 31) to raise water levels.

64. By drafting the reservoir deeper than the maximum conservation pool elevation this measure would have beneficial effects on peak flow reduction as the additional storage could

be used to further reduce downstream flooding. Associated with the benefits in peak flow reduction, this measure would reduce the magnitude and frequency of spill operations required at the downstream Big Cliff dam. High levels of spill at Big Cliff dam can cause very high levels of TDG known to be harmful to juvenile salmon and steelhead. By reducing the magnitude and frequency of spills, this action would improve water quality and fish survival downstream from Big Cliff dam. Some increased suspended sediment and turbidity could occur in Detroit Lake and possibly downstream, so should be monitored, but experience at other projects suggest this effect will be of short duration and not a significant contributor to the annual sediment budget.

65. I have also reviewed the Plaintiffs' proposal for the Corps to use the lower and upper regulating outlets for temperature control during the fall. I have reviewed the 2015 Water Quality Report, which describes positive results of temperature control operations conducted in fall 2015 by using the upper and lower regulating outlets to release colder water. In my professional opinion, the Corps should use the dam's lower and upper regulating outlets as needed to reduce water temperatures in the fall and prioritize meeting downstream temperature targets over power generation. This is particularly important in the fall, when eggs are incubating and current operations cause an increase in water temperatures.

Cougar Dam

66. I have reviewed Plaintiffs' proposed interim measures for Cougar dam, which are a deep drawdown by November 15 to 1,505 feet elevation until December 15 and delayed refill in the spring, with prioritization of the regulating outlets during both times. These are similar to OMET measures 5.8.3 and 5.8.5 and alternatives discussed in a draft Environmental Assessment that I reviewed. In my professional opinion, because deep drawdown has been shown to increase the rate of passage at Cougar dam and the regulating outlets have been shown to be the safest

route of dam passage, this measure would substantially increase the survival of juveniles from high quality upstream habitats passing the reservoir and dam, thereby increasing the utility of the upstream habitat and improving the resilience of the population. Because the majority of juvenile salmon enter the reservoir during the spring, delaying refill of Cougar in the spring would shorten fish residence time in the reservoir, reducing their exposure to predators and pathogens in the reservoir, thereby improving their survival. Delayed refill would also allow the fish to express their natural life-history strategy with the majority of juvenile salmon migrating to the sea in the spring.

67. Delayed refill in the spring should have substantial benefits by making the regulating outlets more available for fish that naturally prefer to migrate in the spring while reducing harmful effects of refilling and high reservoirs. The Corps rejected consideration of a delayed refill alternative in primary part because of the Portable Floating Fish Collector (PFFC), which was deployed for research purposes and may not have worked properly under delayed refill. The agency also suggested impacts to water flows and temperature were reason to dismiss this alternative. I disagree with those premises. The PFFC was a research prototype that performed poorly and is, by its very name, portable. Use of this unsuccessful device should no longer preclude a beneficial passage measure. I also find it odd that the Corps mentions decreased dissolved oxygen as a concern with this measure because prioritizing discharge through the ROs would aerate the flow. I agree that because refill would occur during the late spring the reservoir would capture warmer water than under current operations, but I expect that only in warm, low flow years (like 2016) would this substantially reduce the Corps' ability to meet downstream temperature targets. Considering the substantial likely benefits to passage

survival and overall reproductive success, the small risk to water temperature control that delayed refill would present seems acceptable.

Lookout Point Dam

68. In my professional opinion, Plaintiffs' proposal to implement a deep drawdown of Lookout Point reservoir in the fall and ungated spill in the spring would improve juvenile passage survival in several ways. It would: help reduce the numbers of predatory fish in the reservoir, reduce travel time through the reservoir, and make the regulating outlets available, a safer route of passage than the Lookout Point powerhouse.

69. I have reviewed a June 2017 version of a study proposal entitled "Behavior, Distribution, and Passage Metrics of Juvenile Salmonids for Lookout Point Dam," which would test an operation very similar to Plaintiffs' proposal. That proposed study follows prior work that showed about double the dam passage success when a spring ungated spill operation was employed and seeks to gain further understanding of passage options through both a spring ungated spill operation and a deep fall drawdown prioritizing discharge through the regulating outlets. Given the success of the prior ungated spill operation test and the high levels of successful passage observed through deep drafts and the use of the low-level regulating outlets at other dams, I believe the Plaintiffs' proposed measure would markedly improve juvenile passage survival at Lookout Point dam. Adopting this measure would also facilitate completing the proposed study. I strongly support completing that study as the information gained would be useful to identifying fish passage options at Lookout Point/Dexter and other developments in the basin.

70. I have also reviewed the Corps' draft environmental assessment that considered several measures to improve juvenile passage survival at Lookout Point in 2017. The preferred alternative was a set of experimental operations and studies similar to Plaintiffs' proposed interim measure, with similar expected benefits, yet the Corps has not adopted this measure. These measures are likely to have minor short-term effects on downstream water temperatures and turbidity, and possibly TDG concentrations. Flow, water temperature, turbidity and TDG are continuously monitored at a USGS station downstream from Dexter dam and these data should continue to be monitored during this operation to determine if there are any meaningful effects on water quality. Based on the results of similar actions at other dams, I expect any water quality effects to be minor to negligible while the benefits to fish passage would be substantial.

71. I have also reviewed the Plaintiffs' proposal for the Corps to use the regulating outlets for temperature control during the fall at Lookout Point dam. The regulating outlets are lower in elevation and capture cooler water than the powerhouse. This cooler water is needed to avoid or minimize downstream water temperature exceedances of the resource agency standards in fall and winter. In my professional opinion, operation of the regulating outlets is needed to minimize the project's adverse effects on downstream water temperatures and salmon reproductive success.

Fall Creek Dam

72. In my professional opinion, Plaintiffs' proposal to implement a spring deep drawdown of Fall Creek would greatly benefit juvenile salmon passage. Fall drawdowns at Fall Creek dam have proven successful in passing juveniles. However, the majority of juveniles enter the reservoir during the spring and have to endure reservoir residence for months until the fall drawdown to pass the dam, as successful passage during the spring and summer is very low. As

explained above, the shorter the reservoir residence time the greater the likelihood of survival as there are fish predators and parasites in the reservoir that can kill juveniles. I have reviewed proposals by NMFS and ODFW and believe that drawing down the reservoir to 685 feet in the spring and holding through June would provide substantial benefits for juvenile salmon that try to migrate during that time period by reducing reservoir residence time and increasing dam passage survival. A spring drawdown would also allow the fish to display its natural life history strategy without the interference caused by delay in the reservoir.

Prioritization

73. I have also reviewed Plaintiffs' requested direction for the Corps to prioritize dam and reservoir options that benefit fish survival and recovery above all other authorized uses except flood control, human health and safety, and emergency situations. In my professional opinion, this will help avoid unnecessary conflicts that sometimes harm fish. During my time at NMFS, I experienced instances where the Corps prioritized other project uses—like recreation and power production—above actions that could have benefited fish. Thus, I believe this direction will be beneficial because it would clarify, for the Corps, which project objectives to prioritize, possibly opening the door to a broader evaluation of operating options to avoid jeopardizing the continued existence of the species, or adversely modifying their designated critical habitat.

74. I have also reviewed Plaintiffs' proposed interim measure for the Corps to re-run OMET operational alternatives without including faulty assumptions about priorities. I support operational measures that would consider additional or longer reservoir drawdowns, in particular run of the river scenarios. Run of the river scenarios would likely provide much greater benefits to fish through improved reservoir conditions, passage options, and water quality and flows

while still allowing for flood control. For example, OMET measure 5.6.6 explains that run of the river operations for Lookout Point would likely improve fish passage, reduce TDG exceedences, and improve water temperatures. But the Corps did not recommend moving forward with it due to power production impacts. This was not in line with the RPA, and was an inappropriate avoidance of the Corps' responsibility to avoid jeopardizing the species.

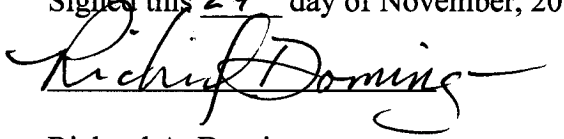
Conclusions

75. The continued operation of Project dams presents high risk to UWR Chinook salmon and steelhead that use the limited habitat downstream from the dams by grossly modifying the hydrologic regime and adversely affecting water quality. The dams also prevent use of high quality upstream spawning habitat for both species. These impacts limit the potential for the fish to survive and recover. Recent fish population downturns make remedying these problems as rapidly as possible an urgent need, yet the Corps has often postponed or rejected proven protective measures, or chosen not to study measures that might prove effective due to perceived conflicts with other Project purposes. These decisions by the Corps to avoid meeting its obligations under the Endangered Species Act to protect UWR Chinook salmon and steelhead suggests that unless Plaintiffs' interim measures are adopted the viability of the fish populations affected by the Project would further decline.

76. It is my professional opinion that the long-term viability of UWR Chinook salmon and steelhead requires the development of highly productive populations upstream of Project dams and safe passage through the dams and reservoirs. While NMFS recognized this need when formulating the 2008 RPA, recent steep declines in abundance and the accelerating effects of climate change make providing fish passage improvements increasingly urgent. Plaintiffs' proposed interim measures are urgently needed to improve juvenile passage and water quality conditions. Plaintiffs' proposed interim measures are the best immediate steps in that direction with the existing facilities, and, in my professional opinion, are wholly reasonable and feasible.

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

Signed this 29th day of November, 2018, in Portland, Oregon.



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