Lauren M. Rule (OSB #015174)
Elizabeth H. Potter (OSB #105482)
ADVOCATES FOR THE WEST
3701 SE Milwaukie Ave. Suite B
Portland, Oregon 97202
lrule@advocateswest.org
epotter@advocateswest.org

Attorneys for Plaintiffs

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 Kirk Schroeder In Support of Plaintiffs' Motion for Preliminary Injunction

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

Professional Qualifications and Experience

3. I received a Bachelor of Science (B.S.) from University of Idaho in 1975 and have almost 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. The research on Chinook salmon involved

survey of rivers for spawning activity, collection of biological information from salmon carcasses, survey of rivers for juvenile salmon use, tagging of juvenile fish for migratory behavior, and gathering of other information to assist in the conservation and management of Chinook salmon.

4. I have worked with spring Chinook salmon on numerous rivers including 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. I was involved in the design, implementation, and evaluation of acclimation studies of winter steelhead in the Siuslaw River and studies on reducing stray hatchery fish in coastal rivers. I also help design and direct studies of acclimation for spring Chinook salmon in the lower Willamette River and Clackamas River.

5. Our research project designed and implemented a broad set of research activities starting in 1996 that included intensive spawning surveys, juvenile fish sampling in spawning tributaries and in the mainstem Willamette River, 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). I have extensive knowledge of streams

and rivers in the Willamette Basin while conducting adult and juvenile salmon surveys from 1996 through 2013. Results of our surveys have been published in a series of annual reports and in 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 provided 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 scientist 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, B. Cannon, and P. Olmsted. 2015. Juvenile life history diversity and populations stability of spring Chinook salmon in the Willamette River basin, Oregon. Canadian Journal of Fisheries and Aquatic Sciences 73:921–934.

Schroeder, R. K., L. D. Whitman, B. Cannon. In preparation. The contribution of life history diversity to the stability of adult spring Chinook salmon populations in the Willamette and Sandy basins, Oregon.

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, K., B. Cannon, L. Whitman, and M. Walker. 2013. Sandy River Basin spring Chinook salmon spawning surveys – 2012; compliance monitoring for Sandy Hatchery Biological Opinion – September 2013. Oregon Department of Fish and Wildlife, Salem.

Schroeder, R.K., R.B. Lindsay, and K.R. Kenaston. 2001. Origin and straying of hatchery winter steelhead in Oregon coastal rivers. Transactions of the American Fisheries Society 130:431–441.

Kenaston, K.R., R.B. Lindsay, and R.K. Schroeder. 2001. Effect of acclimation on the homing and survival of hatchery winter steelhead. North American Journal of Fisheries Management 21:765–773.

Schroeder, R.K., and J.D. Hall, editors. 2007. Redband trout: resilience and challenge in a changing landscape. Oregon Chapter, American Fisheries Society, Corvallis (also Introduction).

Schroeder, R.K. 2007. Rainbow trout in the Deschutes and White rivers, Oregon. In Redband trout: resilience and challenge in a changing landscape. Oregon Chapter, American Fisheries Society, Corvallis.

Schroeder, R.K., and C.A. Savonen. 1997. Lessons from floods. Fisheries 22(9):14-16.

6. Since retiring from ODFW, I have continued to work with the Willamette research project to analyze and write research papers for professional journals, and have met frequently with project personnel on various project activities within the Willamette and Sandy basins.

7. I have served on science and professional society committees including Clackamas Science Review Team to assess 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 on the Resolutions Committee for AFS at the national level.

8. 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) and ODFW awards of Biologist of the Year (2011, Northwest Region) and Technical Achievement Award (1997, Northwest Region). I have not testified as a witness in the last five years.

Upper Willamette River Chinook Salmon and Steelhead

9. Upper Willamette River ("UWR") Chinook salmon and steelhead are the only two native runs of salmon and steelhead within the UWR basin above Willamette Falls. These species are listed as threatened under the Endangered Species Act ("ESA") and have designated critical habitat within the Willamette Basin. 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, prior to construction of dams.

10. Willamette Falls historically restricted migration of adult spring Chinook into the upper Willamette River basin to periods of high spring flows. Adult spring Chinook return to the lower Willamette River beginning in February and as early as March in the Clackamas River.

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 upper portions of the larger subbasins and "hold" in the deeper pools with cooler water temperatures through the summer. At present, adult salmon must hold in the lower reaches of three subbasins—North and South Santiam and Middle Fork Willamette—because access to these upper watersheds is blocked by dams. The historic spawning period for UWR Chinook probably extended from July through October, but at the present spawning generally begins in late August and continues into early October, with peak spawning in September. Adult Chinook salmon deposit their eggs in the fall, and low water temperatures in fall and winter insures that incubation is timed to allow fry to emerge the following spring when there is sufficient food for survival and growth. 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.

11. As with spring Chinook salmon, the run timing of UWR steelhead reflects the influence of Willamette Falls as a barrier to migration except in winter and early spring when flow was high enough to allow steelhead to pass the falls. Native UWR steelhead return from the ocean as adults in January through April and migrate past Willamette Falls from mid February to mid May with peak migration in late March-April. They spawn in March through June, with peak spawning in late April and early May. Although UWR steelhead do spawn in the mainstem areas of the tributaries, they also migrate farther upstream than spring Chinook and are able to spawn in small and high gradient streams because winter and spring flows provide access to these smaller streams. Juvenile steelhead rear in mainstem habitats and the upper

portions of the subbasins for 1-4 years, most frequently for 2 years before migrating to the ocean as smolts in April and May. Smolts are believed to migrate quickly downstream, and migrate faster when river flows are higher. Most UWR steelhead spend two years in the ocean but may spend 1-4 years before returning to freshwater. UWR steelhead appear to be more genetically diverse than steelhead in the Lower Columbia River evolutionarily significant units (ESU)[1], and populations appear to be more distinct from each other than populations in the Lower Columbia.

12. Currently, less than 10,000 wild Chinook salmon return each year to the UWR basin, which is a fraction of the several hundred thousands that historically returned each year. In addition, only the Clackamas and McKenzie subbasins have significant numbers of naturally produced fish. Seven independent populations of spring Chinook have been identified in the UWR Chinook ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette. Populations in the Clackamas, North Santiam, McKenzie and Middle Fork Willamette subbasins were classified as "core populations" and the McKenzie was classified as a "genetic legacy population." As of 2015, most of the populations were considered to be at a very high risk of extinction except for the Clackamas (moderate) and the McKenzie (low). About 70% of the Chinook salmon that return to UWR basin are hatchery fish.

13. Abundance of winter steelhead is not available prior to 1971, so historic abundance is unknown. However, over 10,000 late run winter steelhead—those returning after February 15 are considered to be the native run—returned on average in 1971–1988 compared to an average of about 3,200 in 2008–2018, a decrease of almost 70%. Four independent populations of winter steelhead were identified in the UWR: Molalla, North Santiam, South

[1] 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 steelhead are classified as distinct population segments (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.

Santiam, and Calapooia. The North Santiam and South Santiam rivers are thought to have been major production areas and these populations were designated as "core" and "genetic legacy." As of 2015 the Calapooia population was considered to be at a moderate risk of extinction and the other three were considered to be at a low risk of extinction, with a decrease in the trends for all populations. Recent analyses of the effect of pinniped predation on an already low abundance of winter steelhead suggested that the risk of extinction had increased for all populations, especially with the very low returns to the UWR in 2017 (543) and 2018 (1,233). Hatcheries produce out-of-basin summer steelhead for recreational fishing within the basin as mitigation for the loss of winter steelhead due to the dams. These hatchery fish do not aid in the conservation of the species.

14. The 2011 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 and steelhead 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 viability of salmon and steelhead 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 and a value of the metric or threshold above which the population would be considered viable. 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 or steelhead 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 number and distribution of spawning areas and 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.

Willamette Project Impacts

15. The Willamette Project negatively impacts UWR Chinook salmon and steelhead in each of the four major tributaries. The operation and maintenance of the Corps' dams on these tributaries—Detroit and Big Cliff Dam on the North Santiam River, Foster and Green Peter Dams on the South and Middle Santiam rivers, Cougar Dam on the South Fork of the McKenzie River, and Lookout Point, Dexter, Fall Creek, and Hills Creek Dams in the Middle Fork Willamette River sub-basin—has altered the habitat, flows, and water temperatures throughout the Willamette Basin. In general, the dams were built primarily to control floods in the Willamette Basin and as such they are operated to hold back the high flows of winter and spring in reservoirs, to keep reservoirs high through the summer, and to empty reservoirs starting in the early fall. Although some changes have been made to the operation of the dams, the overall operational guidelines have had numerous negative impacts throughout the Willamette Basin that has resulted in degradation of fish habitat and harm to UWR Chinook and steelhead.

16. <u>General habitat and flow conditions</u>: The Corps' operation of the dams alters the natural flow pattern to which spring Chinook salmon and winter steelhead have adapted over

millennia. Dam operations largely hold back high runoff events in late fall through early spring that historically were important for providing cues for adult and juvenile migration, and providing access to important winter habitat and refugia. Winter and spring floods that go over the banks of the river are important for providing winter habitat for juvenile fish on floodplains and in seasonally flooded side channels and for recharging groundwater that helps provide cool water during summer. Dam operations also result in longer periods of flows that are at or near the top of river banks (bankful flow) than what occurred historically and these flows result in exposure to high velocities for juvenile fish rearing in mainstem habitats. Dams prevent the downstream transport of large wood and sediment which are important for the formation of complex habitats such as development of islands and side channels. The combination of reduced peak flows, reduced wood and sediment, and construction of dikes along the mainstem rivers have reduced long reaches of the lower tributaries and the Willamette to a single channel, compared to the historic river which was a complex of multiple channels.

17. Dam operations that prioritize refilling reservoirs result in a reduction of flows in the late spring and early summer, which can increase water temperature and reduce available rearing areas for juvenile salmonids that in turn can decrease their growth and survival. For example, a substantial component of juvenile spring Chinook rear through winter and spring in the lower reaches of the tributaries and in the Willamette River and migrate to the Columbia River during late spring and early summer of their first year of life. Dam operations have also negatively affected the survival of adult salmon by increasing mortality because of stress caused by high water temperatures and delayed upstream migration. Overall, operation of dams in the Willamette Basin has negatively impacted the survival of adult and juvenile salmon because

actions that would benefit fish have been a lower priority than other purposes such as recreation and power generation

18. Fish passage: The Corps' dams block access to a significant portion of the historic spawning and rearing habitat for both spring Chinook salmon and winter steelhead. More than 90% of historic spawning and rearing habitat for spring Chinook salmon has been blocked in the Middle Fork Willamette sub-basin. Spring Chinook salmon lost about 70% of their spawning and rearing habitat from dams in the North and South Santiam sub-basins, and winter steelhead lost about one-third of their historic habitat. Cougar Dam on the South Fork McKenzie cuts off about 25 miles of spawning habitat for UWR Chinook salmon that was considered to be the best habitat in the McKenzie subbasin. The Corps' dams do not have functional fish passage facilities for adult or juvenile salmon or steelhead. Currently the only passage for adult Chinook and steelhead is to trap the fish and haul them in trucks to release sites above the dams, which allows a limited number to reach historic spawning areas. Any juvenile salmon and steelhead produced by the transport of adult fish upstream of the dams face difficulties in migrating downstream because of the lack of juvenile fish passage facilities and the operation of dams and reservoirs. Our research in the McKenzie River indicated that juvenile fish may migrate downstream in almost any month with distinct peaks in winter and early spring (fry), late winter through early summer (yearling smolts), and fall into early winter (fall migrants). Presently any fish migrating downstream in spring encounter reservoirs that are filling and are therefore unable to continue downstream migration, which interferes with the natural timing of migration and eliminates some life histories.

19. Trap and haul programs are a non-volitional passage solution that harms fish by increasing stress from handling and transport which results in high mortality. Further, not all

returning adult fish are trapped and hauled above the dams. Some fish are forced to spawn in reaches below the dams which exposes them to high water temperature resulting in high mortality before spawning. For those that do spawn, their eggs are exposed to unnatural water temperatures during incubation that leads to mortality or premature development of embryos. In addition to blocking adult passage, any juvenile fish that are produced above the dams are generally forced to pass downstream through the dams using routes such as turbines and deep outlets. These passage routes harm fish because injuries and physiological stress sustained during passage can result in instantaneous death or in delayed mortality that manifests itself as the fish continues to migrate downstream or makes the transition to life in salt water.

20. Reservoirs: Juvenile fish that are progeny of adult fish transported upstream of dams must pass through the reservoirs formed by the high head dams in order to migrate to the ocean. Reservoirs harm juvenile salmonids because of long travel times through the reservoirs, exposure to predation in the slow water, exposure to diseases and parasites, and poor water quality in summer. Reservoirs and lack of passage at the dams also interfere with the natural timing of growth and downstream migration. For example, research in the Willamette Basin has shown that diversity of life histories adds stability and resilience to the population. One life history type is represented by the long-distance downstream migration of newly hatched fry salmon to the lower reaches of tributary rivers and the Willamette River where they rear through late winter and early spring. Reservoirs and dam operations in the basin restrict the timing of downstream migration, and thereby prevent juvenile salmon from completing this migratory life history and other life histories. This results in a simplification of life history and a consequent reduction in population stability and resilience.

21. Water quality: Presence and operation of the dams has contributed to water quality problems in the UWR basin. Because water released from the dams is drawn from reservoirs, it has changed the natural temperatures of the river and has caused harm to fish. A principal effect of increased water temperatures downstream of dams in fall and winter is either direct mortality of eggs in redds or accelerated incubation of eggs such that fish emerge early when food availability is low and high winter flows may wash fish out of the gravels before they are ready. Because adult salmon are blocked by dams and must hold downstream (rather than in the upper watershed), they are exposed to warm water temperatures that results in mortality before they have a chance to spawn. In some areas, water releases from dams causes high levels of dissolved gases in the water that can kill or injure fish, and may also damage eggs during developmental stages.

22. Hatchery fish: In an attempt to mitigate for the loss of salmon and steelhead caused by the Willamette Project, the Corps has funded hatchery programs in the basin. However, the introduction of hatchery fish into the UWR basin harms wild fish through competition for rearing habitat, interbreeding with wild fish with potential loss of productivity in the wild fish, introduction of disease, high density of hatchery fish downstream of dams where most of the hatcheries are located (which can increase transmission of disease or increase stress in wild fish by crowding), and attraction of predators when large numbers of juvenile hatchery fish are released, which may increase predation on wild fish

23. North Santiam River: Lack of adult and juvenile fish passage at two dams harms the populations because 70% of Chinook and about 1/3 of steelhead historic spawning, incubation, and rearing habitat has been blocked. Pre-spawning mortality has been high downstream of Big Cliff and Detroit dams because of high water temperatures in the lower

reaches of the North Santiam River. Although fish have been trucked upstream, mortality of transported fish has been high in some years and adults have often spawned in just a few areas, resulting in multiple redds superimposed on each other. Lack of passage facilities for getting juvenile fish downstream past two closely proximate dams has further reduced the success of passing adults upstream for purposes of conserving or restoring wild populations. In areas downstream of dams, operation of the dams has altered flows and water temperature which harms fish that spawn and rear in those areas. Spill at the dams in an attempt to pass juvenile fish also results in high levels of dissolved gas in the water, which affects juvenile fish attempting to pass downstream, as well as juvenile and adult fish downstream of dams. Dam operations in the North Santiam have altered historic streamflow patterns downstream of the dams, including higher flow in fall and lower flow in late winter and spring. These changes in flow can affect migration, spawning, and rearing for steelhead and salmon.

24. Operation of Detroit Dam has resulted in water temperatures that reach an annual maximum in fall and can exceed the water temperature criterion. High levels of pre-spawning mortality in Chinook salmon have been observed in the North Santiam River (average = 40%; as high as 75%). Adult fish passage at upper Bennett Dam in the lower North Santiam River has improved with reconstruction of the fish ladder and the average pre-spawning mortality has been lower (28% in 2012–2018), but mortality has still been as high as 58% (2018) and 63% (2015) in the areas upstream of upper Bennett Dam. For those fish that survive to spawn, flow has been ramped up or down during spawning season, which causes fish to spawn in areas that may be dewatered or that may later be too deep for successful incubation of eggs. Flows are often unnaturally ramped up in early to mid October to empty Detroit Reservoir because it is held at high levels to accommodate recreation and must then be lowered in time for flood control.

These unnaturally high flows can affect the structure of redds and intergravel flow through redds which provide oxygen to developing eggs. In addition, because surface water in the reservoir is warm at the end of summer, the water being released from the reservoir is unnaturally warm, and this results in accelerated development of eggs and premature hatching and emergence of fry. Early emergence of fry in early winter reduces their survival because of high flow and associated high velocity and because of low food availability.

25. South Santiam River: Corps dams blocked passage to 70% of historic habitat for Chinook and about 1/3 for steelhead, particularly the Middle Santiam River, which was blocked by Green Peter Dam and historically contained some of the most important spawning and rearing habitat for salmon and steelhead in the subbasin. Pre-spawning mortality of Chinook has been high downstream of Foster Dam because of high water temperatures and high density of adult salmon immediately downstream of the dam (average of 22%, as high as 72%). Although an adult fish trap at Foster Dam has been recently renovated, there have been problems with attracting adults into the trap, therefore the numbers of fish available for transport have been small in recent years. Spawning in the South Santiam River upstream of Foster Reservoir is limited because much of the river is high gradient with long reaches of bedrock with little spawning gravel. High flows during winter can result in the erosion of redds because gravel patches are often shallow and lie on top of bedrock. Spawning and incubation success of fish transported upstream of Foster Reservoir has varied because of high mortality of transported fish, scouring of redds and poor incubation success. A fish weir designed to improve downstream fish passage at Foster Dam has been recently installed, but it is unclear if the weir will substantially increase passage survival.

26. McKenzie River: Cougar Dam blocked passage to important spawning and rearing areas in the South Fork McKenzie River. Although an adult fish trap was constructed at the base of Cougar Dam to facilitate the passage of adult fish upstream of the dam, numerous problems have arisen including the mortality of fish in the trap and the mortality of transported adult fish. In addition, genetic studies of adult salmon caught in the trap indicated early migrants were often progeny of fish that had spawned downstream of the dam. Because of these results only adult salmon trapped in the latter part of the run are allowed to be transported upstream, but this also increases handling of fish in the early part of the run that must be trucked downstream after entering the trap.

27. Construction of a tower to control the water temperature downstream of the dam was completed in 2005 and has helped to return water temperatures to a more normal seasonal distribution. However, based on the average daily mean temperature (2005–2017 water years; Oct 1–Sep 30)_the water temperature downstream of the dam was about 3–7 degrees F higher in mid-April through mid-October than that upstream of the reservoir. Although downstream warming would occur naturally, USGS estimated a maximum natural warming of about 1 degree F for the 6-mile length from the upstream gauging site to the dam. Water temperatures below the dam remain higher than that upstream of the reservoir through mid January during the early incubation period. The number of salmon carcasses recovered downstream of Cougar Dam has often been too small to accurately estimate pre-spawning mortality. However, a comparison of mortality upstream and downstream of the South Fork McKenzie indicates that mortality is generally lower upstream of the confluence (3.5% vs. 7.7% in 2002–2018). Mortality has decreased both upstream and downstream of the South Fork since the completion of the temperature control tower (9.3% to 2% upstream and 16.8% to 5.4% downstream), although

some of this is likely attributable to improvements to fish ladders at Leaburg Dam in 2004–2006, which allowed adult salmon to more quickly migrate upstream. The temperature control tower did not include provisions for passing juvenile fish downstream, therefore the passage of any juvenile fish is through passage routes such as turbines or deep regulating outlets which causes fish to dive to depths that are unnatural in order to find an outlet and results in direct and delayed mortality to juvenile fish.

28. Because the McKenzie River is the only subbasin upstream of Willamette Falls that still has access to historic spawning and rearing habitat in the upper watershed, 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. Because of dam operations, any juvenile fish produced by adult fish transported upstream of Cougar Dam are trapped in the reservoir and not allowed to carry out their inherent life history behaviors. Rearing in the unnatural environment of the reservoir exposes juvenile fish to predation as well as disease and parasites which may result in direct mortality and delayed mortality after passage and migration to the ocean because of the weakened health of the fish. In addition, the juvenile fish attain an unnaturally large size because of high growth rates with unknown effects on survival through passage routes. In addition, large size smolts have been shown to result in adults returning at a younger age and smaller size which affects productivity of the population because small females have fewer eggs.

29. Middle Fork River Sub-basin: Over 90% of the historic habitat for spring Chinook salmon has been blocked by dams in the Middle Fork Willamette subbasin. Pre-spawning mortality has been particularly high in the Middle Fork Willamette River downstream of Dexter and Lookout dams, with almost 100% of fish dying before spawning in some years (average = 80%). Any redds produced downstream of the dams are subjected to high water temperatures which results in high mortality of eggs. Surveys have indicated little natural production in reaches downstream of the dams. As with the other subbasins, adult salmon trapped and hauled upstream have had high mortality rates and passage of juvenile fish has shown limited success. Any juvenile fish produced upstream of dams are subjected to predation and disease in reservoirs, and must pass downstream through the dams resulting in high mortality. Fall Creek reservoir has been drawn down since fall of 2011 to facilitate passage of juvenile salmon and results suggest a slight improvement in returns. The average return of wild adult salmon to Fall Creek Dam was 351 in 2014–2017 compared to 277 in 2002–2013 (the fall 2011 drawdown would have affected juveniles from the 2010 brood year and 2014 would have been returns of the age 4 adults). Estimates of wild fish in the Middle Fork Willamette subbasin indicate that over 70% are found in Fall Creek, although the total number of wild adults in the subbasin remains less than 500, well below levels that would lower the risk of extinction for this population. Adult salmon are transported upstream of dams but mortality has been high because of injuries and stress associated with trapping and transport in trucks, including in Fall Creek.

30. The ongoing operation and maintenance of the dams and reservoirs continues to disrupt the life history of UWR Chinook salmon and winter steelhead. Despite some recent changes in operations, continued effects include high pre-spawning mortality, premature incubation of eggs and emergence of fry, lack of access to historic spawning and rearing habitat,

and lack of effective and safe passage for juvenile fish through reservoirs and dams. Winter flows in mainstem habitats that are held at bankful levels and not allowed to go over the banks can disrupt rearing and growth of juvenile fish because they are exposed to high water velocities and cannot access areas of refugia such as floodplains. Plans to identify and remove non-essential levies and other structures that armor river banks have not been implemented resulting in loss of habitat complexity and important rearing habitat for juvenile fish.

31. All of the attributes considered as critical for long-term viability of the salmon and steelhead populations continue to be affected by operations of the dams. 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 presence of hatchery fish; and disruption to rearing and migratory life histories. Our research has shown that life history diversity at 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 likely be critical for maintaining spring Chinook and winter steelhead populations. Under current conditions and operations of the dams, populations have continued to decline throughout the Upper Willamette Basin.

32. In recent years, the abundance of salmon and steelhead in the Clackamas and Sandy basins has increased likely because of improvements to upstream and downstream passage through alterations at dams (Clackamas) or removal of dams (Sandy). In contrast, the lack of substantial improvement in the UWR populations suggests ongoing operations of dams has continued to harm salmon and steelhead.

Population Level Harms

33. When NMFS issued the Biological Opinion for the Willamette Project in 2008, UWR Chinook salmon and steelhead were highly imperiled. Numbers of wild spring Chinook have been available since 2002 when all returning hatchery fish could be identified with an adipose fin clip and unclipped hatchery fish could be further estimated from the presence of an induced thermal mark in the otoliths of carcasses recovered on spawning grounds. Since the Biological Opinion was issued, the species has continued to decline. Estimated numbers of wild spring Chinook at Willamette Falls have declined from 13,228 (2002–2007) to 7,639 (2008–2018), a decline of 42%. In addition, peaks in abundance have declined. A recent peak in abundance in 2015 was about 8,800, which was lower than previous peaks of about 12,000 in 2011 and about 17,600 in 2003. From the 2015 peak of 8,800 the population has steadily declined to about 4,800 in 2018.

34. In contrast, the number of wild Chinook salmon in the Clackamas and Sandy basins has increased in recent years from about 1,430 (2008–2014) to about 2,940 in the Clackamas and 3,540 in the Sandy (2015–2018). Improvements have been made for passage at the dams in the Clackamas by Portland General Electric, especially providing passage for juvenile salmon and steelhead past the dams. Marmot Dam in the Sandy River was removed and the number of wild fish has increased.

35. Estimates of total wild Chinook in the individual subbasins is based on a combination of redd surveys, dam counts, and recovery of carcasses to estimate pre-spawning mortality and the wild:hatchery mix in the population. These estimates provide a good index of trends in abundance through 2017 (data on wild populations are not available for 2018). The core population of wild spring Chinook in the McKenzie River has declined by over 50% from 2002–2007 to 2008–2017, to a mean of less than 1,600 adults. Peaks in abundance of wild adults

has also declined in the McKenzie from about 5,030 in 2003 to 2,750 in 2007, 2,500 in 2011, and 1,790 in 2015. Although populations of wild fish in the other subbasins have generally increased from 2002–2007 to 2008–2017, these numbers may include first generation progeny of hatchery fish that spawn in the rivers. In addition, mean abundance remains below 1,000 fish in the North and South Santiam and below 500 fish in the Middle Fork Willamette subbasin, with 75% of these occurring in Fall Creek (2008–2017 mean). Of particular concern is the recent steady decline of wild adult Chinook in the South Santiam from 1,530 in 2013 to 245 in 2017.

36. Winter steelhead are enumerated at Willamette Falls and those that pass after February 15 (late run) are considered native to the basin and not progeny of naturalized winter steelhead from hatchery programs that have been discontinued. The 2008–2018 average run was about 3,200 compared to the 1975-2007 average run of about 7,600 (-58%). The average run in 2017–2018 was just 888 compared to about 3,700 in 2008–2016 (-76%). The peaks in abundance have also decreased over time from over 15,000 in 1970s and 1980s to about 11,000 in 2001 and 2002 to less than 5,000 after 2010. Estimates by subbasin have been estimated by partitioning the Willamette Falls count based on dam counts, redd counts, and redd densities in the subbasins. Although there is much uncertainty in these data, they provide a general index of trends. In the North Santiam the 1985-2007 average was 1,263 compared to 790 in 2008–2016 (-38%). Estimated abundance in the South Santiam decreased from 1,847 in 1985–2007 to 821 in 2008–2016 (-56%). The Molalla population decreased from 1,801 in 1985–2007 to 1,313 in 2008–2016 (-27%) and the Calapooia decreased from 412 to 360 (-43%) during the same periods.

37. In contrast to the population declines in the upper Willamette Basin, the populations of winter steelhead in the Clackamas and Sandy basins have increased in recent

years. The count of winter steelhead at North Fork Dam in the Clackamas River has increased from an average of about 1,000 in 2003-2007 to about 1,300 in 2008-2018. Including estimates of abundance from redd counts downstream of the dams on the Clackamas, the total abundance for the Clackamas increased from an average of about 1,500 (2006-2007, the only years with full redd counts) to over 3,100 in 2008-2018. Total population size has averaged over 3,300 in recent years (2015-2018). Similarly in the Sandy Basin, the estimated abundance of winter steelhead increased from 1,100 in 2006-2007 to over 3,000 in 2008-2018. In recent years, the estimated population has averaged over 4,500 (2015-2018).

38. During the last several years, studies have documented several ongoing or new threats to UWR Chinook salmon and steelhead. A radio-tracking study of Chinook salmon indicated a loss of adult fish between Willamette Falls and the spawning tributaries that probably reflects pre-spawning mortality as adult fish migrate upstream rather than fish entering other tributaries (e.g., westside streams) or spawning in the Willamette River or the lowest reaches of the eastside tributaries. High levels of total dissolved gases have been documented in recent studies in the North Santiam River downstream of Detroit and Big Cliff dams, and may negatively affect wild adults passed upstream of Minto Dam as well as incubating eggs and juvenile fish. Predation by sea lions has increased in recent years, especially on winter steelhead. Effects of predation are more pronounced when runs are low, thus the mortality rate is higher on a low run of fish than if the population was at recovery levels.

39. Recent analyses suggest the projected effects of climate change will result in lower snowpack, possible shifts in rainfall patterns and intensity, and higher summer air temperatures. These effects would lead to reduced winter water storage, lower minimum flows, and higher maximum water temperatures. Conditions downstream of dams would degrade

further for salmon and steelhead blocked by dams. Studies of adult salmon at Cougar Dam indicated that returns of progeny from adults transported upstream of the dam were well below replacement levels (0.31 and 0.41). Tagging studies of juvenile salmon suggested poor survival through Cougar Reservoir and Dam. Studies in the Middle Fork Willamette subbasin indicated high mortality of transported adult salmon.

40. A research study of wild Chinook salmon in the Willamette Basin documented that life history diversity found in both juveniles and adults provided stability to the populations through time. Diversity allowed fish to respond to changing conditions such that certain life histories performed better in some years than other life histories, which served to buffer the population as a whole. These results indicated the importance of diversity and suggests that loss of diversity caused by lack of access to historic habitats and lack of downstream passage could reduce the stability and resilience of populations.

41. In my professional opinion, the Corps' ongoing operation and maintenance of its dams have contributed to the continual decline of spring Chinook salmon and winter steelhead and has prevented their recovery. Viability criteria for salmon and steelhead recovery are a combination of abundance/productivity, spatial structure, and diversity. Without access to historic spawning and rearing areas in the North and South Santiam and the Middle Fork Willamette subbasins, it is highly doubtful that delisting recovery will be achieved for the species, much less broad sense recovery. This is particularly the case under probable future effects of climate change which will make the areas downstream of dams less hospitable for adults to hold and spawn, and for juvenile fish to rear.

42. In my professional opinion, progress toward recovering these species will not be possible as long as adult salmon and steelhead are restricted to a fraction of their historic range

downstream of the dams. In addition, measures for upstream and downstream passage must allow fish to express their full range of life histories to meet both the spatial structuring and diversity criteria for viability. Our research and others have shown the diversity of life histories in both juvenile and adult fish is important for providing stability and resilience to populations. For juvenile salmon and steelhead, passage should be provided at different times of the year depending on the migratory behavior exhibited by progeny of adult fish transported upstream of dams. In the upper reaches of the McKenzie subbasin where adult salmon can access historic spawning areas, the primary periods of migration are winter to early spring for newly emerged fry migrating to mainstem habitats, October through December for fall migrants, and March through mid-June for yearling smolts.

43. Although other factors have contributed to the decline of the species through time, such as fishing and water pollution in the Willamette River, measures have been taken to reduce their effects. In addition, several measures have been taken in the Willamette Basin to reduce the number or impact of hatchery fish, such as eliminating some hatchery programs (winter steelhead, fall release of some hatchery Chinook), reducing the numbers released, targeting releases in areas away from spawning tributaries within the basin or farther downstream in the Columbia River. Improvements have been made to several fish ladders at small dams in the North and South Santiam and the McKenzie subbasins.

44. In contrast, primary effects of dams and dam operations such as blocked access to historic habitat and changes in temperature and flows downstream of dams have largely continued without substantial change for decades. Other factors have contributed to the decline of the species including climate change and associated effects on freshwater and ocean environments. However, the effect of these factors is exacerbated because dams and dam

operations have diminished the capacity of the species to adjust to changing conditions by blocking access to upper watersheds where environments are more favorable and by increasing the effects downstream of dams. Recently, predation by sea lions at Willamette Falls has affected populations, especially winter steelhead. However, the effects of predation are more pronounced when populations have already been reduced than if the populations were at recovery levels. In my professional opinion, the dams are the primary reason that the species were listed as threatened under the ESA and recovery will not be possible without major alterations to the dams and dam operations.

45. The current trajectory of changes proposed for dams and dam operations are inadequate in the face of the declining trends in populations of salmon and steelhead. Plans for providing successful juvenile and adult fish passage at dams in the upper Willamette basin (e.g., Cougar, Detroit, Lookout Point) are years away from finalization, much less implementation. Therefore, in my professional opinion, I believe interim measures are needed to enable progress in providing passage for adult and juvenile salmon and steelhead.

Plaintiffs' Proposed Interim Measures

46. I have reviewed Plaintiffs' proposed interim measures. In my professional opinion, these measures are necessary for preventing further decline of the salmon and steelhead populations and for moving populations toward recovery criteria. Therefore, the operation of dams in the upper Willamette Basin should be prioritized to meet objectives for fish recovery over that of other uses. These would include flow and temperature targets, total dissolved gas, and providing juvenile and adult fish passage.

47. More natural flow conditions are needed to support all life cycles—egg incubation, juvenile rearing and migration, and adult migration, holding, and spawning. Deep

drawdowns should be required to allow juvenile fish to migrate during late winter through spring (fry and yearling smolts), and during fall and early winter (fall migrants). Ultimately, some dams may need to be operated as run-of-river to provide passage for adult and juvenile salmon and steelhead, with provisions for continuation of flood control. Successful passage of juvenile salmon and steelhead at the dams may require turning off turbines at dams such as Lookout Point, Dexter, Detroit, Big Cliff, Green Peter, Foster, and Cougar. Long term recovery plans should consider the alternative of removing dams to improve passage of adult and juvenile salmon such as Dexter and Big Cliff dams.

48. In addition to improving passage at the dams, the dam operations should set a priority on providing adequate water quality for adult and juvenile salmon and steelhead downstream of the dams. Water temperature is an important factor that affects the survival of adult salmon, influences the timing of incubation of eggs and emergence of fry, and the growth and survival of juvenile fish. Measures to more closely match water temperatures upstream and downstream of dams will be needed to minimize the effect of dams,

49. These measures should be considered as a minimum to prevent further decline of the species while the agencies complete a new ESA consultation. However, a long-term strategy should include measures that prioritize the recovery of the species in the basin. For example, to recover Chinook salmon in the Middle Fork Willamette, the Corps may need to operate Lookout Point dam as run-of-the-river except when needed for flood control, and to remove Dexter Dam.

50. <u>Lookout Point Actions:</u> I have reviewed the proposal to draw down the Lookout Point reservoir to 750 feet for one month in the fall. At this reservoir elevation, the regulating outlets will be located 14 feet from the top of the reservoir, which will make them more accessible for juvenile salmonids. In my professional opinion, this deep drawdown will improve

conditions for allowing juvenile salmon to pass the dam. A deep drawdown would likely provide a more natural riverine environment for juvenile fish to migrate, allow fish to more easily sound and pass through the dam, and would likely reduce effects of predation by reducing the abundance of predators either through flushing them downstream or interrupting their reproductive cycles.

51. I have reviewed the proposal to conduct free, ungated spill at Lookout Point during the spring. In my professional opinion, this operation will provide an opportunity to test effectiveness for juvenile salmon passage in spring and fall. Further delays in conducting tests will jeopardize progress toward recovering salmon in the Middle Fork Willamette subbasin where the largest impediment to recovery remains a lack of access to historic spawning and rearing habitat upstream of Lookout Point and Hills Creek dams. Results of the effectiveness of downstream passage will inform decisions about long-term passage strategies. Should studies show that passage through spill is not feasible, an alternative may be to operate Lookout Point as run-of-river with associated modifications to Dexter operations such as drawdown, removal of turbines, or removal of Dexter Dam.

52. I have reviewed the proposal to use the lower regulating outlets of Lookout Point dam to perform temperature control operations during the fall. This will release colder water, which should lower river temperatures from their abnormally high temperatures in the fall. Benefits to fish would likely include higher survival of eggs in redds that are made in fall, and depending on the duration and temperatures achieved, could also slow the incubation time of eggs and the emergence timing of fry.

53. Fall Creek Spring Drawdown: I have reviewed the proposal to drawdown Fall Creek reservoir in the spring to 685 feet and to hold that reservoir elevation until June. In my

professional opinion, this operation will provide a possible passage route for juvenile salmon to migrate in the spring. An entrainment study indicated that peak migration occurred in late May and June but the only passage route was through the fish horns that are known to be ineffective in safely passing fish and result in low survival. A deep drawdown would allow fish to pass through the regulating outlet, which has been shown to successfully pass juvenile fish in the fall. Extending the drawdown into spring would provide a passage option for juvenile salmon that matches their natural migration timing. An additional benefit would be a more natural growth pattern than what is currently observed when juvenile fish are trapped in the reservoir. Although high growth rates in the reservoir result in juvenile salmon attaining a large size, survival benefits are unknown and large smolts are known to result in adult fish returning at a younger age and smaller size, thus affecting fecundity (fewer eggs in females) and productivity of the population. Since the fall drawdown was initiated, the average return of wild adult salmon to Fall Creek Dam has increased modestly from 277 to 351. Because recovery of Chinook salmon will depend on large improvements in passage at the dams, it is imperative that studies are conducted immediately in order to develop long-term alternatives for adult and juvenile passage. Operating Fall Creek as run-of-river may be necessary to ensure successful juvenile salmon passage.

54. Green Peter Chinook Salmon Outplanting: I have reviewed the proposal for the Corps to begin outplanting adult Chinook salmon above Green Peter dam to comply with the RPA. In my professional opinion, this operation will provide a needed opportunity to evaluate and identify juvenile and adult fish passage options, and will initiate the development of effective reintroduction strategies. The Middle Fork Santiam River, which joins the South Santiam River at the current site of Foster Reservoir, was considered the top producer of

Chinook salmon and an important winter steelhead watershed in the South Santiam subbasin. Providing passage to this historic spawning and rearing habitat may be the only feasible option for recovering salmon and steelhead in the South Santiam subbasin.

55. Cougar Actions: I have reviewed the proposal to drawdown Cougar reservoir to 1,505 feet by November 15 and holding this level for four weeks to allow passage of juvenile salmon through the regulating outlet. As with the other Willamette projects, safe and effective passage for adult and juvenile Chinook salmon is needed for recovery of the species in the McKenzie subbasin. A drawdown and priority of the regulating outlet as the passage route (vs. a turbine route) would provide an opportunity to evaluate this option for safe and effective passage. In my professional opinion, a volitional passage route for juvenile salmon should be a high priority and would likely be more effective and safe than attempting to trap juveniles in the reservoir, handle them, and transport them around the reservoir for release downstream of the dam.

56. I have reviewed the proposal to delay refill at Cougar Reservoir in the spring. This measure would provide an opportunity to evaluate passage for fry and juvenile salmon. Likely benefits would include providing passage for natural downstream migration timing of juvenile salmon. Studies indicated a large number of fry produced by outplanted adults migrated downstream in late winter to early spring but were then trapped in the reservoir, exposing them to various sources of mortality and parasite infestations. Based on research in the McKenzie River, many of these fry would likely continue migrating to the McKenzie and Willamette rivers to rear. Other life histories may rear through summer in the South Fork McKenzie downstream of the dam and in the McKenzie River and migrate in the fall or following spring. A delayed refill of the reservoir until late May or into June and priority of regulating outlet passage would

allow fish to volitionally migrate downstream. Volitional migration should be a higher priority passage option than other alternatives such as trapping and hauling juvenile fish downstream.

57. Detroit Dam Actions: I have reviewed the proposal to drawdown Detroit reservoir to 1,370 feet by November 15 and to hold at that reservoir elevation until December 15. This action should benefit fish by providing a passage route through regulating outlets that could be reached more easily because juvenile fish would not have to sound as deep to locate the outlet. Based on work in the McKenzie River, most migration in fall and early winter for Chinook salmon occurs before mid December. Evaluation of the effectiveness and survival of juvenile fish passing downstream would inform the development of long-term passage options.

58. I have reviewed the proposal to operate the lower regulating outlets of Detroit Dam to provide temperature control during the fall. In my professional opinion, this operation would lower the water temperature during early incubation. Operations in 2015 indicate that the lower regulating outlet could be used to access cooler water and in that year this measure provided lower water temperatures downstream, albeit still above target maximum temperatures. Although the temperatures in 2015 were still above targets by about two degrees, the use of the lower regulating outlet nevertheless prevented downstream temperatures from being closer to 60 degrees F, which would have greatly accelerated egg development during the early part of the incubation period. Aggressive interim measures are needed to reduce harm to depressed salmon and steelhead runs while more long-term strategies are implemented.

Conclusions

59. Corps dams have blocked passage to historic spawning areas in the North and South Santiam, McKenzie, and Middle Fork Willamette subbasins, resulting in a loss of about 20–90% of historic habitats. To date, efforts to reintroduce adult salmon and steelhead have had

limited success or have not been implemented (above Green Peter Dam). Where fish have been transported upstream of dams, mortality has often been high and lack of passage for juvenile fish means that reintroduction efforts have had little effect in mitigating the loss of habitat from dams and reservoirs. Research has indicated juvenile fish may migrate downstream in almost any month of the year with distinct peaks in winter and early spring for fry, fall through early winter for fall migrants, and late winter through early summer for yearling smolts. Reservoirs and lack of passage at dams interferes with the natural migratory behaviors of juvenile fish, resulting in a loss of life history diversity which has been shown to provide stability to populations.

60. Operation of Corps dams in the upper Willamette Basin that would benefit fish have often been a lower priority than other uses (e.g., recreation, power generation), even when flood control can be achieved. As a result, salmon and steelhead have been negatively affected by unnatural flows, water temperatures, and total dissolved gases. Unnatural flow and temperature conditions downstream of dams has resulted in environmental conditions that can lead to high pre-spawning mortality of adults and premature development of eggs and emergence of fry. Altered flows and temperatures can affect the growth of juvenile fish and interfere with cues for migration. Controlled flows in the winter have reduced access to refuge habitat in floodplains for juvenile fish and exposed them to high water velocities during extended periods when flows are unnaturally kept at bankful levels. The presence of unneeded dikes and armored banks results in loss of habitat complexity for rearing and exacerbates the effects of controlled winter floods by preventing access to floodplains and other habitats off the main channel of the rivers.

61. The abundance of salmon and steelhead in the UWR basin is at a historic low, and most populations are showing a downward trend with numbers that are below replacement

levels. Because some of the naturally produced adult salmon are likely the first generation progeny of hatchery fish spawning in the rivers, the status of wild salmon may be even more precarious than is currently known. Estimated numbers of wild spring Chinook at Willamette Falls has declined 42% from 2002–2007 to 2008–2018, with a recent steady decline from 8,800 in 2015 to about 4,800 in 2018. The "genetic legacy" and core population in the McKenzie subbasin has declined by over 50% from 2002–2007 to 2008–2017 to an average abundance of less than 1,600 wild adults. The late run of winter steelhead at Willamette Falls has decreased by 58% from 1975–2007 to 2008–2018 with a further decline in the last two years of 76% to an average of just 888 adults.

62. In contrast, the abundance of salmon and steelhead has increased in recent years in the Clackamas and Sandy basins where adult and juvenile passage has improved because of alterations at dams (Clackamas) or removal of dams (Sandy). The precarious status of the UWR salmon and steelhead populations indicate the need for substantial changes to operations and meaningful measures to benefit the populations.

63. In my professional opinion, the proposed interim measures are needed to prevent further decline of UWR salmon and steelhead. Operations of the dams should be prioritized to meet objectives to benefit fish including flow and temperature targets, total dissolved gas, and providing juvenile and adult fish passage. As such, the proposed interim measures would help prevent further harm to the species and should help populations by improving passage conditions and water quality. The proposed drawdowns would result in conditions that should improve downstream passage for juvenile salmon at Fall Creek, Lookout Point, Cougar, and Detroit dams. Outplanting spring Chinook above Green Peter Dam would allow agencies to evaluate and identify juvenile and adult fish passage alternatives, and begin development of a long-term

and effective reintroduction program. Proposed measures to use lower regulating outlets at Lookout Point and Detroit dams would provide lower water temperatures downstream of dams during the early part of the incubation period, thus improving conditions for survival of eggs and more natural timing of egg development.

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

Signed this 28th day of November, 2018, in Philomath, Oregon.

K. Schroeder

Kirk Schroeder