TODD D. TRUE (WSB #12864)
ttrue@earthjustice.org
STEPHEN D. MASHUDA (WSB #36968)
smashuda@earthjustice.org
Earthjustice
705 Second Avenue, Suite 203
Seattle, WA 98104
(206) 343-7340 | Phone
(206) 343-1526 | Fax

DANIEL J. ROHLF (OSB #99006)
rohlf@lclark.edu
Earthrise Law Center
Lewis & Clark Law School
10015 S.W. Terwilliger Boulevard, MSC 51
Portland, OR 97219
(503) 768-6707 | Phone
(503) 768-6642 | Fax

Attorneys for Plaintiffs

THE HONORABLE MICHAEL H. SIMON

UNITED STATES DISTRICT COURT

DISTRICT OF OREGON

PORTLAND DIVISION

NATIONAL WILDLIFE FEDERATION, *et al.*,

Plaintiffs,

and

STATE OF OREGON,

Intervenor-Plaintiff,

v.

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

Defendants,

and

No. 3:01-cv-00640-SI

SECOND DECLARATION OF BRENDAN M. CONNORS

NORTHWEST RIVERPARTNERS, INLAND PORTS AND NAVIGATION GROUP, STATE OF IDAHO, STATE OF MONTANA, STATE OF WASHINGTON, KOOTENAI TRIBE OF IDAHO, CONFEDERATED SALISH AND KOOTENAI TRIBES, and NORTHWEST POWER AND CONSERVATION COUNCIL,

Intervenor-Defendants.

I, BRENDAN M. CONNORS, state and declare as follows:

1. I am a quantitative ecologist and fishery scientist by training and experience who studies how natural- and human-mediated processes interact to shape the dynamics of fish populations. I have previously filed a declaration in this case in connection with a motion for summary judgment by the plaintiffs, National Wildlife Federation, *et al*. In that declaration I described my background and experience and provided a copy of my curriculum vitae.

2. In preparing this second declaration, I have reviewed the declarations of Drs. Richard W. Zabel and Christopher Toole, filed by the National Marine Fisheries Service in connection with their cross-motion for summary judgment. I have also reviewed the declaration of Anthony Nigro, previously filed by the State of Oregon in connection with its motion for summary judgment. Finally, I have reviewed various published papers and studies that Dr. Toole or Dr. Zabel cite and discuss in their declarations.

Overview

3. In the remainder of this second declaration, I address points raised by Drs. Toole and Zabel in response to my prior declaration. As a preliminary matter, however, I would like to clarify that the purpose of my prior declaration was not to dispute the conclusions or findings of Appendix C to the 2014 BiOp, *see* Declaration of Christopher Toole at ¶ 19 ("Dr. Connors does not materially dispute NMFS' conclusions") (hereinafter "Toole SJ Dec."). Rather, my purpose, as I explained, was to describe factors relevant to understanding aspects of density-dependent interactions in salmon populations and to identify information that may be relevant to

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

understanding these processes in the larger context of a population's overall dynamics. *See* Declaration of Brendan M. Connors at ¶ 3 (hereinafter "Connors SJ Dec."). It is in the same vein that I respond to points raised by Drs. Zabel and Toole below.

4. More specifically, the purpose of my prior Declaration was to articulate a possible biological explanation for why interior Columbia Chinook salmon and steelhead populations may be exhibiting strong evidence of density-dependent declines in productivity in response to recent increases in abundance, despite the fact that in recent years many of these populations have remained at average abundances well below abundance levels described by the Interior Columbia Technical Recovery Team (ICTRT) as minimum viable population abundances. *See* 2014 BiOp at 80, 82 (Tables 2.1-5 and 2.1-6) (26 of 27 Chinook and 13 of 21 steelhead populations from the Interior Columbia River basin have most-recent 10-yr geometric mean abundance below ICTRT threshold abundance goals, most well below those goals).

5. I also sought to describe several lines of evidence and relevant factors that affect salmon survival and productivity outside tributary habitat that could be limiting the ability of Interior Columbia Chinook and steelhead populations to overcome currently observed density-dependent interactions in tributary habitat and grow to secure and stable levels. *See* Connors SJ Dec. at ¶¶ 17-18. In his declaration, Mr. Anthony Nigro describes in greater detail factors outside tributary habitat that may be limiting population growth and productivity for many Interior Columbia salmon and steelhead populations. *See* Declaration of Anthony Nigro at ¶¶ 6-11, 25-35 & 36-43 (hereinafter "Nigro SJ Dec."). As he explains, these factors may limit population growth to such an extent that survival increases from tributary habitat restoration (in those populations where tributary habitat restoration is occurring) would have to exceed biologically plausible levels in order to overcome the factors limiting their growth and allow the populations to increase their abundance to a more stable and secure level. *Id*.

Discussion

6. In my prior declaration, I explained that density-dependent interactions in tributary habitat can occur under more than one set of circumstances, Connors SJ Dec. at ¶ 14;

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

see also id. at ¶¶ 10-13. One of these circumstances can occur where population abundance is high and close to the overall carrying capacity of freshwater spawning and rearing habitat. *Id*. at ¶ 14. Dr. Toole refers to this form of density-dependent interaction in his declaration. *See* Toole SJ Dec. at ¶ 12 ("When the abundance of spawners is high . . . productivity is generally low") ("R/S is high when abundance is low and R/S is low when abundance is high"). However, I also described in my declaration that density dependence may be strong during periods of relatively low abundance, rather than periods of higher abundance, as a result of the spatial contraction of the population to a subset of habitat patches. This density dependence at relatively low abundance would explain why some interior Columbia Chinook and steelhead populations are exhibiting strong evidence of density-dependent interactions despite being at relatively low average abundance in recent years. Connors SJ Dec. at ¶ 15.

7. Dr. Zabel, in his declaration, agrees that my description of density-dependent interactions at relatively low population abundance is "plausible from a theoretical standpoint." Declaration of Richard W. Zabel at ¶ 7 (hereinafter "Zabel SJ Dec."). He also says, "When populations are depressed, they only occupy a proportion of habitat patches (i.e., Connors Figure 1B); when populations are abundant, they occupy all habitat patches (i.e., Connors' Figure 1A). This part of Connors' hypothesis is realistic." *Id*. at ¶ 10.

8. However, Dr. Zabel goes on to dismiss the possibility that a number of Interior Columbia Chinook salmon and steelhead populations are exhibiting this form of density dependence because "it is highly speculative and has little empirical support for the following reasons: 1) Connors' interpretation of meta-populations in the Columbia River basin is misconstrued; 2) available data on the spatial distribution of spawners are not consistent with Connors' postulations; and 3) the mechanisms necessary for this hypothesis to occur are not consistent with observed salmon behavior." *Id*. at ¶ 7.

9. In the following paragraphs I respond to each of these points by explaining how Dr. Zabel has selectively interpreted only part of the available and relevant evidence to support his points, and how consideration of all of the evidence he describes, as well as the evidence I

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

identified in my declaration, suggests it is quite possible that density-dependent interactions at relatively low abundance levels may be affecting a number of Interior Columbia Chinook salmon and steelhead populations. My point is not that increased density dependence in freshwater at relatively low abundance as a result of the spatial contraction of the population to a subset of habitat patches is, in fact, occurring in these populations, but instead that the available evidence suggests consideration of this form of density dependence is reasonable to consider and may be relevant to understanding the nature of density dependence in tributary habitat described in Appendix C to the 2014 BiOp. It also may be relevant to the larger issue of understanding the factors that are currently limiting population productivity and growth.

10. Dr. Zabel correctly points out that interior Columbia Chinook and steelhead populations are not individual meta-populations. Instead, in the strict sense of the term (e.g., Schtickzelle and Quinn 2007), the *collections* of all the individual populations within each ESU in the interior Columbia are more appropriately described as meta-populations. However, my purpose in referring to the individual populations themselves as a "meta-population" was to highlight that each of these individual populations can appropriately be thought of as an aggregate of smaller groups of fish within the individual population that occupy semi-discrete patches of spawning and rearing habitat and that these groups may interact through the movement and interactions of individuals within the overall population's habitat. As a result, within each population's habitat there may be particular spawning areas, for example, to which some salmon may have high fidelity (sub-populations) and these sub-populations could (and do) still show the patterns of spatial expansion and contraction I describe. Dr. Zabel agrees that within these individual populations, groups of fish can show patterns of spatial contraction and expansion and that there is empirical evidence of this for some Interior Columbia Chinook. Zabel SJ Dec. at ¶ 9 (citing Isaak and Thurow 2006). In addition, within these same individual interior Columbia Chinook populations there is molecular evidence of fine-scale spatial population structure in female spawners (Neville et al. 2006). Dr. Zabel's criticism is about technical terminology, not substance. My use of the term meta-population in this looser sense,

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

rather than its strict definition, is thus not misleading, and is in fact relevant to recognizing the density-dependent process I describe for populations at relatively low abundance.

11. While Dr. Zabel agrees that "populations do spatially expand and contract with population density," *id*. at ¶ 9, he states that my characterization of this expansion and contraction (i.e., that at low abundance, population subunits spatially contract and only utilize a portion of the available habitat) is not consistent with empirical observations, citing Isaak and Thurow (2006). Isaak and Thurow (2006) describe empirical observations of Chinook salmon redds in stream reaches in the Middle Fork Salmon River. During the course of the study the number of Chinook salmon redds increased 100-fold from a historic low of 20 redds in 1995 to over 2,000 redds in 2003. 2003 roughly corresponds to the highest recently observed spawner abundance across most interior Columbia Chinook and steelhead populations [~1980-2006], and to more redds than had been observed in the study area since the 1970s. This increase in redds provided an opportunity to study how adult salmon distribute themselves over spawning habitat within populations during a period of population expansion.

12. Isaak and Thurow (2006) show that during this period, in 2 of the 5 individual populations they monitored, the number of stream segments with redds increased quickly to a threshold of about 70% of available stream segments (the remaining 30% of stream segments were considered unsuitable for spawning). In the other 3 populations, available stream segments were not rapidly utilized and expansion appeared to be ongoing across the range of observed redd densities. Dr. Zabel, who only references the two populations that appear to have distributed themselves fully across all available stream segments as abundance increased, concludes "these observations are in contrast to the population processes hypothesized by Connors, and further demonstrate that the foundation of Connors' hypothesis lacks empirical support." Zabel SJ Dec. at ¶ 9. However, the fact that as populations expand they occupy more habitat is entirely consistent with my characterization that at high abundance many more habitat subunits will be utilized. Logically at lower abundance, population subunits may spatially contract and only utilize a portion of the available habitat. Consistent with this perspective,

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

Isaak and Thurlow (2006) conclude that "[e]ven at the highest escapements, however, distributions remained clustered, and a limited portion of the network contained the majority of redds" suggesting that even during a period of rapid and substantial increases in Chinook spawner abundance, spawners did not evenly distribute themselves across, or fully utilize, all available spawning habitat." Therefore, the observations reported and analyzed in Isaak and Thurlow (2006) are consistent with the different patterns of density-dependent interactions I described and do not "further demonstrate that the foundation of Connors' hypothesis lacks empirical support." Zabel SJ Dec. at ¶ 9.

13. The final point that Dr. Zabel makes is that the hypothesis that fewer smolts-per-spawner may be produced by populations under a depressed state than an abundant state is not consistent with all available evidence. In order for this to occur, Dr. Zabel states that "individuals would need to pass up unoccupied habitats and instead spawn and/or rear in overcrowded habitats if population abundance in previous generations was depressed. This simply is not consistent with the observation from the studies discussed in my previous paragraph that as abundance increases, salmonid populations quickly utilize available habitat, even at relatively low abundance." Zabel SJ Dec. at ¶ 10. As I explain above, the "relatively low abundance" Dr. Zabel refers to as producing "quick[] utilize[ation]" of available habitat actually corresponds to the highest annual number of spawning redds that had been observed in the study area at any time since the 1970s (Isaak and Thurow (2006) (Figure 2)). Additionally, Dr. Zabel does not mention that 3 of the 5 populations Isaak and Thurlow studied did not exhibit evidence of utilizing all available stream segments despite year-over-year increases in spawner abundance, or that Isaak and Thurlow concluded that even at high abundance, spawner distribution was clustered and a limited portion of the stream segments contained the majority of redds (Isaak and Thurow 2006). The point is that strong density dependence may occur at relatively low and high population abundance depending on whether or not the population has contracted to use only a portion of available spawning and/or rearing habitat or if all available spawning and/or rearing habitat is being used.

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

14. Dr. Zabel goes on to say that "not surprisingly, Connors offers no evidence to support [his fewer smolts-per-spawner at low abundance] salmon population behavior. Nonetheless, this type of behavior is necessary to support Connors' claim that under current conditions, spawning and rearing habitat is underutilized and consequently habitat actions will be ineffective." Zabel SJ Dec. at ¶ 10. However, I specifically cite evidence of this pattern from a study of steelhead in the Keogh River in British Columbia (Ward 2000). This study noted that during a period of reduced marine survival and overall population size, freshwater density dependence was stronger than during a period of increased abundance. Dr. Zabel does not address this evidence in reaching his conclusion that the patterns of density dependence I describe had little empirical support.

15. In his declaration, Dr. Toole makes a different point than Dr. Zabel. He says that the majority of the actions in the 2014 BiOp RPA are not focused on tributary habitat but instead on other actions outside tributary habitat. Toole SJ Dec. at ¶ 10. Dr. Toole therefore concludes "The purported shortcomings of the hypothetical tributary-focused management strategy described by … Dr. Connors are not relevant to the management actions that NMFS actually relied upon in the 2008 Biop." *Id*. at ¶ 43.

16. Dr. Toole's comment is not particularly relevant to my discussion of density dependence and its relationship to salmon and steelhead population growth in the Interior Columbia basin. My point in explaining that the strength of density dependence, and the reasons for it, may differ within a population depending on whether or not it is at a relatively abundant or depressed state was to highlight that under current conditions, for some populations in the Interior Columbia basin, strong density-dependent interactions at current continued low abundance levels may well be occurring and affecting growth even though spawning and rearing habitat may be underutilized. As Dr. Toole highlights in his declaration, many of the Interior Columbia Chinook salmon and steelhead populations—especially the Snake River populations—addressed in the 2014 BiOp RPA are not a focus of tributary habitat restoration. Toole SJ Dec. at ¶ 43 & Table 1. That is because most of these populations are not in need of habitat

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

restoration (i.e., their tributary habitat is located in near-pristine areas). Nonetheless, these populations too exhibit signs of strong density dependence despite being at relatively low average abundance. Consequently, in these populations, actions beyond tributary habitat improvements that address downstream bottlenecks to survival would be predicted to be necessary to allow these populations to increase in abundance to levels, such as the ICTRT thresholds for minimum population size, that are consistently more stable and secure. Over time such actions may lead to more fish returning and consistently using more of the available spawning and rearing habitat, potentially reducing the strength of density-dependent interactions at low abundance in the freshwater environment.

17. To the extent that survival improvements from actions outside tributary habitat in prior years are identified in the 2008 and 2014 BiOps and are predicted to have already occurred, the fact that most interior Columbia Chinook salmon and steelhead populations remain at relatively low average abundances (and well below identified minimums), would suggest the actions have been insufficient to boost survival for these populations sufficiently to allow them to expand their use of tributary habitat patches and alleviate the possible effects of density dependence at relatively low abundance. As I explained in my prior Declaration, it would be logical and prudent to examine the available evidence in light of this potential problem. *See* Connors SJ Dec. at ¶¶ 17-18. Mr. Nigro's declaration also describes, and in more detail, why it would be rational to examine more closely the role of mortality factors outside tributary habitat in order to understand what and where the limitations on population growth for many Interior Columbia basin Chinook salmon and steelhead populations are occurring and need to be addressed. *See, e.g.*, Nigro SJ Dec. at ¶¶ 6-11, 25-35 & 36-42.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge. Executed this 1st day of April, 2015, at Vancouver, B.C., Canada.

BRENDAN M. CONNORS

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340

Literature Cited

Isaak D.J. and R.F. Thurow. 2006. Network-scale spatial and temporal variation in Chinook salmon (*Oncorhynchus tshawytscha*) redd distributions: patterns inferred from spatially continuous replicate surveys. Canadian Journal of Fisheries and Aquatic Sciences 63: 285-296.

Neville, H.M., D.J. Isaak, J.B. Dunham, R.F. Thurow, and B.E. Rieman. 2006. Fine-scale homing and localized movements as shaped by sex and spawning habitat in Chinook salmon: insights from spatial autocorrelation analysis of individual genotypes. Molecular Ecology 15: 4589-4602.

Schtickzelle, N., T.P. Quinn. 2007. A metapopulation perspective for salmon and other anadromous fish. Fish and Fisheries 8: 297-314.

Ward B.R. 2000, Declivity in steelhead (Oncorhynchus mykiss) recruitment at the Keogh River over the past decade. Canadian Journal of Fisheries and Aquatic Sciences 57: 298-306.

Earthjustice
705 Second Ave., Suite 203
Seattle, WA 98104-1711
(206) 343-7340