Testimony of
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This testimony considers the recent analyses on Snake River endangered salmon in perspective with the current trends in fish stocks and ocean conditions.

My name is James J. Anderson, I am an Associate Professor in the School of Fisheries at the University of Washington. Mr. Chairman, I thank you and the committee for this opportunity to testify before this hearing to review how the pending Federal decision could affect the operations of the Federal Columbia River hydropower system. In my testimony, I will not specifically discuss how decisions will affect the hydropower system. Instead, I will discuss whether the science on which the decision must be based is adequate and sufficiently up to date to reflect the status of the salmon and the possible effectiveness of the alternative recovery actions.

I base my analysis on my participation in the Plan for Analyzing and Testing Hypotheses (PATH), my reviews of the work of the NMFS Cumulative Risk Initiative (CRI), recent findings from the North Pacific Marine Science community, and finally on the recent returns of salmon to the Columbia River.

The state of analysis of endangered salmon stocks.

Analyses on the effectiveness of salmon recovery efforts have been on going for a decade and two milestones in the analyses, the PATH 1998/1999 reports (Marmorek et al 1998, 1999) and the CRI report in 2000 (CRI 2000), have reached very different conclusions as to the effectiveness of recovery actions. PATH has concluded that breaching the lower Snake River dams will allow the Snake River chinook to recover. The CRI analysis suggests that salmon are in a dire condition and breaching alone will not recover them. Finally, the recent studies from the North Pacific marine science community and the actual Columbia River salmon runs suggest the ocean has substantially improved.

In my testimony I explore how such contradictory results are to be expected when the analyses must rely on information up to a specific point in time, while the studies advance and nature itself continues to change. The essential point of my testimony is that the existing scientific analyses on which the decision on the hydrosystem is being based are simply not up-to-date and reflective of the current state of the system.

Why are PATH and CRI views on dam breaching different?

PATH concluded that dam breaching would recover the runs, while the CRI analysis indicates that breaching alone would not recover the runs. The reasons for these differences involve the data used in the models and the assumptions on what happen with dam breaching and transportation. The PATH optimistic analysis is based on the belief that hydrosystem passage survival is low and transportation lowers fish vitality so they die in the estuary and ocean, in what is referred to as differential delayed mortality. Designated D in the models, the differential delayed mortality is the ratio of the post Bonneville survival of transported fish relative to the post Bonneville survival of in-river passing fish. A low D value means low transport survival. In the 1998 report for spring/summer chinook, PATH favored low D values (about 0.3) and low in-river passage survival (about 20 to 30%). In this scenario, breaching dams stops the ineffective transportation and about doubles in-river survival so the stocks recover quickly. The CRI analysis in the April 2000 report is based on the recent survival studies not incorporated in PATH. These new survival studies show smolt passage survival is

about twice what was favored by PATH. Furthermore, results from recent transportation studies suggest that D is over twice the PATH estimate. Thus, the CRI model has low transportation and dam passage mortalities so removing these factors does not significantly improve survival and will not recover fish.

Finally, it is important to note that the low passage survivals and D values from PATH have been largely discarded and the values of these critical parameters used by state, tribal and federal scientists are converging. This convergence of assumptions is important because as the analyses assume higher in-river survivals and D values the benefits of dam breaching diminish and eventually breaching could make things worse.

Are the CRI estimates of extinction realistic?

The CRI uses Snake River spring/summer chinook spawner recruit data between 1980 and 1994 to estimate the probability of extinction over 24 and 100-years (CRI April 2000). The analysis is based on a simple extinction model and the CRI report goes into detail addressing the assumptions of the model. In actuality, few of the technical issues raised by critics and by the CRI itself are germane to whether or not the estimated extinction risks are realistic. That is, issues of uncertainty in the data, errors in the observation, positive or negative effects of density dependence on productivity, effects of fish maturation rates, and the definition of extinction are all relatively inconsequential to the conclusions of the analysis. Decision-makers, scientists and the public can argue over these details but the conclusion is robust: *if the decline between 1980 and 1994 continues the stocks are threatened with extinction.*

The single most important factor for this conclusion is the 15-year spawner/recruit time series. The interval 1980 to 1994 is within a cyclic ocean regime *unfavorable* to the survival of salmon in the Pacific Northwest (Hare, Mantua and Francis1999, Anderson 2000). Therefore, the extinction projections developed in CRI analysis are *worst-case* scenarios.

Do these worst-case predictions have value to decision-makers? The 24-year predictions have value if they are updated with the most recent information on the condition of the

stocks and the ocean. A 100-year prediction based on 15 years of data has little value and in fact substantially biases the perceived risk to the stocks. It ignores a major driving force of the stocks-- variability in salmon productivity resulting from decadal scale ocean cycles.

To illustrate the problem, note that the CRI analysis says that two out of the seven Snake River spring/summer chinook index stocks have 5 to 10% chance of extinction over the next 24 years and four of the seven stocks have a high probability of extinction over 100 years. Thus, if the 1980-1994 trend continues the stocks are in dire condition; however, if the conditions change the extinction probability changes. To demonstrate the possibilities assume that the survivals experienced in the early 1980s, when the stocks temporary increased, were repeated in the period 1995 through 1999. Note that the CRI data says nothing about these brood years since its data ends in 1994. To make the last five years like the early 1980s, spawners for each index stock from 1995-1999 are multiplied by the spawner/recruit ratio of the index stocks from 1980-1984. Using this hypothetical time series in the extinction model, the chance of extinction is zero over 24 years and only one of the seven index stocks has a chance of extinction over 100 years.

This exercise illustrates the sensitivity of the extinction models to the data. In particular, the Dennis (1991) extinction model, which is the foundation of the CRI analysis, is extremely sensititive to the last data point in the series. The mean rate of change in the population is determined by the difference between the first and last data points (Hinrichsen, R. personal communication). Thus, CRI extinction predictions depend strongly on whether or not 1994 was a good or a bad year. Clearly, this is not a good method to predict the chance of the stocks' existence in the year 2084.

Finally and mostly important, the CRI extinction predictions are based on stock performance over 15 years of anomalously warm ocean conditions, which have been significantly adverse for west coast salmon. The CRI analysis has not adequately addressed this weakness in its analysis, nor has it conveyed the fact that the ocean and the fish runs have improved considerably subsequent to years used in the CRI analysis.

The state of the ocean

The recent observations from oceanographers, fisheries and atmospheric scientists show the ocean is currently in a state favorable to west coast salmon. Furthermore, the evidence provides signs that the North Pacific has shifted into a cool regime favorable to west coast salmon. Here are some findings reflecting conditions after 1995:

1. Ocean survival was good in 1997: Survival of wild Snake River spring/summer chinook has improved by a factor of three or more over the returns of the early 1990s. Based on returns of the 2-ocean fish, smolts migrating in 1997 have a smolt to adult ratio (SAR) of 1.55% (Williams personal communication). The return of the 3-ocean fish should increase the SAR to 3 or possibly 4%. In comparison, SARs in the early 90s were about 0.5%. Further evidence comes from the ratio of early returning males (jacks). The percent of jack returns from the 1997 smolt outmigration is twice the 1992-1996 average. (DART 2000)

2. Ocean survival in 1998 should be better: The percent of jack returns from the 1998 smolt migration is twelve times the1992 –1996 average. (DART 2000)

3. Ocean survival in 1999 may be the best yet: For this year, jack returns through April 16 are 650% of the ten-year average. Total returns of chinook salmon through April 16 are over twice the ten-year average. (DART 2000)

4. Zooplankton species changed: Off Oregon "warm water" zooplankton species common year round throughout most of the 1990s were consistent with weak, but persistent, El Niño conditions throughout this period. However, in May 1999 "cold water" species dominated solely. The switch may be ephemeral, due solely to the present La Niña or it could be a harbinger of another climate shift in the northern California Current (Peterson 2000).

5. The ocean is cooler: The Pacific Decadal Oscillation index (PDO), which is an indicator of ocean regime shifts (Hare, Mantua and Francis1999) exhibited a major shift into the negative condition favorable to west coast salmon production.

The reversal in 1998 is representative of cooler coastal waters off the Columbia River.

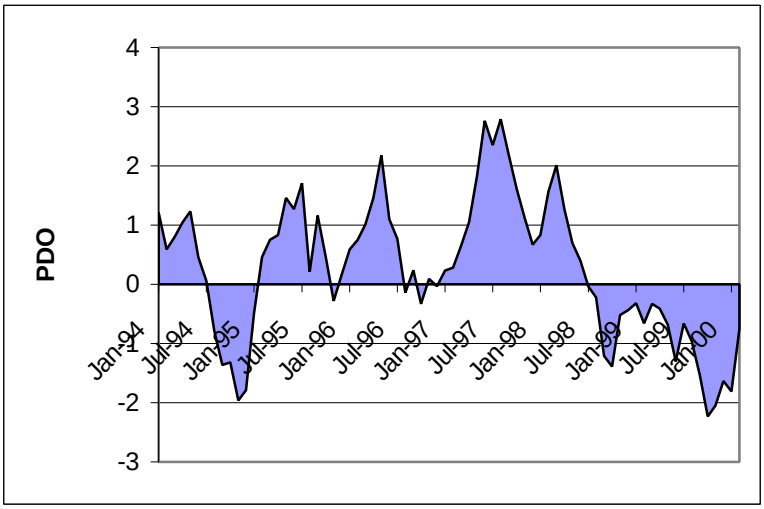

Figure 1 Monthly PDO pattern showing reversal.

6. The cool ocean should persist: The eastern North Pacific region is under the influence of cold surface temperature anomalies that will persist beyond the current La Niña. These conditions will result in the fertilization of surface layers (Freeland 2000).

7. A regime shift: Scientists at the Jet Propulsion Laboratory in Pasadena, studying the satellite observations of Pacific sea-surface data, have observed a multiple-year trend that may represent an ocean regime shift (JPL 2000). Many reports from the March 2000 conference of the North Pacific marine community (PICES 2000) support this suggestion.

Conclusions: Salmon and other marine species respond to the decadal scale shifts in ocean conditions. Cool ocean conditions correlate with higher productivity of west coast salmon while warmer ocean conditions correspond with higher productivity in Alaskan salmon (Hare and Mantua 1999, Anderson 2000). The current La Niña corresponds with increased west coast salmon runs and Alaskan runs that have returned below forecasts (NW Fishletter 1997, 1998). Irrespective of whether or not an ocean regime shift has

occurred, the recent improvement in the ocean considerably improves the chance of fish survival over the next decade. These findings are not contained in the CRI analysis.

The evolving analysis

Vastly different views of the future of salmon are seen through the different analyses. PATH, using salmon runs from the 1960s through 1990, sees dam removal as the only viable way to recover Snake River salmon. The CRI, using runs from 1980 through 1994, sees dam removal as ineffective on its own and concludes the stocks are in dire condition. In a recent statement they stated, "Indeed, the way to interpret the result of this [CRI] report is to realize that for low lambdas and high extinction risks there is little "wiggle room", and the situation is close to "one must do everything." (NMFS March 29, 2000). Finally, the international marine science community sees fundamental and large-scale changes in the North Pacific in which the current La Niña may be the harbinger of a reversal back to the ocean conditions prior to 1977 (PICES 2000).

These different views to a large degree represent different snapshots of the expanding knowledge of salmon in the context of a dynamic and changing ecosystem. Ultimately, nature and humanity together control the fate of the stocks. The ocean affects salmon in cycles while human effects are gradual and cumulative (Anderson 2000). We are fortunate to have a La Niña. It gives us valuable time to pause and reflect on the best course of action. In my judgment, the arguments on the impacts of the hydrosystem have mostly reached an impasse. Fish survive the hydrosystem and transportation. To understand what is killing them in the estuary and ocean, we must observe the fish in these environments.

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