Testimony of

James J. Anderson
Associate Professor
School of Aquatic and Fishery Sciences
University of Washington

before the

Subcommittee on Water and Power
of the U.S. House of Representatives
Committee on Resources

Held May 19, 2001
in
Tacoma, Washington

This testimony considers the current science and status of the fish populations of the Columbia River System.

My name is James Anderson; I am an Associate Professor in the School of Aquatic and Fishery Sciences at the University of Washington. My research over the past two decades has involved Columbia River salmon and the influence of the hydrosystem and climate on the survival and productivity of the stocks. I wish to thank the Power Water Subcommittee for this opportunity to testify on the current science and status of fish populations in the Columbia River system.

Background

I first appeared before this committee in June of 1995 and testified on the state of Columbia River salmon (Anderson 1995). That spring the salmon run in the Columbia River was the lowest ever recorded. In my testimony I explained how scientists were finding that throughout the North Pacific marine populations were correlated with decadal-scale patterns of ocean temperatures and currents. I suggested that the very low salmon populations were in part due to climate change. The young salmon smolts were entering a warm ocean in which food was scarce and warm-water predators were abundant. I concluded that the fate of the endangered salmon was strongly determined by what happened in the ocean (See Anderson 2000 for summary). At that hearing the committee also heard from witnesses claiming that the fish were doomed to extinction unless the Snake River dams were removed. The hearing encapsulated an ensuing scientific debate, reduced to whether the salmon's decline was nature's fault or the dam's fault.

Now, six years later the region is face with a near record drought, the value of the water has raised the cost of salmon recovery to billions of dollars, and the largest spring chinook run in 40 yrs has just returned to the Columbia. The question is no longer whether the ocean is major contributor to population variations. The question now is what is the real value of recovery measures in terms of fish survival. In my testimony I review the status of the stocks and the scientific information on the effectiveness of current hydrosystem actions to aid fish survival.

Salmon population status

Returns of wild salmon are not yet available for this year, but the counts at dams, which include both hatchery and wild fish, indicate a good year for 2001 following on the good returns from 2000. Over 360,000 spring chinook passed Bonneville dam this spring. On the peak day, twenty seven thousand fish passed Bonneville, which is nearly three times the entire spring run in 1995. Figure 1 illustrates how incredible the difference was between the two years. This year the run is five times larger than the ten-year average. Last year 177,000 spring chinook returned, which was one the largest run in 20 years.

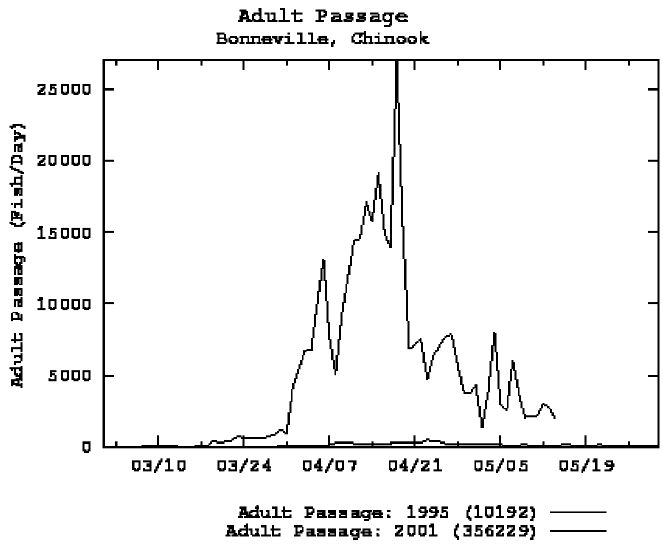

Figure 1. Daily Passage of spring chinook at Bonneville Dam in 1995 and 2001 (From DART). Note the 1995 passage barely registers compared to the 2001 passage numbers.

Figures 2 through 8 show the daily counts of adult salmon returning to the Snake and the mid-Columbia and put the recent runs in a historical context spanning 40 years. The Snake River chinook population was low in the early 1980s and throughout the1990s. It increased in 2000, and this year the run was the largest on record (Figure 2).

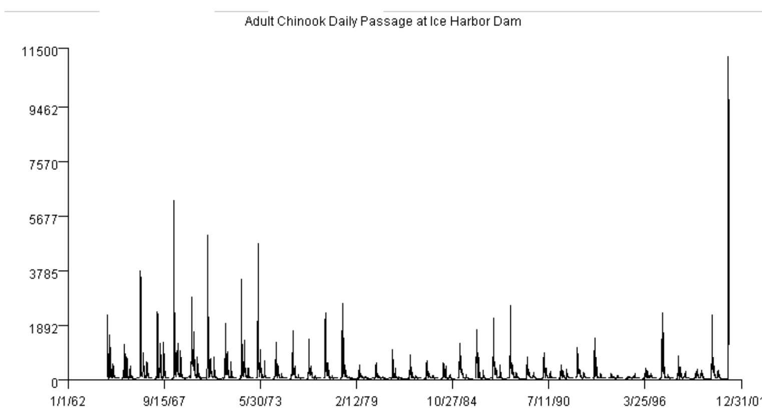

Figure 2. Daily passage of chinook into the Snake River Basin

The Snake River sockeye exhibited a decline in the early 1980s and reached near extinction levels in the 1990s. However, the captive brood program and improved ocean conditions are likely factors attributable to the small increase in 2000 (Figure 3).

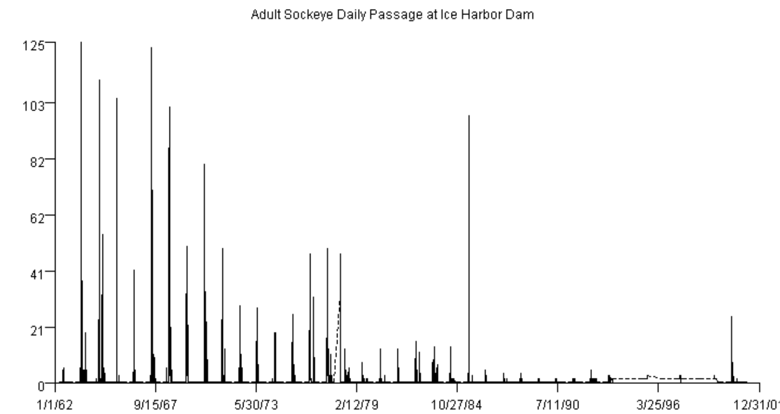

Figure 3. Daily passage of sockeye into the Snake River Basin

Snake River steelhead population was low in the 1970s and has increased largely through a hatchery program. Currently, the wild run is about 10% of the hatchery run (Figure 4).

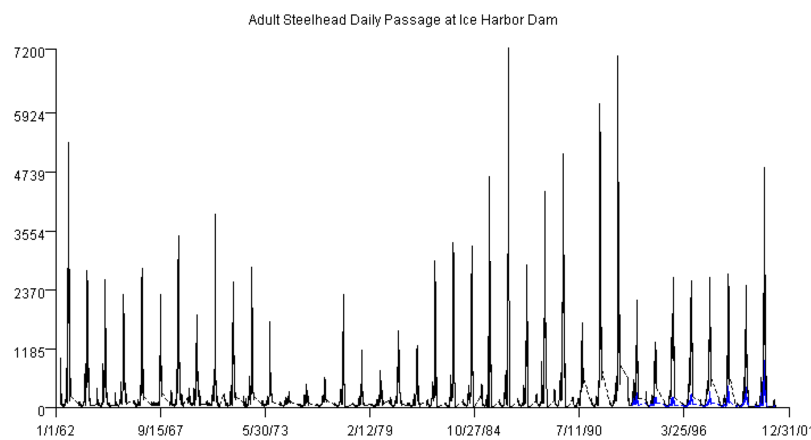

Figure 4. Daily passage of steelhead into the Snake River Basin

In the Mid-Columbia, the chinook were also low in the 1970s, but haved improved over the last two years presumably because of improving ocean conditions (Figure 5).

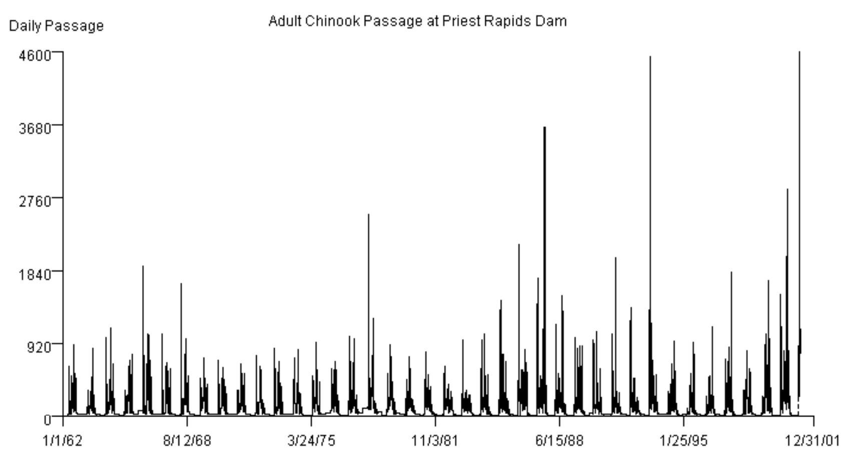

Figure 5. Daily passage of chinook into the Mid-Columbia Basin

Mid-Columbia sockeye returns were low in the1990s but improved in 2000 (Figure 6).

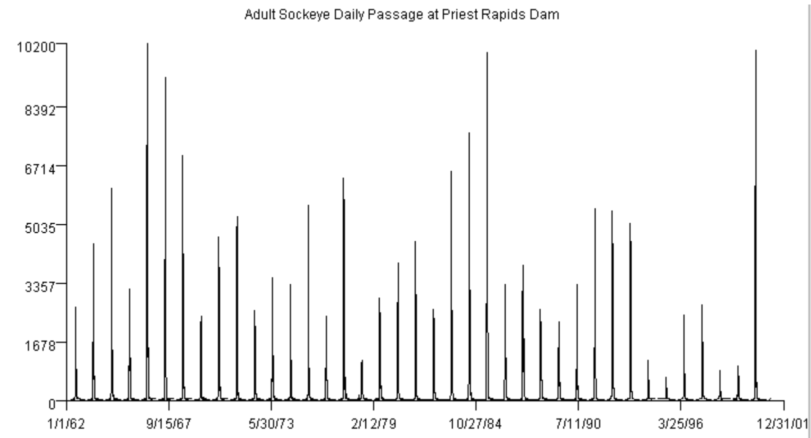

Figure 6. Daily passage of sockeye into the Mid-Columbia Basin

The mid-Columbia steelhead run has been small for 40 years. It was especially low in the mid 1990s and increased in 2000. The run is essentially maintained as a hatchery program (Figure 7).

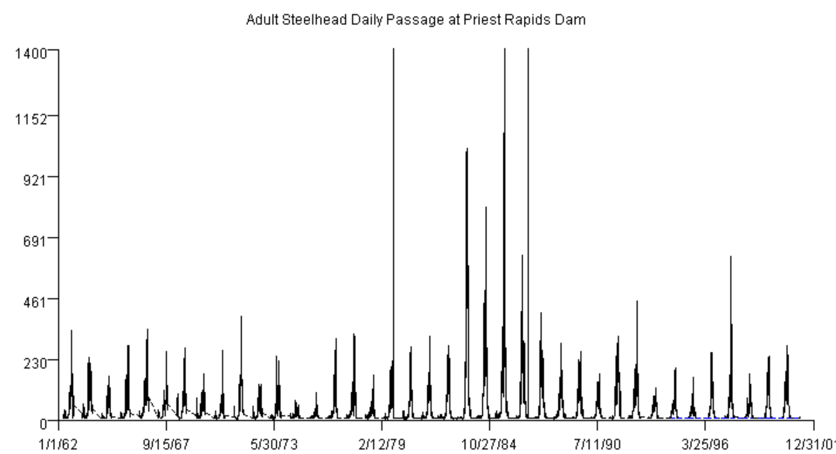

Figure 7. Daily passage of steelhead into the Mid-Columbia Basin

The passage of chinook at McNary Dam characterizes the total Snake and Columbia River runs. Note the double peak each year. The first peak represents the Snake River spring chinook and the second peak is mostly composed of Hanford Reach fall chinook. The total run was low in the 1970s and the 1990s. Again, this year's return is the highest in the record (Figure 8).

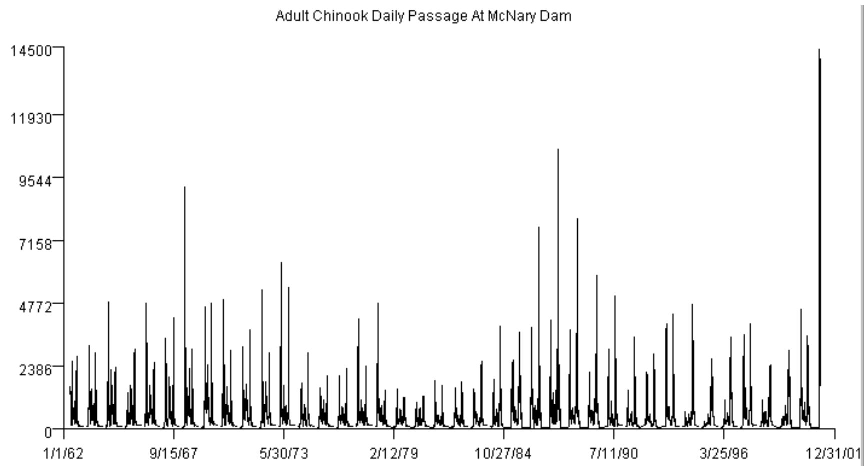

Figure 8. Chinook passage at McNary Dam

Finally, to put the 2001 drought into perspective, the daily flow at McNary Dams between 1962 and 2001 is illustrated in Figure 9. Three significant droughts have occurred: 1973, 1977 and 2001. In these years the spring runoff peak is essentially missing from the daily record.

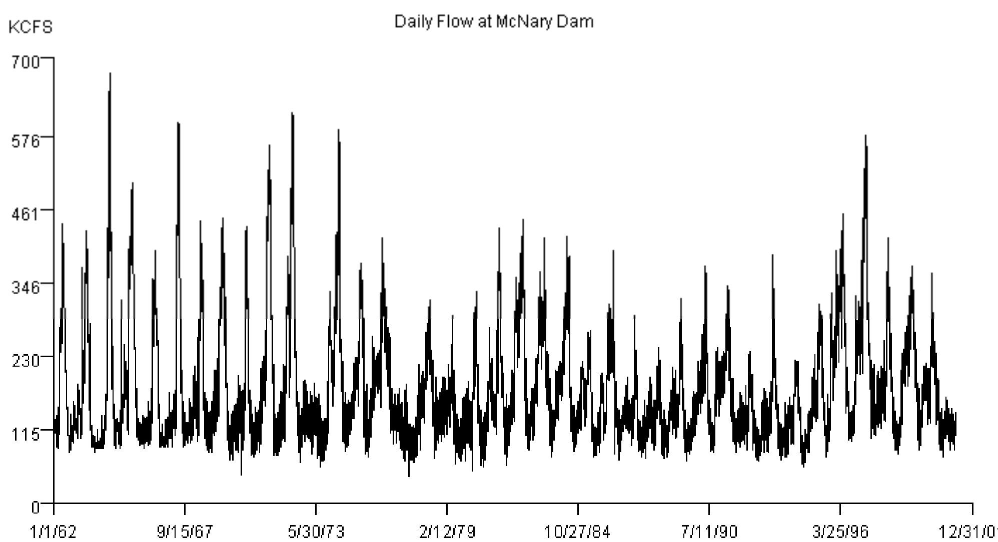

Figure 9. Daily Flow at McNary Dam

Several general characteristics are noteworthy in these records. First, the returns represent both hatchery and wild stocks with wild fish dominating the runs in the early part of the record and hatchery fish dominating in the recent years. Second, the records demonstrate that salmon populations vary on decadal scales and between years. Stocks were generally higher in the 1960s and 1980s and lower in the 1970s and 1990s. Year-to-year variations in all stocks are considerable. It is not uncommon for a stock to increase or decrease by a factor of two to three from one year to the next.

Status of Salmon Science

In my testimony six years ago I presented information that the ocean was a significant factor in determining the survival of salmon populations. This hypothesis was not controversial to many ecologists, but it was largely ignored by Columbia River fishery managers, who attributed the decline of the stocks to the hydrosystem. Today, with six additional years of research coupled with a significant change in the ocean there is acceptance that the year-to-year and decadal scale variations typified in the figures above cannot be attributed to any single factor; be it the ocean currents, sea surface temperatures, coastal winds, river flows, or dam operations. Because many factors are beyond our control, fishery managers have focused on hydrosystem operations as primary recovery measures: flow regulations, river temperature regulation, and dam operations. The strategy assumes that managing the hydrosystem within specified physical standards will improve fish survival and facilitate fish recovery.

However, because of the increasing value of the water and concerns as to the effectiveness of control measures, the strategy of operating the hydrosystem according to physical standards alone is not sufficient. Managers need to base the physical actions in terms of the resulting biological impacts on the salmon and especially in terms of survival. The effectiveness of actions needs to be put in the perspective of their contribution to the overall life history of the fish. I will briefly discussion the major hydrosystem actions and their effectiveness.

Flow augmentation

A significant question during this drought concerns the effectiveness of flow augmentation in improving fish survival. To address this question it is important to first realize that a relationship of seasonal flow and smolt survival within a year, or a relationship of flow and survival between years, does not imply flow augmentation will increase survival. Flow augmentation is produced by scheduled releases from storage reservoirs and by limiting municipal and agricultural withdrawals. Flow augmentation does not change the yearly averaged flow; it only reshapes the runoff over the season. Flow augmentation has a small and variable impact on the natural seasonal flow, temperature and turbidity, because the natural patterns are driven by the unregulated tributary runoff while flow augmentation is mostly from storage reservoirs.

Based on flow and smolt survival research, a relationship has been found between yearly-averaged flows and the survival of chinook and steelhead passing through the hydrosystem. However, the same research demonstrates that seasonal flows are not correlated with hydrosystem survival. Because flow augmentation makes up a small portion of the seasonal flow, it too is not correlated with smolt hydrosystem survival.

A relationship between seasonal flow and survival of fall chinook migrating from Hells Canyon to Lower Granite Dam has been observed in studies. Here again, the contribution of flow augmentation to this seasonal flow is small and the potential impact on survival is not measurable. Furthermore, there is a reasonable possibility that flow augmentation from the Hells Canyon dam complex may in some years decrease fish survival (Anderson, Hinrichsen and Van Holmes 2000). The research indicates that the natural seasonal patterns of flow, temperature and turbidity are correlated, so simple correlations any of these variables with smolt survival does not identify which one may affect survival. Based on fish bioenergetics, increased temperature will increase smolt mortality and since water releases from Hells Canyon can increase the Snake River temperature, augmentation can increase mortality. Furthermore, in these studies fish travel time was uncorrelated with flow, so it has no effect in reducing smolt exposure time to predators.

Simply put, flow survival studies conducted over 8 years indicate that the impacts of flow augmentation on smolt survival are not measurable at best, may be neutral, and in some situations may decrease survival. Potential impacts of flow augmentation on survival can be estimated with models. However, the benefits were not estimated in the NMFS Biological Opinion.

Dam Passage and Spill

Studies on smolt dam passage indicate benefits for smolts passing dams in spill water compared to passing through bypass systems and turbines. However, recent model analyses show the benefits of spill are small. Not spilling at Columbia River dams this year decreases the total passage survival of Snake River smolts from about 50% to 49%; a difference of 1%. The net change for Mid Columbia smolts is about 10% and for lower Columbia River smolts is about 3% (NWPPC 2001).

Considerable progress has been made on identifying the impacts of hydrosystem operations on the upstream migration of adult salmon (Bjorn et al 2000). Of concern is the effect of spill. Periods of high spill appear to delay salmon passage and increase fall-back across the dams.

Transportation

The vast majority (80 to 98%) of salmon smolts from the Snake River reach Bonneville tailrace in barges. Ninety-eight percent of the fish survive the barge trip, but after release the fish die at a higher rate than smolts that have arrive at Bonneville tailrace via in-river migration. If this differential mortality of transported fish relative is equal to the mortality of smolts passing through the river, then barging has no benefit over in-river passage. In normal and low water years it is believed that barging is better for Snake River salmon and this is the preferred strategy for this year. Barging mid-Columbia salmon is less effective because the fish must migrate through several of dams before they reach McNary Dam, from which can be transported.

Ultimately the efficacy of transportation depends on the level of differential mortality. Few reliable estimates are available and it appears to vary between species, over the season, and from year-to-year. Furthermore, the reason why transported fish die at a greater rate than fish that have passed through the hydrosystem is unclear. Hypotheses, focusing on stress in transportation, suggest it may be possible to improve the transportation system, making it the preferred passage route.

Ocean effects

Over the past six years a number of studies have correlated ocean variables and marine populations. For example, Alaskan and west coast salmon have an inverse relationship with decadal scale cycles in ocean currents and temperatures (Hare, Mantua and Francis 1999). Between 1977 and 1998 ocean conditions, characterized by the Pacific Decadal Oscillation (PDO) (Figure 10), favored Alaskan salmon and were detrimental to west coast salmon. In 1998, the PDO reversed and correspondingly west coast salmon stocks increased while many Alaskan stocks declined. Studies in the Oregon coastal waters confirm a recent and significant increase in the abundance of salmon food (Peterson 2000). An article in the Seattle Times noted "This is the third spring in a row that scientists working out of Newport have encountered a fertile Pacific, a trend that began in one of the wettest Northwest years on record and has continued even as onshore weather patterns this year set the stage for a severe drought (H. Bernton, Seattle Times staff reporter, May 09, 2001)"

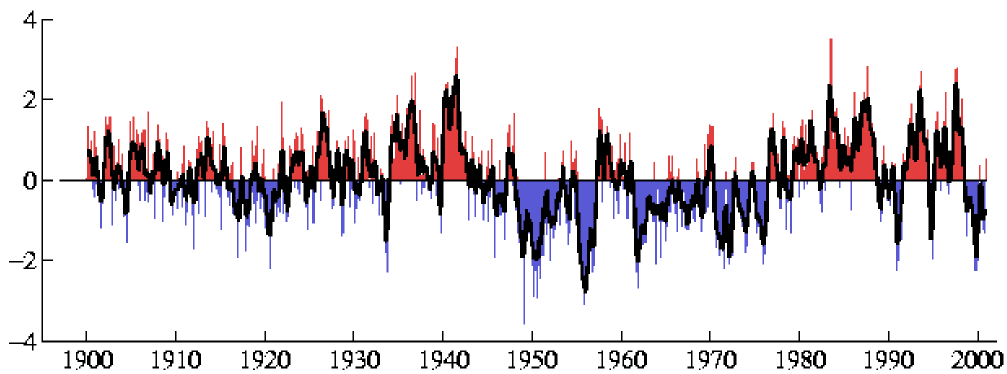

Figure 10. A one-hundred year record of the "Pacific Decadal Oscillation" (PDO). Positive values indicate a warm ocean; negative values indicate a cool ocean. Major changes in northeast Pacific marine ecosystems correlate with phase changes in the PDO; warm eras have seen enhanced coastal ocean biological productivity in Alaska and inhibited productivity off the west coast of the contiguous United States, while cold PDO eras have seen the opposite north-south pattern of marine ecosystem productivity (From http://www.atmos.washington.edu/~mantua/).

Combined effects of ocean and hydro operations on salmon

An important step in setting hydrosystem performance standards and selecting recovery actions is to recognize and adjust for the considerable influence that ocean and climate cycles have on salmon populations. The improved ocean conditions over the past three years have benefited both wild and hatchery stocks and are a major factor in the record returns of spring chinook. The data suggest ocean factors outweigh the effect of hydrosystem operations. Comparing smolt to adult survival from the 1995 outmigration to the 1998 and 1999 outmigrations, the survival has increased from 0.25% in 1995 up to about 2% in 1998-1999 period. This 1000% increase in relative survival can creditably be attributed to the increased productivity in the ocean. In comparison, the relative change in survival with spill and flow augmentation have been estimated to be on the order 1 to 10%. This comparison to the poor conditions in the mid 1990s is relevant because virtually all estimates of salmon extinction and recovery probabilities assume the ocean remains in the extreme poor state of the 1990s.

A recent paper on recovery options concluded that even dam breaching would not recover the stocks under the conditions that existed for brood years 1990-1994 (Kareiva, Marvier, McClure 2000). However, the paper did not mention that the years used in the analysis represented some of the warmest years on record (See the PDO in Figure 10). If the analysis were revisited, including both good and bad ocean conditions, the conclusions would be significantly different. In fact, an analysis in the Plan for Analyzing and Testing Hypotheses (PATH) demonstrated that with a regime shift back to cool ocean conditions, the stocks would recover without changes to the hydrosystem (Marmorek, Peters, Parnell 1998). The majority of PATH participants rejected this hypothesis as unrealistic, with little chance that the smolt-to-adult survival could rise above 1%. However, the recent shift in the ocean follows the analysis assumptions, and if the ocean survival persists through this decade, the PATH analysis suggests the stocks would recover without aggressive the hydrosystem operations. However, most analyses on salmon recovery to date consider scenarios that require draconian measures to save the stocks from extinction. Conspicuously absent are analyses that include ocean cycles.

I am not suggesting that salmon will recover irrespective of societal efforts. Such a stance would be irresponsible. But to implement performance measures without regard to their benefits in relationship to the status of the ocean is equally irresponsible. Science, in service of salmon recovery and management, must assess the impacts of physical actions in terms of their biological effects on the stocks. The science must quantify biological performance through monitoring, and where the data is insufficient, through biologically realistic models. Furthermore, the science must seek to understand the mechanisms by which the environment affects salmon survival.

The improved ocean conditions give salmon a temporary reprieve from extinction. But, eventually the ocean will warm again and with or without a drought, the competing demands for the water will be great. If we continue to increase our understanding of salmon ecology and if we begin to realistically assess the benefits of recovery actions, we may be able to meet the coming challenge. However, if we forgo learning and disregard quantified analyses in making decisions, salmon management could face a failure of public trust and salmon recovery would be jeopardized.

References and Notes

Anderson, J. J. 2000. Decadal climate cycles and declining Columbia River salmon. In *Sustainable Fisheries Management: Pacific Salmon*. Edited by E. Knudsen et. CRC Lewis Publishers, Boca Raton. p. 467-484. (www.cbr.washington.edu/papers/jim/victoria.html)

Anderson, J. J Testimony presented before the Subcommittee on Water and Power of the US House of Representatives Committee on Resources. June 1995 Washington D.C.

Anderson, J. J., R. A. Hinrichsen and C. Van Holmes. 2000. Effects of Flow Augmentation on Snake River Fall Chinook. *In* Comments on Idaho Water Users on the draft All-H paper by the Federal Caucus: Conservation of Columbia Basin Fish-Building a conceptual recovery plan. Submitted on behalf of the Committee of Nine and the Idaho Water Users Association. March 16 2000.

Bjorn et al 2000, Migration of adult spring and summer chinook salmon past Columbia and Snake River dams, through reservoirs and distribution into tributaries, 1996

DART. 2000. Data Access in Real Time. (http://www.cbr.washington.edu/dart/dart.html)

Hare, S. R., N. J. Mantua and R. C. Francis. 1999. Inverse production regimes: Alaskan and West Coast Salmon. F*isheries* 24(1):6-14. (www.iphc.washington.edu/Staff/hare/html/papers/inverse/abst_inv.html).

Kareiva, P. M. Marvier, M. McClure 2000, Recovery and Management options for spring/summer chinook salmon in the Columbia River Basins, Science 290(3) 977-979.

Marmorek, D.R., C.N. Peters and I. Parnell (eds.) 1998. *Plan for Analyzing and Testing Hypotheses (PATH): Final Report for Fiscal Year 1998* (ESSA Technologies, Vancouver, Canada, 1998

Peterson, W. T. 2000. RECENT SHIFTS IN ZOOPLANKTON ABUNDANCE AND SPECIES COMPOSITION OFF CENTRAL OREGON. Beyond El Nino. PICES conference (North Pacific Marine Science Organization). (pices.ios.bc.ca/elnino/abstracts.htm)