Wild Salmon in Western North America:

Forecasting the Most Likely Status in 2100

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We know and understand the direct causes of the decline of wild salmon numbers. The trajectory remains downward. Nothing will change unless we address the core policy drivers of this trend: the rules of commerce, particularly market globalization; the increasing demand for natural resources, especially high-quality water; the unmentionable human population growth in the region; and individual and collective preferences regarding life style. Do we, as a society, understand the connections? Can we, and do we want to, turn the ship around?

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Introduction

Restoring wild salmon to the Pacific Northwest and California is one of the most vexing public policy problems facing the region (Wu et al. 2003). Billions of dollars have been spent, people's lifestyles have been affected negatively, and commercial activities altered, but still the prognosis for the long-term future of wild salmon has not appreciably changed.

The prognosis is problematic in spite of support for restoring salmon remaining a high priority policy goal, and a massive and far-reaching restoration effort continues. The recent and much improved salmon runs have been due primarily to changes that made ocean conditions more favorable to salmon; the improved runs do not appear to be the result of an effective or comprehensive restoration effort. As recently as 2004, a senior official of the federal agency in the United States responsible for recovering salmon observed that "there are no recovery plans in place for Pacific salmon" (Darm 2004).

The purpose of this chapter is to describe the most likely future for wild salmon given the best available current scientific information and the most likely future policy drivers. This chapter is *not* seeking to pass judgment on the desirability of current policies affecting salmon, nor to offer an opinion on what *should* be done, if anything, regarding the future of salmon in western North America.

Let us start with a simple statement of fact, one that, even for contrarian scientists, will likely engender little argument: in spite of abundant uncertainty about the relative importance of the various factors that drove the decline of wild salmon in California, Oregon, Washington, Idaho, and southern British Columbia, we essentially know and understand the direct causes of the long-term decline. The causes have been, and in many cases still are

- Intense commercial, recreational, and subsistence fishing and, especially since the 1990s, mixed stock fishing;
- Freshwater and estuarine habitat alteration due to urbanizing, farming, logging, and ranching;
- Dams built and operated for electricity generation, flood control, irrigation, and other purposes;

The views and opinions presented in this chapter are those of the authors and do not necessarily represent those of any organization.

- Water withdrawals for agricultural, municipal, or commercial requirements;
- Stream and river channel alteration, diking, and riparian corridor modifications;
- Hatchery and aquacultural production to supplement diminished runs or produce salmon for the retail market;
- Predation by marine mammals, birds, and other fish species, often exacerbated by unintentionally concentrating salmon or their predators;
- Competition, especially competition with exotic fish species, many of which are better adapted to the highly altered aquatic environments we now have in the region;
- Diseases and parasites;
- Pollutants from many sources; and
- Reduction in the annual replenishment of nutrients from decomposing, spawned-out salmon.

To no one's surprise, it is a long list and it spans the entire human enterprise. The causes are not many, but they interact in synergistic ways that are not well understood. We also know that ocean and climatic conditions greatly influence salmon abundance, even if we do not understand how this happens (Sharp 2003).

If we examine the history of the other three regions where salmon originally occurred, the Asian Far East, eastern North America, and Europe, we find a similar list of causal agents and the same ultimate result

Figure 1. Culverts often impede migrating salmon. While individual culverts do not typically completely block salmon, in aggregate they can have a significant negative effect on salmon runs. (Source: National Park Service U.S. Department of the Interior.)

Figure 2. Salmon are relatively easy to grow in captivity. Farmed and wild salmon now compete in a worldwide commodity market where the lowest cost producer usually wins out. Such commodity markets typically drive down the price of both farmed and wild salmon, often with adverse affects on fishermen. (Source: U.S. Army Corps of Engineers.)

(Hindar 2004; Nagata 2004; Whoriskey 2004). The specifics in each region differ, but the causal agents and resulting decline in salmon runs follow a markedly similar pattern.

Scientists and salmon advocates know much about the long-term trajectory for wild salmon, even if many do not like to acknowledge it publicly. Let us offer a second statement of fact: as we move into a new century in California and the Pacific Northwest, in spite of ups and downs, good years and bad years, favorable and unfavorable ocean conditions, and newspaper headlines proclaiming record runs, wild salmon have been on a 150-year downward trend and wild runs are now at very low levels.

Newspapers regularly trumpet the fact that runs of both wild and hatchery fish in the region are generally larger than the past several decades. Given shifting ocean and climatic conditions, the increases are not surprising. For accurate assessments of the future, we need to focus on long-term trends and not be distracted by short-term variations in background conditions.

In our area of focus, wild salmon are well on their way to attaining a status enjoyed by some of their notable brethren—wolves, condors, grizzlies, bison—wild animals that are unlikely to disappear entirely but struggle to hang on as remnants of once flourishing species in small portions of their original range.

But how can it be that the recovery prognosis is poor when the direct causes of the decline are reasonably well known and have been studied in great detail and the public is generally supportive of reversing the long-term downward trend?

The answer is captured in a simple policy statement of fact: effecting any change in the long-term

downward trend of wild salmon is futile in the absence of shifts in the core policy drivers of this decline. It is the core policy drivers—the root causes—that have determined the status of wild salmon and will continue to determine that status through this century. Habitat alteration, dams, water withdrawals, fishing, hatcheries, and many more are simply the ways in which the core policy drivers have been expressed. Intended or not, by focusing on these highly visible, but *secondary* factors, government agencies have instituted a patchwork approach to salmon restoration that has distracted attention away from the less obvious, but fundamental core policy drivers.

What are these elusive drivers of the future status of wild salmon in western North America and especially in southern British Columbia southward—these agents of decline that must also be the agents of any recovery? We argue that there are four of them, which society can choose to influence, or not, over the 21st century.

The four crucial drivers play out within the context of changes in climate and changes in ocean conditions, two factors over which society has minimal control, at least in the near term. A 2,200-year reconstruction of Alaska sockeye salmon *Oncorhynchus nerka* abundance, for example, demonstrates that shifts in salmon productivity, lasting several centuries, have occurred without human influence (Finney et al. 2002). In a policy sense, these are largely givens, essential for assessing the relative importance of the more immediate causes of the decline, but pretty much beyond our control (Francis and Mantua 2003).

To the extent that human actions are effecting changes in ocean and climate patterns, we could conceivably do something about them, at least over the long term. Reducing greenhouse gas emissions may have

Figure 3. Competition for key natural resources, especially for high quality water, will continue and increase in severity through the 21st century. Use of water for salmon recovery is one of many competing priorities. (Source: Crissy Watkins.)

some effect on wild salmon by the end of this century, but climatic and ocean cycles are predominantly independent of human influences as the 500-year and longer reconstructions of salmon, sardine, and anchovy abundance clearly demonstrate (Sharp 2003).

The four core drivers are ones society *does* control and *could* change, so we will elaborate on each of these core policy drivers and defend why we think each must be at the crux of any serious effort to restore wild salmon in California and the Pacific Northwest.

Core Policy Driver #1—Rules of Commerce

The first core driver is an overarching one and, like everything else in salmon science and policy, difficult to rigorously quantify as to its influence on wild salmon. It is that the rules of commerce, especially trends in international commerce and trade as reflected in increased market globalization, tend to work against increasing the numbers of wild salmon. The drive for economic efficiency and low-cost production is a widely professed approach to trade, both within and between nations. Our purpose is not to argue for, or against, such a philosophy of commerce, but rather to note its impact on wild salmon.

Our assumption is that economic efficiency, and the corollary of free trade, will continue to be a dominant government policy through this century. One upshot of such an approach to commerce is that noneconomic values, such as preserving remnant wild salmon runs, tend not to be considered in decision making.

We obtain our computers from where they can be manufactured most cheaply. We move our automobile assembly plants to where they can produce cars most inexpensively. We tend to produce electricity in the most cost-effective way. We obtain most of our wheat where it can be grown most productively and consistently. We obtain wood products where they can be grown and harvested most efficiently and sold at the lowest price. We buy our salmon from Chile, Scotland, Norway, and British Columbia where they can be grown most cheaply. Most consumers appear to be unwilling to pay a premium for wild fish, nor are they willing to limit their salmon consumption to only a few months of the year.

“It is simplistic to hide behind the political rhetoric that bread, electricity, and automobiles can be produced just as cheaply in a salmon-friendly manner. They cannot.”

The benefits of public policies that favor economic efficiency are well recognized, but there are also consequences that, in our view, are not all that favorable to wild salmon. How much more are people willing to pay for bread, for electricity, or for automobiles produced in ways that will help restore wild salmon? It is simplistic to hide behind the political rhetoric that bread, electricity, and automobiles can be produced just as cheaply in a salmon-friendly manner. They cannot.

Global free trade also removes or at least dampens the negative feedback that might otherwise reduce adverse ecological effects because wealthy importers can transfer negative ecological effects to distant, unknown, and policy-irrelevant ecosystems (Rees 2004). As much as we might wish it otherwise, the affluence of the wealthy cannot be extended significantly without bearing the corresponding ecological consequences.

Whether that ecological cost is borne locally or in some distant land is a policy choice.

There are no scientifically “right” policy choices, but there are winners and there are losers associated with any choice, and that point is rarely made clear. As we observe consumer behavior today and project

Figure 4. Both high quality water and high quality spawning and rearing habitat are relatively scarce in western North America and will become even more so through the 21st century. (Source: Michal Zacharzewski.)

it into the future, most people seem unwilling to pay much more for what might be called salmon-friendly products. Society's collective preferences and values may change somewhat in response to salmon decline, but we do not see much indication of a wholesale transformation.

Core Policy Driver #2—Increasing Scarcity of Key Natural Resources

The second core driver is reflected in many of the past, current, and likely future *proximal* causes of the decline of wild salmon. It is that the demand for critical natural resources, especially for high quality water, will continue to be great (and increase) through this century.

Many rivers in California and the Pacific Northwest suffer from severe water shortages, especially of high quality water (Service 2004). Our seemingly insatiable demand for freshwater shows little sign of letting up, nor do we expect it to do so anytime soon. We are not arguing that allocating water for salmon is more important than allocating it for alternative uses, but as competition for scarce water continues and becomes more intense, how will advocates for wild salmon fare relative to advocates for competing priori-

ties such as drinking, irrigation, manufacturing, generating electricity, recreation, or any of a thousand other water needs?

The continuing water war in the Klamath basin, along the California–Oregon border, gives us an indication of the future: farmers defying law enforcement agents and illegally opening locked valves and releasing water to irrigate their fields, streams choked with dying salmon caused by low water flows and poor water quality, and lawyers from various competing interest groups dueling in court over who will get how much water. Every faction in the battle is dissatisfied with the result, and each believes that its interest did not get a fair share of the water. Each faction then continues to plot ways to be more politically effective in next year's battle.

It is not just water that is becoming increasingly scarce. We demand land: somewhere to build a second home, a place to build the next Disneyland, a mountain watershed to accommodate the next Whistler Resort. Paper, wood, wheat, transportation, airports, and shopping centers—they all require scarce natural resources.

Figure 5. The number of humans in California, Oregon, Washington, Idaho, and Southern British Colombia will assuredly increase through this century, and the aggregate demand for chosen life styles will continue to constrain the abundance of wild salmon. (Source: U.S. Army Corps of Engineers.)

Life for individuals, as for society, is a series of trade-offs, choices, and selections between appealing alternatives. Policy choices are arguably zero-sum games. As key natural resources become scarcer through this century, it appears from current and likely future behavior that the individual and collective choices permitting long-term salmon abundance will become increasingly unacceptable to more and more people.

Core Policy Driver #3—Regional Human Population Levels

The third core driver that will determine the status of wild salmon through this century is that the number of humans in the region will continue to increase and their aggregate demands to support chosen life styles will constrain the abundance of wild salmon.

The most probable—indeed the most nearly certain—scenario for the human population trajectory through this century in this region is upward, substantially upward. As core drivers go, population growth is right up there at the top, but it is no longer popular to raise this issue. It has been a taboo subject in most circles. Environmental advocacy groups avoid it like the plague, even though it dwarfs most of the human behaviors they are trying to modify. Wild salmon advocacy groups likewise rarely mention population expansion, much less take policy positions based upon it.

Advocacy groups avoid raising it for some very good reasons. As a colleague told one of the authors when discussing what he might say before giving a talk on the subject of salmon restoration,

> You are absolutely right, most people already know it, and that's exactly why you should let it rest. Back off. You'll leave the proponents of wild salmon restoration depressed. Worse, you'll have the rest of the audience wondering why you are pontificating on the intuitively obvious. And you run the risk of being attacked as a racist, nativist, xenophobe, cultural imperialist, or, at the least, an economic elitist.

Undoubtedly, he was providing some very good advice. However, if society wishes to do anything meaningful about moving wild salmon off their current trajectory, then something must be done about the unrelenting growth in the number of humans in western North America (Langer et al. 2000). We are not arguing necessarily that we collectively *ought* to change any specific policy. But the simple and inescapable fact is that in our region of interest, the human population level we should realistically anticipate through the rest of the 21st century is a serious barrier to achieving any significant long-term wild salmon recovery. We therefore need to initiate candid conversations about the past and likely future growth of the region's human population as an important, even dominant, determinant of the future for wild salmon.

Many readers may wish it otherwise, but that is the way it appears. Yes, the latest demographic forecasts show a flattening of the world population growth rate toward the end of this century, and such may well be the case. For example, most countries in Western Europe have declining and aging human populations, and the attendant economic and social consequences are the focus of policy debates. For the Pacific Northwest, however, there is another story. It is largely one of immigration—continuing immigration to the Pacific Northwest from all directions.

“Life for individuals, as for society, is a series of trade-offs, choices, and selections between appealing alternatives. Policy choices are arguably zero-sum games.”

Washington, Oregon, Idaho, and British Columbia combined are home to 15 million humans. Assum-

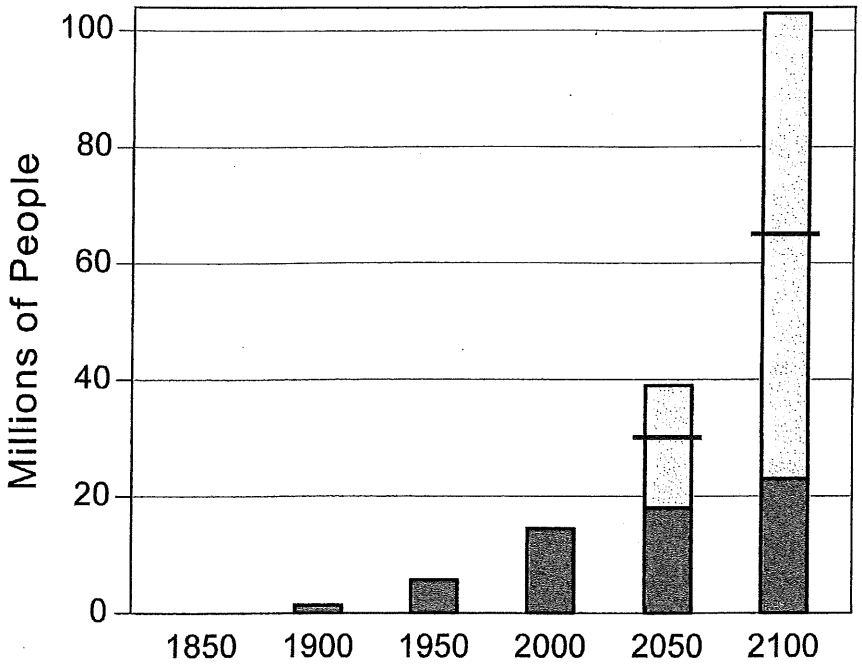

Figure 6. Forecasts of the human population level in the Pacific Northwest (Oregon, Washington, Idaho, and British Columbia) through this century are based on a number of assumptions, but *any* realistic set of assumptions generates a predicted large increase. (Source: Lackey 2003.)

ing a range of likely human reproductive rates, migration to the Pacific Northwest from elsewhere in Canada and the United States, and continuing immigration policy and patterns, by 2100, this region's human population will not be its present 15 million, but rather will be somewhere between 50 and 100 million, a quadrupling or more of the region's human population by the end of this century.

Visualize 50 or 100 million people in this region, and their demands for housing, schools, tennis courts, football stadiums, expressways, planes, trains, automobiles, Starbucks, McDonalds, Tim Hortons, WalMarts, electricity, drinking water, pipelines, marinas, computers, DVDs, 12-screen movie theaters, ski resorts, golf courses, weed-free lawns, big city hotels, and university conference centers.

Let us speculate about 2100 and the footprint of the human population for which we should plan.

Visualize Washington and southern British Columbia in 2100 with its metropolis of "Seavan," which mushroomed into a truly great city as smaller, discrete cities grew together. Seavan in 2100 stretches from Olympia in south Puget Sound northward through the once stand-alone cities of Tacoma and Seattle, and on to Vancouver, east to Hope, and west to cover the southern half of Vancouver Island. Rather than the 6 million people back in 2005, Seavan in 2100 rivals Mexico City or Tokyo in 2005 with its 24 million inhabitants.

Visualize Oregon and southern Washington in 2100 with "Portgene," the other great metropolis in the Pacific Northwest. Portgene extends from its southern suburbs of what was once the stand-alone city of Eugene northward to Portland and across the Columbia River to Vancouver, Washington and onward to sprawling suburbs to the east, west, and north. Remember back in 2005, when what was to

eventually grow into Portgene had a population of a mere 3 million. In 2100, it is a whopping 12 million.

You do not have to visualize California. We already have such metropolises there today.

Regardless of whether our assessment turns out to be right or wrong, population issues are not easy ones to raise, much less discuss, without seeming to advocate curbing the birth rate. There are understandable, strategic reasons why the big environmental groups, most groups in fact, stay clear of population issues. But the current and expected population level in this region is at the core of any credible analysis of potential recovery strategies, or at least those strategies that are offered as serious attempts to actually recover wild salmon.

Core Policy Driver #4—Individual and Collective Preferences

Let us offer a fourth and final core policy driver—one that is very closely tied to the prior three: individual and collective preferences directly determine the future of wild salmon, and substantial and pervasive changes must take place in these preferences if the current long-term, downward trend in wild salmon abundance is to be reversed.

This core driver is perhaps the most obvious and arguably the most important. Among individuals working directly on salmon policy and science, it is easy to assume that salmon are near the top of the public's priorities. Just look at the polling results. Everyone supports salmon and especially wild salmon! But the fact is that salmon recovery is only one of many priorities that society professes to rank highly. It is difficult for us to conceive of this, but that is the situation out there. Even the first author's own children—and he's had over three decades to inculcate them—regularly admonish him, "Dad, get a life. Most people out here in the real world just don't care that much about restoring wild salmon. They have other things to worry about!"

It is society's collective behavior—not opinion polls, nor massive, impenetrable recovery plans but our individual and collective behavior—that provides the best indication of the relative priority of wild salmon as a public policy objective.

Let us offer an example. In western North America in 1991, the first salmon "distinct population segment" was listed under terms of the U.S. Endangered Species Act. With this listing of salmon as a protected species, the policy debate in Washington, Oregon, Idaho, and California shifted away from restoring salmon runs in order to support fishing, to protecting wild salmon runs from extinction. Note that these are two very different policy objectives. In 1991, protecting at-risk runs of wild salmon won out over providing fishing opportunities through supplemental stocking or other efforts to put fish on the hook or fish in the net. The residents of the western United States apparently made a choice.

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But did they? Jump ahead to 2001. Just a decade after the first salmon listing, a severe drought, combined with several electrical blackouts, provoked the Bonneville Power Administration to declare a power emergency, abandon previously agreed upon interagency salmon restoration commitments, and generate electricity using water reserved to help salmon migrate. In one of the most striking recent barometers of competing societal priorities, air conditioners and electricity took priority over both wild and hatchery-bred

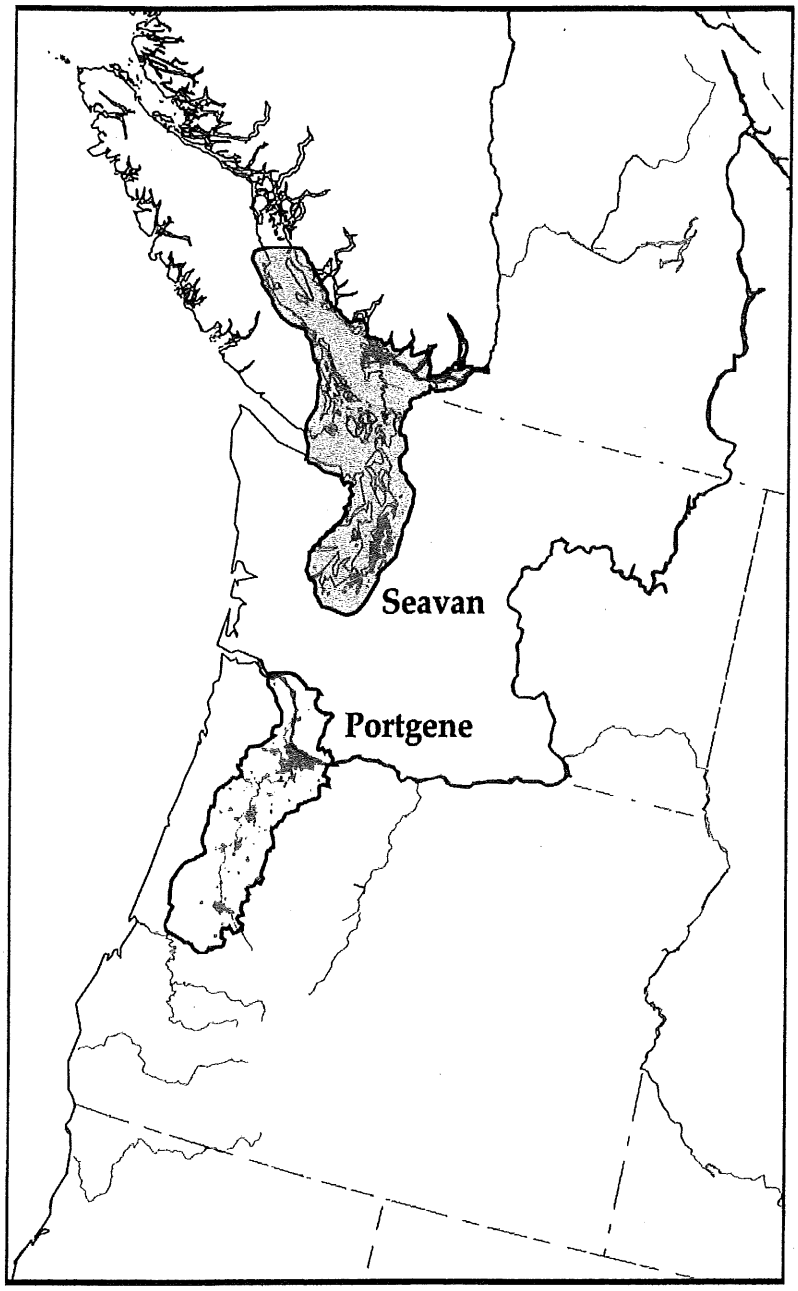

Figure 7. Extrapolating the past 50-year growth rate of the human population in the Pacific Northwest generates more than 100 million people in 2100. Under this scenario, cities growing together will result in two major urban centers, Seavan (Seattle and Vancouver, British Columbia merging) and Portgene (Portland and Eugene merging). (Source: Robert T. Lackey.)

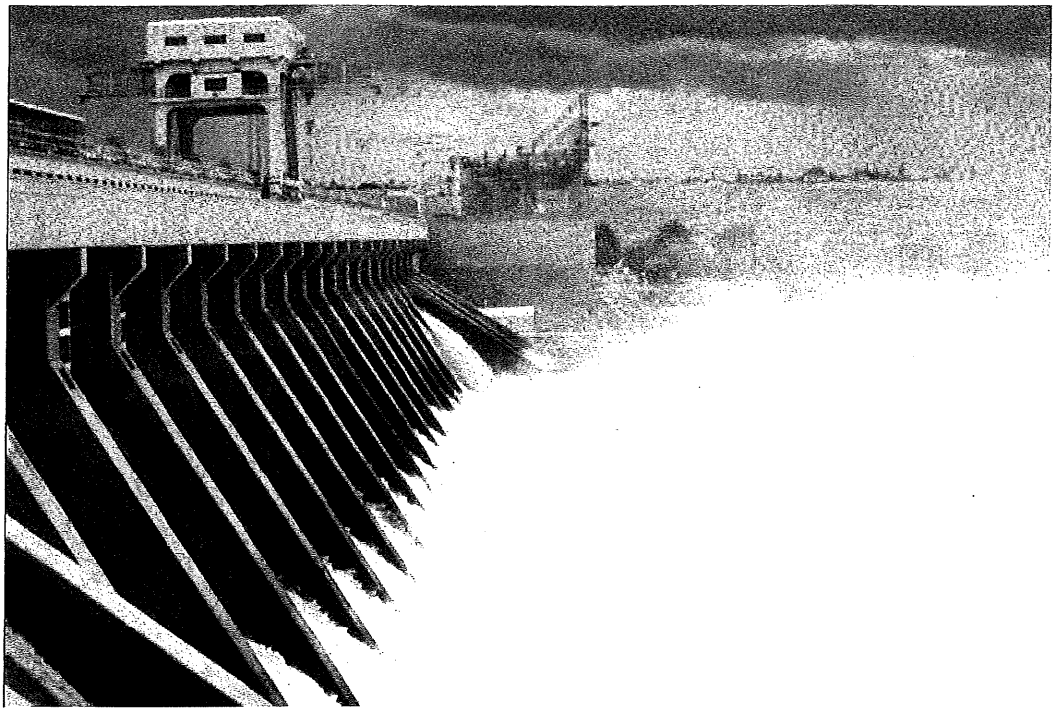

Figure 8. Dams and many other human enterprises produce substantial benefits for society but at great cost to wild salmon runs. How society balances such benefits and costs will be one key to the long-term viability of wild salmon in western North America. (Source: U.S. Army Corps of Engineers.)

salmon and with scant public opposition. No street protests. No legal challenges. No elected officials publicly pleading for salmon. No environmental groups blanketing the Internet with calls to mobilize fax machines in defense of salmon. What we witnessed instead was near complete silence.

Over the past 150 years, we have made plenty of these kinds of choices: contradictory, opposing, apparently inconsistent. They roughly reflect our collective and relative priority for wild salmon. These choices, which we continue to make, are trade-offs, and they are the real measure of the relative importance of salmon.

We are *not* cheerleading for wild salmon. Nor are we cheerleading for electricity, property rights, hatcheries, deeper shipping channels, or having fast food restaurants, donut shops, or coffee bistros on every corner. However, it is naive, if not downright disingenuous, to consider salmon recovery as anything but one potentially minor element in a constellation of competing wants, needs, and preferences, many of which are mutually exclusive. Whether we can ever change enough of our collective preferences to benefit wild salmon is a wide open question.

Conclusion

We have offered here a forecast of the 21st century from a salmon-centric perspective, a forecast driven by assessing four core drivers that largely will determine the future of wild salmon in California and the Pacific

Northwest. For those with a predilection to restoring wild salmon, it is not a cheerful message. For those readers who rank restoring wild salmon as just one of many societal priorities, this forecast also may not be uplifting because society will probably continue to spend billions of dollars in a restoration effort that will likely be only marginally successful over the long term.

By making a few different assumptions about the future, my 21st century salmon forecast would change, but in making the assumptions we did, we struggled to avoid succumbing either to unfounded pessimism or to baseless optimism. Nor should anyone fall into the trap of equating the well-being of wild salmon with overall environmental health from a human perspective. Good water quality is much easier to maintain than large runs of wild salmon. Just because runs of wild salmon in California and the Pacific Northwest almost assuredly will be reduced even further by 2100, it does not inevitably follow that these areas will have worse water quality.

“As for ecological forecasting, it should always be mixed with a strong dose of humility about the track record of salmon technocrats for predicting the future.”

As for ecological forecasting, it should always be mixed with a strong dose of humility about the track record of salmon technocrats for predicting the future. Ecological prediction requires scientific understanding but also some guesses about the likelihood of technological breakthroughs and sometimes drastic social change. Considering technological breakthroughs, who, for example, would have predicted that, within a half century, computers would have dropped from the size of a small house to the size of a deck of cards, yet be many times more powerful? Or, on the social side, who would have predicted that by the beginning of the 21st century, France would have more Muslims than practicing Christians? Predicting the future is, indeed, risky.

We will end this chapter with a prediction, a challenge to wild salmon advocates, and also an opportunity: any policy or plan targeted to restore wild salmon runs must at least implicitly respond to these four core drivers or that plan will fail. It will be added to an already long list of prior, noble, earnest, and failed restoration attempts.

Look down the road to the end of this century, to 2100, less than 10 decades away, only a few dozen generations of salmon beyond today's runs, a few human generations, just two or three ocean regime shifts from now, to a time when this region's human population will not be its present 15 million but rather will be somewhere between 50 and 100 million. However, there are still salmon recovery options that are likely to be ecologically viable and probably socially acceptable, but the more time passes, the more the range of options will narrow.

For professional fisheries experts, for fisheries scientists, technocrats, analysts, and managers, for those who are involved with salmon issues in California and the Pacific Northwest, it is a time neither for crippling pessimism nor for delusional optimism. Rather, we contend it is a time for uncompromising ecological and social realism, leading to forthright policy analysis.

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