Can We Get There from Here?

Salmon in the 21st Century

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At the end of the day, no one disagrees with the most likely trajectory for wild salmon under current policies, and no one disagrees with the four core drivers that continue to impose their broader effects on our regions of study. The wide-ranging ideas and policy prescriptions from independent authors have fallen into four overarching categories. Is there any kind of consensus? And perhaps even more interestingly, what have they not *talked about as policy options?*

Can We Get There from Here? Salmon in the 21st Century

Denise H. Lach, Sally L. Duncan, and Robert T. Lackey

Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them.

—Laurence J. Peter

What Are We Doing?

Salmon recovery might best be described as a "wicked problem," which can be described as an evolving set of interconnected issues and constraints. There is no definitive statement of a wicked problem, and, in fact, you might not even understand what the real problem is until you find a solution. Solving wicked problems such as salmon recovery is fundamentally a social process, and getting the "right" answer may not be as important as having stakeholders accept whatever solution emerges. To make wicked problems even more difficult to deal with, constraints on emerging solutions—ranging from limited resources to political ramifications—are highly volatile over time. Other characteristics of wicked problems include large numbers of people who care about getting the problem resolved—with stakes ranging from financial to spiritual or ethical; confusion and disagreement, even anger, among stakeholders; and the tendency to go on for years without any real progress. The idea of so-called wicked problems was advanced by Horst Rittel and Melvin Webber more than 30 years ago to explain why it is so difficult to resolve certain types of problems (Rittel and Webber 1973).

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In part, the Salmon 2100 project has evolved precisely because we recognize that restoration of salmon runs in the Pacific Northwest and California may be the ultimate wicked problem. The complex life history of the salmon requires that vast areas of land and sea be considered in any solution. Individuals, corpora-

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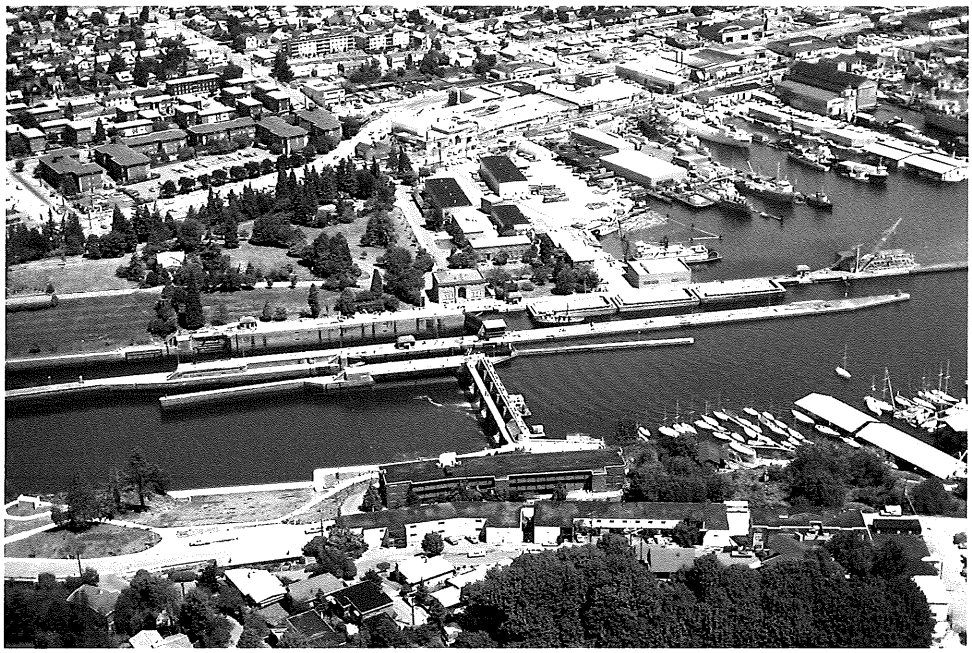

Figure 1. "Wicked problems" are a special category of problems that make solutions tough; salmon recovery and restoration may be the most wicked of all current natural resource problems we face. (Source: U.S. Army Corps of Engineers.)

tions, nongovernmental organizations (NGOs), and local, state, tribal, and federal governments, all with specific objectives and needs, own these lands and rights. Multiple—often conflicting—rules, regulations, and oversight bodies manage the areas involved. Individual practices from water use to transportation choices all have an impact on salmon habitat. And in the case of Pacific salmon, there is no consensus on just what the problem is. Some authors in this book and others believe that salmon in this region are doomed to remnant runs in the relatively near future unless changes are made in the way we manage the land, streams, and ocean that are salmon habitat. Others, including scientists and federal agencies as well as fishers, power producers, and land owners, say "define problem."

The wickedness of salmon recovery is made worse by the wickedness of the core policy drivers presented in Chapter 3: the rules of commerce, increasing scarcity of resources, growth in regional population, and apparent individual and collective preferences. Each of these drivers may be a wicked problem in itself—with no clear problem definition and multiple stakeholders paying very close attention to any proposed solutions. Combined with salmon recovery, these interconnected problems are truly magnificent—even 'awe'ful in all senses of the word—to contemplate. Because wicked problems have no definitive problem formulation, there is no decisive option that solves them to everyone's satisfaction. The problem-solving process ends when you run out of time, money, energy, or some other resource, not when some perfect solution emerges.

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Salmon 2100 project participants were all asked to address the same question:

> What specific policies must be implemented in order to have a high probability of sustaining significant runs of wild salmon through 2100 in California, Oregon, Washington, Idaho, and southern British Columbia?

None of our authors says it's time to throw in the towel on salmon recovery; they all believe that some solution may yet emerge. Each has proposed one or more policies for citizens, companies, and governments of the Pacific Northwest and California to consider in devising recovery strategies. All appear to assume that the four core drivers have to be addressed. Few of the authors, however, explicitly take on the combined wickedness of salmon recovery and the four drivers. Instead, they suggest variations on existing policy options—revise the U.S. Endangered Species Act (ESA) or the Canadian Species At Risk Act (SARA), protect and/or restore more and/or different salmon habitat, create new hatchery practices, change K–12 education, invest in coordinated science programs, and/or transform people's attitudes. Two authors (McDonald and Rees) do suggest shifting our current economic model to one more closely resembling a steady-state economy. Neither, however, deals with the questions of totally reconfiguring all sectors of society to conform to a steady state model.

These are classic responses to wicked problems—buying time through "domestication." Domestication is the process of taking wild and wicked problems off the table until solutions begin to emerge or the problem goes away—often when a different wicked problem reaches a crisis point. The most common forms of domestication include "more research is needed," "let's get stakeholders together to create a solution through collaboration," and "if we amend this regulation, that should take care of it." Domesticating strategies are incremental changes to practices already in place that do not propose revolutionary approaches or challenge existing beliefs. They assume that we will figure it out, if not now, then some time in the future. They also assume that the problem can be solved within the existing arrangement of social, political, and physical variables. We all use domesticating strategies in both our daily lives and in society

Figure 2. Domestication of wicked problems happens when there is no apparent immediate solution so (A) more research and (B) better coordination are called for; this is basically a holding pattern until we figure out what is going on. (Source: U.S. Army Corps of Engineers [top] and Jenny Roberts, environmental education outreach specialist with the Friday Harbor Marine Laboratories.)

for many policy problems to buy more time when we do not know what to do. In the case of wicked problems, domestication may be the *only* option at any given time. After all, we may not even be sure what the problem is, much less know what possible solutions we need to assess.

More of the Same?

Taken together, the prescriptions offered by the authors fall into four general areas:

1. Maintain enough freshwater and estuarine habitat to sustain wild runs.
2. Change institutional structures to more effectively implement salmon recovery.
3. Increase the role of science and technology in recovery efforts.
4. Change people's values and beliefs, which are assumed to translate into changes in practices and actions.

Each of the prescriptions is summarized below along with questions that arise when thinking about the proposed policies. Appendix 1 provides a full breakdown of authors and their proposed prescriptions.

Salmon Sanctuaries

Federal, state/provincial, and local policies are already in place in the Pacific Northwest and California to recover endangered salmon runs listed as threatened and/or endangered species through the ESA or SARA. Instruments for implementing the policies include population protection (e.g., harvest restrictions), habitat restoration, incentives (e.g., conservation easements), sanctions (e.g., water curtailment), and technology development (e.g., hatchery practices). Many of the Salmon 2100 authors propose changes to these existing policy options as a way to ensure continued salmon in rivers and streams of the region.

One of the core prescriptions provided by the authors is some version of protecting healthy salmon stocks while there is still time. This is proposed by multiple authors, including Rahr and Augerot, as well as Ashley, Bella, Dose, Michael, and Nicholas. These authors argue that we haven't had much luck restoring streams with threatened or endangered species, even though we have spent billions of dollars and countless hours in the effort. Instead, they suggest, let's "proactively focus efforts and resources on the permanent protection of the remaining salmon ecosystems with the highest functionality, salmon biodiversity, and inherent salmon productivity" (Rahr and Augerot 2006, this volume).

The authors describe a range of triage approaches and share a common philosophy that at least some streams—those with the greatest likelihood of supporting sustainable runs of wild salmon—would have to be managed as refuges where there is no salmon harvest or other detrimental practices allowed. Bella, for example, proposes a wild salmon national park distributed across the area and purchased with public money. He argues that one of the most successful methods we have demonstrated for protecting endangered species is to provide national parks where citizens are allowed to experience species in their habitat. While recognizing the inherent dangers of "loving national parks to death," Bella suggests that visits to parks are often the *only* experience some people have with nature. If citizens cannot experience nature for themselves, it becomes an increasingly abstract idea that can be disregarded when other priorities intervene. Rahr and Augerot (2006) echo these ideas by proposing the creation of salmon sanctuaries in "basins where society has chosen to ensure that salmon will be protected and restored over the next 100 years." They see this sanctuary system as a social commitment to ensuring the survival of salmon "in the face of the inevitable pressures they will face."

"One of the core prescriptions provided by the authors is some version of protecting healthy salmon stocks while there is still time."

Ashley proposes a four-level strategy ranging from refuges on public lands with intact habitat to work-

ing watersheds in fragmented basins. No activities harmful to salmon would be permitted on refuges, including hatcheries, harvest (stream or ocean), residential dwellings, or water withdrawal. Refuges would be supported by reserves on partially fragmented watersheds with limited activities such as harvest by native or local communities and hydroelectric development above anadromous habitat. To complement the refuge/reserve system, working and industrial watersheds in multiowner, fragmented watersheds would allow some levels of in-river fishing, hydroelectric power, industrial sites, and hatcheries (among other activities). Ashley suggests that these basins could generate revenues to support the restoration and protection of salmon refuges and reserves.

The authors proposing some type of protected zones for salmon often skip over explicit statements of the other element of triage, that is, writing off some streams with less likelihood of sustainable runs. How would they choose which streams would be protected and which would lose protection? And how do they propose to change the ESA or SARA to allow this kind of prioritization of protection? Their basic policy prescription is to focus society's resources on restoring areas with the greatest recovery potential rather than the ESA approach of focusing on the worst situations first, those with the most imminent danger of threatening or endangering a specific species.

Under the current ESA and SARA guidelines, any protection of healthy salmon streams would have to be done in combination with the restoration and protection of the most endangered runs. In addition to the increased costs associated with this strategy, political costs may be high and social acceptability low if individual landowners— including public landowners—are asked to change behavior and practices to protect healthy streams without compensation. If this stream is functioning well under current practices, they will ask, "Why should I bear the cost of changing practices for further protection?" While it may be sound scientific reasoning, political and economic costs of protecting healthy streams may be too high for many decision and policy makers to willingly pay.

"Another option is to modify the ESA and SARA so that in order to protect the healthy habitat, "sacrifice zones" could be created where wild salmon recovery is de-emphasized."

Another option is to modify the ESA and SARA so that, in order to protect the healthy habitat, "sacrifice zones" could be created where wild salmon recovery is de-emphasized or halted. Ashley's proposed "industrial salmon watersheds" describe such basins where the "stocks are most likely to go extinct because of conflicts over water, habitat loss and/or destruction, and episodic point and non-point source pollution events within the watershed" (Ashley 2006, this volume). While technically and maybe economically sound, the idea of industrial watersheds and/or sacrifice zones is likely to run into fierce political and cultural opposition—at least in the near future—from those individuals and groups who are committed to recovery of the salmon at any cost. For these groups the salmon are an icon species—far more than a biological indicator—and represent the rich history and high quality of life in the Pacific Northwest and California.

As described by Steel (2006, this volume), the "public wants to save wild salmon" and has been convinced by scientists, agency staff, and elected officials that it will be possible. We have been told that more research, especially the development of technical solutions, will allow us to have all the services we require from our rivers—including hydropower—and save wild salmon at the same time. What emerging crisis will allow the creation of salmon sacrifice zones to become the endpoint of a huge public investment in salmon recovery and restoration? Over the next 100 years, of course, there are likely to be many crises that will

Figure 3. Current ESA and SARA policies make any "sacrifice zone" illegal and would be hard to justify to a public that has spent years and billions on salmon restoration, such as by retrofitting dams to become more "fish friendly." (Source: U.S. Army Corps of Engineers.)

change the political and social acceptability of salmon recovery strategies. In the short term, however, any changes to current salmon recovery and restoration strategies will include the political task of explaining why the past investment failed—and, inevitably, who is to blame.

Reformed Institutions

Several authors begin to apportion responsibility for the failure of wild salmon recovery. Their prime candidate is "institutional arrangements," although the analysis of the failure ranges from institutions that are too centralized to institutions that are too fragmented and decentralized. Institutions themselves are often wicked, with multiple and interdependent issues and constraints, operating in a dynamic environment with multiple and conflicting stakes and interests that need to be satisfied. Institutions by definition are those stable arrangements that allow social work to take place. And as Dose (2006, this volume) notes, what makes institutions stable also makes them resistant to change.

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Bureaucratic institutions—such as state and federal management agencies—are particularly stable, with many practices, policies, and ideologies that support the continued existence of the institution rather than the solution of any particular problem. We need bureaucratic institutions to be there for the long haul; they

provide continuity of practice and knowledge over many domains. What's frustrating to most of us who interact with these institutions—including employees—is the inflexibility of generalized institutional rules. We know that problems typically require solutions based on local conditions, needs, and practices. Bureaucratic institutions, however, are well experienced in creating generalized rules and guidelines—regulations, statutes, best practices, laws—that are unlikely to be equally applicable or even sensible in all situations. In the not too distant past, representatives of bureaucracies had more flexibility in applying standardized policies. Not everyone was satisfied with those arrangements either; at their best, they tended to favor those with the most invested and allowed practices that tended to disregard less powerful interests including those of community members and species. At their worst, it was possible to buy or bully the representative of bureaucratic institutions so that practices benefiting "special interests"—those that could afford to pay to ensure that the bureaucratic services they received were to their liking—were allowed or even encouraged.

> "Where will the political power come from in a stand-alone institution responsible for the recovery of salmon?"

The authors identify many examples of what they perceive to be institutional incompetence in salmon recovery. These include application of generalized rules whether they make sense or not in specific watersheds, protection of the institution (or individual) rather than the salmon, and allowing elected officials and/or citizens to make recovery decisions based on interests rather than science. In response, authors' prescriptions include decentralized recovery efforts with rural residents playing leadership roles (Bailey and Boshard) and replacing "anti-managers" with reasonable people who use science and rationality to solve problems (Buchal). While some authors suggest the evolutionary approach of moving away from institutional and technical fixes to ecological approaches (Dose), others suggest the more revolutionary approach of dismantling and replacing bureaucratic structures currently responsible for salmon recovery (e.g., Ashley; Kolmes and Butkus).

Kolmes and Butkus suggest that an institutional structure can be created to develop an integrated, transboundary plan to recover salmon in the region. In this context, it is helpful to examine the history of the Northwest Power and Conservation Council (NPCC, formerly the Northwest Power Planning Council). Originally conceived as a way to coordinate regional planning decisions on the Columbia River, the NPCC was quickly caught in the conflicting needs of power production and salmon recovery. And, as Lackey, Lach, and Duncan point out in Chapter 3, when the energy crisis of 2001 hit the western United States, the primary role of the Columbia River was to produce electricity without regard for salmon habitat.

Even if a regional, transboundary institution was created with a sole focus on salmon recovery, it would be interacting with other agencies and individuals whose designs on the habitat would be different. In addition to the production of electricity, developers are looking at the desirability of riparian areas and undeveloped areas, private landowners are looking at individual practices on their property, farmers are looking at the economic feasibility of recovery efforts on their land and the cost of water for irrigation, and municipalities are looking at tax bases if riparian areas become off-limits to development. Where will the political power come from in a stand-alone institution responsible for the recovery of salmon? Can a single institution effectively champion the interests of the salmon in the face of private and public sector challenges to the ecological and economic services provided by salmon habitat? Does a diffuse set of institutional and individual champions—although fragmented and uncoordinated—serve the salmon better across the complex landscape that is their habitat?

In response to the challenges of managing salmon recovery through bureaucratic institutions, several authors suggest shifting the responsibility much more fully to local watersheds. Nicholas describes how the Oregon Plan is designed to move watershed restoration to landowners and citizens in relatively small basins. The underlying idea of the Oregon Plan is to capitalize on land-based experience with specific streams and local interest in seeing a healthy watershed. The state provides some oversight in the form of assessment requirements, guidelines for restoration activities, and financial support for qualified watershed coordinators. While this strategy has the potential to satisfy Bailey and Boshard's call to decentralize recovery efforts and increase the leadership role of rural residents, it does not eliminate the responsibility of the state and federal governments to restore habitat of threatened and endangered species. How does the state or province, for example, know that local individuals and communities have the skills and capacity to recover salmon habitat? Should public money be distributed to individuals to restore private lands? While Bailey and Boshard claim that we do not need "salmon cops," they recognize that there is at least some role for central planning and oversight. How would that be different from the role played by the state of Oregon regarding the Oregon Plan?

A final set of institutional reforms relates to changes in the subsidies and taxes used to encourage and discourage specific behaviors. Curtis and Lovell, for example, suggest removing all subsidies for development activities in important salmon habitat. Others (e.g., Ashley; Bailey and Boshard; McDonald, Knudsen, and Steward; and Michael) propose progressive tax penalties that would discourage land-use practices harmful to salmon streams. Other proponents of institutional reform, including Lombard, Martin, and Nicholas, suggest restricting land use practices across large areas, making watershed protection and restoration the first priority on those lands.

Figure 4. Wicked problems require local solutions while bureaucracies require generalized rules/guidelines—something has to give and it is usually the local, as can often be seen in land-use planning standoffs. (Source: U.S. Army Corps of Engineers.)

Our current tax and subsidy systems are designed to promote individual rights to use of privately owned land. While providing protection to salmon and other species might be an important social goal, most owners believe that they have the right to develop their property to the highest current value. In many cases, this means substantial development and ultimately a kind of suburban sprawl across the landscape that is not salmon-friendly. Even in the relatively salmon-friendly state of Oregon, for example, voters recently decisively opted to relax strict "urban growth boundaries." Tax and subsidy reform always changes who wins and who loses–some sector of the population will believe that their rights have been curtailed. In these intensely political and personal struggles, who will champion the rights of the salmon? More importantly, can they buck local and national cultures and win?

New Science and Technology

Recognizing that institutions both help and hinder salmon recovery, it is difficult to formulate a problem that generates a solution that furthers salmon recovery. Some authors suggest that the solution is to focus on improving our knowledge of habitat needs throughout the life history of salmon species and increasing our technological options, particularly in the reform of hatchery practices. Current policies require that any rules or guidelines for salmon recovery be based on the best available science, although Bisbal (2006, this volume) claims that our current scientific understanding of salmon is "ambiguous, flawed, or simply non-existent." The migratory range and life cycle of salmonids, combined with the complex suite of climatic, atmospheric, and oceanic variables encountered during that life cycle, have made it very difficult to understand and quantify the causes and consequences of habitat change, most of which are related to human activity. Bisbal suggests that salmon science is due for a renaissance, beginning with a philosophical shift that encourages fisheries managers and scientists to take more seriously anthropological, economic, and sociopolitical variables. He hypothesizes that the passage of SARA in Canada indicates that this may already be happening; under SARA, risks to species are assessed using not just scientific knowledge, but also community and aboriginal traditional knowledge. This is in contrast to the U.S. model, which requires that any information used in assessments be published and available to everyone for their inspection. Knudsen and Doyle would like to see scientists engaged more fully in the decisions about managing salmon and suggest the formulation of a high-level science advisory panel, along with concentrated research and development funding.

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Other authors propose creation of new streams that replace lost or highly altered salmon habitat. An engineered stream would "complement the space, woody debris, and complexity of natural habitat but [is] designed to provide the security, flow control, and nutrient productivity requirements for survival," as proposed by Brannon (2006, this volume). While much of the technological and scientific know-how exists to construct these streams, he recognizes that new technologies will be needed for efficient operation and refurbishing of streams and greater genetic knowledge and use of local stocks will be critical to maintaining salmon distinct to stream reaches. Dose, however, suggests that we currently know enough about salmon habitat and have existing technology to reverse the root causes of degradation including removal of dams, allowing floods, restoring vegetation, and reducing logging and road building; he argues

that it is a question of applying current knowledge and technology rather than developing a new body of knowledge.

Ultimately, however, several authors argue that some supplemental stocking from salmon hatcheries will be required to sustain salmon productions at levels that support significant and sustainable fishing for sport, commercial, and tribal interests. While most find fault with current hatchery practices, Talbot and Galbreath, and Stout suggest that the controversy over wild versus hatchery salmon is misplaced. They argue that the dispersal of hatchery fish to different streams over many decades resulted in the "giant stirring of the genetic pool" (Stout and Galbreath 2006, this volume). Regardless of where authors stand on the genetics of wild salmon, many suggest that if a harvestable number of salmon is desired by society, hatchery reform will be critical (e.g., Curtis and Lovell; Dose; Kolmes and Butkus; MacDonald, Knudsen, and Steward; Michael; Stout; and Talbot and Galbreath). Technology is currently available, according to one author, to make the "best use of [hatcheries] in an ecologically sustainable framework" (Talbot and Galbreath 2006, this volume).

> "In actual practice, however, it may be easier to restore salmon runs in the Pacific Northwest and California than to change cultural values and practices."

But prescriptions for protection, restoration, and funding for salmon science, as well as technofixes that inch our knowledge and practices forward, allow us to believe that we are getting closer to solutions. They help us, in other words, to continue domesticating the problem of salmon recovery. Along with the other prescriptions, the science and technology prescriptions are still in the chaotic stage of wicked problems. Problems are being formulated and discarded, stakeholders are coming in and out of the process as their interests are threatened by findings and proposed applications, and no one really seems to be in charge of the big picture or even to comprehend the dimensions of the big picture.

Cultural Shifts

As is clear from this discussion and the authors' prescriptions, domestication strategies are unlikely to create the kind of wholesale change in policy that may be required to fully recover salmon in the Pacific Northwest and California. Where will the impetus for such change come from? Many authors prescribe a change not only in our behavior, but also in our cultural and ethical standpoints. Changing social norms—especially deeply embedded ones like private property rights, personal freedom of choice, and distrust of government—may be easy hypothetical targets but may also be analogous to what Steel (2006) calls "symbolic politics." If all else fails, turn attention to culture and underlying social norms–goodness knows, there is plenty to work with–and at least we can say we are doing something. In actual practice, however, as described in Chapter 2 it may be easier to restore salmon runs in the Pacific Northwest and California than to change cultural values and practices.

Hoopes and Nicholas argue for stronger environmental education during the critical K–12 years. They suggest that investment in children's understanding of the natural world will help change people's values, at least some time in the near future. Unfortunately, while it does appear that environmental education affects people's attitudes about the environment, we are unaware of any empirical evidence to suggest that it has a long-lasting impact on behavior. It is difficult for all of us who live in an industrialized society to avoid practices that we know are harmful to salmon: many of them, such as transportation modes, energy use, and development patterns, are issues over which we have little control.

Steel and Bella point out moments in history where cultural values *have* dramatically shifted—abolition in the 19th century for example—and point out that a social movement may be required for changes necessary to creating an effective salmon recovery. A distinctly political approach to sustaining wild salmon runs would include the development of a "diverse, national, social movement dedicated to pressuring the political and economic elites to change current policies" (Steel 2006). To be effective, a social movement needs to create widely shared "mobilizing frameworks" or statements of the problem that many people can share in making sense of salmon recovery. A social movement that is successful in maintaining wild salmon will require participation by a wide range of individuals and groups who are supported by both governmental and nongovernmental organizations with resources and authority to make changes to existing policy and practice. This would require collaboration and alliances among parties who currently see themselves as adversaries.

Several authors, including Curtis and Lovell, Kolmes and Butkus, and Lombard, agree that one of the first steps to effective salmon recovery would be reframing the debate. Even though they were developed independently, their suggested reframed questions all redefine the current situation as "subsidizing destruction" (as opposed to promoting development) and ask whether society can take on the challenge of the positive action of creating sustainable salmon runs (as opposed to restoring or protecting endangered runs).

Given the wickedness of the salmon recovery problem as reflected in the variety of prescriptions by the authors, it is clear that the way forward is still uncertain. Throw in the complications offered by future challenges as discussed above, and the way forward becomes exponentially more difficult.

How Likely Is Salmon Recovery?

Taking into account the complexity and wickedness of the wild salmon recovery problem, we consider the authors who took us up on the challenge to redraw the future of salmon in 2100 to be exceptionally brave. They ended up having to reflect on their own training, organizational and professional careers, and political ideologies, which turned out to be a challenging experience for many, as described in the epilogue of this book. Most authors recognize that the way forward will not be through a single solution: more science will not restore wild salmon if institutional arrangements are inflexible; new institutional arrangements will not restore salmon runs if economic priorities are not reassessed; and technological fixes may help us muddle through this phase of problem solving but are unlikely to provide a simple, easy and effective policy that will ultimately restore endangered salmon. But we cannot stop muddling through. On the contrary, the domestication strategy we are currently engaged in requires that we continue to try searching for solutions.

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We also consider the authors to be somewhat optimistic in their understanding of the social and political consequences of their proposed prescriptions. Salmon are dependent on habitat that provides water, power, food, and recreation to an increasing number of people in the Pacific Northwest and California. Practices and policies for providing these services are based on rules, regulations, and values deeply embedded in individual, organizational, and cultural value systems. Probably the most dearly held of these are the values surrounding private property rights and individual freedom of choice. Most people report that they want to support the common goods that are salmon and salmon habitat. In our experience, however, few

people are willing to give up any privileges in the way they manage their property or their perceived standard of living. We are even becoming reluctant to pay for the sustenance of more widely acknowledged and accepted common goods like public education, transportation, parks, and environmental protection. What would it take for the public and private sectors to place the highest priority on salmon recovery in their everyday political, economic, and social choices?

The authors may have been aware of social reluctance—at least implicitly—in the types of policy prescriptions that they *did not* suggest. No one mentioned changing property rights, for example, and few even suggested halting *all* salmon harvest (although many suggested *limiting* harvest). No one suggested abrogating treaties to eliminate or reduce tribal rights to a certain portion of the wild salmon harvest. Not a single author said we needed to shift away from hydropower to coal, nuclear, and/or tar sands—potentially more salmon-friendly forms of energy production. While some authors did propose shifting to renewable energy sources beyond hydropower, none grappled with the fact that without either hydroelectric or nuclear power, there probably is not enough renewable energy to fuel our economy in the foreseeable future. None of these solutions is socially or politically acceptable *given current conditions*. Only when we accept the realities and scope of future challenges will we be able to recognize that some of the current unmentionables may become more politically and socially salient over the next 100 years.

> “...there will be major crises; the first two are most likely to be related to energy and water shortages, both of which will have major impact on the management of salmon habitat.”

What else is likely to change between now and 2100? Our guesses into the future are based on a few assumptions. First, until major crises occur, current practices will continue with only slight modifications. Second, there *will* be major crises; the first two are most likely to be related to energy and water shortages, both of which will have major impacts on the management of salmon habitat. Third, there will be unimaginable technological changes, but in the near to intermediate future, we should be looking for changes related to nanotechnology, microbiology and genetics, and biomimicry. It is not impossible to imagine, for example, new forms of renewable energy that take advantage of advances in all three of these fields, but these are likely decades, if not longer, away from fruition.

Let us take a look at the likelihood of changes driven by the four core drivers affecting salmon restoration and recovery (see Lackey et al. 2006, this volume). For example, while we may believe that near-term rules of commerce are largely immutable, a quick look at events during the past decade has to convince us that these rules have changed quite rapidly, unfortunately generally not to the advantage of salmon. In particular, the shift to a global economy has had negative impacts through trade agreements that consider environmental protection rules imposed by the state as unfair trade practices. At the same time, a move toward regionalization is promoting local products and services; if we understand what it *really* means to live in our own watershed, salmon recovery and restoration may become more than symbolic. This trend may be advantaged (and globalization disadvantaged) by any sharp increase in price or decrease in availability of oil.

Our current rules of commerce appear to be driven by exuberant belief in economic growth as a good thing and may in fact be necessary to support a rising standard of living throughout the world as well as the intergenerational welfare programs like Social Security, Medicare, and pensions that both the United States and Canada have committed to. However, any stumble or failure of the market can create conditions that rearrange existing rules relatively quickly. What shifts in rules of commerce will benefit salmon recovery? Or,

Figure 5. Change is often driven by crisis; most likely crises in the near future will be energy and water shortages, leaving the future of the hydroelectric power turbine at best highly conflicted. (Source: U.S. Army Corps of Engineers.)

to be more strategic, how can salmon recovery be protected from any quick shifts in the rules of commerce? How does environmental protection become a "good" in the economic sector? Incorporating environmental factors, which are currently considered externalities, into the rules of commerce is a widely recognized challenge; no one yet has come up with an approach that has been widely embraced by the public. The first two resource shortages likely to have a large impact on salmon recovery are water and petroleum based fuels (i.e., oil and natural gas). While there are substitutes for petroleum and many are working to find ways to replace oil and natural gas with renewable energy and cell-based products, there are no substitutes for water—especially for salmon who are highly sensitive to both the amount and quality of water. The initial water shortage will emerge as severe competition for a fixed water supply; water shortages are currently driven by population growth, especially in areas without local sources of adequate water. These allocation problems will be exacerbated in the relatively near future, however, by climate change altering the distribution of water sources.

What are some of the policy changes that will be required to provide protection of salmon habitat in the face of increasing competition for a fixed water supply? Land use planning and restrictions may provide some limited protection of riparian areas if political will is in place to control development. One hint of how difficult this will be occurred recently in Portland, Oregon—arguably one of the most environmentally friendly and salmon-centric cities in our area of interest. During recent efforts to create a "healthy stream" initiative, the regional government ran into a firestorm of protests from land owners who did not want to be told how to manage their riparian properties. The proposal has been withdrawn for more study.

Emerging technologies currently under study and likely to have a large impact on salmon habitat in-

clude creation of permeable hard surfaces that reduce run-off and erosion, both harmful to salmon streams. Technologies for water reuse, already in place in some water-short countries, may have the potential for removing some water demand on salmon streams. Given the changes in technology society has experienced over the past 25 years, it is foolish to underestimate the possibilities for groundbreaking technologies that have the potential to greatly advance the recovery of salmon, or equally as likely, technologies that greatly speed up the deterioration of salmon habitat.

As mentioned in Chapter 3, the region is likely to see a significant rise in population over the next 100 years. If the trend holds, much of this increase will take place in ever-expanding urban areas as suggested by the supercities of Seavan and Portgene (Lackey et al. 2006). Radical change in population policy remains highly controversial in the United States and Canada. Other countries like China that control population directly have not been especially successful in mitigating environmental impacts. It is also currently unimaginable that we might put policies or laws in place that restrict movement of people across state or provincial lines, which is where most of the growth in the Pacific Northwest and California comes from. Are there other options for managing population impacts rather than managing population itself?

While the image of densely populated urban areas spreading across the west side of the Cascades is mind-boggling, smart-growth solutions focused on channeling growth into areas with existing infrastructure have been found to be effective at slowing sprawling patterns of growth. Other smart-growth tools include adequate public facilities ordinances that require that infrastructure like roads and water systems be fully paid for before development can begin. Making growth pay its own way is not only a method for slowing sprawl, it also pushes at the edges of the rules of commerce discussed above. Affordable housing advocates, on the other hand, argue fairly persuasively that smart growth adds cost to already expensive housing in many areas, reducing choices for low-income residents.

In research on urban and suburban sprawl, researchers have found what may be good news for salmon (Pendall 1999). One of the most important methods for controlling urban sprawl is the protection of farm land and greenbelts that delineate growth areas and protect open spaces around populated areas. States and provinces in the Pacific Northwest and California have had some success with smart growth policies such as limiting land use through laws, taxes, and planning. Oregon's land-use planning laws, for example, have allowed for a 50% increase in Portland population since the 1970s while its land area increased by only 2%. Oregon citizens, however, passed Measure 37 in 2004, an initiative that compensates landowners for value lost due to land-use regulations, raising questions about the long-term acceptability of land-use restrictions as a policy instrument even in relatively salmon-friendly places like the Pacific Northwest. What other opportunities are there to use either existing or new land-use regulations and practices—that are socially acceptable—to enhance salmon recovery? Designating some basins as "industrial" or "working" watersheds, as proposed by Ashley, Michael, and other authors, and then concentrating populations in those areas, may offer the best opportunities for managing the impact of growing populations in the region.

> "Radical change in population policy remains a no-go in the United States and Canada."

The impacts, of course, are magnified by the practices and preferences of individuals and organizations, who make seemingly innocuous choices every day, all the time, with direct and indirect impacts on salmon habitat. Most of us choose to drive a car manufactured at a distant site with parts shipped from around the world; we choose to grow nonnative plants in our yards and on our properties; we choose food that is

shipped from around the world and/or grown in energy-intensive greenhouses; we choose to donate money to people living through natural and human-made disasters rather than to advocacy groups working on salmon restoration; and we choose to live in the modern world, making a myriad of decisions every day that have some indirect or direct impact on the salmon of the Pacific Northwest and California.

These choices are intimately tied to the other driving forces and may, in fact, be their most obvious manifestation. We can see the impact of the rules of commerce in the prices of goods that make it economically rational to buy things imported from long distances that are disposable after only short use. We can see the impact of scarcity of water when a municipal water supplier tells its customers to boil any water they drink because it is contaminated with chemicals used in the manufacturing process. And we can see population growth in new housing developments and rush-hour traffic jams of individuals sitting in their gas-hungry vehicles.

“There will be multiple opportunities over the next century to rethink the way we organize our social, political, and economic lives.”

Preferences are driven not only by individual needs and desires but also by outside pressures from our friends, people with more money, and exposure to marketing that drives expectations about what is reasonable and what is not. Many readers will remember in their life times when one car and one bathroom per household were perfectly acceptable arrangements for most people. Sometime between 1980—a somewhat arbitrary predate to the dramatic increase in house size in the United States and Canada spreading across the landscape—and today, multiple cars and even more bathrooms became not just dreams but needs in the Pacific Northwest and California. Most corporations prior to this date were pleased with a stable growth rate of just under 5%. Now, the shareholders of most publicly held companies will fire executives who cannot deliver double digit growth every year.

How did our individual and collective preferences change so radically over the relatively short course of 25 years? New lending policies, low interest rates, reduced limits on credit, and high employment rates all contributed to increased spending during this time. And, many of us have our retirement pensions and investments tied to the performance of the stock market, and we expect high returns to help ensure that. Changes in the way information is delivered—especially the development of the internet and other high speed information systems—amplified the full range of choices available to us regardless of where we live. It is no longer necessary to live in New York City, for example, to buy the designer furniture featured in *Architectural Digest.* Now, anyone who can connect to the internet can order direct from the manufacturer or, better yet, through some discounter in New Jersey. Yet at the same time, a growing sustainability movement is pushing environment-friendly practices in everything from hybrid cars to organic food to renewable energy. The question is how to ensure that any sustainable practices are also salmon-friendly.

There will be multiple opportunities over the next century to rethink the way we organize our social, political, and economic lives. The challenge will be to face the future with excitement and commitment as we address the challenges facing society if we want significant, sustainable runs of wild salmon.

Will We Get There from Here?

Society is currently in a holding pattern—the salmon recovery problem has been domesticated, and we are waiting for something to change—science, technology, economics, or even public attitudes. We hope something will shake us into a place where the problem becomes so apparent that the way forward is clear.

However, that something just might be a further deterioration of salmon runs on both private and public lands. We may decide that the best we can do is to create salmon zoos like those for buffalo in Yellowstone so that our great-grandchildren will not forget the large salmon runs of the 19th and 20th century Pacific Northwest and California. Of course, taken out of their natural context, the fuss over salmon might not seem so reasonable in hindsight. History may wonder why we spent billions of dollars trying to recover salmon when we had so many other pressing needs, including poverty, health care, homeland security, and homelessness, to attend to. The list of things we could be spending our money on is not infinite, but it is long. Looking back in 2100, will we be judged for having made the right decisions about salmon recovery? Will we have made the right policy choices?

The problem now is that we do not know how to assess the rightness of any policy choice because, as a society, we have not quite got our hands, heads, or hearts around the problem—we have not reached consensus yet about whether or not there is even a problem worth fixing. The authors of this book have made valiant efforts to propose solutions based on their framing of the problem. One thing that became even more evident during the course of this project is that there will not be a single, elegant solution. Many of the authors propose full suites of prescriptions to try and address multiple aspects of salmon recovery. Others focus on a single prescription, locating that policy in the complex setting of salmon restoration. We will most likely stumble on a clumsy solution—cobbled together over years and disparate efforts—that is nothing at all what we expected or planned for.

In the meantime, the authors all agree that if society truly wishes to sustain significant runs of wild salmon throughout this century, then it is vital to continue protection and restoration efforts, including reform of hatchery practices. Every scale of endeavor, current and future, matters: nothing in the Salmon 2100 project is supposed to suggest that we abandon our efforts. Nor does anything suggest that additional efforts (or the current efforts) should be continued—these are choices for society to make, not us, but we do believe that current efforts will not be successful. The authors suggest using the resources, public support, and political will—while they are available—to provide a buffer for salmon in the event of future actions that remove or reduce our options. As Bella (2006, this volume) warns, however, dynamic systems like salmon habitat will be "dominated by the irreversible tendencies" of our actions regardless of what many people value or what we want. The very least we can do is to share our best knowledge, make known implications as explicit as possible, and promote intentional choices. Ultimately, of course, it is the general public that must become knowledgeable and engaged in salmon policy debates if intelligent, informed, and efficacious decisions are to be made. Therefore, we present this book and its policy prescriptions to the general public in a quest to clearly define what would have to change if wild salmon recovery efforts are to have a reasonable likelihood of success.

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Appendix 1. Span of policy prescriptions among authors.

	Ashley	Boshard/Bailey	Bella	Bisbal	Brannon	Buchal	Curtis	Dose	Hartmann	Hoopes	Knudsen	Kolmes/Butkis	Lombard	MacDonald	Martin	Michael	Nicholas	Rahr	Rees	Stout	Steel	Talbot	Williams
Salmon sanctuaries—protect habitat, triage	X		X					X								X		X					
New ownership structures (e.g., salmon societies)	X																						
Sanctions—progressive tax penalties	X	X												X		X							
Harvest changes: limit harvest of wild salmon, eliminate mixed-stock ocean fisheries, remove restrictions on warmwater competitors	X					X		X	X			X		X		X	X			X			
Decentralize recovery efforts—locals take lead, RIMBY		X				X	X		X			X		X									
Funding through self-generated economic activity (e.g., bonds, self-taxes, taxes on previously subsidized goods/services, conservation bonuses)		X											X	X	X	X							
Institutional reform—change role of agency "experts"		X																					
Consolidate—all funding into single jointly held fund, Wild Salmon congress, ecoregional level, Council of Governments		X										X	X	X	X								
Turn problem over to undergraduate students			X																				
Improve decision processes (e.g., rethink adaptive management)				X																			
Reform salmon science—define best available, consider social and economic data, integrate local knowledge, interdisciplinary				X		X	X				X						X						
Engineered streams—create optimum habitat					X	X																	

Appendix 1. Continued.

	Ashley	Boshard/Bailey	Bella	Bisbal	Brannon	Buchal	Curtis	Dose	Hartmann	Hoopes	Knudsen	Kolmes/Butkis	Lombard	MacDonald	Martin	Michael	Nicholas	Rahr	Rees	Stout	Steel	Talbot	Williams
Use technology for monitoring water quality, and so forth					X						X												
Hatcheries—decommission "production" hatcheries								X															
Reform hatchery practices—careful, temporary, reward for sustaining runs, conservation aquaculture, integrated landscape approach							X	X				X		X		X				X		X	
Habitat restoration, landscape level								X	X			X		X								X	
Remove subsidies for development							X																
Professional organizations take explicit stands (advocacy)									X														
Environmental education in K–12										X							X						
Include climate change in planning, including reduction of fossil fuel consumption												X		X									
Regional water/energy conservation												X											
Alternative, renewable energyenergy							X					X											
Revise development critiera—sustainability												X											
Restrict land use across large areas, make WS protection/restoration first priority													X	X	X		X						
Mitigate local loss through restoration at other places on landscape where it makes sense													X										
Reframe the debate—subsidizing destruction versus development													X										
Steady-state economy														X					X				

Appendix 1. Continued.

	Ashley	Boshard/Bailey	Bella	Bisbal	Brannon	Buchal	Curtis	Dose	Hartmann	Hoopes	Knudsen	Kolmes/Butkis	Lombard	MacDonald	Martin	Michael	Nicholas	Rahr	Rees	Stout	Steel	Talbot	Williams
Reconnect wild populations to head waters, dam management, including removal, significant modification															X		X					X	
Widen flood plains, include high flow events																X							
Hydropower changes: limit to select rivers; privatize						X										X							
Restrict agricultural/forest practices to protect riparian habitat; end all subsidies for resource-extraction							X									X				X			X
Modify ESA/SARA to allow some populations to go extinct, provide incentives																X	X						
Restrict predators, revise ESA as necessary																	X			X			
Don't need to reform ESA, get public consensus to protect some populations																		X					
Acquire land/easements to protect habitat																		X					
Shift funds for salmon recovery to habitat protection and restoration																		X					
Modify urban water use/conservation																				X			X
Eliminate distinction of wild versus hatchery fish																				X			
Major unified research efforts, including ocean conditions											X									X			
Social movement mobilizing multiple constituents																						X	
Reduce consumption of natural resources																							X
Engage scientists in decision making											X												
Enhanced Science Advisory Panel											X												
Salmon 2100 R&D funding											X												