

Can We Get There from Here?

Salmon in the 21st Century

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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 can best be described as a “wicked problem,” an idea 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). A wicked problem is really an evolving set of interconnected issues and constraints. There is no definitive statement of it, and in fact you might not even understand what the problem is until you have found a solution. Other characteristics include the 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 its tendency to go on for years without any real progress. Solving wicked problems is fundamentally a social process; getting the “right” answer may not be as important as having stakeholders accept whatever solution emerges. And, to make wicked problems even more difficult to deal with, constraints on emerging solutions – ranging from limited resources to political ramifications – are dynamic over time.

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, corporations, nongovernmental organizations (NGOs), and State, local, 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 wild 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 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 the problem 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.

Salmon 2100 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, and southern British Columbia?

None of the authors of *Salmon 2100* 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. None of the authors, however, seriously takes on the combined wickedness of salmon recovery and the four drivers. While they may implicitly assume that the drivers have to be addressed, they do not generally propose solutions that explicitly address the constraints or opportunities presented by the drivers.¹ 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.

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 don’t 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 to buy more time when we don’t know what to do. In the case of wicked problems, domestication may be

¹ Two authors (McDonald and Rees) 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. In some senses, this is a prescription equivalent to suggesting that everyone in society change their values (see discussion below).

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. Increase habitat protection through salmon sanctuaries or refuges
2. Change institutional structures to more effectively address salmon recovery
3. Increase the role of science and technology in recovery efforts
4. Change people's values and beliefs, which is 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.

Salmon Sanctuaries

Currently, Federal, State/Provincial, and local policies are 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 Ashley, Bella, Dose, Michael, Nicholas, and Rahr and Augerot. 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, this volume).

The authors describe a range of “trriage” approaches and share a common philosophy that at least some streams would have to be managed as refugia 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’ve 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 can’t experience nature for themselves, it becomes an increasingly abstract idea that can be disregarded when other priorities intervene. Rahr and Augerot 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.” What is not clear is whether they would “write off” other areas currently or historically populated with salmon.

Ashley proposes a four-level strategy ranging from refugia on public lands with intact habitat to working watersheds in fragmented basins. No activities harmful to salmon would be permitted on refugia including hatcheries, harvest (stream or ocean), limited residential dwellings, or water withdrawal. Refugias 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 refugia/reserve system, working and industrial watersheds in multi-owner, 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 refugia and reserves.

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’ll 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” would be created where wild salmon recovery is de-emphasized or halted. Ashley’s proposed “industrial salmon watersheds” describe 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, 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. These groups and people view the salmon as an icon species – more than a biological indicator - the salmon represents the high quality of life in the Pacific Northwest and California.

As described by Steel, 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 – especially hydropower – and save wild salmon at the same time. What emerging crisis will allow the culmination of a huge public investment in salmon recovery and restoration to be the creation of salmon sacrifice zones? Over the next hundred years, of course, there are likely to be many crises that will 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 notes, what makes institutions stable also makes them resistant to change.

Bureaucratic institutions – such as State and Federal management agencies – are particularly stable, with many practices, policies, and ideologies to 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 quite a deal 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. At their worst, it was possible to buy or bully the representative of bureaucratic institutions so that practices benefiting special interests were allowed or even encouraged.

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 policy or interests rather than science. In response, their 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, trans-boundary plan to recover salmon in the region. It might be 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 the 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 points out in Chapter 2, when the energy crisis of 2001 hit the western U.S., the primary role of the Columbia River was to produce electricity without regard for salmon habitat.

Even if a regional, trans-boundary 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 will be looking at the desirability of riparian areas and undeveloped areas, private landowners will be looking at individual practices on

their property, farmers will be looking at the economic feasibility of recovery efforts on their land and the cost of water for irrigation, and municipalities will be 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 in 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 doesn't 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 don't 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.

As discussed above, our current tax and subsidy systems are designed to promote individual rights to use of privately-owned land. Even in the relatively salmon-friendly state of Oregon, citizens have protested the use of strict "urban growth boundaries." 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. 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?

New Science and Technology

Recognizing that institutions provide both benefits and limitations for salmon recovery, it is difficult to formulate a problem that leads to a solution furthering salmon recovery. Other authors suggest, instead, the real need 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 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 scientifically explore 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 socio-political variables. He hypothesizes that the passage of SARA in Canada as indicator 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. Knudson and Doyle would like to see scientists engaged more fully in the decision process and suggest the formulation of a high-level Science Advisory Panel and concentrated research and development funding.

Other authors propose habitat protection based on existing scientific and technological knowledge, including creation of new streams that replace lost or degraded 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. 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 of local stocks will be critical to maintaining salmon distinct to stream reaches. Dose suggests that by using what we currently know about salmon habitat and existing technology we can reverse the root causes of degradation

including removal of dams, allowing floods, restoring vegetation, and reducing logging and road building.

Ultimately, however, several authors argue that some supplemental stocking from salmon hatcheries will be required to sustain salmon productions. While most find fault with current hatchery practices, Talbot and Stout both suggest that the controversy over wild vs. 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). 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, Knudson, and Steward; Michael; Stout; and Talbot). Technology is currently available, according to one author, to make the “best use of [hatcheries] in an ecologically sustainable framework” (Talbot).

Along with the prescriptions for protection, restoration, and institutional planning funding for salmon science and techno-fixes that inch our knowledge forward and allow us to believe that we’re getting closer to solutions help to domesticate 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.

Cultural Shifts

As is clear from this discussion and the authors’ prescriptions, domestication strategies are unlikely to create any wholesale change in policy that may be required to fully recover salmon in the Pacific Northwest and California. Where will the impetus for that change come from? Many authors proscribe a change not only in our behavior, but also in our cultural and ethical standpoint. This prescription is like a “desperation play” at a football game – if you’re behind, the clock is running out, and nothing else has worked – just throw the ball high and deep to see what happens. There is no plan, no strategy, no intentional assessment of options, just a last ditch effort to make something happen. 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 another case of what Steel 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’re doing something. In actual practice, however, it may be easier to restore

salmon runs in the Pacific Northwest and California than 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, there is no empirical evidence to suggest that it has a long-lasting impact on behavior. It is difficult for all of us who live in the modern world to avoid practices that we know are harmful to salmon – many of them such as transportation modes, energy use, and development patterns over which we have little control. Environmental education has also been challenged as “indoctrination” by many who see it as the radical challenge it is to the current arrangements of our economic system that, for the most part, are not salmon-friendly.

Steel and Bella point out moments in history where cultural values *have* dramatically shifted - during the abolition movement in the 19th century for example – and point out that a social movement may be required for changes necessary that would create 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). To be effective, social movements create widely shared “mobilizing frameworks” or statements of the problem that many people can share in making sense of salmon recovery.

Several authors, including Curtis and Lovell, Kolmes and Butkus, and Lombard, all agree that one of the first steps to effective salmon recovery will be reframing the debate. Even though they were developed independently, their suggested reframed questions 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 chaotic.

Can We Do It?

Considering the complexity and wickedness of the problem, we consider the authors who took us up on the offer to contemplate 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 an interesting experience for many, as described in the Epilogue of this book. Most recognize that the way forward will not be through a single solution: more science will not get us where we're going if institutional arrangements are inflexible; new institutional arrangements won't restore salmon runs if economic priorities aren't reassessed; and technological fixes may be able to help us muddle through this phase of problem solving but are unlikely to provide the silver bullet that will ultimately restore endangered salmon. In truth, we can't stop "muddling through," because the domestication strategy we're already engaged in requires that we continue to search for solutions.

We also have to consider the authors generally naïve 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 that are deeply embedded in individual, organizational, and cultural value systems. The most deeply-embedded may be 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 how they live their lives. They are even becoming more reluctant to pay for the sustenance of obviously common goods like public education, transportation, and environmental protection. What would it take for the public and private sectors to place salmon recovery at or near the top of the list of 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 *didn't* 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 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 isn't enough renewable energy to fuel our economy in the foreseeable future. None of these solutions is socially or politically acceptable *given the current conditions*. Only

when we accept the 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.

What else is also 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’s take a look at the likelihood of changes driven by the four core drivers affecting salmon restoration and recovery (see Lackey et al., Chapter 3). For example, while we may believe that the rules of commerce are immutable, a quick look at events during the past decade has to convince us that these rules have changed quite rapidly, unfortunately not to the advantage of the natural world. 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.

While our current rules of commerce appear to be driven by exuberant belief in the infallibility of the strong market, any stumble or failure of the market can create conditions that re-arrange the rules relatively quickly. What shifts in rules of commerce will benefit salmon recovery? Or, 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? There are those like Amory Lovins and Hank Patton searching for ways to use the strengths of the rules of commerce to the advantage of the environment. They suggest, for example, the use of intergenerational bonds as an instrument that can ensure ecosystem services for the future.³

The first two resource shortages likely to have a large impact on salmon recovery are shortages in water and oil. While there are substitutes for oil and many are working to find ways to replace oil with renewable energy and cell-

³ For more information see <http://www.worldsteward.org/>

based products, there are no substitutes for water – especially for salmon who are highly sensitive to both water quality and quantity. 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 natural 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 include creation of permeable hard surfaces that reduce run-off and erosion, both harmful to salmon streams. New location tools are being used by fishers; even more sophisticated technology may be able to locate all those hatchery fish, for example, which have radio tags inserted into their clipped adipose fins. Technologies for water re-use, 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 we’ve experienced over the past 25 years, it is dangerous to underestimate the possibilities for groundbreaking technologies that have the potential to greatly advance the recovery of salmon, or equally as likely, technologies which greatly speed up the deterioration of salmon habitat.

As mentioned in Chapter 2, the region is likely to see a significant rise in population over the next hundred years. If the trend holds, much of this increase will take place in ever-expanding urban areas as suggested by the super-cities of Seavan and Portgene (see Lackey et al., Chapter 2). Radical change in population policy remains a no-go in the U.S. and Canada. Other countries like China who control population directly have not been especially successful in mitigating environmental impacts. It is also not currently imaginable that we might cross the policy line that allows movement across State or Province lines. 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 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.

In research on urban and suburban sprawl, researchers have found what may be good news for salmon (Pennal 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 percent increase in Portland population since the 1970’s while its land area increased by only 2 percent. The recent passage (2004) of a new law in Oregon that compensates landowners for value lost due to land use regulations, however, raises 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 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.

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. We choose to drive a car manufactured at a distant site with parts shipped from around the world; we choose to grow non-native 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 disasters rather than to advocacy groups working on salmon restoration; 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 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's contaminated with chemicals used in the manufacturing process. And, we can see population growth in new housing developments and rush-hour traffic jams.

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 reasonable arrangements for most people. Sometime between 1980 – a somewhat arbitrary predate to the dramatic increase in house size in the U.S. 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 percent. Now, the shareholders of most publicly held companies will fire executives who can't 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. 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 environmental- and salmon-friendly practices in everything from hybrid cars to organic food to renewable energy.

Resource scarcity alone is likely to change our preferences and the choices we make even over the next 10 years. When gasoline and other petro-chemical products are made from gallons of \$100+ oil, products and services will need to be made with cell-based plants and animals. Biomimicry is an approach that studies natural models and then imitates them or takes inspiration from their designs to solve human problems. An ecological standard is used to evaluate the success of any innovation – does this invention support the environment and its inhabitants? Researchers at Oregon State University, for example, are exploring ways to use the incredibly powerful adhesive substances that barnacles create to replace chemically-based adhesives across a wide spectrum of applications.

There will be multiple opportunities over the next century to re-think the way we organize our social, political, and economic lives. The challenge will be to

face the future with excitement and commitment, taking people up on their stated desire for a healthy environment by finding multiple ways to provide the goods and services we want and need within the context of salmon habitat protection.

Will We Get There from Here?

We are currently in a holding pattern – the salmon recovery problem has been domesticated. We are waiting for something to change – science, technology, economics, or even public attitudes – that will shake us into a place where the problem becomes so apparent that the way forward is clear. That 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 glory that was the 19th and 20th century Pacific Northwest and California salmon runs. 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 on recovering salmon when we had so many other pressing needs including poverty, health care, and homelessness. 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 don't know how to assess the rightness of any policy choice because, as a society, we haven't quite got our hands around the problem – we haven't reached consensus yet about whether or not there even is a problem worth fixing. The authors of *Salmon 2100* 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 it is vital to continue protection and restoration efforts, including reform of hatchery practices. The most important choices we can make over the next few years are ones that protect as much habitat as possible; any future social, economic, or political changes may as likely be negative as positive for salmon. They suggest using the resources, public support, and political will – while they're available – to provide a buffer for salmon in the event of future actions that remove or reduce our options. As Bella 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.

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