Return to the River

12

Federal and State Approaches to Salmon Recovery at the Millennium

Peter A. Bisson, Ph.D., James A. Lichatowich, M.S., William J. Liss, Ph.D., Daniel Goodman, Ph.D., Charles C. Coutant, Ph.D., Lyman L. McDonald, Ph.D., Dennis Lettenmeier, Ph.D., Eric J. Loudenslager, Ph.D., Richard N. Williams, Ph.D.

Mainstem Habitat and Fish Passage

None of the recovery documents recommends removal or breaching of the four dams on the lower Snake River, but they all recognize issues of mainstem habitat structure and function more than did earlier plans. Some aspects of the recovery strategies represent an evolution in thinking about mainstem habitat and fish passage, whereas other proposed actions represent a continuation of previous recovery programs. The Governors' Plan is essentially a statement of social and political support for restoration activities. Next in level of detail is the Fish and Wildlife Program, which is largely a statement of principles, goals, and general strategies. The Basinwide Recovery Strategy further outlines proposals that are restated and elaborated in a different format in the BiOp, which provides more details about hydroelectric operations than any other aspect of salmon recovery (Figure 12.1). The strategies have a salmon life cycle orientation, which represents a more realistic approach than that which existed in some of the older recovery plans.

The success of the new plans for managing the mainstem Columbia River hydrosystem depends on the level of implementation. The old plans had some action items that were ecologically oriented, but these items were often ignored in practice (Independent Scientific Review Panel [ISRP] 1997, 1999). For mainstem restoration efforts to be successful, feasibility studies would be required and proposed actions deemed feasible before full-scale implementation. This has not often been done. In contrast, traditional measures (e.g., flow regulation, screens and juvenile bypass systems at dams, smolt transportation) have the momentum of past history that makes it likely they will be continued and even expanded

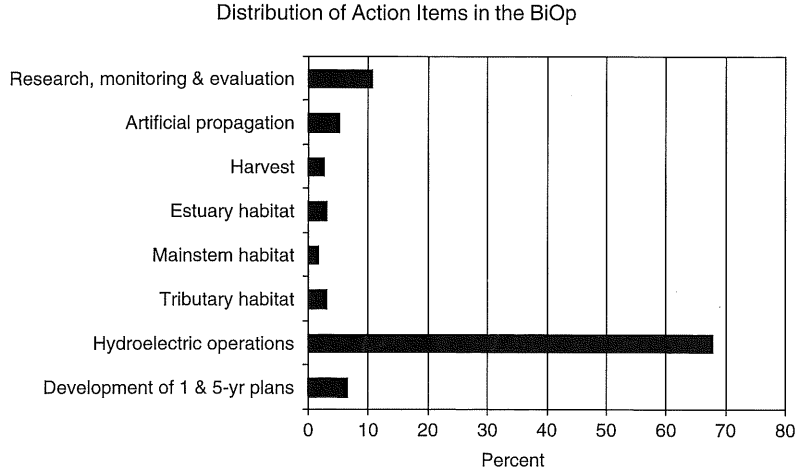


Figure 12.1 The distribution of action items specified by the December 21, 2000, BiOp among various salmon restoration categories.

incrementally, perhaps to the detriment of newer, ecologically oriented initiatives. For example, the barge transportation program for smolt migration is still advocated in the BiOp, despite adopting an overall recovery strategy that moves toward natural ecological processes (either directly or through engineering designs that mimic nature)—a direction the Independent Scientific Group (ISG) termed moving toward more normative conditions (ISG 1999).

Tributary Habitat

The Governors' Plan and the Fish and Wildlife Program outline conceptual or procedural approaches to tributary habitat restoration but do not explicitly consider limiting factors or habitat performance measures. The BiOp and the Basinwide Recovery Strategy, on the other hand, contain a much more substantive discussion of tributary habitat. The process for recovering tributary habitat relies heavily on a combination of modeling, interagency cooperation, and landscape assessments at the subbasin level. Progress toward meeting regional tributary habitat goals depends on (1) landscape modeling efforts being able to generate useful first-level subbasin assessments, (2) action agencies being able to agree upon robust and ecologically meaningful sets of performance standards, (3) adequate habitat and fish population monitoring, and (4) participating organizations learning from past restoration failures and new scientific information. A breakdown in any of these steps will significantly delay implementation of landscape-based restoration (Independent Scientific Advisory Board [ISAB] 2003b). Given current institutional monitoring programs and the extended time period required for many habitat recovery actions to become fully effective (Figure 12.2), monitoring will probably not provide *quantitative* answers about the success of many tributary habitat restoration projects in meeting the goals of the BiOp within 10 years.

Hatcheries

Little evidence is provided that hatchery reform measures proposed in an earlier artificial production review will be implemented or that they will improve salmon recovery. The BiOp and Basinwide Recovery Strategy do not outline a quantitative way to assess the extent to which hatchery programs impact ESA-listed species, or to what extent the artificial propagation of one species could affect the recovery prospects of another species (e.g., Levin and Williams 2002). Since the magnitude of hatchery impacts on naturally spawning salmon is unknown, benefits derived from reducing the impacts of hatchery fish on native stocks are also unknown. Similarly, evaluations of existing supplementation and captive rearing programs provided in the documents are inadequate to determine if these activities can make significant contributions to recovery of listed species (ISAB 2003a).

Figure 12.2 Tributary habitat improvement measures such as riparian revegetation and cattle exclusion often take decades to achieve full recovery. Marks Creek near Prineville, Oregon. Photo by P. Bisson.

Harvest

The documents do not directly address harvest but rather assume that changes in harvest management that evolved over the past 10 to 20 years will continue, depending on the status of stocks. Those trends have included substantial reductions in the total rates of exploitation on naturally spawning salmon populations, fisheries responsive to changes in abundance, and management of total fishing mortality, that is, catch plus associated incidental mortality. In general, the agencies preparing the recovery documents do not regulate Columbia River fisheries, with the notable exception of the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Services' (USFWS) responsibility for jeopardy evaluations of ESA-listed fishes.

Consequently, there are no guarantees that harvest rate reductions on weak stocks assumed in the assessments will continue. If the productivity of the natural populations remains depressed in years with large returns of hatchery fish, as seen in 2000–2003 in the Snake River Basin, harvest rates of wild stocks will likely increase. This would not be an "allocated" harvest, but rather harvest due to mortality associated with bycatch and catch-and-release.

Each document supports the expansion of selective fishing techniques and, in particular, the development of mass-mark selective fisheries in which marked hatchery fish would be retained and unmarked wild fish would be released. The implicit assumption in mass-mark selective fisheries is that the total mortality of naturally produced salmon associated with catch-and-release selective fisheries is less than the mortality in complete retention fisheries and that the resulting harvest rate of wild stocks is sustainable. Intuitively this assumption seems obvious, but it has not been adequately tested.

A related concern is the potential impact of mass-mark selective fisheries on the Coded Wire Tag (CWT) program. The CWT program is essential to the estimation of total exploitation rates in ocean and freshwater fisheries by age and stock (natural and hatchery) and is currently the only means to measure these parameters (Figure 12.3). At this time, it is uncertain whether the viability of the CWT program can be maintained if widespread mass-mark

Figure 12.3 The Coded Wire Tag (CWT) program permits the identification of different stocks of salmon in ocean fisheries, thus permitting managers to target strong stocks and protect weak stocks. Photo by T. Quinn.

(e.g., adipose clip) selective fisheries are implemented. The loss of information may be unacceptable to other fishery management processes outside the Columbia River system. For example, the Pacific Salmon Treaty requires that each country assess the aggregate exploitation rates over all Chinook salmon fisheries to ensure that this aggregate value is less than a maximum value stated in the treaty agreement. The adoption of mass-mark selective fisheries as a harvest tool may also ignore potential ecological interactions between hatchery-produced and naturally produced fish. Mass marking hatchery fish and developing selective fisheries to utilize this production provides a powerful incentive for maintaining large-scale production of hatchery fish. However, what is not considered in this strategy is the potential for ecosystem effects associated with the continued release of large numbers of hatchery-produced fish.

Models, Monitoring, and Evaluation

The documents do not present very much detail with respect to monitoring. They identify the need for successful long-term monitoring programs, but only general suggestions for monitoring are given. Determining monitoring success, that is, the ability to detect the effects of management actions, will depend on details of statistical design and the intended scale of monitoring efforts. Successful implementation requires a high level of cooperation, including give and take by all concerned—state and federal agencies, tribes, and private organizations. The recovery documents do not contain enough details to provide assurance that monitoring plans will be up to the difficult task of tracking recovery actions in the Columbia River Basin. Whether sufficient details about monitoring programs will be presented in subbasin plans is not yet known.

Climate, Hydrology, and Water Resources

The salmon recovery documents do not fully consider the interactions of climate and hydrology as they affect the managed Columbia River hydrosystem. Specifically, the influence of climatic variability (Figure 12.4) at a variety of time scales on hydrologic variability and salmon life histories (felt primarily through variations in sea surface temperature, which also affect ocean survival of salmon) is ignored. Additionally, the documents do not address the potential effects of long-term climate changes, which are likely to result in permanent alteration of the patterns of winter snow accumulation throughout the Columbia Basin (Figure 12.5), and consequently, the timing and amount of seasonal discharge. Implications for management of the reservoir system with an earlier spring freshet and reduced summer flows are likewise not addressed.

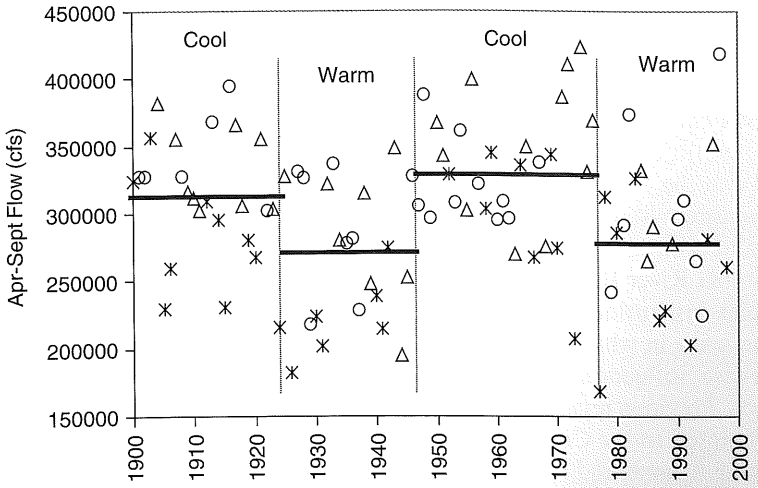


Figure 12.4 April—September average naturalized stream flow for the Columbia River at The Dalles. Solid horizontal lines are Pacific Decadal Oscillation (PDO) phase averages, crosses denote El Niño years, circles are La Niña years, triangles are El Niño-Southern Oscillation (ENSO) neutral years. Figure adapted from Hamlet and Lettenmaier (1999a).

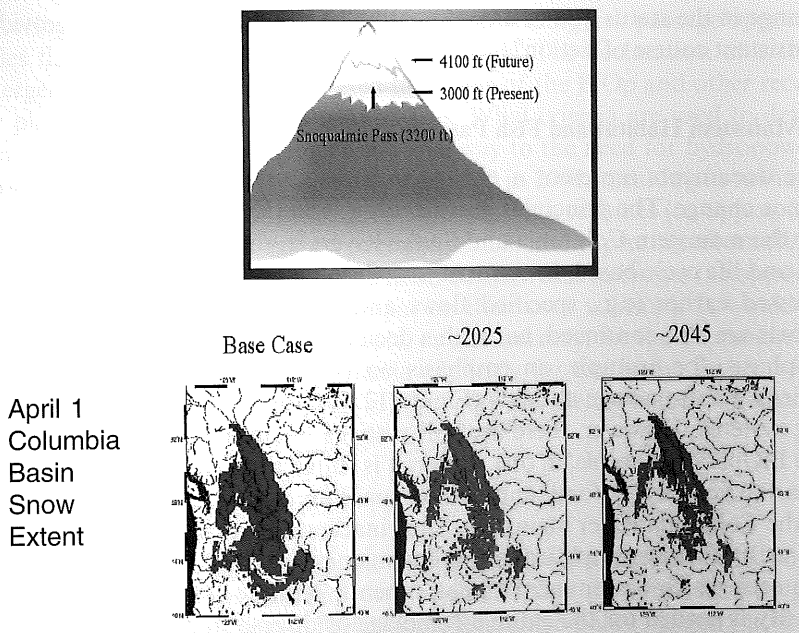
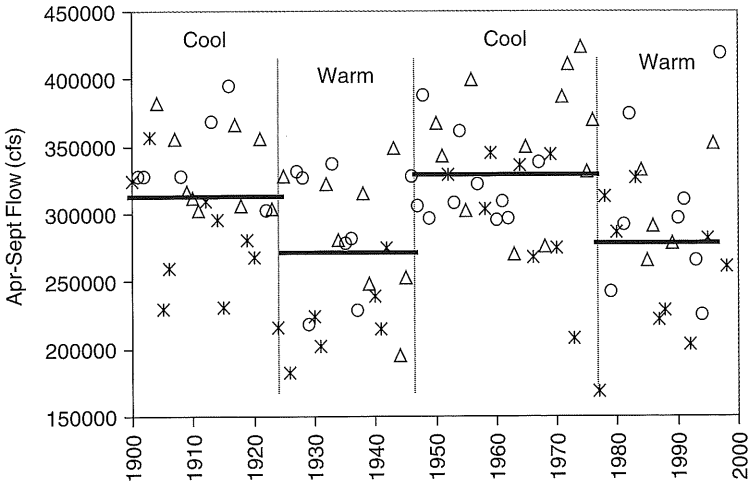


Figure 12.5 Mean Columbia River Basin April 1 snow extent for base case (current climate), year 2025 and year 2045. Figure adapted from Hamlet and Lettenmaier (1999b).



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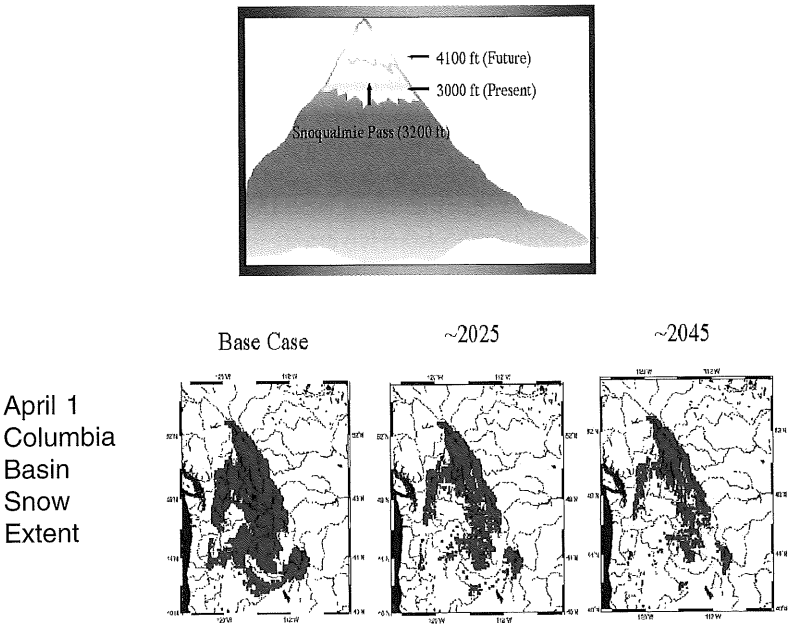

Figure 12.5 Mean Columbia River Basin April 1 snow extent for base case (current climate), year 2025 and year 2045. Figure adapted from Hamlet and Lettenmaier (1999b).

Institutional Arrangements

While the recovery documents attempt to define the problems and identify desirable future conditions, and in some cases suggest measures to determine whether those conditions have been attained, they provide little guidance on how institutions can function more effectively to promote ecosystem recovery. With the exception a general discussion in the Governors' Plan, there is no treatment in any of the documents of probable trends in human population and economic growth, and of the impacts these trends could have on the Columbia River Basin. In addition, there is almost no discussion of the very complex institutional structure existing within the Columbia River Basin or of the ways in which elements of that structure might facilitate, impede, or otherwise influence planning processes and implementation of recovery actions. Previous reviews (e.g., National Research Council 1996) have repeatedly pointed to the Columbia Basin's complex institutional structure and the resulting fragmented jurisdictional authority as one of the major barriers to salmon recovery efforts.

A Significant Change or the Status Quo?

Do the salmon recovery documents, in aggregate, represent a significant change in the status quo or a continuation of past efforts? Do they provide a consistent course of action?

Mainstem Habitat and Fish Passage

The documents represent a change in the status quo, but probably not a major change. The principles, justifications, and the specific recovery actions for the mainstem Columbia and Snake Rivers in the documents are ecological and life cycle based, in contrast to technologically based engineering fixes stressed earlier (e.g., specified flows and dam modifications). Many past efforts are also continued, but with a decidedly more ecological and life-cycle emphasis, for example, an emphasis on compatible surface bypasses and weirs for fish passage at dams (Figure 12.6) rather than on artificial screening systems. However, there are still vestiges of obsolete salmon biology in the BiOp. For example, in one section it is stated that habitat features such as riparian vegetation, food, and rearing space are not needed by certain stocks in the Columbia River mainstem. Such inaccurate statements have been used to justify further simplification of the mainstem based on a narrow view of protecting a few prominent stocks, when a return to natural habitat complexity is needed for the entire assemblage of diverse stocks and species.

Recognizing that each document has its own specific objective, audience, and level of detail, the documents seem quite consistent about protecting and

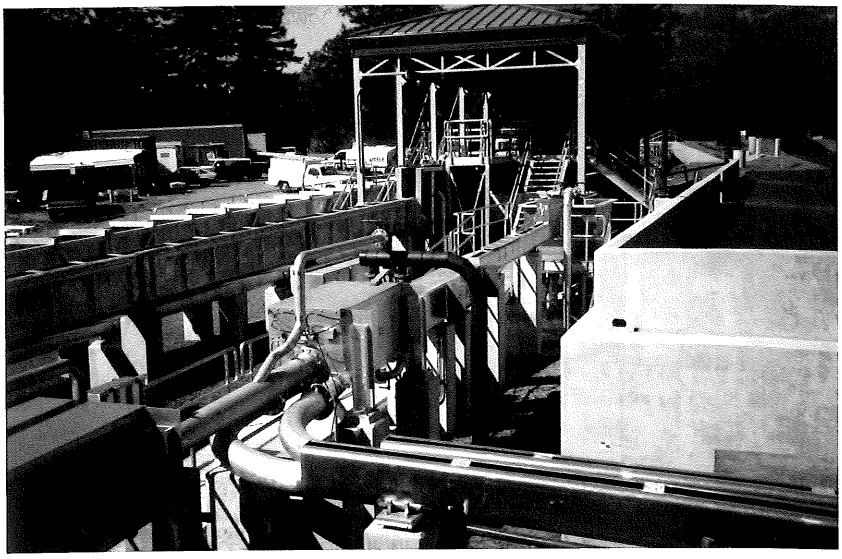

Figure 12.6 Fish bypass systems can be complex and expensive, but they do provide an opportunity to track the downstream movements of PIT-tagged fish. The automated detection system shown here from Bonneville Dam separates marked from unmarked fish for further examination. Photo by P. Bisson.

restoring habitat values in the mainstem and providing fish passage opportunities that better match natural migration needs. The declaration of a flow emergency in early 2001 that vacated the terms of the BiOp and other recovery plans, however, raises important issues. What criteria are used to determine when fish recovery actions must give way to the need for hydropower? Some unwritten threshold was clearly exceeded in 2001, resulting in management actions that included passing all water through turbines (as opposed to allowing part of the flow to pass over the dams), and capturing all smolts at the upstream dams and transporting them downstream in barges (as opposed to allowing them to move downstream on their own volition). It would be useful to know what these criteria were, or alternatively, for the documents to establish a process for creating criteria explicitly for use in the future when emergencies arise. The documents in aggregate are silent on such emergency criteria from the fish recovery perspective.

Tributary Habitat

The greatest difference between the approaches outlined in the four documents and past tributary habitat restoration efforts is that current strategies place much more emphasis on formulating landscape-based recovery actions, although relatively few details are given. This means that tributary restoration projects will, in principle, be chosen on the basis of their overall

contribution to recovery within the context of salmon life history needs (preferred habitats, seasonal movements) and the extent of habitat alteration (locations of habitat bottlenecks or high-quality refugia) within a tributary subbasin of interest. Whether implementation of tributary restoration efforts under the strategies represents a continuation of past programs or a real change in the status quo depends on their ability to take advantage of recent improvements in knowledge of salmon life history and watershed processes. This requires agencies to achieve a level of communication and coordination that is unprecedented for such a large area, particularly because their institutional mandates may occasionally promote actions that are contradictory. Habitat performance standards that transcend water quality hazard thresholds, the traditional approach, and take dynamic watershed processes into account are appropriate for this approach (ISAB 2003b). Subbasin plans that demonstrate linkages between programs and integrate the entire freshwater life cycle of salmon, rather than serving as a collection of individual restoration projects, will be most effective.

The BiOp, Basinwide Recovery Strategy, and Fish and Wildlife Program outline a consistent course of action for tributary habitat restoration, and all three documents utilize independent scientific peer review to provide external quality checks. The Governors' Plan appears to be least consistent with the other documents. Although the section on habitat in the Governors' Plan is brief, it is clear that it endorses restoration efforts designed by local organizations such as watershed councils, municipal and county authorities, and conservation groups, as opposed to being designed by large federal agencies. The Governors' Plan, however, makes no mention of scientific peer review of local plans. There is thus a tendency for the documents to endorse traditional bioengineering approaches to habitat restoration (Figure 12.7).

Hatcheries

The salmon recovery documents tend to advocate a continuation of past hatchery efforts. With regard to artificial production, this may not be an entirely unavoidable or undesirable approach, at least in the short term. Abandoning or substantially curtailing artificial production, concluding that it is a failure, will only happen once stakeholders have exhausted their efforts to make it succeed. Even though all four documents recognize a need for hatchery reform, none of them describes specific reforms or provides guidance on how to implement them.

All four documents explicitly recognize genetic and ecological risks associated with artificial production and acknowledge that past and some current programs continue with high-risk practices. The reports deal with that issue simply by calling for implementation of reforms outlined in earlier reviews of artificial production programs (ISRP 1997; Brannon et al. 1999), and as a

Figure 12.7 Tributary habitat restoration, showing an engineered stream channel, mid-stream rock weirs, and streamside vegetation planting in Asotin Creek, a tributary of the Clearwater River that supports steelhead and spring Chinook spawning populations. While such projects are commonplace, few are peer-reviewed or monitored. Photo by R. Williams.

consequence, they assume that the risks will be minimized (see Chapter 8 on artificial production for additional detail). Unfortunately, most reviews lack details about what reforms are needed or how reforms are to be implemented and subsequently monitored (Figure 12.8). This lack of detail is a result of several data gaps. First, there are no clear statements of different types of risks associated with different hatchery practices, for example, selective breeding changing the makeup of originally native-source broodstock versus the use of non-native broodstock. In addition, a thorough evaluation of the evidence for genetic and ecological risks is lacking—at least for salmonid fishes (ISAB 2003a). Concerns over risk are acknowledged in a vague sense, but priorities for dealing with those concerns are not detailed in practice or policy. A clear explanation of the genetic and ecological issues, as well as an assessment of the relevant evidence, would provide helpful guidance for hatchery operations in the Columbia River Basin.

Harvest

The documents propose both a continuation of the status quo and some new harvest initiatives. There is a general assumption that reduced harvest

Figure 12.8 Many recovery documents are unclear with regard to the specific steps needed to reform hatchery operations. Bonneville Hatchery. Photo by P. Bisson.

impacts will be continued, although the large salmon returns in the years 2001 to 2003 saw both new fisheries and extended seasons. The implementation of more selective fishing techniques is an emerging policy and is a significant change from the status quo. In the Columbia River, selective fisheries have involved taking hatchery fish marked with an adipose fin clip and releasing naturally spawned, unmarked fish (Figure 12.9). This policy has several issues associated with it that are not fully discussed in the four documents. In general, however, there is a high degree of concordance among the four documents. They include strategies for maintaining conservative harvest levels and honoring treaty obligations.

Although harvest strategies are generally consistent among the recovery documents, the topic of harvest definitely receives the least attention of the Hs in recovery planning. This likely follows from two factors: (1) Each document notes major reductions in exploitation of salmon stocks, to the extent that additional reductions are assumed to have marginal value to most populations, and (2) the organizations responsible for the documents have a direct role in annual harvest management plans. As summarized in the Basinwide Recovery Strategy, regulation of ocean harvest occurs pursuant to the Magnuson-Stevens Fisheries Management and Conservation Act and the Pacific Salmon Treaty, and management of in-river harvest occurs under the

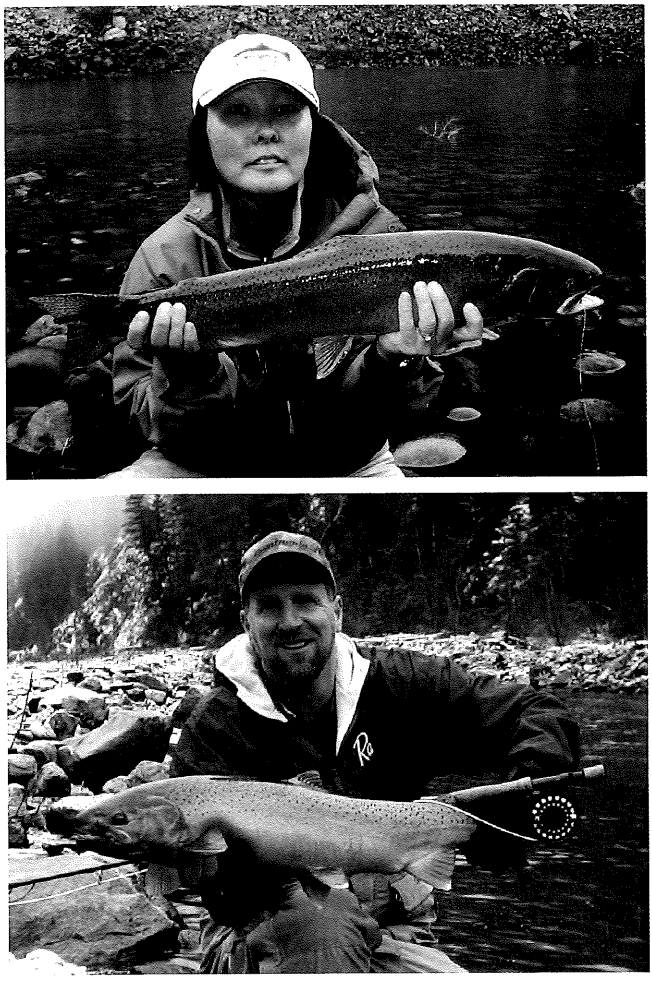

Figure 12.9 Upper: hatchery steelhead marked with an adipose fin clip. Note erosion of the dorsal fin commonly associated with hatchery rearing. Lower: unmarked naturally spawned steelhead with intact fins. Photos by R. Williams.

auspices of the federal court in *U.S. v. Oregon*. In addition, NMFS or USFWS must authorize any harvest of ESA-listed fish. Even the new Pacific Salmon Treaty agreement was reviewed by the NMFS under Section 7 for consistency with the ESA. However, while the treatment of harvest may be limited, the importance of harvest management to salmon recovery is paramount for the immediate short-term survival of populations, and management policies reflect the degree of change that has already occurred in the fisheries and fishing communities. As stated in the Governors' Plan, "*Salmon*

fishing has decreased to a level that represents a mere fraction of what once occurred." Maintaining these reductions in harvest impacts is a core assumption of recovery planning.

Models, Monitoring, and Evaluation

With respect to harvest, hatcheries, and hydropower, the strategies in the documents advocate a continuation and evolution of past efforts in monitoring, evaluation, and modeling. Increased emphasis is placed on monitoring and evaluation of management actions for improvement of tributary habitat for anadromous species and on the effects of hatchery-produced fish on naturally spawning stocks. Also, added emphasis is placed on monitoring reproductive performance of wild stocks throughout the Columbia River Basin, that is, monitoring "fish coming in and fish going out" of natural production areas.

The four documents are consistent in their call for aggressive monitoring and evaluation of management actions aimed at recovering threatened or endangered salmonid populations and supporting a sufficient abundance of salmon to allow for sustainable harvests. Emphasis is placed on (1) continuing the present monitoring programs for the harvest and hydropower systems and adding the tiered monitoring efforts of the hierarchical plan identified in the BiOp and Basinwide Recovery Strategy for threatened and endangered fish species (including resident fishes) and their habitats; (2) increasing monitoring of the effectiveness of projects in the Fish and Wildlife Program consistent with monitoring recommendations in the BiOp and Basinwide Recovery Strategy and recent programmatic recommendations by the Council's Independent Scientific Review Panel (ISRP 2001, 2002); (3) implementing the recommendations for monitoring of hatcheries called for in a recent review of performance standards for artificial production (ISAB 2000); and (4) re-evaluating the harvest and hydropower monitoring programs as needed.

Climate, Hydrology, and Water Resources

The four documents do not represent a meaningful change in the status quo. The inherent assumption in them is that future climate conditions will resemble the past. This assumption, which underlies essentially all water resource design and management in the Columbia River Basin, is now being called into question. The four documents are consistent in that they deal, in one way or another, with flow and flow augmentation issues in the Columbia River mainstem and major tributaries. Hence, even if not explicitly recognized, the use of historical flow observations to determine effects of different flow management options implies an assumption about climate. None of the docu-

ments explicitly considers the implications of proposed climate changes on hydrosystem performance, particularly in low water years that are the basis for annual projections of the minimum available power.

Institutional Arrangements

While agency plans have grown in detail and complexity, the primary focus of the documents is on desired future conditions of the Columbia River Basin, largely ignoring the institutional arrangements that have led to the current situation. Proposed recovery strategies, for the most part, rest on the assumption that top-down planning (at least, at the subbasin scale), informed by science, can restore productive salmon ecosystems. The Governors' Plan departs from this assumption somewhat by proposing more authority for local planning inputs, but it presents little evidence that local planning will lead to a dramatic change in the status quo resulting in effective salmon recovery actions. The four documents are likewise, and somewhat understandably, inconsistent with respect to institutional arrangements. Each document has different goals and was inspired by somewhat different problems. Assignment of organizational responsibility for planning, key participants in identifying restoration priorities, and responsibility for monitoring and evaluation differs among the reports.

Are Linkages among the Proposed Strategies Adequate?

Among the various documents and plans, are linkages among strategies for dealing with the four Hs adequately identified?

Mainstem Habitat and Fish Passage

For the most part, the four documents do not describe how management of mainstem salmon habitat and fish passage will be adjusted for changes in management actions with respect to the other Hs. Cross-linking of items in subsequent drafts of the reports can be useful for coordination within the Columbia River Basin. Implementation of certain mainstem-related actions from the BiOp might not be seen in isolation (or worse, as competitors with other strategies), but as responding to an element of the Basinwide Recovery Strategy, a principle or strategy in the Council's Fish and Wildlife Program, and a general mandate in the Governors' Plan. Although it might be seen as a bookkeeping exercise, such cross-referencing (including referencing the Tribal Plan and Interior Columbia Basin Ecosystem Management Plan) could be the first step toward a mutually accepted, integrated, regional recovery plan.

Tributary Habitat

Tributary habitat recommendations in the documents, in general, are inadequately linked with recovery strategies in the other Hs. The Fish and Wildlife Program does, however, stress the need for supplementation to be linked to watershed condition and to be integrated into subbasin planning. The consequence of putting more water back into tributaries (one of the goals of tributary habitat recovery) is not clearly related to mainstem habitat management or to water quality issues such as temperature and dissolved gas. The important ecological role of salmon carcasses as vectors of marine-derived nutrients in salmon-producing watersheds is not adequately linked to harvest and escapement levels in most of the documents. Changes in habitat restoration tactics are not related to climate shifts or disturbance agents such as droughts, floods, or wildfires.

Hatcheries

The connection between hatchery production and harvest level is recognized; however, the problems of developing selective and terminal fisheries are not adequately considered. Coordination of habitat restoration and supplementation is acknowledged, but how subbasin planning and habitat modeling will inform decisions on where and how much supplementation is warranted is not clear. The cumulative effects of hydroelectric operations and other habitat changes (e.g., water withdrawals) on mainstem habitats and how these alterations limit the effectiveness of artificial production deserve increased attention. A climatic regime shift producing favorable ocean conditions and abundant returns of hatchery salmon similar to those of 2001 to 2003 creates pressure for increased harvest levels. How that pressure might be addressed in the context of conserving wild stocks is not articulated.

Harvest

Harvest is only one source of mortality in the life cycle of salmon populations, and life cycle analyses are appropriate means to integrate harvest mortality with other sources of mortality. More in-depth consideration of two issues could have strengthened the discussions of harvest. First, the level of harvest that can be sustained by a stock is determined by its productivity in the existing environment and the size of the spawning population. To assess the appropriateness of harvest that can take place and still achieve recovery requires establishing spawning escapement goals for each production unit (group of spawning populations), predicting adult returns in the next generation, and a management plan for harvesting surplus returns or imposing

harvest restraints to increase the spawning population sizes. The Fish and Wildlife Program calls for the development of these production plans (in the subbasin planning process), but the empirical basis for these assessments in the subbasins is often quite limited. Second, promotion of mass-mark selective fisheries without considering the potential ecological consequences of such a harvest approach may have significant risks. Mass-marking artificially produced salmon and promoting selective fisheries to utilize marked salmon provide an incentive for maintaining large-scale production of hatchery fish, which has significant implications for the long-term fitness of naturally spawning fish in the same watershed. What is not adequately considered in the documents, however, is the potential for population impacts associated with the continued release of large numbers of hatchery-produced fish on wild stocks (Levin and Williams 2002; ISAB 2003a).

Models, Monitoring, and Evaluation

The four documents identify the need for monitoring and evaluation of certain important linkages, such as the effect of naturally spawning hatchery fish on wild populations and the effect of habitat improvement on carrying capacity. Examples of specific monitoring needs that have not received adequate planning include monitoring the effect of selective fisheries on wild stocks, monitoring the survival rates of salmon in the ocean, and developing a long-term plan for monitoring the survival of juvenile downstream migrants. In fairness to the documents, it is unrealistic to expect them to propose monitoring and evaluating all linkages among the Hs everywhere. Given that limitation, the importance of identifying monitoring plans that respond to priority needs is all the more apparent.

Climate, Hydrology, and Water Resources

Linkages between climate, hydrology, and water resources and the various Hs are not adequately identified. Some documents (notably the Basinwide Recovery Strategy) do mention the role of climate cycles on ocean survival, but flow variation is ignored in management planning except for changes in smolt transportation options during low flow years.

Institutional Arrangements

The four documents do not identify specific improvements in institutional coordination within the Columbia River Basin that would make actions involving each of the Hs more integrated and effective. A widely held view in the Columbia River Basin is that scientific research will identify and

resolve key uncertainties, and that once the necessary knowledge is obtained, effective decisions will become apparent. There are at least two difficulties with this belief. First, although scientific knowledge is always desirable and provides insight into unanswered questions, it invariably gives rise to new issues and consequently new uncertainties. Second, even if all the necessary data existed, it is not clear from the four documents that the institutional framework is adequate to utilize that information in ways appropriate to make and successfully implement decisions on salmon recovery that reflect current and best scientific understanding. The region's institutions may simply be developing salmon recovery plans that are consistent with the current organizational framework. Insufficient attention has been devoted to improving the way institutions incorporate scientific information into recovery strategies, and to ways in which coordination of efforts undertaken by different organizations to improve each of the Hs can be made more effective (see Lee 1993).

Discussion

Two major positive trends distinguish the strategies in these documents from previous recovery plans: (1) They tend to reflect a functional ecosystem approach to salmon recovery, and (2) they make use of quantitative models to assess recovery actions, determine jeopardy, and to evaluate management alternatives. With regard to ecosystem health, the current documents emphasize landscape-based approaches and attempt to direct recovery actions at major components of salmon habitat in the Columbia River Basin. In contrast to previous plans, they address recovery of the estuary, tributary habitat, and features of mainstem habitat beyond water temperature, flow, and gas saturation. The documents propose a watershed planning process that tailors recovery actions to natural biophysical conditions of subbasins and provinces. The documents also acknowledge the importance of using natural conditions as a guide for restoration.

With regard to the use of models, the recovery documents place more reliance on mathematical simulation than previous plans. Extinction risk models developed by NMFS were used to assess jeopardy in the BiOp, and the Cumulative Risk Initiative model was used to assess impacts at different stages of the life cycle and to establish reasonable recovery alternatives. The Salmonid Watershed Assessment Model, another NMFS model, is intended for use in developing recovery actions for tributary habitat. The Northwest Power and Conservation Council recommends the Ecosystem Diagnosis and Treatment (EDT) model to evaluate recovery strategies at the provincial and subbasin scales.

Although we believe the overall answer to the question of whether the four documents will lead collectively to salmon recovery actions that have a high chance of succeeding is probably "no," we do not wish to diminish the scientifically sound recommendations contained in each of them. We reach this conclusion for reasons that hinge on data gaps, conceptual gaps, program integration, and implementation of recovery actions. While the strategies outlined in the documents offer some real advances in the science of salmon recovery, particularly with adoption of an ecosystem perspective and better use of models, important scientific data necessary to resolve critical uncertainties still have not been obtained. Shortcomings in program integration and implementation, inadequately addressed in the documents, are particularly troublesome because of the lack of clear institutional arrangements to carry out the programs. While implementation is not strictly a science issue, failure to clearly specify how recovery strategies would be achieved is a problem these documents share with many previous Columbia River Basin salmon plans.

Data Gaps

One of the fundamental shortcomings of salmon recovery planning in the Columbia River Basin has been the failure of management organizations to establish historical population and environmental databases. As a result, current recovery efforts rest on geographically limited data of varying quality and applicability. If reliable data collection protocols are established, future comparisons to current data will have difficulty discerning whether population trends are due to real changes caused by management actions, changes in the environment unrelated to management actions, or whether they just reflect the inaccuracy of historical estimates. This problem did not originate with the present generation of recovery documents, and in fact reasonable improvements in plans for future monitoring and evaluation are specified in some of them. This is a situation, perhaps unfair, in which it will be difficult to assess the effects of proposed management actions and know whether to continue or change them, because baseline data are inadequate. To assume that monitoring strategies can be implemented in time to assess real changes in the 10-year time frame proposed in the 2000 BiOp is probably unrealistic.

Conceptual Gaps

The salmon recovery documents too often fail to address important issues in a really meaningful way. Several examples are noteworthy.

Hatchery Reform

Although all of the documents acknowledge the need for hatchery reform for a variety of reasons, it is not clear from them what they mean by hatchery reform or how it should be implemented. This is a significant gap between concept and application. The four documents do not map a detailed strategy for reducing risks of harmful interactions between wild and hatchery fish, but instead they defer to the Artificial Production Review and recommendations by Brannon et al. (1999). The documents assume that supplementation will succeed in rebuilding populations and that artificial production will mitigate loss of naturally produced fish to habitat destruction—two frequent but unverified assumptions (ISAB 2003a).

Climate and Demographic Trends

Even though the documents acknowledge that environmental variation must be taken into account, they do not appear to be sensitive to the types of environmental variations that are systematic, that is, constitute probable trends. Two such variations seem especially relevant to salmon recovery.

Climate Change. If current forecasts of climate change are correct, it is quite likely that hydrologic runoff patterns in the region will change (Figure 12.5), probably with negative implications for recovery efforts. The documents appear to assume that the Columbia River Basin will remain within the range of climatic variations observed over the last century. They do not specify alternative actions if this assumption proves to be incorrect.

Human Demographic Changes. If current forecasts of human demographic trends are correct, increasing stress will be put on the Columbia River Basin's natural resources and perhaps even more importantly, on the power demands of the hydroelectric system. This trend will have implications for any recovery program. We found few if any attempts to reconcile salmon restoration efforts with regional strategies for future population growth and development.

Tributary Habitat

The documents tend to lack a strong conceptual foundation for determining desired habitat conditions in a watershed, estimating the productive capacity of watersheds for salmonids, and evaluating restoration alternatives. Natural disturbances, usually viewed as undesirable, but in reality important for long-term salmon habitat creation and maintenance (ISAB 2003b), are acknowledged in some of the documents. However, there is little indication of how

managing the effects of natural disturbances such as wildfires and floods would figure in restoration programs.

Harvest

The documents do not provide a conceptual basis for the establishment of escapement goals for each production unit, prediction of adult returns, and plans for how harvest levels factor into conservation and recovery goals. All of the documents support selective fisheries based on retention of marked fish, but there are potential conflicts between such fisheries and the region's coded wire tag program that has been fundamental to the management and conservation of wild stocks.

Integration

To be truly effective, recovery actions integrated in a way that strategically addresses problems occurring throughout the salmon life cycle are necessary. Plans can only be as effective as the weakest link in the chain of management decisions that influence life stage survival. Too often the four documents do not adequately consider interactions between policies that affect different salmon life stages in the context of the various Hs. For example, the potential interaction between habitat rehabilitation projects and population supplementation is not adequately addressed, nor is the potential effect of harvest on nutrient levels in salmon spawning and rearing areas discussed.

Implementation

There are several very difficult issues with implementing the proposed actions. The level of institutional cooperation between state agencies, tribes, federal agencies, and private landowners needed to achieve salmon recovery in the Columbia River Basin is unprecedented. This point is emphasized strongly in the most recent version of the Governors' Plan, which is critical of the lack of coordination between the subbasin planning process and recovery plans being formulated by the NOAA Fisheries Technical Recovery Teams (TRTs). Fully implementing the proposed actions would require a level of cooperation that has never before been achieved, and the documents do not explain how this cooperation would be facilitated. In particular, the recovery documents reject mainstem dam breaching in favor of aggressive tributary habitat restoration, but how coordination will occur between

public, private, and tribal land managers to provide habitat improvement is inadequately addressed.

Details of recovery actions and implementation strategies are often lacking. In many instances, the four documents present "plans to do planning." They assume that details will be worked out sometime in the future in spite of the fact that it has not been possible to work them out effectively in the past. The documents do not provide explicit strategies for dealing effectively with limited knowledge and high uncertainty in an adaptive management context. Some management decisions in the past have been to postpone potential recovery actions pending future scientific findings and verified population responses, but critical data gaps remain. Not acting is a decision that places the burden of proof on organizations attempting to conserve the resource (i.e., to demonstrate that a significant improvement would be likely). Developing explicit strategies for dealing with high levels of uncertainty is a painful but necessary process.

None of the documents adequately explain the procedures and circumstances that would trigger a departure from their recommendations. In the winter of 2000–2001, the Columbia River Basin experienced the most severe drought conditions since 1977, and many of the action items in the BiOp pertaining to operation of the hydrosystem were modified to accommodate the need for electricity production, sometimes to the possible detriment of juvenile salmonid outmigration. This included downstream barge transportation of all smolts collected at the Snake River dams and elimination of spill over the dams in favor of power generation. However, the documents do not describe how or when such extraordinary circumstances might cause a departure from stated restoration strategies. Nowhere are environmental thresholds identified that would lead to significant changes in management actions, including abandonment of existing plans. Such a lack of specificity underscores our concern that these four documents may not have the collective strength to serve as a clear, detailed, and robust blueprint for salmon recovery in the Columbia River Basin.

Summary

The salmon recent recovery documents provide federal and state strategies for salmon recovery in the Columbia River Basin over the next decade. They vary in their scientific content, ranging from the technically detailed BiOp to the more general policy- and process-oriented Governors' Plan. The purpose of this review was not to provide a thorough appraisal of the science contained in each of those documents individually, but to address the question "Do these four documents collectively outline salmon recovery strategies that are likely to have a high probability of success?" Overall, we believe the answer to the question is "probably not," unless state and federal organiza-

tions follow up these reports with strategies and actions that address the significant deficiencies in past recovery efforts and provide a more explicit recovery blueprint.

Taken together, the four papers represent a realistic assessment of the problems facing salmon recovery, and there is consistency in many of the kinds of recovery actions proposed in the documents. However, the strategies often lack details about how various recovery actions would be implemented, with the exception of actions related to mainstem passage. There is no doubt that the proposed strategies would result in some beneficial results, but the status of many wild stocks has become grave. Recovery documents containing *explicit and quantified details* are needed so that their sufficiency can be evaluated. We believe the four documents, collectively, fall short of providing this detail. Furthermore, the documents propose actions that mix ecological recovery (the approach advocated in this book) with approaches that involve artificial substitution and mitigation. While this is unavoidable in a river basin as heavily developed as the Columbia River, we feel a clear and well-coordinated strategy is needed that lays out a rationale for when and where different types of restoration should be used.

Recovering salmon in the Columbia River Basin will be an enormous undertaking, and the four documents represent a serious effort by state and federal organizations to develop a regional salmon strategy. Most of the scientific underpinnings of the documents are consistent with current ecological beliefs. We found relatively few instances in which they are clearly based on outdated science. But many passages in the documents appear to be works-in-progress in which details, hopefully, will emerge from subbasin assessments, experimental management, operational reforms, and research and monitoring. These details, of course, ultimately determine the successes or failures of the strategies contained in the reports. We hope some of the ideas and suggestions in this chapter and the book will be helpful to scientists and policy makers as recovery actions continue to evolve and monitoring programs are put in place.

Addendum

Since the majority of this chapter was written, there have been two important court decisions that have strongly affected federal salmon recovery policy. In the first case, U.S. District Court judge Michael R. Hogan ruled on September 12, 2001, in *Alsea Valley Alliance v. Evans* that NOAA Fisheries could not split an Evolutionarily Significant Unit (ESU) into two components—hatchery and wild fish—when making a determination of whether the ESU deserved to be listed under the ESA. The decision suspended the listing of Oregon coast coho salmon and potentially affected the listing status of 23 out of the 25 ESA-listed west coast salmon and steelhead. NOAA

Fisheries announced that it would review each of the ESUs that included fish reared in hatcheries, and on June 3, 2004, published its proposed hatchery listing policy, the *Federal Register* (*69 Fed. Reg. 31354*), followed by a re-evaluation of listed Pacific salmon ESUs on June 14, 2004 (*69 Fed. Reg. 33102*). Although under the new policy, hatchery and wild fish are included in jeopardy determinations, overall changes in listed ESUs are relatively minor. NOAA Fisheries proposed a re-listing of Oregon coast coho salmon and further proposed to list lower Columbia River coho salmon as Threatened. Two ESUs (Sacramento winter Chinook salmon and Upper Columbia River steelhead) were proposed for Threatened listing, an improvement from their previously Endangered status, and one ESU (California central coast coho) were proposed for Endangered, a change from their Threatened listing status. The Hogan decision has not resulted in major changes in ESA listing actions, but the precedent has been set to include the status of both hatchery and wild fish in the listing and delisting process.

However, NOAA Fisheries' new policy of including both hatchery and wild fish when considering ESUs for listing has sparked considerable scientific debate. The ISAB (2002) recommended that surplus hatchery fish not be allowed to spawn in the wild, arguing that this could lead to both ecological and genetic harm to wild salmon populations. A group of scientists formerly members of NOAA Fisheries' Recovery Science Review Panel (Myers et al. 2004) argued that hatchery salmon should not be included with wild fish when determining listing status. Both groups pointed out the scientific evidence for loss of genetic fitness associated with mixing hatchery and wild fish. Recently, a group of hatchery advocates (Brannon et al. 2004) defended the use of hatchery salmon in rebuilding wild populations, arguing that properly managed supplementation programs should be used to assist the recovery of wild runs. Readers are referred to Chapter 8 in this book to learn more about the evidence for and against the efficacy of supplementation.

The second important court decision occurred on May 7, 2003, when U.S. District Court Judge James A. Redden ruled in *National Wildlife Federation v. NMFS* that the 2000 Federal Columbia River Hydropower System BiOp did not meet the requirements of the ESA. The BiOp was referred back to NOAA Fisheries, which was given a year to revise it. Judge Redden found that the BiOp was inadequate because it relied heavily on non-federal actions outside the mainstem Columbia and Snake River hydrosystem (e.g., tributary habitat improvements) to mitigate ESA-listed salmon and steelhead losses, and there was little certainty that such mitigation would be successful. The judge stated that the BiOp was arbitrary and capricious because it was improper for NOAA to rely on both federal basin-wide actions encompassing the Columbia Basin as well as the dams and off-site mitigation actions such as those directed at hatchery operations and habitat improvement that had not undergone Section 7 consultation under the ESA. Additionally, the

judge stated that non-federal basin-wide, off-site mitigation actions "are not reasonably certain to occur."

On September 9, 2004, NOAA Fisheries and the federal action agencies (U.S. Army Corps of Engineers, Bureau of Reclamation, and Bonneville Power Administration) released their draft responses to Judge Redden's remand order. In its "Draft Revised 2000 BiOp," also referenced as the "2004 Draft BiOp" on the *www.salmonrecovery.gov* website, the agencies proposed "actions in the operation of the dams that taken as a whole will not jeopardize the existence of the protected stocks." Thus, the question of whether to remove or breach certain federal Columbia River hydrosystem dams was removed from consideration provided suitable modifications were implemented. This policy position departed from the 2000 BiOp, which considered dam removal a possibility if specified salmon recovery goals were not met according to a 10-year schedule. As this addendum is being written, it is uncertain whether Judge Redden will accept the revised BiOp, and in any event advocates of dam removal have promised to litigate. On May 26, 2005, Judge Redden ruled that the 2004 BiOp was legally flawed, and as this addendum is being written the future of the BiOp is uncertain.

The two court cases illustrate how quickly federal policy for salmon recovery can change. In both instances, federal agencies shifted important positions (including hatchery and wild fish in an ESU; consideration of dam removal) that had strongly influenced governance of the Columbia River Basin during the 1990s. We note that both policy shifts appear to be at odds with some of the concepts discussed in this book. These new policies have been highly controversial and in all likelihood will catalyze further court battles. The use of "sound science" or "best science" will be an important part of the debates. While there is no scientific certainty in the optimum path to recovering salmon in a river basin as large or as complex as the Columbia, we hope the "normative" restoration principles identified here will assist agencies and all other stakeholders in making the best use of current scientific information.

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