# Endangered Species UPDATE

*Including a Reprint of the latest USFWS Endangered Species Technical Bulletin*

*February 1992 Vol. 9 No. 4*

THE UNIVERSITY OF MICHIGAN
**School of Natural Resources**


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# Declining Salmon and Steelhead Populations: New Endangered Species Concerns for the West

by

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## Introduction

The history of Pacific salmon has been closely intertwined with that of the region's human inhabitants. For 10,000 years, the region's Indian tribes have received physical and spiritual sustenance from the salmon. The sustainable harvest practices of the tribes allowed them to catch salmon without depleting the resource.

White settlement began in the early 1800s. At first, these settlers used salmon for their own sustenance, but soon commercial trade in salmon began. The first salmon cannery on the West Coast was opened in 1864 on a scow moored near Sacramento, California (Lufkin 1991). Two years later, the first commercial salmon cannery on the Columbia River began operating (Smith 1979). Rapidly increasing settlement and establishment of canneries inspired intensive fishing at nonsustainable rates. As a result, many of the Columbia River basin chinook salmon stocks largely were fished out by 1884. Effort then turned to steelhead and sockeye, whose harvests crashed in 1900, followed by chum and coho, which crashed in the 1920s. By 1945, all Columbia River basin salmon species had declined significantly [Northwest Power Planning Council (NPPC) 1986]. The situation may have been even more severe in California's Sacramento-San Joaquin rivers system where by 1929, overfishing was blamed for a 90 percent decline in commercial salmon harvest from a level averaging more than 9 million pounds live weight annually in the early 1880s (Clark 1929).

Beginning in 1900, fishery managers prohibited certain gear types that allowed overharvest, which began to reduce impacts associated with overfishing. In the late 1800's and early 1900s, however, mining, agriculture, and logging began destroying spawning, rearing, and migratory habitat throughout the West. Hydraulic mining for gold was so intense along the western slopes of the Sierra Nevada that Stone (1883) considered most salmon and steelhead runs in the Feather, Yuba, and American rivers to be extirpated by 1880. Construction of dams for hydropower and irrigation began in the late 1800's. By the 1940s, there were major dams on the Columbia, San Joaquin, and Sacramento rivers. The period 1940-1965 saw major increases in logging and water storage for a variety of purposes including hydropower generation and irrigation (NPPC 1986, Lufkin 1991 ).

In an attempt to mitigate for extensive habitat loss and destruction, artificial production of salmon in hatcheries was called into play. In 1872, Livingston Stone built the first fish hatchery on the West Coast on California's McCloud River (Stone 1883). The State of Oregon began hatchery operations in 1888 on the Clackamas River (Oregon State Board of Fish Commissioners 1888). Numerous other facilities in California, Oregon and Washington soon followed.

Despite our best efforts, continuing economic development has inhibited salmon populations from returning to their former abundance. For example, in the Columbia River Basin, the present salmon run size is estimated at 2.5 million adults, compared with 10 to 16 million adults prior to 1850 (NPPC 1986). About 75 percent of Columbia River adult fish are spawned and reared artificially, in about 100 hatcheries. Annual runs of salmon in the Sacramento-San Joaquin rivers system averaged 272,000 adults during the 1980s, of which approximately 213,000 were hatchery- supported fall chinook in the Sacramento River (Reynolds et al. 1990).

As early as the 1930s, it was recognized that Pacific salmon, which return to their natal streams to spawn through a strong homing tendency, are divided into many local populations (Rich 1939). Such populations now are referred to as stocks (Ricker 1972). Considerable evidence has accumulated that hereditary differences among stocks increase with decreasing geographic proximity as the result of adaptation to local environments (Utter 1981, Bartley & Gall 1990, Steward & Bjornn 1990). Reduced survival of coho salmon transplanted to foreign streams (Reisenbichler 1988) is a practical demonstration that local adaptation imparts fitness to salmon populations. Factors other than geographic separation, however, such as geologic events or differing life history traits, alter the evolutionary rates within salmonid species and preclude the use of geographic separation alone to identify stocks.

Because stocks are the basic evolutionary building blocks of the Pacific salmon species, it is at the stock level that conservation and rehabilitation of salmon, if it is to be successful, will take place (Rich 1939). Although Rich (1939) recommended management based on the stock concept, it has only been in the past decade that management has embraced conservation of local stocks as a goal (Lichatowich & Nicholas, in preparation). Unfortunately, many stock declines and extinctions already have occurred.

## Status of the Resource

During the 1970s and 1980s, the American Fisheries Society (AFS), the largest professional society representing fisheries scientists, became increasingly concerned that certain stocks of West Coast salmon and steelhead were slipping towards extinction. In 1985, the California-Nevada Chapter of AFS petitioned the National Marine Fisheries Service (NMFS) to list the Sacramento River winter chinook salmon as a threatened species. This population ultimately was listed as threatened on 4 August 1989 thus becoming the first salmon stock to be protected by the Endangered Species Act (ESA). A recent petition to reclassify the Sacramento River winter chinook as endangered is pending.

Involvement of AFS with the winter chinook prompted a review of all salmon, steelhead, and sea-run cutthroat stocks on the West Coast. The resulting AFS report (Nehlsen et al. 1991) provided the first comprehensive overview of the status of anadromous salmonid stocks in California, Idaho, Oregon, and Washington. The report addressed the status within those states of chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), sockeye (O. *nerka*), chum (*O. keta*), and pink salmon (*O. gorbuscha*), steelhead (*O. mykiss*) and sea-run cutthroat trout (*O. clarki*).

Stocks were classified by Nehlsen et al. (1991) as **at high risk of extinction, at moderate risk of extinction**, or **of special concern**. Those stocks listed as threatened or endangered pursuant to the ESA and those that were extinct were noted separately.

Stocks **at high risk of extinction** are those whose spawning escapements are declining with fewer than 1 adult fish returning to spawn from each parental spawner. Populations with escapements under 200 during 1 or more of the past 5 years were included in this category unless there was historical evidence to suggest that the population always had been this small. A stock in this category, if further analysis confirms its identity as a "distinct population segment," likely has reached the threshold for listing as an endangered species pursuant to the ESA (Nehlsen et al. 1991).

Stocks **at moderate risk of extinction** are those whose spawning escapements appear to be stable after previously declining more than natural variation would account for, but are above 200. A stock in this category, if further analysis confirms its identity as a "distinct population segment," likely has reached the threshold for listing as a threatened species pursuant to the ESA (Nehlsen et al. 1991).

Stocks were listed as **of special concern** if 1) relatively minor disturbances could threaten them (especially if a specific threat is known), 2) insufficient information on population trend exists, but a decline is suspected, 3) there are relatively large ongoing releases of nonnative fish and the potential for interbreeding exists, or 4) the population is not presently at risk, but requires attention because of a unique character.

The report identified 214 native, naturally-spawning stocks or groups of stocks in California, the Oregon Coast, the Columbia Basin (including parts of Idaho, Oregon, and Washington), and the Washington Coast/Puget Sound area that met the above criteria.

About half (104) of the stocks have a high probability of introgressive hybridization with hatchery-released fish. Only 2 of the 214 stocks, the Sacramento River winter chinook salmon and the Snake River sockeye salmon, are listed as threatened or endangered pursuant to the ESA. Another 100 stocks were considered to be at high risk of extinction, 58 at moderate risk, and 54 of special concern (Table 1).

The full extent of the problem still may be clouded because of incomplete data in many areas. In some basins the picture is blurred by data that were not collected annually or were collected for other purposes and provide only anecdotal information about stock sizes. For other areas like the Columbia Basin, the data are relatively comprehensive and the picture of decline is in sharper focus.

Underrepresentation in the report also may have resulted for those native stocks whose decline was masked by increasing hatchery returns. This has occurred with Washington's Nooksack River coho, where the native stock coexisted with a nonnative hatchery program. Escapement data do not show a decline, but the native stock may have become extinct during the 1980s. In Oregon's Sandy River, spring chinook escapements have increased since the mid-1970s as the result of releases of nonnative hatchery spring chinook and habitat improvements. This increase may have masked the decline or extinction of the native stock that was at very low levels when the hatchery program was begun.

For the reasons outlined above, the AFS report should be characterized as provisional and subject to refinement as better data become available (Nehlsen et al. 1991). The true picture may never be known because many small populations possessing unique characters have


**Endangered Species UPDATE**

*A forum for information exchange on endangered species issues*
February 1992
Vol. 9 No. 4

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The Endangered Species UPDATE is published approximately ten times per year by the School of Natural Resources at The University of Michigan. Annual rates are $23 for regular subscriptions, and $18 for students and senior citizens (add $5 for psotage outside the US). Students please enclose advisor's signature on university letterhead; senior citizens enclose proof of age. Send check or money order (payable to The University of Michigan) to:

Endangered Species UPDATE
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Production of this issue was made possible in part by support from the Chevron Corporation.

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ERRATA: Replacement for page 3, Vol. 9, No. 4 Feb. 1992 issue. Restores missing lines inadvertently cut off by Fig. 1

Table 1. Summary of stock status by geographic region and degree of risk. Data modified from Nehlsen et al. 1991.

| Status | California | Oregon Coast | Columbia Basin | Washington Coast/ Puget Sound | Totals |
|---|---|---|---|---|---|
| Listed as T or E | 1 | 0 | 1 | 0 | 2 |
| At High Risk of Extinction | 20 | 19 | 35 | 26 | 100 |
| At Moderate Risk of Extinction | 12 | 24 | 14 | 8 | 58 |
| Of Special Concern | 6 | 15 | 26 | 7 | 54 |
| Totals | 39 | 58 | 76 | 41 | 214 |

been overlooked in past surveys and may disappear unrecognized.

Many stocks already have been extirpated by construction of dams, excessive logging, pollution, interbreeding with hatchery fish, or combinations of these factors. The most obvious cause of stock extinction is the construction of dams without fish passage facilities. Completion of Dworshak Dam on the Clearwater River in 1974, for example, blocked steelhead and salmon entering this tributary of the Snake River. On the Klamath River, construction of Iron Gate Dam in 1916 blocked runs of chinook salmon into the upper Klamath, Sprague, Williamson, and Wood rivers. Warner (1991) provided a stirring account of efforts to save the San Joaquin River spring chinook following completion of Friant Dam in 1948. From 1948 to 1950, biologists trapped the spring chinook running up the San Joaquin River and transported them to other waters, built weirs to divert the run into the nearby Merced River, and pleaded with the Bureau of Reclamation to release enough water to allow spawning, all to no avail.

At least 106 major populations of salmon and steelhead have been extirpated (Figure 1). These losses include 50 chinook salmon stocks, 15 coho stocks, 9 sockeye stocks, 5 chum stocks, 2 pink stocks, 23 steelhead stocks, and 2 sea-run cutthroat stocks. Actual losses may be even greater. Counting smaller streams as separate stocks, a conservation organization listed more than 200 stocks in the Columbia Basin as extinct (Paul Felstiner, Oregon Trout, pers. comm.).

## Proportion of Stocks at Risk

It is clear from the AFS report that large numbers of salmon, steelhead, and sea-run cutthroat trout stocks in the West are at risk of extinction or have already been lost. But, how do these numbers relate to the total number of stocks in each basin? Unfortunately, a long-term monitoring database does not exist to quickly answer this question for any major western region.

For the Columbia River Basin, an estimate can be made of the proportion of anadromous salmonid stocks at risk by comparing the subbasin list of populations contained in the Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin (Columbia Basin Fish and Wildlife Authority 1990) to the Columbia River Basin stocks identified as at risk or extinct by Nehlsen et al. (1991). These reports indicate that approximately 192 anadromous salmonid stocks occurred in the basin. Of these, 67 (35%) are extinct, 36 (19%) are at high risk of extinction, 14 (7%) at moderate risk, and 26 (13%) are of special concern (Figure 2). Forty-nine stocks (26%) included in the Integrated System Plan are not listed in Nehlsen et al. (1991) and therefore are considered to be secure.

## History of Salmon and the ESA

Two salmon populations are listed as endangered species pursuant to the ESA. The first population to be listed was the Sacramento River winter chinook of California's Central Valley (Figure 3). The California-Nevada Chapter of the AFS petitioned NMFS to list the population on 7 November 1985. NMFS found in 1987 that the Sacramento River winter chinook constituted

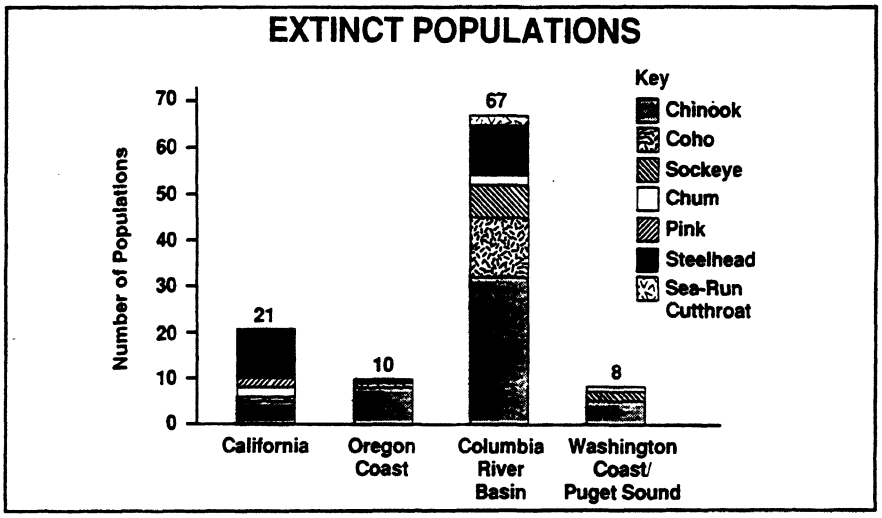


Figure 1. Recently extinct populations of salmon, steelhead, and sea-run cutthroat from the West Coast of the United States. Data from Nehlsen et al. (1991).

## STATUS OF COLUMBIA RIVER BASIN POPULATIONS

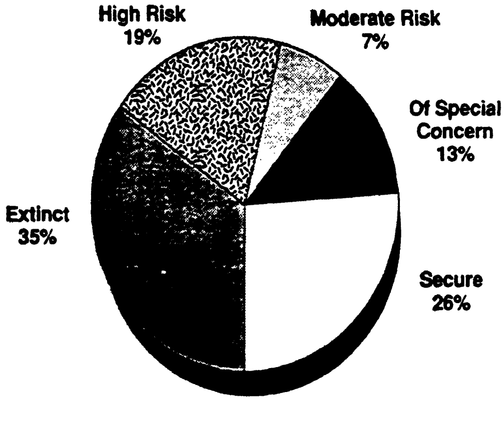


Figure 2. Status of Columbia River Basin populations of salmon, steelhead, and sea-run cutthroat (n = 192). Data compiled from Columbia Basin Fish and Wildlife Authority (1990) and Nehlsen et al. (1991).

a species pursuant to the ESA but that listing was not warranted because resource agencies had agreed to a 10-point restoration plan that was believed to provide all the recovery effort that was necessary. It was not until the 1989 run returned at 547 adults over the Red Bluff Diversion Dam and artificial propagation efforts failed that NMFS changed its opinion. From 1967 to 1969, the winter chinook run averaged 86,509 adults past the Red Bluff facility (Williams & Williams 1991). The low 1989 count and continuing drought conditions in California prompted NMFS to publish an emergency rule on 4 August 1989 temporarily listing the winter chinook as an endangered species. A proposed rule for long-term protection was published on 20 March 1990 and was followed by a second emergency rule on 2 April 1990 and a final rule on 5 November 1990 listing the Sacramento River winter chinook as a threatened species. The 1991 run past the Red Bluff facility totalled only 191 fish.

The second salmon population to be listed was the Snake River sockeye, which was declared to be an endangered species on 20 November 1991. This population was petitioned on 2 April 1990 for listing by the Shoshone-Bannock Tribes. The future of this population looks particularly grim as only 4 adults are known to have returned to their spawning grounds at Redfish Lake, Idaho in 1991. These adults were spawned artificially as part of an emergency captive broodstock program in an attempt to rebuild the run. Sockeye salmon have been extirpated from other lakes in the Snake River Basin, including Alturas, Pettit, Yellowbelly, Stanley, and Little Redfish.

### Meeting the ESA Species Criteria

Section 3 of the ESA defines "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of vertebrate fish and wildlife which interbreeds when mature." For most marine species, including most anadromous fishes, the responsibility for listing "species" as endangered or threatened rests with the Secretary of Commerce through the National Marine Fisheries Service.

In the 20 November 1991 *Federal Register*, the NMFS finalized a policy for applying the species definition in the ESA to Pacific salmon stocks (see also Waples 1991). By this policy, a stock (or group of stocks) will be considered a species for the purposes of the ESA if it represents an evolutionarily significant unit (ESU) of the biological species. The stock must satisfy two criteria to be considered an ESU: 1) it must be substantially reproductively isolated from other conspecific population units, and 2) it must represent an important component in the evolutionary legacy of the species (Waples 1991). Reproductive isolation need not be absolute, but must be sufficient to allow "evolutionarily important differences to accrue in different population units" (1991 *Federal Register*, 56(224):58618). The criterion concerning evolutionary legacy is more of an enigma, but a stock clearly would be considered an ESU if it is genetically distinct, occupies a distinct habitat, or possesses a unique life history characteristic. As summarized in the 20 November 1991 policy as a question, "if the population became extinct, would this event represent a significant loss to the ecological/genetic diversity of the species?"

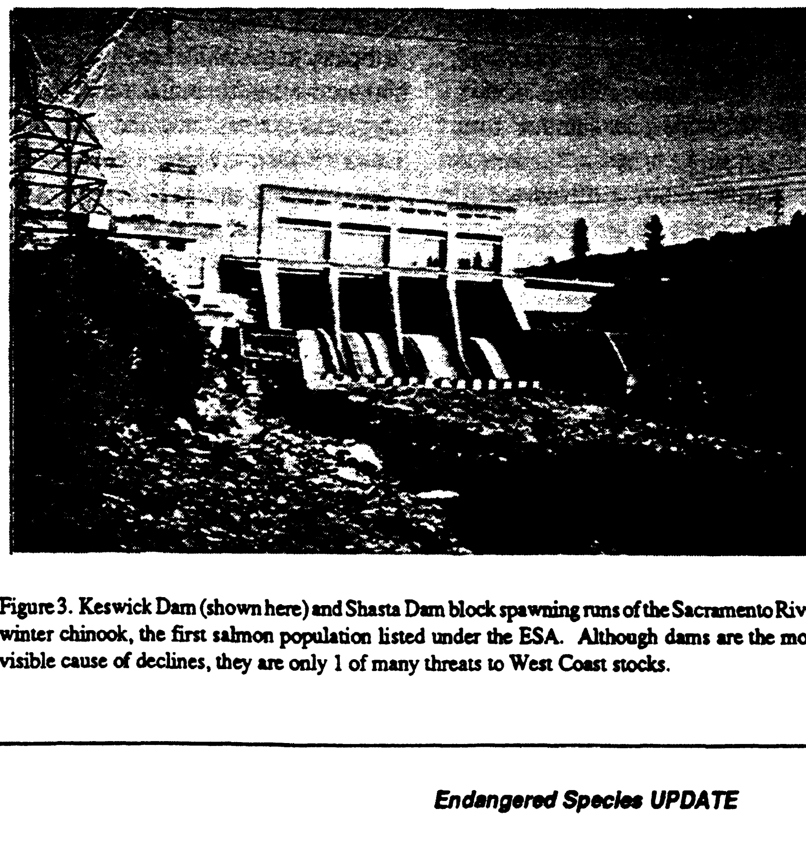

Figure 3. Keswick Dam (shown here) and Shasta Dam block spawning runs of the Sacramento River winter chinook, the first salmon population listed under the ESA. Although dams are the most visible cause of declines, they are only 1 of many threats to West Coast stocks.

Application of this policy to those stocks that have been petitioned for protection under the ESA has produced mixed results. Spawning habitats of the Snake River sockeye salmon are farther from the ocean and are at a higher elevation than any other sockeye population. For these reasons alone, the Snake River sockeye salmon clearly is an ESU. The issue is complicated, however, by the presence of kokanee (a landlocked form of sockeye) in Redfish Lake. In the final rule listing the Snake River sockeye salmon as an endangered species, NMFS cited several studies that indicate the likely reproductive isolation between sockeye salmon and the kokanee in Redfish Lake.

Populations of chinook salmon in the Snake River provide a more complex test. Separate petitions for the spring, summer, and fall runs of chinook salmon in the Snake River were filed by Oregon Trout et al. on 7 June 1990. The NMFS found "compelling evidence" that the fall run constituted an ESU. Significant differences between the Snake River fall chinook and its closest relative, the upper Columbia River fall chinook, include ecological differences in spawning habitat requirements, differences in average adult size, and differences in ocean areas occupied by adults (Waples et al. 1991). Concerning the spring and summer runs, however, NMFS found that "the key information necessary to understand the reproductive and evolutionary relationship between the spring- and summer-run fish is lacking" (Matthews & Waples 1991). NMFS grouped the spring and summer runs together as a single "species" under the ESA despite finding differences in spawning timing and elevations even where the two runs spawn in the same stream. Ironically, NMFS made clear in the final rule that lumped the two stocks as a single "species" pursuant to the ESA that conservation of both stocks still would be required.

The prudent manager should view such lumping of stocks with concern. Biochemical genetic data typically can demonstrate that populations are distinct when differences are found, but cannot necessarily determine similarity based on a lack of observed differences. Utter (1981) described this problem by noting genetic studies that found substantial differences between steelhead populations in the Snake River and upper Columbia River, where earlier studies could find no such separation. Hatchery stockings, when mixed with rare but unique native stocks, often mask the unique features and further complicate an already confusing picture. Given the fact that any stock lost is an irreversible loss, the existence of a stock as an ESU should be given the benefit of the doubt in the presence of sparse or seemingly-conflicting data.

Another petition concerned the lower Columbia River coho salmon, which also was petitioned for listing on 7 June 1990. In this case, the NMFS concluded that the lower Columbia River coho salmon did not constitute a "species" pursuant to their policy. Information available to NMFS did not demonstrate that the lower Columbia River coho were distinct from other wild coho populations along the Oregon and Washington coasts. The issue was complicated by large releases of coho salmon from Columbia Basin hatchery programs, which appear to have introgressed with most of the remaining wild fish. The decision by NMFS to reject the petition and to consider lower Columbia River coho to be extinct may confuse management of the few remaining wild coho in lower Columbia tributaries, such as those from the Clackamas. Although excluded from the petition, wild coho spawning in Oregon's Clackamas River (tributary to the Willamette and Columbia) are well-differentiated from hatchery stocks in run timing and other characters (Robert Deibel, USDA Forest Service, pers. comm.). The Clackamas River coho have declined to approximately 300 adults returning in recent years and appear to be in danger of extinction.

## Conflicting Economies

The extensive distribution of salmon along the West Coast has brought it into contact and conflict with many human activities. Dams inundate spawning habitat and block or impede the upstream migration of adult salmon and the downstream migration to the sea of salmon smolts. Unscreened irrigation ditches divert water and juvenile salmon onto croplands. Poor logging practices degrade stream habitat. Industrial pollution limits stream productivity.

The history of salmon management has been one of continuous conflict between human economic activities that degrade some part of the salmon's extensive habitat and the need to maintain the productivity of this important resource. Recent attempts to seek protection for some stocks of Pacific salmon under the ESA has brought the conflict into sharper focus, and increased scrutiny of the economics of salmon conservation.

Fishery managers allocate Pacific salmon among contemporary users of the resource and between this generation and future generations. Contemporary users include not only native, commercial and sport fishermen but irrigators, loggers, dam operators, developers, etc. — anyone harvesting salmon directly or whose activities diminish the productivity of the resource. Fishery managers allocate the resource to the latter group indirectly through implementation of environmental protection statutes. The allocation of resource between generations highlights the differences in the opposing values of conservation and economic gain. Many of the conflicts that are a part of salmon management stem from a focus on differing time frames (long- vs. short-term) and are the product of differing operating principles inherent in the two economic systems: the natural and the industrial economies (Lichatowich 1992). A review of the differences in the two economies (Table 2) suggests the underlying roots of the conflict in the management of Pacific salmon as well as other renewable natural resources and provides insight as to how the stocks of Pacific salmon in California, Oregon, Washington and Idaho arrived at their present state. An analysis of the interaction of the two economies in the management of Pacific salmon inevitably focuses attention on hatcheries, a major tool of the salmon managers.

From the very beginning of salmon management in the West, hatcheries have exerted a fundamental influence on the direction and outcome of management and they continue to be the dominant

Table 2. A partial list of the differences in the industrial and natural economies (from Lichatowich 1992).

| | Industrial Economy | Natural Economy |
|---|---|---|
| 1. | Fossil fuel supplies the primary source of energy. | Solar radiation supplies the primary source of energy. |
| 2. | Large centralized production facilities (economies of scale and monocultures). | Dispersed production (stability through diversity, the principle of spreading the risk). |
| 3. | Emphasis on production (linear extraction of growth). | Emphasis on reproduction (renewable cycles, limits to growth). |
| 4. | Improvements/changes are external (humans dominate, shape the course of evolution). | Improvements/changes are internal (natural processes/genetic diversity determines scope for change). |
| 5. | Independent sphere of economic activity (individualism). | Interdependent parts (contextual). |
| 6. | Global imbalance (greenhouse effect, holes in ozone). | Healthy cycles of global gas exchange. |

expenditure in the budgets of state and federal management agencies. One reason hatcheries played such an important role in the management of Pacific salmon was their close correspondence to the industrial-economic paradigm from which several features of the conventional hatchery are derived. For example, the design of large, efficient, production hatcheries is consistent with the economies of scale of modern factories rather than an attempt to mimic an ecological process. Theoretically, the hatchery allows the manager to regulate supply to meet demand—in other words, to make management responsive to markets. The ultimate expression of this is the catchable trout programs that placed the "product" in reach of the consumer in numbers and at times determined by the market. The stream became equivalent to a stage prop to give the proper feel of fishing, but the actual productivity of the habitat became irrelevant. Hatcheries also created the illusion that we could obtain the benefits of economic activities that destroyed salmon habitat while at the same time maintaining salmon production. The attempt early in this century to replace conservation with a management program that leaned heavily toward the industrial economic processes and relied on substitution of hatcheries for natural production has had enduring effects on the Pacific salmon resource.

The enthusiastic support given to artificial propagation caused Cobb (1930) to declare that hatcheries themselves present a threat to the fishing industry. Cobb was particularly concerned about the lack of evidence that hatcheries were providing the benefits that their proponents claimed. Early managers, however, faced with political concerns and the dominant industrial-economic philosophy, learned a lesson that would have important implications for the salmon up to the present: They "...paid homage to the need to control harvesting and environmental degradation, [while finding that] promising to sustain the economy's supply of fish without interrupting existing patterns of use yielded far greater political rewards" (McEvoy 1986). Unfortunately, hatcheries not only failed to replace production lost from destroyed habitat, but hatcheries themselves contributed to the decline of fisheries (McEvoy 1986).

## The Future Role Of Hatcheries

Although hatcheries are still impacting wild stocks through mixed stock fisheries and the straying of hatchery fish onto natural spawning areas where they interbreed with wild salmon, the outlook for the use of hatchery technology is improving. Since the mid-1970s, there has been a growing recognition of the need to achieve a balance between the natural and industrial economic processes in the operation of hatcheries. The salmon management paradigm is changing (Bonneville Power Administration 1990, 1991) to include the recognition that successful hatcheries depend on the maintenance of the productivity of existing wild stocks and habitats. Oregon's Wild Fish Policy, adopted in 1978 and strengthened in 1991, is an administrative example of the change. Successful hatchery programs will be managed in ways that integrate the artificial and natural production system (Lichatowich & McIntyre 1987). Nowhere has this recognition been more evident than in the massive Columbia Basin Fish and Wildlife Program of the NPPC. The Columbia Basin, which once supported annual salmon runs of 10 to 16 million adult fish, now supports about 2 million hatchery produced salmon and an additional 0.5 million wild salmon. The NPPC has proposed to double the existing run, and expects hatcheries to play a major role in meeting that goal (NPPC 1987). Future hatchery production must include assessments of genetic risks to native stocks and evaluations based on performance standards that include ecological and genetic criteria are critical to lessen or eliminate adverse impacts to remaining wild fish. Perhaps the most serious threat posed by a dependence upon hatchery production is the mistaken belief that increased technology can compensate for habitat degradation and poor fishery management (Hilborn 1992).

## Dams

In some drainage basins of the West, particularly the Columbia Basin and Sacramento-San Joaquin system, dams have been a major factor in the decline of Pacific salmon. Several hundred dams throughout the West continue to block or impede salmon migration and impact the productivity of the resource. Many of these dam projects, originally permitted without adequate regard for fishery impacts, will face relicensing in the 1990s.

In the Columbia Basin, where natural production today is about 5% of historic levels, salmon and steelhead are the focus of a massive restoration program. This program recently was amended to include a provision to alter the operation of mainstem dams to reduce the high mortality on juvenile salmon migrating downstream to the sea (NPPC 1991). During low flows, mortality at each dam and reservoir project on the Columbia River may be as high as 45% for juvenile salmon and steelhead migrating downstream (Raymond 1988). The proposed changes to operation of mainstem dams is a major departure from the dominance of power production in the basin.

Another unprecedented process is unfolding in the Elwha River on the Olympic Peninsula in Washington. Two dams on the Elwha have blocked salmon runs for about 80 years, including the spring chinook run that was noted for the large size of returning adults (100+ pounds). Both dams may be removed in the near future. Removal of the dams will provide valuable lessons regarding the restoration of salmon production in habitats where access was blocked by dams early in this century. Biological lessons will be supplemented with economic ones, particularly where restoration of salmon production provides greater economic return than the original "benefits" provided by the dam.

## Logging

For many coastal streams, impacts from dams often are secondary to general degradation of watersheds. Oregon's coastal streams contain 4,764 miles of stream habitat accessible to salmon (Oregon Department of Fish and Wildlife 1982), and of that total, only 1% is impacted by dams (Pacific Fishery Management Council 1979). Other areas, such as the Olympic Peninsula, also contain many streams that have not been impounded by dams. In Oregon's coastal streams, timber harvest is the land use activity that has had the greatest impact on salmon habitat (Bureau of Land Management 1985). The current production potential of coho salmon in these streams is about half historical levels (circa 1900); whereas production of chinook salmon is about the same as historical levels (Lichatowich 1989, Nicholas & Hankin 1989). Comparing current and circa 1900 production of chinook salmon may be misleading, however. Early logging concentrated in the mainstem reaches of coastal rivers and was particularly devastating to chinook salmon. Chinook salmon production at the turn of the century was already depressed from logging along the stream banks and the use of rivers to transport logs by splash damming (Lichatowich 1989) and certainly cannot be considered a fair representation of historic production potential. In contrast, data on coho production at the turn of the century reflect production from relatively healthy habitats because logging in the less accessible habitats of coho salmon did not begin until the invention of the steam donkey and high lead rigging around 1920. Although it is impossible to separate logging impacts from other factors in the decline of coho production, timber harvest was probably responsible for a major part of the decline.

Since the 1970s, Oregon, Washington and California have adopted state forest practices rules in an attempt to protect salmon habitat from the worst effects of clearcut logging. However, the rules and the degree of protection they provide have remained controversial. After a decade of bitter litigation and struggle, Washington developed a special mediation process, the Timber Fish and Wildlife Program (Halbert & Lee 1990).

## Conclusion

In a recent move to forestall future listings of old-growth forest dependent species, including salmon, the Secretary of the Interior asked the Northern Spotted Owl Recovery Team to look at other species that might be affected by the owl recovery plan. An outcome of that task is a draft set of sweeping recommendations to improve the protection of stream riparian zones in selected basins. The recommendations, if enacted, would be a major departure from current practices on federal land and certainly would improve the condition of salmon habitat. In addition, a Congressional panel ("Gang of Four Report," Johnson 1991) recently has reviewed endangered species issues in the Pacific Northwest forests and concurred that substantial changes in watershed practices are needed on federal lands to protect the anadromous salmonid stocks identified in the AFS report. These actions indicate that a significant change in management of our Northwest watersheds is possible.

Although strategies are needed to save individual populations of threatened and endangered salmon, the large number of threatened stocks suggests that a majority of the 214 populations listed in the AFS report are not likely to be saved through separate listings of each stock as threatened or endangered species. Such a strategy would be exhaustively expensive, time-consuming, and unlikely to lead to long-term sustainability of the diversity inherent in the salmonid resource.

Instead, a new management philosophy that shifts major effort toward riparian restoration, natural production, and river restoration is needed to save the salmon and steelhead resources. The increasing number of endangered and threatened stocks is a clear signal of the degradation of our western rivers and their watersheds. Past dependence on hatcheries as a primary mitigation and enhancement strategy has served only to aggravate this problem. Efforts must be refocused on restoration of habitat integrity in major rivers and watersheds as the primary way to restore the widely depleted anadromous salmonid resources of the West.

## Acknowledgments

Support and encouragement for this work originally came from the American Fisheries Society. We thank Cindy Deacon Williams for her reviews of earlier drafts of this manuscript.

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# Book Review

## An Environmental Profile of the Greater Yellowstone Ecosystem. 1991. Greater Yellowstone Coalition. Bozeman, MT.

Edited by Dennis Glick, Mary Carr, and Bert Harting

Over the last century, environmental protection efforts have undergone a significant expansion in focus and scale. Historically, environmental protection activities dealt almost exclusively with such issues as contaminated drinking water, unsanitary waste disposal, and other human health concerns. As human populations have continued to grow and adverse effects of human activities have begun to overwhelm assimilative capacities of natural systems, the focus of environmental protection efforts has, by necessity, expanded to include protection of entire ecosystems. Unfortunately, the effectiveness of ecosystem management and protection programs is hampered by myriad technical, administrative, and political problems. These problems include delineation of ecosystem boundaries, measurement of ecosystem health, coordination of diverse resource management agencies, consolidation of support from disparate political forces, to name but a few.

"An Environmental Profile of the Greater Yellowstone Ecosystem" represents the culmination of a multi-year effort to address many of the technical/scientific aspects of ecosystem management as they relate to the Greater Yellowstone Ecosystem (GYE). Prepared by the Greater Yellowstone Coalition (GYC), a non-profit environmental group, and the GYC Science Council under the auspices of the Greater Yellowstone Tomorrow project, the 131 page Profile contains numerous maps and original illustrations covering a wide range of ecological and environmental subjects. The stated purpose of the Profile is to "provide a common base of understanding of Greater Yellowstone — its ecological underpinnings and the future being created for the Ecosystem by current development plans and activities."

The Profile is divided into six parts. Part 1 focuses on the definition of the GYE and includes a discussion of various criteria used to delineate the Ecosystem. For their purposes, the GYC employed a combination of various characteristics including elevation, river systems, mountain ranges, wildlife ranges, characteristic flora and fauna, and human land-use patterns to delineate the GYE. Part 2 provides a discussion of various functional aspects of the GYE including energy flows, nutrient and hydrologic cycles, disturbance regimes, and geologic processes. A brief discussion of biological diversity and principles of conservation biology, including case studies, is also presented.

These two sections provide a logical basis for Part 3, which focuses on the structural components of the GYE. Beginning with an overview of the diversity of landscape types and climatic influences, this section also contains highly readable introductions to many of the habitats found in the GYE. Wildlife diversity in the GYE is discussed using profiles of elk, grizzly bear, wolverine, burrowing owl, and other species. Some of the most contentious wildlife issues facing the GYE include habitat fragmentation, threatened and endangered species, and reintroduction of extirpated species. These issues are cogently presented in individual case studies providing the reader with specific information within the context of the GYE.

The influence of humans on the GYE is presented in Part 4. Following brief discussions of economics and resource management policies in the GYE, eight resource degrading human activities are discussed. Ranging from hardrock mining to development of rural subdivisions to timber harvesting, this section provides readers with a succinct overview of some of the most pressing environmental issues facing the GYE. Parts 5 and 6 focus on alternative futures facing the GYE and the national and international significance of the GYE.

Overall, "An Environmental Profile of the Greater Yellowstone Ecosystem" represents a valuable contribution to the management of the GYE. It provides a succinct yet substantive discussion of the many ecological factors which make the GYE so unique, and does so in a highly accessible manner. The maps, figures, and illustrations contained in the Profile accurately portray existing conditions in the GYE yet do so in a fashion that is neither alarmist nor extreme. Facts are presented in a refreshingly unbiased form which lends credibility to the entire document and the authors have managed to do this while maintaining a high degree of readability for scientists, policymakers, and the general public.

Given the Profile's high quality and unique approach, I would suggest that it serve as a template for use on other outstanding ecosystems. Environmentalists, land managers, policy-makers, and others would be well served by development of similar profiles on other important regional ecosystems. Hopefully, this document will serve to strengthen efforts to protect the Greater Yellowstone Ecosystem from further degradation.

Reviewed by David J. Zaber, PhD student in the School of Natural Resources, Ann Arbor, MI 48109-1115.

# Opinion

## Scientists and Endangered Species Act Reauthorization

by Dennis D. Murphy

With reauthorization of the Endangered Species Act on the immediate horizon, politicians, lawyers, environmental organizations, and industry associations will all be heard on the benefits and attendant costs of species protection. Interestingly, though, one historically quiet contingent may have much to say about the next iteration of the Act and its implementation. That group is scientists. Scientists outside of government are increasingly being called upon to advise on listings, develop conservation plans, head recovery teams, and resolve legal challenges. Recognizing that good science is inseparable from effective and defensible conservation planning, last November Congress asked the National Academy of Sciences to render its opinion on a number of controversial aspects of the Act, including technical issues that cut to the very core of the endangered species debate.

Six months earlier, The Wilderness Society gave science similar recognition in a workshop on legal, political, and scientific challenges that will be faced in reauthorization of the Endangered Species Act. Discussions involving a dozen scientists, all familiar with the political and legal workings of the Act, were instructive and should prove useful to those involved in ongoing deliberations and negotiations.

A number of participants in the scientific exchange spoke to the need for all encompassing biodiversity legislation, in recognition that the preservation of healthy functioning ecosystems should be the nation's ultimate conservation goal. Most scientists agreed, however, that the clearly stated intent of Congress, "to conserve threatened and endangered species and the ecosystems upon which they depend," provides the appropriate direction and scope to conservation activities under the Endangered Species Act. All agreed that this intent is not being realized often enough — and for a number of reasons, many of which are unrelated to science. In fact, the single unanimous choice as the overarching contributing factor was the **gross underfunding** of the USFWS endangered species programs (see Bean *ESU,* 9[1&2]:1-4 and Campbell, *ESU* 9[1&2]:6). The panel fairly argued that the Act's potential to provide protection to vanishing species will not be realized until funding is brought up to levels at least several times that of recent appropriations.

Such mandatory funding increases would go far in clearing agency decks of uncompleted listing proposals, critical habitat designations, and recovery plans. But workshop participants also noted that increased funding could only encourage a more effective Endangered Species act if significant resources were directed to **training of personnel** in USFWS regional and field offices. At a time when biologists are rapidly refining techniques of immense value in conservation problem-solving, many on the front lines remain woefully unfamiliar with such tools as population viability analysis, geographic information systems, inventory and monitoring methods, and risk analysis. That training almost surely must come from academia in a new and dynamic relationship with government biologists. Such training is necessary to bring rigor to recovery planning exercises, to the "biological opinions" upon which jeopardy decisions are made under Section 7 of the Act, and to the technical bases of habitat conservation plans under Section 10.

Dollars and training are necessary, but not in and of themselves sufficient to meet the endangered species challenge. **Retaining current Endangered Species Act language** in reauthorized versions also will be essential. Challenges are being mounted by opponents of the Act in three key areas: 1) the breadth of protected taxa — some have proposed that "lower" organisms, particularly invertebrates, be denied protection; 2) the taxonomic level at which protected status is conferred — many, including the Secretary of Interior, have discussed limiting protection only to full species at risk in the entirety of their ranges, and 3) the lands on which species protection is afforded — a growing contingent of private landowners wish to restrict Act prohibitions solely to public lands. Each proposal would greatly compromise the scientific integrity of the Act as currently amended and drive it further from original Congressional intent.

Additionally, specific **Endangered Species Act provisions and associated codes must be strengthened and clarified.** Troubled Habitat Conservation Planning efforts, like that for the Oregon silverspot butterfly (see *Atlantic Monthly*, January 1992; journalistic excesses notwithstanding) and the US Fish and Wildlife Service's necessary retreat from its initial position that it could not designate critical habitat for the northern spotted owl, speak to the need for explicit standards and guidelines to provide schedules and structure to Act implementation. Indeed, the very definitions of key terminology in the Act — including such central quantifiable concepts as threat, endangerment, and recovery — need a firm scientific basis (see Murphy and Noon, *ESU* 8[12]:6).

Encouragingly, several amendments similar in content to proposals from the Wilderness Society's scientific panel have surfaced in Congress in HR 4045 by Gerry Studds (D-MA), which would set two-year deadlines for recovery plans for listed species, give priority to multiple species recovery plans, establish funding for conservation planning for candidate species, as well as increase overall funding authorization levels.

The implementation of these and other constructive suggestions will be made moot if proponents for weakening of the Act have their way. The Act's reauthorization presents a call for all scientists to step forward with their special perspectives on this most critical of all environmental legislation.

Dennis Murphy is Director of the Center for Conservation Biology, Dept. Biological Sciences, Stanford, CA 94305.

# Bulletin Board

### Conservation Biology Workshop

Colorado State University is conducting a workshop to introduce particpants to the field of conservation biology, 13-17 July in Fort Collins. An increased emphasis and concern for biotic diversity on public and private lands has resulted in the need for information on how best to approach this complex issue. Additionally, restrictions on logging, grazing, mining, and recreation have placed those responsible for natural resources in the position of attempting to manage, simultaneously, for apparently conflicting goals. Workshop enrollment is limited to 30 participants. For further information, write or call: Dr. Richard Knight, Dept. of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, (303) 491-6714 or Dr. Luke George, Dept. Wildlife, Humboldt State University, Arcata, CA 95521 (707) 826-3430.

### Migratory Bird Habitat Sites

Alexander, S. A., Ferguson, R. S., and McCormick, K. J. 1991. Key Migratory Bird Terrestrial Habitat Sites in the Northwest Territories (2nd ed.). Occasional Paper No. 71. Canadian Wildlife Service.

This report describes key habitat areas that are essential to the welfare of various migratory bird species in Canada. It identifies 80 Key Habitat Sites (a terrestrial area that supports at least 1% of the Canadian population of at least one migratory bird species) for migratory birds in the Northwest Territories. Revisions to the first edition are substantial and 20 new sites have been added to the list.

### Cichlid Fauna of Lake Victoria

The Ohio State University College of Biological Sciences and the Columbus Zoological Gardens will co-host a symposium entitled "Conservation Genetics and Evolutionary Ecology: A Case Study of the Cichlid Fauna of Lake Victoria: on October 30 - November 3, 1992 in Columbus, Ohio.

The objective of the symposium is to bring together diverse workers from academic, zoo/aquarium, governmental, and private sectors to discuss the genetic conservation of endangered fish communities using the Haplochromine cichlids of Lake Victoria as a case study. The meeting will include international speakers dealing with topics of taxomony of Lake Victorian and African cichlids, the endangered state of the members of the Haplochromine fauna, ecology of various endangered aquatic taxa, progress of ecological stabilization, status of *in situ* and captive breeding programs, captive breeding husbandry, development of longterm captive management strategies, and future prospects of environmental restoration and species reintroduction. Sessions are also planned which involve consideration of the more general aspects of the captive genetic conservation of fish. For more information contact: Doug Warmolts, Curator, Johnson Aquatic Complex, Columbus Zoo, 9990 Riverside Dr., Box 400, Powell, OH 43065-0400. USA. Phone: (614) 645-3446. FAX: (614) 645-3465.

*Bulletin board information provided in part by Jane Villa-Lobos, Smithsonian Institution.*

*Announcements for the Bulletin Board are welcomed.*


**Endangered Species UPDATE**

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