PERSPECTIVES

Salmon Management and the Search for Values[1]

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This perspective addresses the role of human values in North American salmon management. Salmon resources have been aided and harmed by technology, and managers must carefully assess how current and future technologies will be used to manage salmon. Effective managers must be knowledgeable of fishery science and human values. The science in fishery management is the objective, logical, and systematic method of obtaining reliable knowledge about fishery resources. The art in fishery management involves our values, that is, what we judge to be good, desirable, and important in the long run. A rational management plan is a selective embodiment of the values of the manager or of the organization or society that the manager represents. More surveys are needed to assess the values of the public toward salmon resources. Several potentially desirable directions are discussed for future salmon management in the Pacific Northwest.

Le présent article porte sur le rôle des valeurs humaines dans la gestion du saumon en Amérique du Nord. La technologie a aidé et nui à la fois aux saumons, et les gestionnaires doivent évaluer avec beaucoup de soin comment les techniques actuelles et futures seront utilisées en vue de gérer le saumon. Les gestionnaires efficaces doivent connaître l'halieutique et les valeurs humaines. La science dans le domaine de la gestion des pêches constitue la méthode objective, logique et systématique pour obtenir des connaissances fiables sur les ressources halieutiques. Par contre l'art dans ce même domaine touche à nos valeurs, c'est-à-dire ce qui nous semble bon, souhaitable et important en fin de compte. Un plan de gestion rationnel est une personnification sélective des valeurs du gestionnaire, de l'organisme ou de la société qu'il représente. D'autres études sont nécessaires afin d'évaluer les valeurs du public à l'égard du saumon. Plusieurs orientations qui peuvent être souhaitables sont abordées en vue de la gestion du saumon dans le Pacifique nord-ouest dans les prochaines années.

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> The problems of salmon management... represent in microcosm some great issues of our time.
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> ...many analysts see mankind to be entering a threefold crisis. Firstly... of numbers; secondly... of scarcity; and thirdly, of values (we have lost sight of how we ought to live).
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> —Mundie 1977
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> When very little is known about an important subject, the questions people raise are almost invariably ethical. Then, as knowledge grows, they become more concerned with information and amoral, in other words more narrowly intellectual. Finally, as understanding becomes sufficiently complete, the questions turn ethical again. Environmentalism is now passing from the first phase to the second phase, and there is hope that it will proceed directly on to the third.
>
> —Wilson 1984

Science and Technology in Search of Values

The salmons (*Oncorhynchus* sp. and *Salmo salar*) are examples of fish resources simultaneously aided and harmed by advanced human technology. On the positive side, managers of oceanic salmon fisheries off the Pacific coast of North America now establish fishing seasons with the aid of detailed computer programs and spreadsheets that simulate potential harvest patterns and evalute quickly and precisely (although not always accurately) the effects of alternative management strategies on yields, allocations, and escapements (Johnson 1975; Larkin 1979; Wright 1981; Pacific Fishery Management Council 1985). Technological advances in electrofishing (Reynolds 1983), hydroacoustics (Thorne 1983), and radio and ultrasonic telemetry (Winter 1983) have allowed biologists to penetrate the depths of rivers and lakes and learn about many aspects of salmon life histories heretofore hidden from view. Technologies for the artificial propagation of salmon for mitigation, enhancement, or food have also advanced rapidly on several fronts, including nutrition (Leitritz and Lewis 1976), genetics (Hershberger and Iwamoto 1985), rearing facilities (Senn et al. 1984), disease control and treatment (Leong and Barila 1983), stress detection (Barton and Toth 1980), and reproductive physiology (Billiard 1982). Larkin (1980) forsees that twenty-first century salmon managers will use vast new technologies such as genetic engineering and tissue culture for maintenance, mitigation, and enhancement of salmon.

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Nevertheless, at least as many other technological advances have been harmful to salmon or their habitats. Development of large-scale hydropower has prevented or impeded the movement of salmon up most of the world's large salmon rivers (Netboy 1958; Salo and Stober 1977; Blumm 1981). Advances in low-head and small-scale hydropower threaten to block many smaller rivers previously spared from dam construction. Advancing technologies in agriculture, forestry, and mining have enabled humans to alter or destroy salmon habitat much more quickly than in the past, and far more rapidly than the salmon stocks can respond through natural selection. And even hatchery technology, which can be a beneficial tool of salmon management if used wisely, can result in the spread of diseases (Oregon Department of Fish and Wildlife 1982a, 1982b), straying and resultant changes in stock composition (Nicholas et al. 1982), undesired competition between hatchery and wild salmon stocks, and expansion of offshore fisheries to the preclusion of needed escapements of wild stocks (Oregon Department of Fish and Wildlife 1982a, 1982b). The problems created by hatcheries for wild stocks are particularly insidious because other nonfisheries users of water resources such as developers of hydroelectric power frequently pacify the fishery proponents by financing the construction of one or more hatcheries along with their dam. These hatcheries must mitigate for — not militate against — the affected salmon resources. If hatcheries are to benefit salmon rather than harm them, managers must carefully and consciously define if, how, and when the hatcheries are to be used in a comprehensive salmon management plan. The proper role of hatcheries in salmon management is one specific case of two larger, related issues: *Where, when, and what kinds of technologies should be used in salmon management in the twenty-first century and beyond? What is our philosophical basis for using these technologies?* Technology has effectively given us dominion over the salmon. This generation must decide how salmon are to be managed, and how fully salmon should be forced to participate in our technological revolution. Perhaps we sufficiently value natural, untampered ecosystems and the maintenance of wild stocks to insist on in-river harvest and management of these individual wild stocks, by using comparatively benign technologies such as computers, unobtrusive sampling gear, small-scale habitat manipulation, and, where needed, stock-specific hatchery programs. Or maybe such management, however ecologically rational and inexpensive to implement, is mere fantasy in view of our overall technological capabilities as well as the economic and social benefits to specific users. Perhaps the days of the truly wild salmon are behind, and the future of salmon is not ecological but production agricultural, as for domesticated animals such as cows, sheep, or pigs, ranched and pen-reared by humans by the application of diverse high technologies. Perhaps salmon are to be managed in nature's way, based on ecological principles, using appropriate technologies as tools. Or perhaps our aim is really to develop and manage our technologies for their own sakes, using salmon as the tools — as mere raw materials for our technological experiments. We must decide which technologies should be used, and why.

To deal with these issues wisely, managers must understand three diverse considerations: the nature of fishery management, and salmon management in particular; how the salmon management systems evolved; and the personal or societal value system on which the management of salmon is to be based. Rational salmon management is not just a search for technologies: it is a search for values.

In the first of three sections in this perspective, I propose a new definition of fishery management and discuss the relation between science and art in salmon management. Secondly, the role of values for a salmon manager is considered. Thirdly, the roles of technology and values are considered in suggesting possible directions in several aspects of salmon management. Examples are drawn from the Pacific Northwest salmon management systems.

Art, Science, Fishery Management, and the Salmon Manager

According to Bennett (1970), "Fishery management can be defined as the art and science of producing sustained annual crops of wild fish for recreational and commercial uses." Although some salmon managers today might question Bennett's use of the restrictive word *wild*, variations of this definition have been accepted without major discord. In recent years, through the development of the optimum sustainable yield concept (Roedel 1975), managers have become more aware of complex economic and social concerns of fishery management in addition to biological ones. Indeed, in a popular text entitled "Fisheries Management," Nielsen and Lackey (1980) gave no one-sentence definition of fishery management, but instead identified it as diverse activities related to the aquatic biota, the aquatic habitat, and the human users. Definitions like that of Bennett (1970) and generalized statements of complexity like that of Nielsen and Lackey (1980) were often presented by professors to students on the first day of class, and not mentioned again. The coursework consisted almost entirely of scientific and technological approaches to management.

Many incipient salmon managers thus entered the work force with a good education on specific management techniques but less of an education of when, where, and (most important) why to use a particular tool of salmon management. Many of these managers had little time to think about why they were performing specific technical actions; their technological skills progressed ahead of their philosophies. Their way of dealing with the complex, irrational, or illogical aspects of their jobs was usually to rely on what Bennett (1970), Nielsen and Lackey (1980), and others have called the *art* aspect of management.

Art is commonly said to be a large part of fishery management; it was even placed before science in Bennett's (1970) definition. Nielsen and Lackey (1980) wrote: "Indeed, the question of whether fisheries management is an art or a science is a favorite subject of debate for fisheries professionals (professors usually argue that management is science, managers usually argue for art!)." Although technology itself has blurred the distinction between science and art (Grant 1986), a distinction between them can still be made.

The definition of science has of course been long debated, and no universally held definition exists. Lastrucci (1963), after examining many texts and references on the subject, called science "an objective, logical and systematic method of analysis of phenomena, devised to permit the accumulation of reliable knowledge." The key words are objective, logical, and method. Science is a *method* that to the extent possible is free from value judgments. For example, most salmon managers would agree that the quantitative models of stock and recruitment (Ricker 1954), the understanding of the effects of climate (e.g. El Niño) on salmon abundance (Pearcy 1983), and the physiological and behavioral theories of homing (Hasler 1966) and oceanic migra-

tion (Royce et al. 1968) are all parts of the science of salmon management.

Most fishery professionals today have participated in and witnessed the development of fishery science, and have a clearer understanding of science than of art. To some managers, it seems that the art is little more than a breezy way of saying that our scientific knowledge of a particular process or method is incomplete or imperfect. For example, most salmon managers have been told at least once in their careers that interpreting salmon scales is an art, evidently because one must guess at some of the ages of fish that have poorly defined annuli on their scales. By this line of reasoning, interpreting highly confusing scales from old brook trout (*Salvelinus fontinalis*) is even more of an art — even though one probably feels much less like an artist after the tenth consecutive artistic guess.

Fortunately, other salmon managers recognize that art in management consists of more than spinning a roulette wheel, talking fast, or managing by the "seat-of-the-pants" (Healey 1982) when science and technology let us down. The scale example above merely demonstrates inadequately developed science or technology — not art in any important sense. The art of fishery and salmon management involves our values — that is, what we judge to be good, desirable, and important in the long run.

Roubiczek (1969) stated that "a value expresses the *significance*... which man ascribes to matters related to a particular activity or experience or to his life in general and thus *provides him with guidance for his behavior*" (italics added). These values may be developed within a generation, or may persist over many generations.

Rand (1975) defined art as "the selective re-creation of reality according to an artist's metaphysical value-judgments." In her words, by selective re-creation, "art isolates and integrates those aspects of reality which represent man's fundamental view of himself and of existence.... Art is the concretization of metaphysics. Art brings man's concepts to the perceptual level of his consciousness and allows him to grasp them directly, as if they were percepts.... *Art is the voice of our philosophy*" (italics added). Art in its many forms contains what Rand called cognitive abstractions (what is) and normative abstractions (what ought to be) and is a primary medium for communicating our philosophy and our values to others. Just as a motion picture or a novel conveys a sense of the values of the director or novelist, our management of fishery resources conveys the values of the fishery manager, or, in common property fisheries, of the society or constituency that the manager represents. If art is the voice of our philosophy and fishery managers must use art in their management, then clearly fishery managers must work to develop a coherent philosophy to guide their actions.

The management plan and its implementation are the salmon manager's works of art. Unlike a landscape painter, however, salmon managers do not start with a clean canvas. Instead, a manager attempts to reshape nature's artworks — complex communities, populations, and habitats — within physical and biological constraints, according to the values of the manager or those of society.

Since most fishery managers in Western countries equate inaction with laziness, most make changes — few adopt a "do nothing" philosophy. Fishery management thus can be defined analogously as *the selective modification of fish communities, populations, and their habitats, according to the manager's or society's value judgments*. Fish communities and populations and their habitats, and the values of the manager or society, thus are all part of fishery management. The fishery itself is one part of the modification. Unlike Bennett's (1970) definition, this one does not promote a particular goal; management need not be good, by our values, or even be directed toward a specific goal to still be management. But just as Rand (1975) argued that an artist's primary purpose is to "bring his view of man and of existence into reality," a goal-oriented salmon manager's primary purpose is to modify salmon resources consistent with his or society's values of what the resource should provide and how mankind should interact with it. Ironically, fishery managers have consistently underrated and underutilized art in their management — while all the time professing to use it often. They actually use mostly educated guesses, often based little on articulated information about their own values or those of society.

Public values and attitudes can and should be identified, at least approximately, by census-like surveys and questionaires. In the late 1970s, the U.S. Fish and Wildlife Service sponsored survey research on selected attitudes of Americans toward animals and wildlife issues (Kellert 1980). In Kellert's (1980) surveys, an appropriate distinction was made between the general public and special interest groups. Public values and attitudes can then be expressed through government policy statements or administrative rules, such as the Oregon Department of Fish and Wildlife's "Wild Fish Management" Policy (Oregon Department of Fish and Wildlife 1984). This policy, for example, affirms the public's intent to maintain genetic diversity and the associated benefits of wild, naturally produced fish.

Public surveys and the resulting policies are best drafted during periods when no imminent economic or social crises threaten the major special interests. During crises, the longer term values of the public toward salmon resources may be undermined by immediate concerns of vocal special interest groups for next year's harvest or similar demands, expressed either by the interest groups themselves or through elected officials inordinately pressured by them (Wright 1981). Seldom are the long-term values of the public at large sought or recognized explicitly at ad hoc so-called "public" fishery meetings during times of crisis; instead, actions center on appeasing the demands of vociferous, on-site user groups. If no meaningful survey of public values is available and sufficient or adequate policy statements have not been developed for salmon resources, managers may take an intellectual and political shortcut, spare themselves some verbal abuse from special interests, and assume that more fish, however produced, in the short run is automatically better management — regardless of long-term impacts on stocks or ecosystems, loss of future scientific information, or loss of subsequent management options. In such a situation, a salmon hatchery becomes more than a selectively used technological tool of management: it becomes a politically acceptable symbol of more fish (at least potentially) and less shouting, and embodies a simple, easily understood goal of better management: produce more fish through any available technological method. The goal embodies modern agribusiness more than ecology.

Historically, this process has allowed some salmon managers to forego developing a more complex, long-term, ecologically oriented philosophy in favor of a simpler, short-term, production-oriented one. The desirability of living with the ecological or technological ramifications of, for example, mixed-stock oceanic fishing or mega-hatcheries is seldom considered explicitly. Without a clearly defined and expressed value system on which to base management, the intellectual default of managers, supported by special interests and acquiesced to by the

public, has usually been that high-technology salmon management of almost any form is desirable, so long as it can possibly provide more fish and squelch the complaints of the most powerful special interest groups. But any failure to adequately consider art and broad societal values does not diminish their importance in formulating policies for sound management. The art in salmon management reflects our values toward the salmon populations and habitats, toward land, water, and nature in general, and toward ourselves. If in science and technology we find the methods of managing salmon, in art we find the meaning.

Values, the Salmon Manager, and the Management Plan

In a hypothetical simple case, if the owner of a salmon river were also its manager, his management plan for the river and its stock(s) would embody his values. But in a second, more complex, and prevailing case in nearly all economically important fishery resources, including common property, the owners of the resource (e.g. society, an association, or a corporation) and the manager are not the same people. The manager's role is then more complicated. In most instances, the primary role is to manage according to the values of the owner, the owner's association, or society — not just for the manager's own values nor, in common property situations, just for special interests. The manager, who seldom controls the resource itself, must interpret the values of the owner's association or society and express them in the management plan.

One expression of the manager's own values is in his choice of employment. If the values of the manager conflict so much with those of the owners or those of society's managers that he cannot in good conscience prepare or implement the requested form of a management plan, he can seek to manage someplace else where his values and beliefs are not compromised. Fortunately, there are often less drastic options. The manager can also tactfully exchange relevant scientific information and philosophical perspectives on resource use with the owners or the public, either individually or more formally through his management agency. The manager can also inform them of management options and the philosophical motivations and scientific evidence supporting these options. He must also assess, either formally or informally, the values of the owners or public, either through his own studies or by reviewing those of others. His management plan will thereby better match the values of his clients. The manager not only acts as an educator to the owners or public, but is educated by them about their values; he must be a student of not only fishery science, but also of values.

Suppose an individual salmon manager seeks a scientifically rational, congruent, value-oriented management plan for a salmon river and its stocks. He finds an owner, fishery association, or society sharing these values and is hired to create such a plan. Further suppose that the goal of the plan is "preservation of the individual native salmon stocks in that river system and the associated cultural use of those stocks" (a definition proposed by Lichatowich 1985). Once this goal has been articulated, the manager has a basis for stating specific objectives and then tasks to achieve the goal. Such a plan, if effectively implemented, might endure for many years, even centuries, barring catastrophic man-made or natural environmental changes. Two, three, 10, or thousands of people with similar values could be represented by such a plan, even if their values differed, if they could agree on which values were to be expressed in the plan. Just as important, such a plan insures that certain objectives and tasks, such as widespread stock transfers, construction of mixed-stock megahatcheries, and mixed-stock oceanic fisheries would by conscious choice not be implemented. A rational management plan, like other works of art, is *selective* — some management actions are permitted, and some are excluded.

In the Pacific Northwest, however, management has been based more often on an *accumulation*, not a selective integration, of different vaguely defined value systems of inland and oceanic commercial fishers, inland and ocean recreationists, diverse Indian tribes, fish culturists, salmon ranchers, and the public at large. This accumulation is the by-product of complex compromises among the various users. In implementing these accumulated management plans, actions have often been conflicting and contradictory within and between agencies. Management agencies have directed much research and development toward the artificial propagation of salmon for widespread mitigation and enhancement, while other portions of these same management agencies acted to perpetuate the wild stocks of salmon. Much management-sponsored research has been directed toward identifying and characterizing distinct stocks of salmon, while other management has been directed toward not only maintaining, but also institutionalizing, through long-standing salmon commissions and Federal Fishery Management Councils, mixed stock oceanic harvest of these same stocks. Much (although not all) of the feverish activity of one group of managers and the researchers supporting them both between and within agencies has been counterproductive to other such groups.

As an example, consider the Pacific Fishery Management Council's (1984) harvest management objective 3.2.1.1: "Establish ocean harvest rates for commercial and recreational fisheries that are consistent with requirements for optimum spawning escapements, treaty obligations, and continuance of established recreational and commercial fisheries within the contraints of meeting the conservation and allocation objectives." The meaning of this sentence may not be clear after several readings, but it is clear that many pieces of value systems are represented here, not all of which are compatible with each other. There is little of the selectivity in this objective that art in fishery management demands. No major management options are excluded (e.g. wild stock preservation, hatchery development for increased production, oceanic harvest, in-river harvest, commercial fisheries, recreational fisheries). Management of the common property salmon fisheries has created a management commons, where shards of all value systems are expressed, but none are expressed completely. The assumption is evidently that none of these many value systems or management approaches are mutually exclusive, and that if the Council can just hire the right systems modeler, develop more advanced enhancement technologies, and collect more reliable data, most of these obvious philosophical incompatibilities will disappear. In the words of Garrett Hardin (1969): "An implicit and almost universal assumption of discussions published in professional and semi-popular scientific journals is that the problem under discussion has a technical solution." In the example above, it is unlikely that such a solution can be found at all, let alone in the near future.

Similarly, in one of the few papers directly addressing the basis of salmon management, Larkin (1980) supported the merits (genetic and ecological) of stock specific salmon management: "...easing back on harvest rates provides a better base

for what might be called 'across the board' or 'orchestrated' enhancement, which would have as a goal the restoration to natural levels and subsequent maintenance of the maximum number of natural stocks of all species. The management goal might be a rate of harvesting perhaps at a level as low as what we now see as m.s.y., operating on stocks that are twice as abundant and genetically far more fit than they are today.... It's a nice dream." Just three paragraphs later, we read: "I have recently advocated... [the] large scale introduction [of Pacific salmon] on the Atlantic coast of Canada (where it could be expected that there might eventually be formed a Society for the Extermination of Pacific Salmon. By the year 2000 the battle should be well underway.)" Evidently the natural Pacific salmon stocks are worth saving, but less concern is needed for the natural Atlantic salmon stocks in Canada and elsewhere potentially affected through straying, diseases, competition, or increased mixed-stock fishing pressure that such a "successful" introduction would induce.

Unfortunately, many such philosophical incompatibilities are characteristic of the Pacific Northwest salmon management that Larkin (1980) himself called "the most sophisticated in the world." If the simple management plan for a river that we described earlier is a thematically unified artwork, then most Pacific Northwest salmon plans are themeless collages — surrealistic aggregations of incongruent management goals, objectives, and actions suggestive of many value systems but truly indicative of none. Such is the end result of broadly coordinated, painstaking efforts of hundreds of managers and user-groups representing diverse, often incompatible, value systems — some articulated, some not.

In future management plans, we must emphasize and develop methods to better identify and define the value system and formulate truly public policies to guide salmon management. We must also expend more effort to determine whether different value systems and management philosophies can be accommodated at all. Any successes in these areas would improve the quality and lower the cost of salmon management, as well as reduce wasteful or counterproductive human activity undertaken in its behalf.

How do we go about identifying and defining the value systems on which salmon management is to be based? No single perfect method has been devised, but well-designed surveys to address a wide array of the public's values (not just economic concerns of special interests) are an important tool. More such surveys are needed in guiding our salmon and other resource management. It is to be hoped that we are entering what Wilson (1984) called the "third" phase, where values — not just random technologies or short term economics — once again become important.

Perspectives on Pacific Salmon Management

Management under Uncertainty

Research and detailed knowledge of a particular natural salmon stock are not needed for the stock to be managed well, as long as harvest is moderate. In general, the more intense the harvest, the greater the need for quickly available, accurate information. Most problems with management in North America have not been because of lack of data. Mundie (1977) said it succinctly: "Inadequate knowledge of the ecological needs of the salmon has not been a prime cause of their decline. Decisions have been made knowingly." Under intense harvest situations such as those for salmon in the Pacific Northwest, research may provide the information to fine-tune our knowledge of stock distributions, develop management measures, and perhaps increase production, but no amount of research will compensate for overharvest of stocks or poor habitat management. Just as science is no substitute for values, good research is no substitute for poor management. It has long been accepted that good research leads to better management, but it is less well recognized that, in salmon, good management leads to better research. If the management framework is sound, data collection is facilitated, and more scientific knowledge follows (Silvert 1978).

In the common property salmon fisheries of the Pacific Northwest, self-interest economics and "tragedy of the commons" behavior from commercial, tribal, and recreational fishers often lead to the harvest of every fish even suspected (however unrealistically) of being "surplus" to the needs of escapement. The long-term maintenance of the fish stocks, rather than short-term benefits to harvesters, must begin to receive the benefit of the doubt (Wright 1981).

Who Should Manage the Public's Salmon?

It is ironic that the construction of dams and other technological projects harmful to salmon have funded and inspired most problem-solving technologies such as hatchery production. Dam construction and other such industrial developments on the Columbia River, often decried by biologists, now provide the revenue, both directly through research and management funds and indirectly through taxes, to finance much of the ongoing research and management. Even more ironically, much of this power-generated funding is administered by the Bonneville Power Administration and disbursed by its own cadre of administrators to other federal agencies, states, and private consultants. Many state salmon biologists voicing opposition to dam construction and related technological development harmful to salmon thus find themselves in the awkward position of "biting the hand that feeds them." The situation is similar, but less extreme, in other places in the Pacific Northwest. On the Columbia River, the fox does not merely guard the henhouse, he *owns* it. Clearly, management of salmon in nearly all Pacific Northwest rivers must occur as part of a broader multiple use plan encompassing hydropower development, irrigation, forestry, and other activities. However, there should be movement toward insulating biologists from direct financial control by Bonneville Power Administration contracting officers and other nonagency special interests. Funding from the power generation activities should not be restricted to contracts, but should also include guaranteed grants, with no hydroelectric strings attached, to state agencies charged with managing salmon. Since the salmon paid for the hydropower and other developments, their managers should have a clear voice when defending the interests of salmon.

Specialists and Generalists in Salmon Management

In the Pacific Northwest, where several different value systems vie continually for management authority, regulations are complex and man-made uses and alterations of ecosystems are many, and specialists abound. For harvest, there are specialists in salmon data analysis and salmon stock modeling. The proliferation of hatcheries for mitigation, for enhancement, and for food has led to much research by specialists in narrow segments of reproductive physiology (induced maturation, control of sex

ratios, induced sterility, stress), fish diseases (bacterial, viral, parasites, vaccines), nutrition (diets, feeding regimes), genetics (brood-stock development, selective breeding) — research in a host of highly specialized subfields populated, for the most part, by highly specialized scientists.

These specialists often develop technologies with little consideration of their effects on management. For example, at the 1983 International Symposium on Salmonid Reproduction, a paper was presented by E. M. Donaldson and G. Hunter entitled "Sex control in Pacific salmon: implications for aquaculture and resource management." The authors presented evidence that their artificially sterilized salmon, once released to the ocean, "do not undergo an anadromous migration but remain in the fishery and continue to grow." Their coded-wire tagged salmon were to be caught at sea several years later and at much larger sizes than would have occurred in maturing salmon. They noted that production of sterile salmon would benefit the aquaculturist because the salmon do not undergo maturation and the associated loss of market acceptance that results from poor flesh quality. They went still further in describing the management applications: "Sterile fish also present significant options for fisheries management... the production of sterile fish is a means of redistributing fish from fisheries of low value to fisheries of high value, i.e., from terminal harvest to ocean harvest."

They did not consider the desirability of having millions of larger than normal salmon remaining in the ocean instead of returning to natal streams or hatcheries. Nor did they consider the potential effects of thee large fish on wild smolts — predation on them and competition with them for food. In addition, the effects on other species and community structure were not mentioned. Perhaps most importantly, it is unclear how wild salmon stocks respond to the higher oceanic harvest rates associated with harvesting these sterile fish. With our increasing knowledge of the stock concept and the apparent long-term ecological rationality of harvesting on a stock-specific basis, we must ask if we want to expand our oceanic harvest of salmon.

Managers now have the option of producing sterile salmon, and they must interpret societal values and decide whether or not to produce them, or at least to decide whether to encourage or discourage their use, for example, at hearings of state commissions or of Federal Fishery Management Councils. But the mere discovery of an option must never guarantee its use. Managers must evaluate the particular technological option in the context of the management plan.

Although highly skilled specialists (e.g. good researchers in specific areas) can be vital in developing new technologies and solving many of our fisheries problems, the generalists (e.g. good fishery managers) must keep them in their place. Generalists attempt to understand ecosystems and value systems; specialists attempt to solve specific problems. A generalist either finds a natural ecosystem to investigate (e.g. a natural salmon river) or chooses or is forced to work with man-altered ones. A specialist usually responds to problems created by other specialists. Someone will build a dam, someone will then try to culture fish for mitigation and then have disease or maturation problems, and so on, much like Dr. Seuss' "Cat-in-the-Hat," where more technology is needed to meet the emergencies that technology itself has produced (Grant 1986). In the words of Wendell Berry (1977): "Because by definition, they lack any sense of mutuality or wholeness, our specializations subsist on conflict with one another.... The *problem* thus becomes the stock in trade of specialists" (italics added). For generalists, the emphasis is often ecological; for the specialist, technological. Only the generalist with an ecosystem and cultural perspective is qualified to evaluate these specialists and to be a successful salmon manager. Even if this person is just one of a committee that evaluates the technological discoveries of specialists, he must be cognizant of ecosystems and values.

Ocean Fishing for Salmon and Its Consequences

Many of the problems with current salmon management in the Pacific Northwest center squarely around the evolution of preemptive offshore fishing. Although additional problems have developed regarding the inadequate regulation of private salmon ranching (Shupe 1982) and inriver allocations, these and other problems are more manageable than the question of ocean fishing.

In the Pacific Northwest, there is an extensive history of offshore interceptions that have impeded stock-specific management of salmon (Larkin 1970, 1979, 1980). The interceptions occur internationally (United States, Canada, Japan, Soviet Union) and also between states (California, Oregon, Washington, and Alaska). As more efficient terminal in-river gears were successively outlawed (Smith 1974), the offshore fishery expanded. As wild stocks diminished from habitat destruction and mixed-stock overfishing, the production of hatchery fish rose, until today, commercial and recreational troll fisheries constitute the primary harvesters of salmon in many regions of northwestern United States, and much of their harvest is hatchery-reared fish (Oregon Department of Fish and Wildlife 1982b), paid for by the public.

The proliferation of common property oceanic commercial and recreational salmon fisheries, mostly by nonfarmers and others not closely tied to the land, has divorced the salmon from the land and from the rivers and thereby reduced the possibility of an ecologically oriented North American land ethic benefitting salmon. According to Aldo Leopold (1970), "a land ethic... reflects the existence of an ecological conscience, and... a conviction of individual responsibility for the health of the land." With oceanic harvest by commercial and recreational fishers, harvest has been isolated from land and river stewardship, and the salmon is viewed as a nomad owned by whomever catches it. If the abundance of stocks and yields to offshore fisheries are low, oceanic fisheries blame the managers and the inland people for abusing the rivers and the lands around them. And since these oceanic fisheries have all persisted, to varying degrees, on mixed stocks, some smaller stocks and substocks have almost certainly been exterminated before they were even identified by biologists. An ecologically based North American land ethic (Leopold 1970), although well articulated in books, has thus been largely ineffective in protecting and conserving salmon in the Pacific Northwest.

However, steelhead (*Salmo gairdneri*), which have been designated a game fish and thus not harvestable commercially by non-Indians, and are not often caught at sea anyway, have gained the benefits of a land ethic. In the northwest, the salmon–land linkage persists most strongly, of course, in inland commercial, subsistence, and recreational users — land-linked groups such as Indian tribes and conservation groups such as "Oregon Trout." With land-based salmon management, the linkage has been maintained between wise land and river management and the rewards of harvest.

Before the passage of the *Magnuson Fishery Conservation and Management Act* of 1976, interceptions of salmon between

states and countries in the Pacific were largely unregulated except for salmon stocks covered by international fisheries agreements such as the International Pacific Salmon Fisheries Commission (IPSFC) and the International North Pacific Fisheries Commission (INPFC). In the United States before the mid-1970s, most ocean salmon management outside 3 miles, and virtually all management inside 3 miles, was done by states. With the passage of the *Magnuson Act*, the powers of the U.S. federal government expanded greatly; they assumed primary responsibility for management outside 3 miles, and could even preempt state management authority inside 3 miles if state actions were deemed inconsistent with federal management (Severance and Bubier 1985).

Each of these international agreements and the *Magnuson Act* have led to some stability in the interceptions of salmon, and undoubtedly prevented some extinctions of stocks. In addition, insightful research by the IPSFC and the INPFC has expanded our knowledge of many aspects of the salmons' life histories. However, the long-term effects of these organizations on the salmon stocks are less clear. Since none of the agreements were signed nor the *Magnuson Act* enacted to eliminate ocean fishing, it is not surprising that both the ocean fishing and most of the commissions (or their successors) and the regional Fishery Management Councils are still managing salmon. Most biologists agree that with the existence of oceanic salmon fisheries, the most logical management entity is the federal government. Even the regional Councils cannot adequately address international salmon interceptions (hence the need for the U.S.–Canada treaty). Clearly, no state can possibly address the oceanic harvest and allocation problems alone. Because of the obvious complexities associated with managing mixed stocks of highly migratory salmon at sea, there have been consistent needs and calls for more and more federal authority in U.S. salmon management (Berg 1981). The questions raised here are not whether the federal government should or should not now be involved in salmon management, but in what capacity, and if their powers should be increasing.

The federal government, acting through the Councils, is inherently best able to manage common property fisheries for true ocean species — especially migratory species inside the Fishery Conservation Zone that are not directly linked to the land and can get no protection from a land ethic or from states. But salmon — land-linked species composed of many distinct local stocks — do not fit this description well. Only a very few aspects of ecologically sound salmon management call for federal action. Most aspects of federal salmon management are justified politically and socially rather than ecologically.

As it now stands, preemptive oceanic commercial and recreational fishing for salmon and the Pacific and North Pacific Fishery Management Councils are solutions to each other's problems — the federally funded Councils institutionalize and stabilize the ocean fisheries, preventing rampant overharvest, at least of major stocks or those minor ones involved with treaty obligations. Without the Councils, common property chaos and "balkanized" (Berg 1981) management would lead to overharvest and destruction of the industry. This federal management is highly centralized, energy consumptive (human and otherwise), expensive, and frequently out of touch. It is no exaggeration to say that Council members, Salmon Advisory Subpanels members, and Salmon Plan Development Team members are sometimes making important management decisions in a far-distant hotel conference room for salmon rivers that they have never seen. It is not entirely their fault; under centralized harvest management of oceanic fisheries, it might take years to see all rivers involved in important harvest decisions. Such managers, although often of high innate intelligence, must struggle continuously to stay in touch with the rivers, the land, the salmon, and the human users. In the meantime, land-based salmon stewardship is reduced or preempted.

It is worth asking the public if Pacific Northwest salmon management should be moving, even if gradually, to greatly reduce or even eventually eliminate these oceanic fisheries, rather than merely institutionalizing them. A gradual phase-out or phase-down of these subsidized fisheries would lessen immediate economic hardships on coastal user groups, who have in recent years been inordinately benefitting from the public's (including inland citizens') salmon resources. Without the ocean fisheries, the need for federal involvement would then be restricted to issues such as international fishing treaties, salmon ranching regulations, acid rain effects, certain tribal issues, and other such issues best dealt with at that level. Most aspects of the land- and river-based salmon management could be conducted more ecologically and at lower cost by interstate agreement, and by state and local managers. And with the development of pen-rearing technologies for salmon in North America and abroad, steady supplies of salmon are now becoming available all months of the year. The advantages of terminal management and terminal harvest of stocks will become more evident as oil and gas supplies decline in the mid-1990s, making even the short-term economic rationale for oceanic fisheries less attractive.

However, the state and local managers would need to be insulated from short-term economic pressures of special interests much more effectively than in the past. For example, salmon ranchers have frequently supported reduction or elimination of offshore fisheries, not so much from concern for the plight of wild stocks, but to reduce oceanic harvest rates on their ranched fish. State and local managers would need the autonomy to make decisions based on information about wide-spread public values rather than the short-term economic demands of any of these user groups. The historical inability of states to cope with these special interests is one factor that led to federal management in the first place.

Perhaps in the future, ecologically sound management of salmon will evolve so that less, not more, federal authority is needed. It seems almost a law that oceanic fishing for mixed stocks of salmon, wherever and whenever begun, is never halted by managers — it is just institutionalized and controlled. Perhaps it is time to view oceanic commercial and recreational salmon fishers, salmon ranchers, and other special interests as instruments of the public's values and policies, rather than as mouths that the public's natural, technological, and energy resources must feed at all costs. Oceanic fishing and salmon ranching might then be seen properly as a *privilege* granted by the public and supervised by the manager, not a guaranteed *right* of any one person to profit at the public's expense.

If more salmon would come back to the Northwest rivers, local residents would be more effective in their stewardship and more enthusiastic about the management of their rivers. They could also keep meaningful long-term records on the salmon of their rivers and provide biologists valuable site-specific information for management (like steelhead anglers often do). Salmon biologists could also be biologists — working, at least sometimes, in waders in rivers, and not always seen in three-piece suits in hotel lobbies, rental cars, and airports. Middle layers of bureaucracy would be reduced. The manager making

most of the important decisions on the river and stocks would be the one most familiar with the river and the salmon, and most able to learn and interpret the values of the culture through a balance of outside education and local inside knowledge. Within the ecologically sound centralized framework for local management, many different management plans could evolve for different rivers, each a unique work of art with science as its method, and the persistence of the stocks and the accompanying wise human use as its goal. Some existing positions and programs in the Northwest have these essential characteristics. The District or Regional biologist is one such position from which agencies can foster land and river stewardship. In addition, public participation programs such as the Oregon Department of Fish and Wildlife's Salmon and Steelhead Enhancement Program (STEP) are encouraging land and river stewardship. Similar programs emphasizing long-term stewardship rather than short-term harvest should be expanded and promoted.

The Future of Salmon Management

> The shallow-minded modern who has lost his rootage in the land assumes that he has already discovered what is important. It is only the scholar who appreciates that all history consists of successive excursions from a single starting point, to which man returns again and again to organize yet another search for a durable scale of values.
>
> —Aldo Leopold, *Wilderness*

In the last two chapters of "The Firmament of Time," the paleontologist Loren Eiseley (1960) asks peole to recognize the distinction between advances in scientific knowledge and improvement in man himself. In his words: "Science is not enough for man.... We fallaciously equate ethical advance with scientific progress in a point-to-point relationship."

Humanity's unprecedented technological progress carries with it a great responsibility — we must consciously, willfully decide how to use our discoveries to attain and embody our values. For natural resource managers, this responsibility becomes even more critical as the rate of new technological discoveries accelerates and as these technologies enable us to produce large-scale changes in ecosystems. Yet amidst the deluge of narrowly defined technical papers published on salmon biology and management, papers on the philosophy of salmon management have been scarce. Perhaps the technical demands of biologist's jobs are so great that biologists have no time to develop and articulate philosophies of management. Perhaps our researchers and managers are uncomfortable with philosophy and believe that their roles as objective scientists are compromised by taking philosophical stands on issues. Perhaps in these days of reduced job availability, biologists fear for their financial security and avoid dealing with difficult, awkward political and ethical questions. Or pehaps, as one biologist once told me, fishery management, including salmon management, deserves no special attention in philosophy. As R. D. Hume (1893), an early salmon fishery entrepreneur and hatchery advocate, put it: "The salmon industry of the Pacific Coast has been both directly and indirectly the means by which very many have made fortunes, and who without its benefits would perhaps find themelves out of employment and lighter of pocket." Maybe the complex management system in the Pacific Northwest, with its oceanic fishers, its in-river commercial and tribal interests, its anglers, its culturists and salmon ranchers, its fishery managers, biologists, and technicians, countless administrators and attorneys assembled in committees and working groups, and its multitudes of dam builders and dam mitigators, is just the end product of a growth-oriented, technologically driven society designed and perpetuated to keep everyone, including biologists, employed, off welfare, seeking technologically stimulating solutions to specialized problems created by someone else's technology. Many highly trained people are required to develop and maintain a technological infrastructure, and all these people must be kept busy doing *something*. It may thus be an illusion to suggest that our objective in salmon management is to simplify and reduce the cost of harvest, harvest management, or mitigation and enhancement while creating an ecologically rational and energetically prudent system of salmon management. Maybe this artificially complex, positive-feedback technological society we have created is our destiny, both our means and our end, and this is where society's values lie after all. The tragedy is that 100 yr after Hume, our dwindling natural resources, including the salmon, are still paying a high price for, rather than benefitting from, so many of our experiments with technologies.

In one of the rare articles discussing philosophical aspects of salmon management, Larkin (1980) wrote: "I don't fancy myself as an economist, political scientist, social scientist, or *philosopher*" (italics added). Yet to be an effective salmon manager is to be both a student and a teacher of fishery science, of philosophy, and of human values. The actions of a fishery manager perforce transcend objective science, random application of technology, and moral absolution for actions taken. It is to be hoped that new generations of salmon managers develop and articulate their values and philosophies more clearly than the present generation has done, and that the new generations investigate the public's values and inform the public about values as well. As human demands on the salmon and their habitats inexorably mount, the need for values becomes more and more urgent.

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