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Irrigation, Power, and Salmon: The Case for Voluntary Water Transfers in the Columbia Basin

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Resource Conflict in the Columbia Basin

The Columbia, one of the world's great rivers, has provided human societies with an abundance of resources for centuries. The river basin stretches over parts of seven states and the province of British Columbia, draining an area of several hundred thousand square miles. The river provides fisheries and serves as a water highway linking the inland northwest to the Pacific. With the construction of dams beginning in the 1930's, the Columbia developed into the region's primary source of energy, and currently provides 74% of the region's generating capacity (U.S. Department of Energy 1995c, 2-5). This surfeit of electricity attracted power-intensive industry such as aluminum smelters, and led to the promotion of electricity for space heating and other household and commercial applications. The dams have also assisted navigation, provided water for irrigation, created recreational opportunities, and controlled the flooding that was once a violent annual occurrence throughout the region.

This history of resource abundance has not promoted efficient use of the basin's resources. Only as electricity demand began to exceed hydropower capacity and fish runs began a rapid decline were concerns about conservation and efficient use of resources raised as an urgent matter of public business. Fisheries managers had warned for decades that the long-term impact of dams on salmon could be catastrophic, but the concern was little heeded until recently. Only with hindsight have people begun to ask whether all of the dams should have been built, or whether the huge irrigation projects really do make economic sense. The system of dams is not about to be dismantled, but many questions are being raised about how the river might be managed more efficiently in a manner consistent with the biological needs of salmon and other species.

There are two primary problems driving debate over Columbia River management. The first is the condition of the historically abundant runs of the various

species of salmon. Once, annual runs numbered between eight and 16 million. The 1993 total was 950,000, of which about 240,000 were wild fish (U.S. Department of Energy 1995a, 2-10). Even that decline hides the range of impacts on the various different species and subspecies, some of which are extinct and others which are well on their way. Three species of salmon in the Snake River Basin have been listed as endangered. The presence of numerous hatchery fish in the run totals above has given rise to another controversy, namely, whether to try to save wild runs or simply be content to gradually replace the wild fish with hatchery bred. Because wild fish tend to be much hardier than hatchery and breeding programs depend on infusions of wild stock to renew the gene pools, maintaining wild stocks is an important goal even apart from the cultural centrality, emotional symbolism, and aesthetic appeal of the wild fish (National Research Council 1995).

The second problem, which has run headlong into the first, is the financial condition of the Bonneville Power Administration (BPA), the federal agency charged with marketing the power produced by the federal dams on the Columbia. The BPA has come under pressure from four sources. First, a number of fiscally conservative politicians have for the last decade or more been calling for Bonneville to increase its debt payments to the federal government. Some have suggested that the power system should be sold off to private investors (MacKenzie 1995c). Second, BPA faces a seven billion dollar debt incurred from the sale of bonds used to finance the construction of nuclear power plants that, except for one, were never completed. Although the public utilities involved in the project defaulted on the bonds and were thus able to cut their losses, Bonneville is prevented from doing so by its status as a federal agency. Together, these two liabilities cast a long shadow over BPA's finances (Northwest Power Planning Council 1995).

Recent developments in the electric industry have also undermined Bonneville's competitive position (MacKenzie 1995a). New sources of electricity have come available that are competitive with the cost of hydropower, at least the cost after BPA's liabilities have been covered. Cheap electricity has also been available from California, stimulated by the surplus of production capacity and that state's prolonged recession. Given these developments, some of BPA's customers have been leaving, or at least threatening to leave, the fold. They have either sought greener pastures or have used market conditions to gain rate concessions.

To all of the above is then added BPA's liability for mitigating damage done to wildlife (including salmon) by the federal dams. BPA's annual cost for salmon restoration is approximately $435 million, varying from $250 to $700 million depending on the abundance of water in a particular year (Northwest Power Planning Council 1995, 11). Much of the cost of these measures is foregone revenue from generating capacity that is lost when water is released to flush juvenile salmon to the Pacific. The mounting cost of salmon restoration, combined with other financial pressures, has made it increasingly difficult for Bonneville to remain competitive in the market and meet its financial obligations. This situation has led some observers to conclude that BPA is caught in a death spiral. Although Bonneville negotiated an agreement in 1995 to cap its fish and wildlife expenditures, the issue of future liability is still an open question (Harrison 1996).

Changes in the electricity industry are also driving debate about the future of BPA and the structure of the northwest power system. A comprehensive review of the system was initiated by governors of the northwest states and is considering the place of BPA in a competitive industry (Comprehensive Review of the Northwest Energy System 1996). The review will also consider how best to provide for the public purposes, including salmon and wildlife programs, that BPA has served in the past.

In the face of such changes and pressures, all of the activities on the river are being reexamined. All uses of the river, however, are not equally subject to change. In particular, the allocation and use of water for irrigation has been insulated from change, both in the Columbia Basin and throughout the west. The historical circumstance that have shaped water use, and the legal institutions that developed to protect water uses, have constrained the ability to shift water from one use to another. In the context of competition for resources on the Columbia, the ability to alter the use of water has been a binding constraint on river management. Given the pressure on the Columbia's resources, there is a need to examine whether some change in water use might be beneficial, and if so, how that change might be brought about in a way that is equitable for current water users

This paper begins with a brief history of water law in the west, illustrating the roots of conflict over water allocation. A more detailed examination of activities in the Columbia Basin follows, describing the many parties affected by issues of water use and the overlapping institutional structures that govern the river and its water.

Sources of pressure to change the current pattern of water use are then considered. These include requirements to protect endangered salmon runs and the change over time in the relative values of water for power production and irrigation. This section demonstrates how changes in the value of resources can create conflict when resource allocations are inflexible.

Alternative approaches to water allocation are then detailed. An argument is made that water use on the Columbia should be flexible, and that the ability to transfer water more easily from one use to another would be beneficial. The potential economic, social, and environmental benefits and costs of water transfers are also considered.

The final section of the paper looks at barriers to water transfers and recommendations for institutional change. The section offers examples of market

structures and policy options that might overcome some of the obstacles to water transfers. The argument for a more flexible system of water allocation is then summarized.

Water Use and Water Law in the West

Water is a scarce commodity in the west. Competition for water has shaped western economic and political conflict since the dawn of the frontier. The growth of western population and urban areas in recent decades has increased the pressure on water supplies and brought even greater scrutiny of water use. Water dedicated to irrigation has been the subject of much of this attention, largely because irrigation accounts for 90 percent or more of consumptive water use in the western states (Gibbons 1986). Irrigation has been promoted by huge state and federal irrigation projects, and water from these projects is sold at heavily subsidized rates (Wahl 1989). The availability of subsidized water has led to questions about whether water is used efficiently in irrigation. Laws governing water allocation have also inhibited its transfer, making it difficult to obtain new supplies and leaving water in relatively low value uses. The combination of subsidies and legal barriers to trade has fueled a growing debate about the need for reform of western water law.

Evolution of Western Water Law

Western water law was shaped by the needs of a frontier society. The frontier offered individual freedom and economic opportunity, at least in the vision of those who migrated west. Frontier institutions were developed to promote settlement and private

industry (National Research Council 1995). The laws regarding water use were no exception.

Prior appropriation

Water was a scarce and valuable resource throughout most of the west, necessary for mining, agriculture, and other activities. Often, water was not available where it was needed, so the right to move water and obtain assurance of its future availability was crucial for development. The doctrine of prior appropriation was developed on the frontier to provide stable and dependable water supplies. It allowed rights to be established quickly and provided a clear basis for resolving disputes.

The primary tenets of prior appropriation doctrine are "*first in time, first in right*" and "*beneficial use*". "First in time, first in right" refers to the priority given various claims to water from the same source. Water in the west has generally been available to anyone who wished to stake a claim and put the water to use. That process has gradually been formalized, requiring modern claimants to file applications with a state water agency, but the basic process remains the same. Claims are granted based on the availability of unappropriated water from the source. If the source is deemed to have sufficient supply, the claim is granted. Because supply varies depending on annual precipitation, water is not always available to fill every claim. The first, or senior, claim is always granted priority and is filled in full before more junior claims are allotted any water. In times of water shortage, claims are filled in order and claimants at the end of the line may receive nothing. Senior claims are thus valuable and dependable; investments that depend on availability of water are secured by such claims at the expense of junior claimants, who face greater uncertainty.

"Beneficial use" refers to the requirement that any water claimed must be put to a particular, defined use. Beneficial uses are defined in the water laws of the various western states and have almost always required diversion of water from the source. Thus use of water for agriculture would be granted a vested right, while water left in a river for fish or other instream benefits could be appropriated at any time. The definition of beneficial use has gradually expanded, and most states (including Oregon, Washington, and Idaho) now include minimum streamflow in their definition of beneficial use (Estes 1992, 1027). However, due to the overappropriation of western waterways, reservation of water for streamflow intensifies conflicts between other users.

The requirement of beneficial use also limits the amount of water that can be claimed to the amount that is necessary for a given purpose. Excessive water use is prohibited. Any water that is not put to beneficial use is available to be claimed by anyone who wants to use it for a qualifying purpose. This provision is intended to ensure that water is not wasted. In practice, however, the requirement has been an impediment to water conservation and to the transfer of water between uses.

For example, if irrigators or other water rights holders decrease their use of water through some curtailment or conservation measure, they may lose the right to that water under the beneficial use requirement. Appropriation law generally requires that water be used only on the land specified under the original claim. Use of conserved water to expand irrigated acreage would require amendment of the original claim. Similarly, transfer of the water to another user would require application to the state water agency. However, any such application might amount to an admission that the reclaimed water had previously been wasted and was thus not being put to beneficial use as the law requires. Reclaimed water may thus be subject to forfeiture, and the requirement of beneficial use can be a barrier to both transfers and conservation (Hartman and Seastone 1970, 23-25).

None of these features of prior appropriation prevent water from being transferred or water rights from being traded. But neither is water treated as a simple commodity bought and sold in a market. Water itself is not owned, only the right to use it. Water rights are bought, sold, and otherwise transferred, but such transfers are subject to a variety of practical and legal restrictions. These requirements may be intended to protect other water users or to protect the general public interest, but they are often sufficiently ambiguous as to discourage most attempts at trade.

One potential complication is that water rights may not clearly define the quantity of water available for use or trade. The quantity of water diverted and the quantity actually consumed may be far different, but only the quantity actually consumed is available for trade. In irrigation, the amount consumed is the amount actually transpired by plants or lost through evaporation. The remaining water either percolates into groundwater tables or flows as runoff to the next field, and thus is still available for use. If water rights were defined in terms of quantity diverted, downstream water users would be deprived of the runoff and return flow that is an integral part of irrigation.

This restriction is intended to protect other water users, whose rights may depend on return flows or other established characteristics of water availability. If the consumed quantity is not defined in the water right, transfer is contingent on establishment of historic consumptive use. Establishing the quantity available for trade may entail a quasi-judicial hearing, and may be challenged or protested by downstream water users. The need to establish consumptive use is one transaction cost that can be a barrier to trade. Other changes in water use, including purpose or place of use, point of diversion, sale, or temporary transfer, must generally be approved as well so that the interests of other claimants will be protected. Any change in water use that might affect another claim can be challenged, and this often leads to delays in water transfers.

The distinction between consumptive use and diversion raises a point about water conservation. As water supplies come under increasing pressure in the west, conservation has been promoted as a means of making water available for other uses. However, conservation measures may have serious implications for downstream water users unless conservation measures decrease consumptive use rather than diversion (Whittlesey 1993). Irrigation efficiency is generally defined as the portion of applied water that is actually consumed by crops. Efficiency can be improved by changes in application methods or changes in irrigation technology without affecting the amount of water actually consumed. Such conservation decreases return flows or percolation of water into the water table, making less water available to other uses. The only way to achieve true conservation of water is by decreasing actual consumption by crops. This can be achieved by planting crops that require less water or by applying less than the optimal amount of water for crop production, a technique called deficit irrigation. Water "conserved" in any other fashion, however, is not truly surplus water nor is it available for transfer or trade.

Another potential barrier to water transfer is the control of water by irrigation districts or cooperatives rather than by individuals. Such entities may prohibit transfer of water they control, at least outside the bounds of a particular district, or they may prohibit transfer of their water to a purpose other than agriculture (National Research Council 1995, 96-97). The existence of such districts, or restrictions placed on the district by state law or by their narrow focus on water supply, can make trading of water much more difficult.

In order to transfer water, then, several hurdles must be cleared. The quantity of water involved must be well defined, both in terms of historical diversion and consumptive use. The right to that water must be clear; if irrigation districts or other distribution entities are involved, the possibilities for trade may be restricted. The

concerns of other water users must be addressed, and the transfer must meet any requirements placed by state laws. The new use must also be recognized as beneficial by state law.

States may individually place greater or lesser burdens on water transfers. The state of Idaho, for example, has a number of conditions. Transfers may be allowed, provided other water rights are not injured, the original right is not enlarged, the change is consistent with water conservation, and is in the local public interest. The state code also provides that water may not be transferred out of agricultural use if the change would significantly affect the agricultural base of the local area (Idaho Code 42-222(1)). The state places additional restrictions on transfers across state lines. Idaho has one of the most restrictive codes, but other states also impose significant restrictions (National Research Council 1995).

Other state powers

In addition to the prior appropriation doctrine, there are other legal doctrines and legislative mandates that have a bearing on water rights and water transfers. One of the tools available to challenge current patterns of water use is the judicial doctrine of public trust. This doctrine establishes the duty of the state to protect public benefits in the use of waterways and has its origin in common law. The doctrine traditionally applies to all navigable waterways and establishes state ownership of submerged lands, especially coastal tidelands. In California, the doctrine has been used to protect public benefits such as recreation and environmental quality. The doctrine was used to protect the Mono Lake ecosystem from excessive withdrawals by the city of Los Angeles (National Research Council 1992, 101). Each state, however, enforces its own interpretation of public trust and few states have been as aggressive as California.

States are also empowered to establish laws that protect the public interest. Public interest protection is written in to most state laws regulating water transfers, but the effect of such provisions is largely to protect the interests served by current water allocations. Protection of the public interest has served as the justification for regulating land use, but such state regulation of water use has been much less developed. Water use planning, however, is becoming more widespread. Oregon is one of a few states that have adopted relatively comprehensive approaches to water planning (Squier 1979), but most states have begun to protect instream flows (National Research Council 1992). Oregon now requires that a portion of all salvaged or conserved water must be dedicated to instream flows (National Research Council 1992, 83), and states could require similar exactions as a condition for granting water transfers or changes in water use. Limitation on water use imposed in the public interest, however, could engender heated controversy such as currently exists over land use regulations. States may be hesitant to stir such controversy.

Federal role

The federal government also has a role in water law. The U.S. Supreme court held in Sporhase v. Nebraska ex rel. Douglas (458 U.S. 941 (1982)) that water is an item of interstate commerce and therefore may not be prohibited by the states, but restrictions based on protection of health and welfare are allowed. The Court indicated that water, at least insofar as used for irrigation, is clearly subject to federal regulation (Reisner and Bates 1990). Federal legislation would take precedence over state law, but the federal government has always deferred to the states in matters of water allocation. In practice, states have managed to impose a number of restrictions on interstate transfers.

The federal government is more directly involved in the control of water at federal projects. The Bureau of Reclamation obtains rights to water for their projects through the

states through normal state procedures. It then holds those rights and generally distributes water to irrigators through districts on the basis of repayment contracts (Butcher, Wandschneider, and Whittlesey 1986). The Bureau thus has some control over the transfer of project water. The Bureau's position in water transfers is somewhat ambiguous. It has issued a set of "Principles Governing Voluntary Water Transactions" (U.S. Department of the Interior 1988), but the guidelines are relatively vague and the Bureau has not actively promoted transfers (National Research Council 1992). Since Bureau water is generally distributed through districts, the individual districts may pose an additional barrier to trades. Moreover, transfer of water from federal projects is subject to the same state requirements as any other transfer.

The legal and institutional structures affecting water use were shaped by the environment of the western frontier. The doctrine of prior appropriation served the needs of the frontier well, but the patterns of use and the institutions that developed around that doctrine conflict with the needs, priorities, and values being expressed at the end of the twentieth century. The doctrine presents significant barriers to conservation and to transfer of water between uses. Although states may have the ability to impose new requirements on present water users to protect instream uses and promote efficiency, such requirements would undoubtedly be controversial. Nonetheless, changes are beginning to be imposed on the prior appropriation framework.

Water Allocation in the Columbia Basin

Water law in the northwest states of Oregon, Washington, Idaho, and Montana is based primarily on the prior appropriation doctrine. The sources of competition for water resources are somewhat different in the northwest than is typically the case in other parts of the west. In Southern California and the desert southwest, competition has typically

been between irrigation and urban growth. As new sources of water for urban residents become more and more expensive, cities have eyed relatively inexpensive water used by irrigators as potential new supply. Transfers of water for municipal and industrial use have occurred in California, Arizona, and other areas of the southwest (Smith 1989; National Resource Council 1992). In contrast, competition in the northwest is primarily between irrigation and the instream use of water for power production, fish habitat, and other benefits. Conflict has developed over how much water should be taken out of the system for irrigation and over who will control that decision.

Affected Parties

The interests at stake in the Columbia Basin are numerous. The values that define those interests are often economic, but include cultural, aesthetic, and other considerations. The broad spectrum of interests and the multiple and conflicting objectives they impose on management of the basin create a complex political, social and economic environment resistant to change.

The groups with interests in the Columbia Basin can be broken down into four broad categories. Consumers and producers of electric power make up the first broad group, which includes the federal agencies charged with operating the dams and marketing power. Those who divert water from the river compose the second broad group, which is dominated by irrigators and the agencies that manage federal irrigation projects. The third is concerned with fisheries and wildlife, and includes environmental organizations, recreational and commercial fishers, and federal and state fish and wildlife management agencies. The various Native American tribes in the region also have a great stake in management of the basin and their interests span many aspects of river

management. The tribes are particularly affected by the decline of salmon runs, which have been central to their society for hundreds and perhaps thousands of years.

Power production and consumption

Electric power is produced in the Columbia Basin by a series of federal and private dams. Fourteen federal dams have been built a part of the federal power system, twelve by the Army Corps of Engineers (ACE) and two by Bureau of Reclamation (Reclamation). The early ACE projects were built primarily for flood control and navigation purposes and later became major power producers, while later projects were built primarily for power production. The Reclamation dams were built primarily for irrigation, although the dams also produce a significant amount of power. In addition, other federal projects in the basin bring the total number of federal dams to thirty. In addition to the federal dams, numerous private dams have been built for both power and irrigation, including five on the main stem of the Columbia and ten in the middle and upper portions of the Snake River Basin. In total, there are some 255 federal and private water projects on the Columbia and its tributaries, with locations in British Columbia, Montana, Idaho, Oregon, and Washington (U.S. Department of Energy 1995c, 2-1).

Power produced by the Columbia River Power System is marketed by the Bonneville Power Administration. The dams are actually operated by the ACE, and have been managed in the past primarily to maximize power production. Power demand is highest in the fall and winter months, so the system has been built to store spring runoff for release when demand is high. The ability to manage the dams for maximum power production has been limited by the need to increase river flows in the spring and summer for salmon.

BPA markets power wholesale to numerous public and private utility companies and to the Direct Service Industries (DSI), large industrial users most of whom are aluminum smelters. These purchasers of electricity have all benefited in the past by the low rates BPA was able to offer on its inexpensive and abundant hydropower.

There are several classes of BPA customers, all with somewhat different rate structures. BPA bases its rates to DSIs on factors such as the predictability of demand and the willingness of DSIs to purchase non-firm power (power that is not guaranteed and which may be interrupted). The public power preference dates from BPA's origin in the 1930s, and guarantees public utilities first priority for power purchases. In addition, BPA offers a special rate to private utilities on the power they purchase for residential customers through the residential exchange (MacKenzie 1995b).

All electricity consumers in the Northwest have benefited from inexpensive hydropower. Electricity rates in the Northwest are among the lowest in the country. BPA's customers have a vested interest in protecting these low rates. Until recently, BPA had no price competition as its costs were far below those of any other producer. The squeeze between rising costs and emerging sources of low-cost electricity has BPA officials concerned for the first time about the need to compete in the market. Whereas in the past BPA could recover costs for various programs such as conservation promotion and fish and wildlife protection in its rates, it is no longer possible for BPA to write a blank check for such programs.

Private power companies also have a large stake in the management of stream flows in the Columbia River Basin. Many of the dams are owned by private companies, and their ability to produce power is directly influenced by decisions made about management of the flow regime. The issue is particularly salient in Idaho, where the Idaho Power Company owns dams that produce most of the electricity in the state.

Water users

The primary consumers of water in the Columbia River Basin are irrigators. More than 7 million acres of land are under irrigation in the Basin. More than 32 million acre-feet (maf) of water are diverted for irrigation, and of those almost 14 maf are consumed while most of the remainder runs back to the rivers in return flows (U.S. Department of Energy 1995b, 2-5). Irrigation is provided by Bureau of Reclamation projects throughout the region, as well as by private irrigators.

Irrigation is particularly intense in the Snake River Basin in Idaho. Although only about 18% of the basin's water volume flows through the Snake (U.S. Department of Energy 1995c, 2-1), it provides water to almost half the region's irrigated acreage (U.S. Department of Energy 1995b, 2-6). Agriculture in Idaho is heavily dependent on this source of water, and the state has actively asserted its authority over water appropriations.

Water is also used for municipal and industrial purposes, but the volume of water consumed for these purposes is very small. Most of the water that flows to cities and industries is returned, so the overall impact on river volumes is negligible.

Authority over water use is vested with the states. Water rights are generally allocated through a system of prior appropriation, as described above. Water allocation is one of the only aspects of river management that remains almost solely in control of state government.

Fish and wildlife

Estimates of the number of fish spawning in the Columbia Basin at the peak of harvests in the late 1800s range as high as 16 million (U.S. Department of Energy 1995a). The salmon fishery has supported both commercial and traditional, subsistence harvests.

In addition, salmon have been popular targets for sport, and have supported a large recreational fishery.

Three species of salmon in the lower Snake River Basin have now been declared endangered under the Endangered Species Act (ESA). Biological opinions have been prepared by the National Marine Fisheries Service (NMFS) to guide salmon restoration measures. In addition, the Northwest Power Planning Council (NWPPC) has prepared salmon restoration plans in concert with states and federal agencies. The need to protect endangered salmon runs has significantly affected river operations.

One of the primary features of salmon restoration plans is a call to increase river flows in spring and summer when juvenile fish are migrating to the sea. Salmon restoration measures have also included collection of juvenile fish at upstream dams to be transported by barge to the sea. This measure is intended to protect juvenile fish from predation and from injury in passing over dams or through power turbines.

A number of environmental organizations have called attention to the plight of the salmon. The Environmental Defense Fund and the Sierra Club have advocated various approaches to salmon management. Groups such as Trout Unlimited, which focuses on protection of fish stocks and recreational fisheries, have also been involved. Such groups have pushed for listing of additional salmon stocks as threatened or endangered, and have been involved with court actions demanding protection for the fish.

Tribal government

The connection between various Native American tribes and the Columbia River is both long and deep. Tribal nations have relied on salmon as a source of food, and their annual migrations have a central role in their cultural and economic life. Tribes have been guaranteed a portion of harvests on the Columbia and elsewhere throughout the

region, but have had little power to prevent the decline of salmon stocks. Tribal governments currently have a central role in fishery management, including operation of numerous salmon hatcheries. They are also involved with state and regional planning to restore salmon runs (U.S. Department of Energy 1995a).

Other activities

Dams on the Columbia also provide navigation, recreation, and flood control benefits. Locks in the dams allow barges to navigate the river, primarily to haul grain and other agricultural products. Navigation competes to a degree with power production, as water used in the locks bypasses power turbines. Many recreational activities are associated with the various reservoirs on the river, and to the extent water is released for salmon, activities at reservoirs will suffer. Effective flood control requires that sufficient storage capacity be maintained in the spring to capture runoff and prevent flooding. This necessity sometimes conflicts with ideal storage patterns for power production.

Columbia Basin Planning and Management

In the case of water management on the Columbia, there is a curious dichotomy between authority to manage the river system and authority over the water in the river itself. Dams are operated by the Army Corps of Engineers to achieve multiple objectives, although the Corps generally follows the requests of the Bonneville Power Administration to shape river flows for maximum power generation. The individual states, however, have no direct authority over the operation of the federal power system and only marginal influence over river management.

On the other hand, the federal government has left control over water withdrawal and allocation to the states. Even water rights held by the Bureau of Reclamation are granted by states and are essentially transferred through Reclamation to irrigation districts and individual irrigators. States retain authority over Reclamation water to the extent that Reclamation is only authorized to use the water for the purposes stated in applications for water rights and any transfer of water or change in purpose of use is subject to state law.

Control over withdrawals and water appropriation

Conflict develops between power producers and irrigators in part because those who operate dams are generally powerless to protect flows. States have the ability to grant water rights for power production, but where this has been done the right is almost always made subordinate to future withdrawals for irrigation. In practice, power producers have not been able to protect minimum flows nor to bargain with current or potential irrigators over use of the water. In theory, power producers might offer to pay potential irrigators not to develop new land, but since there is no protection for flows for generation, producers could end up paying several times to protect the same water (Butcher, Wandschneider, and Whittlesey 1986, 60). The inability of power producers to protect flows is a severe disincentive to potential purchases or leases of water rights for power production.

Until recently, instream uses for wildlife habitat had no right to the water and little protection under state laws. Although states have begun to recognize the value of minimum flows for habitat protection, protection is intended to prevent future reductions rather than curtail present use. The value of minimum flows must be taken into account in evaluating future applications for water diversion, and recognition of minimum flows allows the voluntary transfer of water from diversionary to instream use. While states

have the power to limit present rights or even to reclaim them through eminent domain, the political and economic power of agricultural interests makes this prospect unlikely. Opposition to such actions, or to any change in water use at all, can be inferred from legislation such as that introduced in Oregon that would have prevented water presently used in agriculture from ever being transferred to another use (Middaugh 1996). That the legislation passed the Oregon House (but failed in the Senate) underscores how seriously farmers view the need to protect water rights.

State control over water resources is rooted in an institutional structure that reflects the goals and needs of the past. The institutions were not developed to be flexible or to adapt to changing needs, but rather to provide stability and certainty. As Kai N. Lee (1993, 154) states in Compass and Gyroscope:

> The perversities of water law result from the *proper* functioning of institutions, following the mandates assigned by legislatures or a [state] constitution. A cure cannot be found in better implementation of policy or law, but in changing the law. That entails social and political action, which usually encounters resistance from those who benefit from the institutional arrangements as they are. (Emphasis in original.)

Control over instream uses

In contrast to the system of water allocation embodied in state law, the management of water that remains in the Columbia system is directed by principles of multiple use and regional cooperation. The overlapping purposes of the BPA, ACE, and Reclamation force some cooperation and integration onto these federal agencies. The structure of the Northwest Power Act, which combines power planning with fish and wildlife protection and establishes a forum through the NWPPC for planning across state lines and between states and the federal agencies, provides an institutional structure with

considerable capacity to incorporate the range of values that flow from water and to balance and integrate multiple objectives.

The Northwest Power Act, passed by Congress in 1980, established the NWPPC, which provides a forum for regional coordination of the federal power system. The act also required that beneficiaries of the power system pay for wildlife programs to offset the environmental costs imposed by the dams. In practice, BPA has assumed responsibility for fish and wildlife funding in the basin. Power plans and salmon management plans formulated by the NWPPC in accordance with the act have provided a forum for various interested and affected parties in the area to become involved with regional planning, and have force federal agencies to respond to regional objectives.

The NWPPC has adopted the principle of adaptive management to guide its efforts for salmon restoration. Adaptive management incorporates data gathering and scientific analysis into implementation of recovery measures so that a knowledge base regarding the effect of recovery plans can be built (Lee 1993). Adaptive management requires consistent application and long-term approach. One of the primary institutional requirements is stability and continuity, so that programs are administered consistently and insulated from political factors that might alter programs, cut funds, or change management objectives.

The primary benefits provided by dams on the Columbia are power production, irrigation, flood control, navigation, and recreation. Of these, only irrigation removes a significant amount of water from the river system, and only irrigation falls outside the management scope of the Northwest Power Act. The changes in river operation that have been made to benefit salmon have imposed costs on power producers which have not been shared by other beneficiaries of the dams (Northwest Power Planning Council 1995, 18). Irrigators have been insulated from paying the direct costs of fish and wildlife programs and from sharing the indirect costs associated with changes in the timing of

river flows. Salmon recovery plans have called for acquisition of water from irrigators, but opposition from irrigators has prevented any significant shift of water from irrigation to instream flow (Middaugh 1996). The inability to obtain water, through purchase, rental, or other means, decreases the flexibility of the river system. If the waters in the basin are to be managed for multiple purposes, some way of allowing water to shift from agricultural to other uses is needed.

Pressure for Change

The call for changes in water law or allocation is controversial and the need for such change has been disputed. Two circumstances are creating pressure for change. The first is the call in salmon management plans for the acquisition of water from willing sellers in order to supplement river flows. The second is the existence of multiple economic uses for water resources. In particular, expansion of generating capacity has led to questions about the value of water in some agricultural applications. Although hydropower capacity reached its maximum in the 1970s, renewed financial pressure on BPA has led to a reexamination of the opportunity cost of irrigation for hydropower production (Committee on Natural Resources 1993; Committee on Natural Resources 1994).

Salmon Restoration and the Endangered Species Act

The primary pressure for change may come from the courts, as new lawsuits are filed under the Endangered Species Act. The NMFS has yet to impose a binding program for salmon protection, althogh its Biological Opinions have served as guidelines for river management. Should current measures fail to stem declines in population, or should state

actions prevent recovery plans from being implemented, or should some group simply decide that actions taken so far are insufficient, federal courts may be asked to impose their own restrictions on water use and basin management. This possibility may be sufficient to cause states to reexamine the current system of water allocation before change is forced on them by the courts (Estes 1992).

Acquisition of water for flow augmentation in the Snake River Basin has been called for within the context of federal, state, and regional plans for salmon recovery (U.S. Department of Energy 1995a, 10-6). Plans from the NWPPC and the NMFS called for 427,000 af to be delivered from Bureau of Reclamation projects beginning in 1992. This water was to be obtained from uncontracted storage space in Reclamation reservoirs and from water rentals through the Snake River water bank, and has been successfully delivered by the Reclamation for 1993-1995. The NWPPC has also called for the acquisition of an additional 1 maf from the Upper Snake Basin. The call for such transfers is controversial, however, and has been resisted by irrigators and the state of Idaho.

The biological case for increasing the flow of water in the spring and summer is not clear cut (National Research Council 1995). There are apparent advantages to decreasing the travel time of juvenile salmon, but part of the purpose of the flow program is to document the effect of increased flows on salmon survival . Maintaining flow targets, however, is particularly important in low-flow years, when flow targets are least likely to be achieved. If water to maintain flows is not allocated in all years, including dry ones, court-ordered water reallocation is certainly a possibility.

The benefits that might be obtained from water reallocation are not limited to salmon recovery. For a number of years, the argument has been made that some water now used in irrigation may be more valuable if shifted to power production. The case for shifting water from irrigation to hydropower is complementary to the case for salmon

flows. Although not all water released for salmon can be used to increase power production, increased spring and summer flow does result in additional generation. The ability to shift some water from agricultural to instream use could also allow more water to remain in storage for power production in the fall and winter, when demand for electricity is at its highest.

Opportunity Costs in Irrigation

The use of water that has attracted the most scrutiny, not only on the Columbia but in the west in general, is irrigation. The efficiency of water use in irrigation has been questioned in part because under prior appropriation, water has been easy to obtain but difficult to sell or trade. Because water often has no exchange value, it will be used to the point where the last unit of water consumed has little value to the user, where production just covers the cost of the water. This is the same as saying the marginal value product of water in irrigation is equal to its marginal cost. Water is generally free at the point of diversion, with irrigators responsible only for the cost of transporting that water to their land. This implies that the marginal value of water at the point of diversion will be close to zero (Butcher, Wandschneider, and Whittlesey 1986).

The efficiency implications of this arrangement are best illustrated by comparing the marginal value product of water in agriculture to that in other uses. The efficient allocation would equalize the marginal value product of water across various uses. When water can be stored to produce electricity, its marginal value is considerably greater than zero (how much greater depends on a variety of factors).

Marginal water values in irrigation

One detailed estimate of the marginal value of water in irrigated agriculture in the Snake River Basin was made by the USDA. Utilizing 1987 data, USDA estimated the total producer profit that would be lost with incremental reductions in water for irrigation. Extrapolating from this data, the Environmental Defense Fund (Diamant and Willey 1995) estimated the marginal value per acre-foot of water in the Upper Snake River Basin. This value ranges from $12.65 per acre-foot (af) for the last 100,000 af used in irrigation to $43.42 for the increment from 1.3 to 1.6 million af (1994 dollars).

Another estimate of the marginal value of water in Snake River irrigation can be derived from research by Joel R. Hamilton, Norman K. Whittlesey, and Philip Halverson (1989). This research was conducted to determine the feasibility of a contingent water market in the Snake River basin, in which irrigators would contract to reduce water use in low water years. Based on models of several different farm configurations and assumptions about the value of firm power, the research demonstrated that the benefits expected from such a market exceeded the costs by a factor of nine (73). This is particularly significant as the benefits were limited to those that would accrue in the state of Idaho and ignored the additional hydropower that would be generated by dams further down the Snake and Columbia Rivers.

Although not intended to measure the marginal value of water in agricultural production, their modeling of farm operations provides the necessary information to derive such an estimate (table 1). The researchers estimated net revenue per acre associated with incremental reductions in irrigation water delivered. The model allowed for adjustments to inputs such as labor and generated several possible combinations of inputs and yield for each level of consumptive water use.

The average incremental water values reported in table 1 should be interpreted with caution. They are based on data from only one of the seven farm types modeled in the study. In some cases aggregation of the data may have hidden pertinent effects. Nevertheless, the direction of change and magnitude of the values derived is consistent with what would be expected from theory and intuition, and is not inconsistent with the values reported in the USDA study. If the model is a reasonable representation of actual farm operation, it demonstrates that the initial marginal value of water is relatively low.

Table 1:
Response to changes in water supply for the rill irrigated farm in Southeast Idaho[1]

	Percent reduction in delivered water supply						
	0	31	39	50	60	63	69
Water use (acre-inches/ acre)							
Delivery	58	40	36	29	23	22	23
Consumptive	19	17	16	14	13	12	12
Irrigation efficiency (%)	33	43	46	50	54	53	53
Net revenue ($/irrigable acre)	134	129	126	120	111	105	92
Average incremental water value ($/acre-foot)[2]	n.a.	30	29	39	58	78	87

[1] Production costs, water requirements, crop yields, and prices represent 1986 levels.
[2] Incremental value = 12/(change in consumptive use by crop * % crop acreage) * change in net revenue. Consumptive use by crop and % crop acreage are not shown, but their product is approximately equal to the aggregate change in consumptive use. Change in consumptive use * change in net revenue does not equal incremental water value due to rounding error.

Adapted from: Hamilton, Joel R., Norman K. Whittlesey, and Philip Halverson. 1989. Interruptible water markets in the Pacific Northwest. American Journal of Agricultural Economics 71 (February): 63-75.

There is a temptation to use average water values in irrigation as a basis for comparison to alternative uses. In the short run, the net farm income can be attributed to the value of water. Some studies have reported the average net return per acre-foot of water as the value of water. These values are usually specific to a particular crop. A study of the Yakima Basin in Washington State reported water values ranging from $10 -

$86 per af at 1980 price levels, with hops and alfalfa representing the low values and orchard crops (pears and apples) accruing high values (Gibbons 1986, 39). The figures from table 1 can be used to estimate average value per acre-foot on the model farm, which figures to $85 with unrestricted irrigation at 1986 price levels. Such average values may be well above the average value of water in an alternative use.

While these average short-term values may be illustrative of the contribution of irrigation to agricultural income, they do not provide a good basis for assessing the distribution of water resources. For that, it is the marginal values of water in various uses rather than the average values that should be compared. The observation has been made that where high prices for irrigated land are found, such prices indicate a return to water on these lands greater than the marginal return expected from other uses (Butcher, Wandschneider, and Whittlesey 1986). While land price is undoubtedly a reasonable indicator of average returns, average returns are irrelevant to determining efficient allocation. The question of whether resources are efficiently allocated at the margin requires comparison of marginal values, and as long as water is free at the point of diversion, the marginal value of that water is likely to be very low no matter how high the average returns. Available evidence points to a low value for the last increments of water used in irrigation.

Marginal water values in power production

Regardless of what value is assigned, there is seldom a time when the marginal value to the power system of additional water in the river reaches zero. Capacity of the system has been greatly expanded so that in many years all of the water flowing through the river can be used to generate power. Only when the flow is greatly above normal must water be spilled over the dams without contributing to power generation (Butcher,

Wandschneider, and Whittlesey 1986, 36). Due to restrictions on operation of the river system that have been imposed to help restore salmon runs, it is a reasonable approximation to assume that the marginal value of water for electricity production is never zero.

The amount of generation potential lost when water is used in irrigation instead of to generate power depends on where in the system the irrigation water is withdrawn. The further upriver the point of withdrawal, the more generation potential is lost. At American Falls dam, the highest dam on the Snake river affected significantly by irrigation withdrawals, the cumulative generating capacity per acre-foot of water for all dams below and including American Falls is 1,821 kilowatt-hours (kwh). The comparable figure for Brownlee Dam, on the middle stretch of the Snake, is 1,141 kwh. At Grand Coulee, on the middle stretch of the Columbia, the figure is 1,015 kwh, and at McNary, just below the confluence of the Columbia and the Snake, the capacity is 275 kwh (Butcher, Wandschneider, and Whittlesey 1986).

These capacity figures are estimated averages, as the power generated varies throughout the year and from year to year. McCarl and Ross (1984) compared estimates based on these averages to estimates based on historical flow and generation records maintained by BPA. For most of their results, the estimates based on monthly historic data were not significantly different from the results based on the single average (24). Thus while the above estimates of generating capacity are not perfect, they provide a reasonable basis for estimates of water values in power production.

Estimates of the marginal value of water for power production vary depending on assumptions about the value of electricity. The value of electricity generation at the margin has been equated with the avoided cost of acquiring the next least-expensive resource (Hamilton and Whittlesey 1986), the difference between rates for firm and surplus power (Hamilton, Whittlesey, and Halverson 1989) , and with the avoided

operating cost of thermal power resources (McCarl and Ross 1984). Depending on assumptions about how the power system is managed, it may be appropriate to simply equate the value of additional generation with the going rate for surplus power.

The first estimates of the opportunity cost of irrigation on the Columbia were derived from proposals for irrigation expansion made in the late 1970s and early 80s (Hamilton and Whittlesey 1986). The results of that analysis showed that the total costs of various projects outweighed the expected benefits when subsidized power rates and foregone power revenues were considered. The value of power at that time was estimated at 35 mills ($0.035) per kwh and the opportunity cost of diverting one acre-foot was estimated to be $64.00 at American Falls dam and $36.00 at Grand Coulee (Butcher, Wandschneider, and Whittlesey 1986).

Both technology and market structure in the electricity industry have changed significantly since the early 1980s. Low-cost power is being marketed up and down the west coast, and new combined-cycle combustion turbines fueled by natural gas have increased their efficiency significantly. This, combined with historically low prices for natural gas, has brought down the price of electricity for utilities as well as decreasing the cost of adding generating capacity. The combined capital and operating cost for combustion turbines is estimated at 26.3 mills/kwh in 1996 dollars. Of that, 14.9 mills represents the fixed capital cost and 11.4 mills the operating cost (U.S. Department of Energy 1995c, 4-20). The price of firm power in 1995 was at a comparable level, although the range of prices by time of year and quantity purchased was between 19 and 49 mills. In comparison, the price of non-firm power in April of 1996 was from 9-13 mills during peak demand and 5-7 mills off-peak (O'Donnell 1996). The range through the year was estimated to be 7.5 to 22 mills, again depending on time of year and quantity purchased (U.S. Department of Energy 1995c, 4-22).

Strictly for purposes of comparison, the opportunity cost of irrigation diversions at several different dams was calculated for two price levels, 26 mills and 12 mills. The 26 mills is representative of both the price of firm power in the market and the cost of adding generating capacity with combined-cycle turbines. The 12 mills is representative of both the price of non-firm power and the operating cost of turbines. The range of opportunity costs is listed in table 2. If water made available from irrigation can be used to shape river flows and increase the amount of power that can be generated in critical water years ("critical" defined as that portion of the historical stream flow that would produce the least amount of energy), the power so generated would be valued at firm rates. If additional water simply allowed the system to produce more power overall, such power would be valued at non-firm rates. In practice, reallocation of water might be expected to increase both firm and non-firm generation.

Table 2: Opportunity Cost of Irrigation Diversions

	Cumulative	Opportunity Cost ($/af)	
Dam	Capacity (kwh/af)[1]	Firm rate	Non-firm rate
American Falls	1,821	47.35	21.85
Brownlee Dam	1,141	29.67	13.69
Grand Coulee	1,015	26.39	12.18
John Day	211	5.49	2.53

[1] Butcher, Walter R. and Philip R. Wandschneider, with Norman K. Whittlesey. 1986. Competition between irrigation and hydropower in the Pacific Northwest. In Scarce water and institutional change, ed. Kenneth D. Frederick, 25-66. Washington D.C.: Resources for the Future, 33.

Foregone power production is not the only cost of irrigation diversions. In the past, irrigators have been granted subsidized rates for power used to pump water and pressurize irrigation systems. The irrigation discount the BPA has offered to irrigators in the past is currently being phased out, but the rates paid at dams run by the Bureau of

Reclamation have been set by contract years ago. The System Operation Review (SOR) assumes that irrigators at such projects will continue to pay a rate of just 0.95 mills per kwh (U.S. Department of Energy 1995c). This compares to rates of 25 mills and 33.5 mills paid by irrigators in Washington and Oregon, respectively, at the John Day reservoir (U.S. Department of Energy 1995b, 3-4).

One of the largest Bureau of Reclamation projects in the country is Grand Coulee Dam and its reservoir, Lake Roosevelt. Water from the reservoir is currently used to irrigate over 500,000 acres. The SOR estimates that current operations require 959,254 megawatt-hours (mwh) per year. The cost of that power to irrigators is $911,000. If irrigators were instead charged market rates for that power, at a rate of $25.00 per mwh (25 mills per kwh), the cost is $24 million. This means that ratepayers in the region provide a $23 million dollar annual subsidy to irrigators in the Columbia River Project. Assuming that 875 kwh is required to pump each acre-foot of water from Lake Roosevelt and to pressurize sprinkler systems (Hamilton and Whittlesey 1986), the subsidy per acre-foot (at 24 mills per kwh) is $21.00. The total social cost of that irrigation water equals the opportunity cost plus the subsidy. Thus for water taken from Lake Roosevelt, the social cost is between $33.00 and $47.00 per acre-foot.

It is impossible to say de facto how much water might be transferred productively from irrigation to power generation. Many factors such as crop prices, power prices, point of diversion, irrigation technology, input prices, interest rates, and others may affect the economic value of water in different applications. The best way of accounting for such factors may be through some form of water market, where the parties to the transaction effectively resolve such questions in establishing a price. There are many institutional and legal issues that would need to be resolved to establish such a market, but the potential benefits may make the effort well worth while.

Two studies have concluded that some form of water market in the Snake River basin would not only generate a net economic benefit, but would also be a cost-effective means of providing greater flows for salmon. In an extension of their earlier study on contingent water markets in the Snake River basin (Hamilton, Whittlesey, and Halverson 1989), Joel Hamilton and Norm Whittlesey conclude that establishing a contingent water market to transfer water from agricultural to instream use in dry years would provide flows necessary for salmon restoration while generating additional power worth twice the anticipated loss of farm income (Huffaker, Whittlesey, and Wandschneider 1993). In a comparison of several alternative proposals for salmon restoration, the Environmental Defense Fund concluded that the two market-based scenarios they considered were the most cost-effective of all options studied, and that under most assumptions such markets would provide net economic benefits in addition to the benefits for salmon restoration (Diamant and Willey 1995).

Based on this analysis, it is clear that the value of water for power generation often exceeds its value in irrigation at the margin. This implies that there is a potential for a pareto improvement through reallocation of water, or at the minimum a potential net benefit. Achieving that potential, even partially, may prove quite difficult. The way in which water rights have been defined in the law has inhibited the selling or trading of those rights, although transfers from one agricultural use to another have generally been easier to achieve than transfers out of agriculture altogether (National Research Council 1992). The need to carefully define water rights and to consider the secondary effects that transfers may have on other users can impose substantial transactions costs on even relatively simple water transfers. The political clout of agricultural interests has also in many cases prevented the serious consideration of water transfers.

Mechanisms for Implementing Water Transfers

If the current allocation of water is inefficient and present uses cause harm to the environment, then water should be redistributed. The question then becomes, how should water distribution be determined? There are two primary approaches to achieving water transfers: voluntary and involuntary. Our political culture prefers voluntary approaches in general because they minimize government involvement. On the other hand, consumer and environmental groups often question the effectiveness of voluntary regulations, arguing, for instance, that consumer and environmental protection should be mandatory. There is a tension between the desire to minimize governmental regulation of private activity and skepticism toward the prospect that public interests can be served in the pursuit of private ends.

Water Markets

The case for a free-market allocation of water has been forcefully presented by Terry Anderson (1983). He argues that values in water can be captured in the private market as long as water can be purchased for any use and water is freely transferable. Along those lines, James Huffman (1983) argues that instream values for water could be protected in a private market if water rights were easily transferable to instream use. Other economists have argued, however, that the many potential sources of market failure will overwhelm the possibility of efficient distribution through a free market. An unfettered market for water may be both unlikely and undesirable. As Richard L. Gardner (1987, 55) summarized, "The risk that unregulated water markets will ignore hydrologic externalities, public instream uses, and secondary benefits is simply too great [to allow such markets to develop]."

Water Plans

Another possibility is that the distribution of water will be further removed from private control. Authority exists for states to exert a great deal of control over water allocation through application of the public trust doctrine, through regulation in protection of the public interest, and through incorporation of water into state planning processes. The state of Montana has asserted control over a great deal of unappropriated water by reserving it from appropriation. Reservation has been used to protect instream flows by granting reserved quantities to state agencies such as the Department of Fish and Game (Huffman 1983, 264). This approach was possible in Montana because much of the state waters had remained unappropriated. In other states, available supply is fully or even over appropriated. In such cases, states could authorize purchase of private water rights for various public purposes or even exercise the power of eminent domain. At the federal level, it is possible that the Endangered Species Act could supersede private water rights and require that water be left in a river to maintain flows for fish. Any of these measures might result in government control over water appropriations to a much greater degree than is currently the case, but it seems unlikely that centralized control would develop fully in the political culture of the U.S., and centralized control is certainly no guarantee of efficient allocation.

Regulation and Economic Incentives

With respect to water, there are several reasons to think that reallocation can be achieved through voluntary means. The primary basis for this argument is that there are potential gains for all parties through voluntary market transfers, the obstacles to

establishing such markets notwithstanding. There is also a recognition that the political and legal obstacles to involuntary transfer may make forced reallocation infeasible. However, the development of an unregulated market appears unlikely and is probably undesirable. In an international survey of approaches to water management, the editors conclude that, "To safeguard equity, water quality, ecosystems, and future uses, water management should not be carried out solely through a market process or through a purely bureaucratic process. The ideal system would blend economic incentives, conflict resolution processes, and government action in a democratic system" (Loehman and Dinar 1995, viii).

Such a system already exists in several dimensions with respect to management of the federal power system. The presence of the NWPPC as a regional institution that could set the parameters for water marketing and potentially resolve interstate and intergovernmental conflicts regarding transfers is an advantage for the region. The fact that the NWPPC, along with federal fish and wildlife agencies, has already called for water transfers and is studying the issue provides further evidence that the council may play a leading role in facilitating future water transfers.

Whatever the regional approach to future water transfers, the pressure for change is likely to continue. The region has an opportunity to design a regulated market for water transfers that would offers flexibility while accounting for externalities and secondary impacts in the water transfer process. If mechanisms are not developed to facilitate water transfers in the region, economic and environmental demands on existing water resources will continue to increase and may lead to some form of involuntary transfers in the future.

Problems with Involuntary Transfers: The Endangered Species Act

The ESA can be viewed as a mechanism for involuntary reallocation of property rights. The ESA acts to alter the type of rights or protections that are granted salmon and salmon habitat. The framework of property rights can be used to analyze the conflict over water uses in the Columbia Basin and the potential impact of the ESA. In this framework, there is a property right associated with each of the values created by water. Some types of rights take precedence over others, and the law serves to mediate conflict between them.

Norman Whittlesey and Philip Wandschneider (1992) develop a discussion of salmon recovery around the issue of property rights. They identify three levels of entitlement to resources defined under the law (4). A property rule grants control of resources to an owner, and such resources can only be transferred, used, or harmed with the owner's permission. The property rule also grants to the owner the right to sell or trade resources and to set the price. Right to resources under an inalienability rule cannot be lost, but neither can they be traded or sold. A liability rule, on the other hand, establishes a requirement for compensation when resources are taken or destroyed, but grants little control over resources to the nominal owners.

Water rights as they have been established under the doctrine of prior appropriation fall in the category of a modified property rule. The first change in property rights on the Columbia occurred as the common property of fish habitat was appropriated (and privatized) for off-stream use. The initial impact was minimal, but the absence of protection for the common property of fish habitat had long-term consequences. Off-stream water users established protected claims to water that held greater weight when conflicts over water use eventually arose.

Whittlesey and Wandschneider describe the era of dam building as one in which salmon and their habitat were protected under a rule of weak liability (4). Little value was accorded to salmon, and mitigation of adverse effects on salmon population and habitat was only partially provided. As salmon populations continued to decline, the stocks decreased in value, but no owners or trustees of salmon habitat had the power to stop destructive actions or to demand full accounting and compensation for adverse effects.

Listing of salmon species under the (ESA) has the potential to change protection of salmon and their habitat from a rule of liability to a rule of inalienability. The ESA establishes the absolute right of a species to protection, with all other considerations subordinate to that right. The ESA can thus serve to reallocate water uses and property rights on the Columbia. The ESA, however, is a rather blunt instrument, and provides no guidance on how to achieve redistribution or manage a habitat and ecosystem that extends over five states and two countries. The social and biological complexity of the issue overwhelms the ability of the ESA to define a coherent course of action. The region is thus struggling to avoid the kind of legal and political conflict that arose when the spotted owl was listed as endangered under the ESA in the late 1980s (Dietrich 1992).

Use of the ESA as a mechanism to force the reallocation of property rights through the courts was at the heart of conflict over protection of forest habitat. The impact of such protections on the logging industry and on towns dependent on logging for an economic base was significant. Critics of the ESA argued that protection of endangered species should be balanced against the economic impact of such protection. The extension of logging restrictions and habitat protections to private land, in particular, led land owners to protest that their property was being taken without compensation (Stevens, William K. 1993). A resurgent wise use movement in the Northwest adopted such arguments in a call for repeal of government restrictions on private lands, including

major changes to the ESA. A backlash against environmental regulations was one of the factors that drove the conservative resurgence in the 1994 congressional elections. So far, the ESA has not been significantly changed or weakened, but neither has it been reauthorized except on an annual basis, and it remains the source of controversy.

The long-term impact of battles over the spotted owl and the forests of the northwest is still being felt. Although protection for habitat was won in court, implementation of court decisions has been difficult. The election of President Clinton led to development of a forest plan that was eventually accepted in federal court as meeting the requirements of the ESA. Some areas designated for protection, however, have now been opened to logging under the so-called "salvage rider" that was passed by Congress and signed by the President. The application of the ESA in this instance has led to protracted political conflict and attacks on the law that may yet lead to its weakening. Moreover, the stability of the resolution achieved is clearly in doubt.

Such experience with the Endangered Species Act argues strongly for alternatives to the forced reallocation of water on the Columbia. Although the ESA may have the potential to force some change, the political cost would undoubtedly be high and the long-term stability of changes forced by the act, uncertain. Since there is an opportunity to pursue voluntary water transfers, a more productive course might be to use existing regional institutions in an attempt to reduce barriers that currently prevent more widespread transfers from taking place.

At one level, change in management of the Columbia river system requires a reallocation of property rights. At another level, it requires a reassessment of values. Change will occur as new interests are thrust into political discourse by environmentalists, consumer groups, Native American nations, and others who have had little representation in the past. In the Northwest, conflict engendered by resource depletion and population pressure has crystallized around endangered species and the

Endangered Species Act. In both the case of the spotted owl and salmon, the immediate issue is indicative of wider conflicts over ecosystem protection and management, resource use, property rights, and economic and environmental values.

A primary goal of water trades and transfers is to provide flexibility in the use of water resources. In a competitive market, resources are allocated according to willingness of purchasers to pay for their use. When a new use develops that promises a better return than current uses, resources flow into that new use. The current structure of water law and allocation mechanisms creates many barriers that prevent water from flowing to new uses. In order to manage the Columbia Basin for multiple use and provide the best return on public and private investment, water allocation needs to be more flexible. That is not to say that control over water should be transferred from states to regional or federal authorities, or that changes in allocation should be imposed through the courts. Neither does it mean that all regulation of water transfer should be lifted. Rather, it means that creative mechanisms need to be developed that will promote efficient use of resources and environmental protection in a manner that is equitable to current water users.

Issues in Water Transfers

In order to evaluate potential reforms, the issues at stake need to be clearly identified. Table 3 summarizes factors that are involved in any potential water transfer. The multiple factors and parties involved make the subject of water transfers rife with controversy. This is particularly the case when water law and allocation has been predicated on a particular doctrine (prior appropriation) with a particular objective (development of the frontier), and the values associated with that doctrine decrease in importance as other values come to the fore. The values that built the frontier are no long

dominant in the Northwest, but at the very least must contend with other values that were of little concern in the past.

Table 3: Factors in assessment of potential water transfers

Type of Transfer:
- Change in ownership
- Change in point of diversion
- Change in use
- Change in systems operation
- Out-of-basin diversion

Primary Process for Transfer:
- Voluntary
- Involuntary

Primary Market Force for Transfer:
- Government
  - Local
  - State
  - Federal

Affected Parties:
- Rural communities
- Agriculture
- Ethnic communities and Indian tribes
- Environment
  - Instream flows
  - Water quality
  - Ecosystem protection
- Urban interests
- Federal taxpayers
- Other water rights holders

Nature of effects:
- Economic (national/regional)
- Environmental
- Social

Adapted from: Committee on Western Water Management, Water Science and Technology Board, Commission on Engineering and Technical Systems, National Research Council. 1992. Water transfers in the West: Efficiency, equity and the environment. Washington D.C.: National Academy Press, 113.

In evaluating the case for water transfers, all of these factors should be considered. The case in support of water transfers ultimately rests on the economic, environmental, and social effects that a transfer is expected to have. Policies that fail to balance all of these factors will face political opposition and practical barriers to implementation (Metzger 1987). A water transfer is likely to have positive effects in some areas and negative effects in others. Even water transfers that may have net positive economic, environmental, and social impacts can be controversial if the costs fall heavily on one particular group.

Opposition to water transfers is often based on expected social impacts. A common objection is that water transfers may harm rural communities. Such an impact is secondary from an economic point of view, that is, it will be offset by increased activity elsewhere. From the community or local view, however, such losses will be viewed as unfair. How are such impacts to be judged? On the one hand, reallocation of water has the potential to undermine some rural economies and communities, communities built on the assumption that water rights are valid and secure. On the other hand, present water uses may be viable only because water users are subsidized or otherwise insulated from costs associated with diversion. Opposition based on social impacts is often a reflection of the fact that costs and benefits, from water transfers and from other activities, are not equally shared. However, shifts in economic activity often come at a cost, as when declining industry in a sector or region is eclipsed by new activity. Such transitions are often difficult, but also difficult to resist. Voluntary transfers of water provide a mechanism for resource allocation that may be much less destructive than involuntary transfers that might occur in the future.

Obstacles to Water Transfers

The concerns of irrigators and of the northwestern states stand as obstacles to water transfers. So, too, do institutional structures designed to assign and protect water rights rather than facilitate their transfer. The attempt to transfer water from irrigation to instream use in the Snake River Basin serves to illustrate these obstacles. This example can be used to point out some of the economic and structural barriers to transfers as well as suggesting reforms that might overcome obstacles and lead to more broad-based water transfers in the future.

Water and Salmon in the Snake River Basin

Acquisition of water for flow augmentation in the Snake River Basin has been called for within the context of federal, state, and regional plans for salmon recovery (U.S. Department of Energy 1995a, 10-6). Plans from the NWPPC and the NMFS called for 427,000 af to be delivered from Bureau of Reclamation projects beginning in 1992. This water was to be obtained from uncontracted storage space in Reclamation reservoirs and from water rentals through the Snake River water bank, and has been successfully delivered by Reclamation for 1993-1995.

Reclamation has dedicated uncontracted storage capacity to flow augmentation, and has sought to reacquire storage space in its reservoirs. This strategy has emphasized acquiring unclaimed water rather than purchasing or renting water rights from irrigators. A portion of the flow augmentation has been purchased, however, from the Snake River water bank, which was formally established in 1980. The bank facilitates transfers between water users in the state, with priority given to irrigation use. The largest purchaser of water from the bank has been the Idaho Power Company. The availability of water from the bank varies considerably depending on the abundance of water in any given water year, as many irrigators have large reserve holdings as insurance against drought that are sold to the bank when not needed (Gardner 1987, 50). Thus far, water has been available through the bank for flow augmentation, but the priority given irrigators may make banked water unavailable in dry years. Restrictions on price and purpose of use have also kept the bank from reflecting the potential market value of water, although some price restrictions have been lifted (Wahl 1989).

Within the state of Idaho, the Idaho Water Rental Policy Group (later renamed the Snake River Anadromous Fish Water Management Committee) was formed in 1991 to study water rentals for flow augmentation. The group includes Reclamation, Idaho

Department of Water Resources, Idaho Department of Fish and Game, Bonneville Power Administration, Nez Perce and Shoshone-Bannock Tribes, irrigators, and Idaho Power Company (SOR, Main, 10-7). The group has provided a forum for addressing issues related to rentals and releases of water for salmon recovery.

The Bureau of Reclamation, the States of Idaho and Oregon, BPA, NWPPC, and other parties formed the Snake River Basin Water Committee in 1992 (SOR, Main, 10-7). The committee was asked to consider how an additional 1 maf could be obtained from the Snake River Basin, and water transfers are among the options they have studied.

The transfer of unassigned storage and rental of surplus water for flow augmentation in Idaho has been controversial and highlights conflicts between state water law, local priorities, and regional plans. In order to use stored water for salmon flows, Reclamation has filed change of use applications with the Idaho Department of Water Resources (IDWR). Under Idaho law, such applications must be approved by the state legislature before taking effect. In order for such a change to be approved, flow augmentation would need to be recognized as a beneficial use. The Idaho legislature has been reluctant to include flows for salmon recovery in the definition of beneficial use. The State has so far granted only temporary authority for flow augmentation while refusing to approve Reclamation's application for change of use or include flow augmentation as a beneficial use. When Reclamation filed again for change of use in 1995, about 80 protests were made to the IDWR. Reclamation and the other parties reached a negotiated settlement that became the basis for legislation submitted to the Idaho Legislature in 1996 (SOR, Main, 10-7).

As passed by the legislature, temporary authority has been extended through the 1999 water season for release of a maximum 427 kaf per year. The law (Idaho Code, Chapter 17, Title 42, Section 42-1763B) further holds that:

> Nothing in this section shall be construed to... constitute a finding by the legislature that the rental or use of storage water for augmentation of flows for salmon migration is a beneficial use of water, [or] that it is in the public interest...

The bill was accompanied by a concurrent resolution (HCR 037) that states that Idaho does not recognize the concept of flow augmentation or reservoir drawdown as valid for recovery of snake river salmon, and does not support these measures as long-term approaches to Snake River Basin management. The concerns of the state of Idaho as stated in HCR 37 include that, "...flow augmentations have had a documented negative effect on the communities, and on recreation, irrigation and transportation activities, all of which are vital to the stability and quality of life in Idaho." All of this demonstrates that Idaho has been very active in asserting its control over State waters, and that it is concerned with impact on local communities and economies.

Given that Idaho has the authority to control water transfers, and that state concerns are dominated by local impacts, what can be done to promote transfers that might be in the regional interest but are blocked by local concerns? If transfers are to be achieved without overriding state authority, mechanisms will need to be developed that ensure that benefits from trade flow back into Idaho, and that harm to local communities is mitigated or compensated. Evidence and information on the actual impact of transfers also needs to be compiled to counter fears that water transfers will mean the dismantling of the agricultural sector (Middaugh 1995). Water transfers target marginally productive land and water in marginally productive uses, and its impact will likely be felt at the margin rather than at the heart of the agricultural economy.

Winners and Losers

One way to consider how transfers might be promoted is to examine who would stand to gain and who to lose from lessening restrictions on water transfers. The primary beneficiaries should be the immediate parties to a trade. If a trade is made between an irrigator and a power producer, it can be expected that the irrigator has gained more through trade than he would through growing crops, and that the power producer has gained a source of power that is less expensive than other alternatives. This is also a benefit for electricity consumers, because utility regulators generally require that such savings be passed on. If water is obtained for the purpose of salmon recovery, it is expected that the benefits to salmon are greater, or are obtained at a lower cost, than would be the case through alternative recovery measures. In many cases there may be multiple benefits from trade, as when increased flows benefit fish as well as power producers.

All other things being equal, those who stand to gain from trade would be expected to promote it. However, even though a significant portion of water devoted to irrigation has relatively low expected returns, irrigators have generally opposed expanded transfers. Some reasons for this opposition have been explored, but its source can be summarized as risk aversion. Water transfers, even when carried out carefully and reviewed thoroughly, have the potential to harm other rights holders. There is also a fear that water traded today will not be available should it be needed tomorrow. Although water may have very low marginal value in terms of productivity, it may have a much higher value as a form of insurance. One way to promote and encourage transfers, then, is to reduce these sources of uncertainty.

An example of this is provided by legislation authorizing the Snake River water bank. One of the fears regarding lease or rental of water by irrigators is that such water

may be subject to forfeiture. The enabling legislation provided that water leased through the bank would not be forfeited. This allows participation in the bank by irrigators who might otherwise have no use for a portion of their water but still be unwilling to rent or lease (Gardner 1987).

Opposition to trade also comes from the broader community in the area where water originates. The secondary impacts of water transfers can harm those who supply irrigators and those who store, transport, and process agricultural commodities. Secondary effects can include an erosion of the tax base as wealth is transferred out of a community. In the case of Idaho, the importance of irrigated agriculture in the economy ensures a base of support for continued expansion of irrigated acreage, which in turn requires that sources of water for such expansion be defended.

Other river users could certainly be affected by transfers, but it is unlikely that recreation or transportation benefits would provide a primary motive for water transfer. Rather, such interests may be harmed or promoted by transfers undertaken for other reasons. Such externalities, including benefit or harm to wildlife habitat, should be included in the evaluation of potential trades. Forcing external factors to be considered before water transfers are approved represents one legitimate role for public interest review provisions contained in many state water laws, including Idaho's.

Salmon, electricity consumers, and individual irrigators are all potential beneficiaries of water transfers. Irrigators, agricultural communities, and the broader agricultural economy are perhaps most likely to suffer. Even if there is a social benefit in facilitating a water transfer, localized opposition can prevent most transfers from taking place. A good deal of opposition to water transfers is related to uncertainty surrounding their effects. Measures intended to promote water transfers will need to ensure that irrigators and agricultural communities are treated fairly, as well as reducing the uncertainty surrounding the water transfer process. To a large extent, the only way to

address uncertainty is through experience. As Zach Willey of the Environmental Defense Fund suggests, "What we really need is to have some people try it out on a modest scale. We need to substitute some modest action for all the immodest rhetoric (Middaugh 1995)."

Promoting Water Transfers

Two measures are needed if voluntary water transfers are to increase significantly in the Northwest. First, ground rules for market transactions need to be established. This is particularly important for transfers of water out of agricultural use or across state lines. Second, measures are needed to account for externalities associated with water transfers, to ensure that potential transfers are beneficial to the region as a whole and not just to the parties involved in the transaction.

Secure Rights for All Water Users

In order to resolve legal ambiguities over the status of water rights held by various parties, the rights of the various water users need to be more clearly defined. This is particularly true with respect to water rights to minimum flows for power production, fish habitat, or other instream use. As currently defined, power producers may have flows reduced at any time by new claims for irrigation. Butcher, Wandschneider, and Whittlesey (1986) conclude that minimum rights to flows for hydropower production need to be established as a base on which market transactions can be conducted. Without a base right to minimum flows, there is no incentive for the power system to pursue market trades in water, because any water obtained can be claimed again for irrigation.

Without a base right, there is no guarantee that water obtained will actually increase the overall flow available for power production, fish habitat, or other uses.

While such a step may be necessary, the authors also note that any attempt to end subordination of hydropower rights would raise a great number of legal issues, and sorting them out would require "an almost universal adjudication" of water rights in the Basin (Butcher, Wandschneider, and Whittlesey 1986, 61). The relative priority of rights may be thrown into question as some irrigators find their rights suddenly junior to previously subordinate hydropower flows. If water transfers are to succeed, however, some means must be provided to ensure that water actually goes to the intended purpose. Because many rivers are overappropriated, junior water rights holders may absorb water purchased for instream flows (Middaugh 1995). This is particularly likely in dry years, when the water is most needed for instream use.

Another reform suggested by Butcher, Wandschneider, and Whittlesey is the establishment of basin-wide water rights that would be recognized by all states and be transferable across state lines. This would greatly facilitate water transfers, but would require states to give up some of their control over water resources. In the absence of cooperative state action, however, interstate conflict that arise over water use will ultimately be settled by the courts. The courts will be the ultimate arbiter in conflicts between state and federal authority as well unless legislative and/or administrative agreements can be established to govern conflicts between various uses (including fish habitat). Creation of a Columbia interstate compact has been the subject of discussion for many years, and could serve as the basis for establishing interstate water rights.

Barriers to freely functioning water markets are substantial. The lack of secure, well defined rights that are recognized within and between states and that are integrated with federal mandates and authority is a real obstacle to trade. Establishment of a consistent regional structure, combined with reform in state water laws to facilitate

transfers, especially transfers between different uses, would seem to be necessary if water use is to be made more efficient and management of the system more flexible.

Externalities and Equity

Idaho serves as a good example of the potential divergence between the interests of a particular state and those of the region as a whole. From the perspective of the State of Idaho, water transfers can undermine the state's economic base. The state's goal is to ensure a relatively stable, predictable supply of water to agriculture in the face of a river that is fully appropriated, at least in relatively dry years. Any water that is transferred to enhance flows is viewed as water that provides little or no economic return, at least within the state. To the extent that it does benefit salmon, runs would not be expected to support a commercial or sports fishery for many years. And even if salmon runs were to rebound significantly, this would have little impact in the southern part of the state, as salmon habitat above Hell's Canyon has been blocked by dams. The tangible benefit to the state from increased flows is power production, and even here much of the benefit is produced at federal dams downstream from the Idaho border.

One mechanism available to the state to retain some of the benefits from transfers is taxation. An excise tax on water transactions, for example, would generate revenue to help offset the adverse impact of water transfers. Revenues could be used for economic development, or to support development and dissemination of water conservation programs that focus on decreasing crop consumptive use. Such revenues would assist in making the transition to a less water-intensive agricultural economy.

The impact of liberalized water transfers on Idaho's economy and that of other states in the region may not be substantial. To begin with, sales or rentals of water will not occur unless the expected gain from trade is at least as large as the expected income

from crop production. The cost of 1 maf of water for water year 1987 in 1994 dollars at a market clearing price would have been approximately $34 million, while the lost producer profit from the transfer would have totaled just under $23 million (Diamant and Willey 1995). The net gain in income would have been $11 million, a gain of almost 50% over the expected crop income. Attempting to predict the price that would prevail in a market or the quantity that would be traded is beyond the scope of this paper, but such trades should result in a net increase in agricultural income. If such income is reinvested, it should also strengthen the overall agricultural economy even at the expense of a marginal decrease in total agricultural output.

There is reason, however, for Idaho and other states to be concerned about protecting the public interest in water transfers. Transferring water has a real potential to create externalities, effects that may appear as direct costs to other irrigators or as damage to wildlife habitat, recreation opportunities, or other public goods. Provisions in water law to protect the public interest should account for such direct effects as real costs of water transfers, but should distinguish such direct effects from potential secondary impacts. Water transfers are likely to cause some localized declines in the agricultural economy through secondary, or ripple, effects. Such declines should be offset by benefits in the area(s) to which water is transferred, but the local economic activity may or may not be replaced by other business. The standard for approval of water transfers should not require that there be no negative secondary impacts, as such a standard would preclude almost any shift in the structure or location of economic activity. Rather, the goal of the state might best be to assist local areas with economic transition and development, a goal that could be served by allowing water to seek its highest return and ensuring that some of that return is reinvested in the area of origin (National Research Council 1992, 45-50). The alternative is to wait while pressure on resources continues to increase, leading to political and possibly legal conflict and the costs such conflict entails.

Models for Water Resource Acquisition

Specific opportunities for water transfers in the Columbia Basin have been identified and models for resource acquisition suggested. Below are described three qualitative examples of how water markets might function in the Northwest.

Contingent marketing

The dependability of water supply is a crucial variable for irrigators when making the decision to invest in agricultural development. Competition for water resources reaches its height in dry years, when less water is available for all users. Contingent water marketing has been suggested as a potential mechanism to facilitate water transfers while limiting their impact on agriculture (Hamilton, Whittlesey, and Halverson 1989; Huffaker, Whittlesey, and Wandschneider 1993). The appeal of this proposal is its recognition that in wet years, the marginal value of water is higher in agriculture, while in dry years, the value is greater for power production, and perhaps for fish habitat as well. In contingent marketing, irrigators enter into contracts with power producers or with federal or regional entities responsible for both salmon protection and power production. The contracts would allow irrigators use of water unless flows in the river drop below a specified level. In such years, contract holders would be required to reduce their water use in proportion to the size of the flow deficit. In Whittlesey and Hamilton's proposal, irrigators would be required to reduce consumptive use by a maximum 50%. Based on historic water flow, their proposal would require transfers in eight out of fifty years. In this scenario, irrigators would be paid more than the expected value of water to them when transfers are made, but would retain use of the water in most years. Such a system

retains a relatively stable and predictable water supply for irrigators while allowing transfers of water to other uses when its value in those uses is highest.

Water repurchase from high lift irrigation

The Columbia Basin Project serves as a good example of high-lift irrigation. Approximately 1 maf of water are used to irrigate over 555,000 acres in the Project in Washington State. Water for the project is pumped from Lake Roosevelt and is applied primarily through center pivot irrigation systems. Pumping water and pressurizing such systems requires a great deal of electricity. As calculated above, the subsidy to irrigators in the Project is approximately $23 million per year. The opportunity cost from foregone power production adds an additional $12-$26 million annually to the social cost of irrigation in the project. The marginal value of water for production in the Project has not been estimated, but there is indirect evidence that it is in fact close to zero at the point of diversion, consistent with the value that would be predicted (Butcher, Wandschneider, and Whittlesey 1986). Thus there should be ample opportunity for productive trade of water from irrigation to power production.

The ideal remedy for the inefficient use of water induced by subsidies would be to charge irrigators the full cost of power they consume. There are substantial legal and political barriers to such a change. Congress refused to even study such a change in 1982, although it did add provisions requiring farms over 960 acres to pay full cost of power used on those additional acres (Wahl 1989). This provision has little effect because land owners can and do divide their holdings to avoid paying such costs. There appears to be little prospect that such subsidies will end in the near term.

As Wahl points out, however, allowing water to be traded will cause irrigators to value water at its market price rather than at its marginal cost to them. Irrigators would

thus be expected to sell any quantity of water that is worth less to them than its price in the market. Thus trades can lead to the same outcome as eliminating subsidies in terms of how resources are distributed. The primary difference is that where trading is instituted, the value of subsidies accrues to the irrigators rather than being returned to society. In the past, the Bureau of Reclamation has refused to allow sales or rentals of water from federal projects at any price higher than the cost of providing the water. This restriction was intended to prevent irrigators from profiting on federally provided water. Reclamation has since begun to allow such profits consistent with its stated principles on voluntary water transfers (U.S. Department of the Interior 1988).

Transferring water from irrigation to power production would be beneficial up the point where the marginal values of water in both uses are equal. Such a trade might also make more water available to increase flows for salmon on the main stem of the Columbia. In order for trading to take place, it would need to be consistent with the laws of the State of Washington and with the policies of the Bureau of Reclamation. It is an open question how the state might view a proposal to sell or rent water from the Project, but if flexible management of water in the Basin and reallocation of water is a goal, such opportunities for transfer should be pursued.

Water Banking

One of the difficulties involved in water transfers is the need to track flows and water quantities as they are moved. Water banking facilitates transactions by providing a central exchange for small deposits and withdrawals. The Upper Snake River Water Bank is an example of the potential advantages of such an arrangement. While limits are placed by the State of Idaho on transfers of water, the bank nonetheless serves as useful mechanism for transferring water within the state. An interstate water bank would

provide a means of bringing together buyers and sellers and could also help in determining the market value of water. Disparities in power and information between buyers and sellers might otherwise lead to wide variations in the price of water and potential for very large purchasers such as BPA to set the market. A system of banks allowing storage at various locations would facilitate trade and put transactions on more even terms.

Setting Priorities: Cost-Effective Management and Regional Reform

Specific goals for public policy emerge from the political process. That process is one of competition and attrition between conflicting goals and ideas. Once a particular goal is chosen, however, there can be a great deal of difficulty implementing a program to achieve it. There is a strong current in contemporary political life that pushes for cost-benefit analysis (CBA) of every program, to ensure that it will have a net benefit. However, CBA is not always possible, nor is it always desirable. In the case of water transfers in the Columbia Basin, economist Norm Whittlesey has pointed out that CBA is not possible because the value of salmon protection is not amenable to economic quantification (Whittlesey 1992). In such a situation, the best approach is to seek cost-effective policies that achieve a desired result at the least cost.

The Northwest is facing a battle over how to fund salmon restoration measures. While the Northwest Power Act mandates that beneficiaries of the federal power system share in the cost of programs to mitigate impacts on fish and wildlife, in practice BPA has been responsible for most of those costs. Financial pressures on BPA in the form of increased competition and debt load from failed WPPSS investments have caused BPA to search for ways to increase revenues and limit costs. A call has come from BPA and from many of BPA's customers for a cap on the agency's liability for salmon protection.

Of particular concern to BPA is the loss of revenue when water is released for fish rather than stored for power generation, especially since that loss could soar in dry years when most of the available water may be needed for fish.

BPA has chosen to focus on controlling costs related to salmon protection as a means of ensuring its financial solvency. Salmon restoration is a relatively new cost that has grown rapidly, and debate about how to protect the salmon has been very visible. Salmon protection, however, is one of many activities that affect operation of the power system and that impose limits on BPA's ability to maximize power revenues. Among the foremost factors affecting power revenues are the absence of any right to minimum flows for power production and the lack of federal or regional authority to allocate water or control withdrawals. Rather than blaming the cost of salmon protection for BPA's difficulties, all of the factors that impose limitations on power production should be examined together. Opportunity costs are imposed not only when water is released for salmon, but also whenever water is withdrawn or used in any manner that competes with power production. Costs imposed to protect salmon appear more controversial than costs imposed by other activities simply because they are the most recent. Focusing on salmon has put BPA in a position of counting water allocated to fish as a cost, while the cost of allocating water to irrigation is ignored.

The need to protect salmon while ensuring that BPA can remain competitive and meet its financial obligations has focused attention on system efficiency. If the Columbia Basin is to be managed efficiently, authority over river operations and authority over water allocation need to be combined. Regional cooperation on basin management without regional cooperation on water allocation makes achievement of basin-wide goals difficult if not impossible. The legal and institutional structures that control water allocation, however, present significant obstacles to reform. Those structures are rooted in a past where the value of water lay in diversion and consumption rather than instream

use. Although the social calculus of water values has shifted as water use has intensified, the system of water allocations has not changed to reflect those new values. Because water is very valuable, especially where it is scarce, those who benefit from current allocations resist change, and states that depend on water for economic activity are loathe to relinquish any control. The fact that benefits from the current pattern of water use are concentrated among individuals who have appropriated water for private gain, while benefits from more efficient use would be dispersed among the many electricity consumers and residents of the Northwest makes it difficult to mobilize a constituency to press for change. Expansion of regional authority over river operations combined with legal and political pressure for salmon protection may combine to overcome the present inertia and force changes in the system of water allocation.

The key to forcing change in water law may lie in fostering unlikely coalitions between residential power consumers, industrial power customers, environmental interests, and even irrigators themselves. All have something to gain from liberalization of trade in water rights. Moreover, if irrigators are not allowed to trade water rights more freely, they may find their rights constricted or lost to court-imposed systems of water allocation and management. This prospect could provide great motivation for change. The danger is that irrigators and states may continue to believe that such a reckoning can be put off indefinitely, ultimately leading to greater conflict.

The fear of change, to be expected from both current beneficiaries of water rights and from the states themselves, may be a greater impediment to water transfers than the actual impact that would be felt from liberalization of water law. Many of the benefits of water transfers would be shared through the region, while the costs might be more concentrated in certain states or localities. States, and possibly regional authorities, can take measures to compensate for negative impacts, and systems such as contingent marketing could allow benefits to be captured at little expense to agriculture. Rather than

allowing the potential costs of water transfers to prevent marginal changes in water allocation and use, the region should seek means of easing the transition in areas most likely to suffer some economic decline.

In summary, social, environmental, and economic goals can best be served by creation of a flexible system of water management and allocation. The ability to shift water between uses would allow water to flow to where it is most valued at a given time. The relative value of water changes, not only over time but also from year to year depending on annual precipitation. A regulated but consistent and predictable water market would allow both long and short term gains. The BPA should not be limited in its search for greater efficiency and low-cost power by archaic systems of water allocation. Neither should regional plans for salmon protection be prevented from pursuing the most cost-effective management options. The lack of flexibility in the system of water rights as currently administered prevents such goals from being achieved.

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