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Who Controls the Water? Managing the Columbia-Snake System

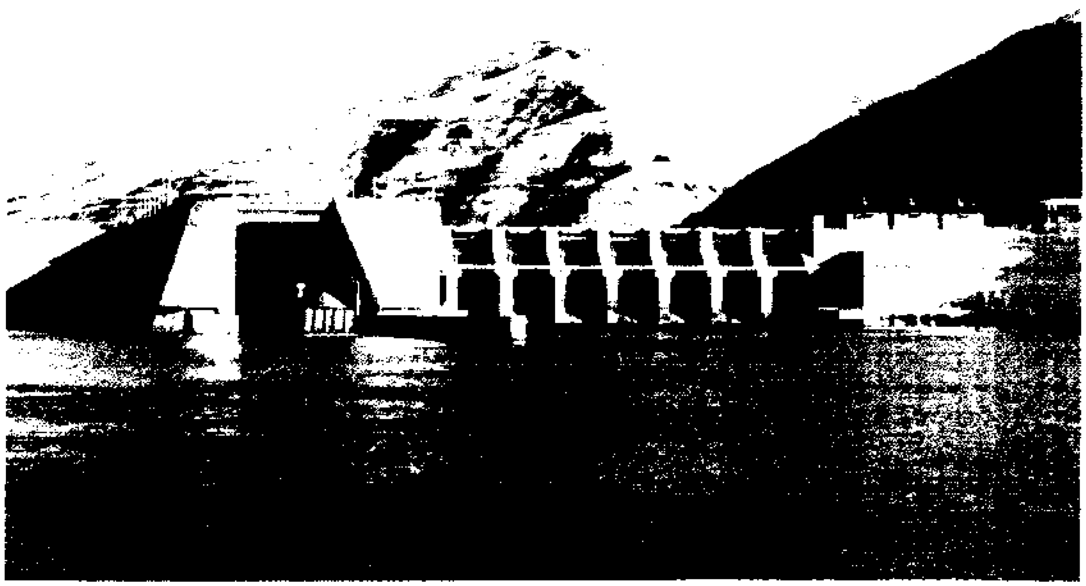

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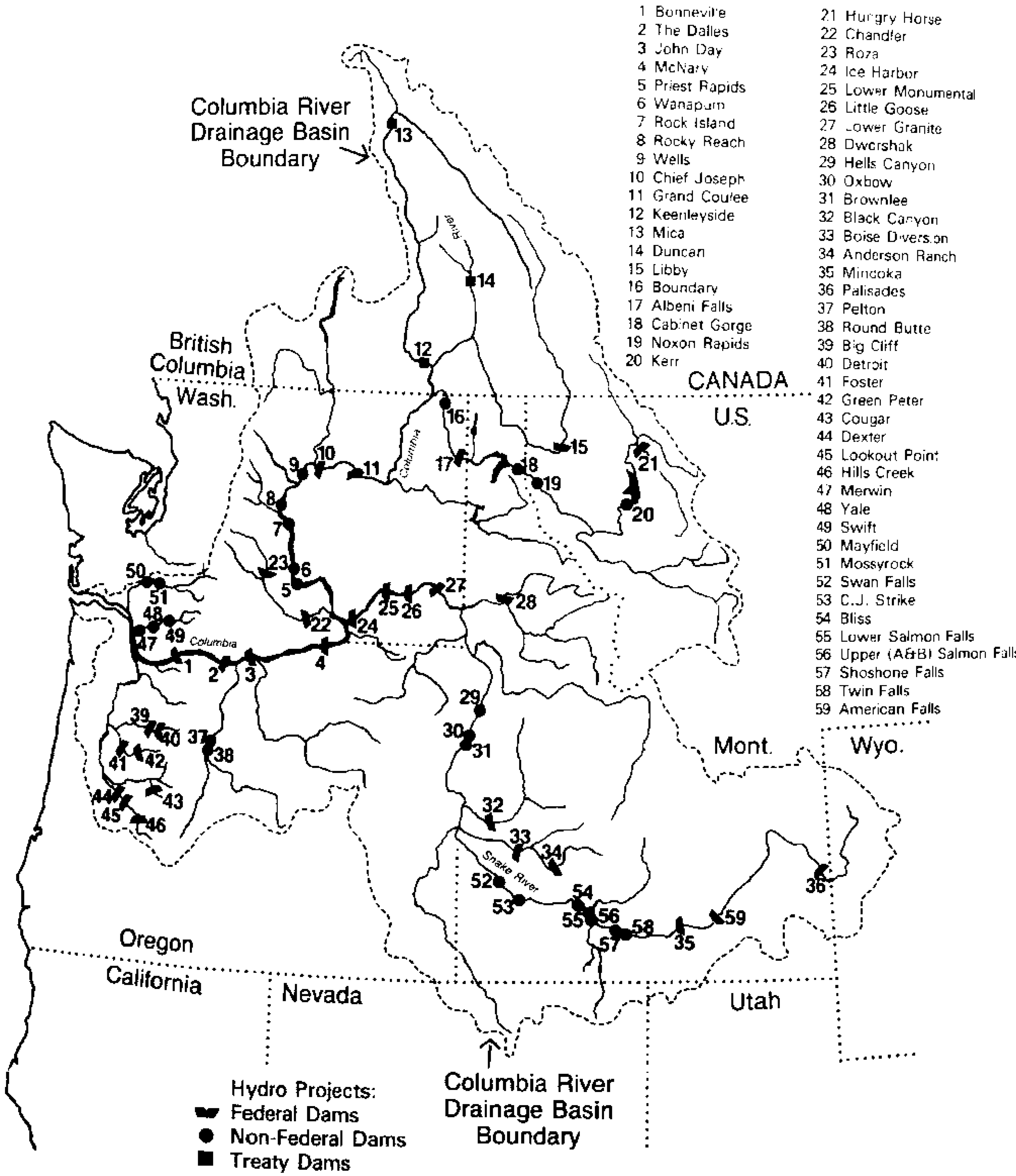
Figure 1. Map of Columbia River System-Major Dams and Reservoirs.



WHO CONTROLS THE WATER? MANAGING THE COLUMBIA-SNAKE SYSTEM[1]

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The Columbia-Snake River dominates the Pacific Northwest geographically and economically (Fig. 1).[2] Few people in the Northwest are untouched by its presence. Some gain their living from its vast resources for power, navigation, fish production, and irrigated agriculture. Others benefit as consumers of abundant and low-priced electricity, fish and food supplies, domestic water, or aesthetic and recreational opportunities.

The vastness of the river has freed most users from concern over the security of their water. (A major exception has been the salmon and steelhead fishery.) As demands for water have increased, conflict between and within user groups has become more prominent. At first someone observing the large volume of water that flows out at the mouth of the Columbia might find it incredible that such a large river could fail to meet all needs. But all water use is not consumptive. Many uses, such as navigation, power, the *anadromous*[3] fishery, recreation, and aesthetic values, depend on the character and volume of the streamflow. In most years, for example, almost all the streamflow goes through turbines to produce power. Years of low streamflow, such as 1973 or 1977, can bring power shortages. Further, use of the streamflow for power production competes with other valuable uses. Diverting water for irrigation makes it unavailable for power; getting the largest possible fish population requires a different seasonal flow pattern from power production. So, although the volume of water is large even in low flow years, the quality and quantity is not sufficient to meet all the demands placed on it.[4].

How the water will be used depends on who makes the decisions and how they are made. The Columbia River decision-making system is complicated and not well understood. It is also an evolving system.[5]

There is an increased need for all those affected to understand how decisions concerning various uses are made. The objective of this bulletin is to provide an overall description of the management system.

Understanding management of the Columbia River is no easy task. No single organization makes the decisions which determine water development, diversions, river flows, reservoir levels, and so forth. Instead many different organizations each have some influence, and each in turn responds to the desires of its clients and to pressure from the agents of competing uses. For example, the Bonneville Power Administration (BPA) plays an important role in managing river flow for hydropower, but to some degree it is merely responding to the demand for electricity from the utilities it serves and their customers. Electrical demand is created by the millions of individuals and thousands of industries that consume BPA's power.[6]

The story is quite complicated. Some order can be introduced by sorting decision-making into three levels: the law-making level, the policy-making level, and the operational level (Fig. 2). The law-making level reviews the legal basis for the respective agencies and jurisdictions. The policy-making level is organized around the various use clusters competing for the water. The operational level focuses on

[1]This work is the result of research sponsored in part by NOAA, Office of Sea Grant, Department of Commerce under Grant No. NA81AA-0-00086 (Project No. R/WSU-3). A more detailed report is available in Wandschneider (1984).

[2]The Columbia River system includes a number of major and minor tributaries with the Snake being the most extensive. The term Columbia River will be used to refer to the whole system.

[3]Italicized terms are defined in the glossary.

[4]See *The Columbia-Snake: Challenges for Multiple-Use River Management* (Queirolo and McNamee) for more discussion of uses and conflicts.

[5]For example, the Pacific Northwest Electrical Power Planning and Conservation Act (1980) created the regional Power Planning Council, which in late 1982 and early 1983 issued its first energy plan and fish and wildlife program. It will take some time before the ultimate role of the council and the full impact of its plans are clear.

[6]The issue is actually even more complex because BPA, especially in its early days, was an active promoter of electricity consumption. See Norwood (1981) for BPA policies and history.

streamflow management from its initial natural state through storage and diversion for consumptive use (irrigation, municipal, industrial) and instream use (flood control, recreation, fish flow, navigation, recreation/safety, hydropower).

Decision-making at each level will be described. By looking at decisions at all levels and for all uses, the reader will be able to understand the many forces impinging on a particular decision. For example, why can BPA do this, but not that? What rights do irrigators have and how do their decisions affect power? Who represents fishery interests and what influence can they have?

THE LAW-MAKING LEVEL

The first stage of decision-making is to make the rules by which other decisions are made. In the United States the fundamental set of rules is the Constitution. Under the Constitution the federal government and the states each have some authority over water use. This section will describe the sources of their respective authority and the principal laws they have made which govern the Columbia River.

National Legislation and Federal Agencies

The power of Congress to pass laws is limited by the Constitution as interpreted by the Supreme Court. Authority not explicitly delegated to Congress is reserved to the states. Since the Constitution does not grant direct control over water to Congress, states make the basic water laws (state water laws will be described later). The U.S. Congress has three important sources of constitutional authority over water use: 1) the commerce power; 2) the general welfare power; and 3) the proprietary power. In addition, the federal government has sole authority to make treaties with foreign governments and Indian tribes.

The Supreme Court has said the power of Congress to regulate interstate commerce (the commerce power) implies national control over navigation and ultimately all navigable rivers. Under this power, for example, only the federal government may authorize obstructions such as dams on navigable rivers, including the Columbia River. The second Congressional power is authority to spend money to promote the general welfare. This power has only been recognized as a separate authority since the 1930s, but it provides the basis for public works and economic development projects. Grand Coulee Dam and Bonneville Dam were both initially developed as public works projects, though they are also legitimate under the commerce power.[7] The final federal authority is the proprietary power, which authorizes the federal government to own and dispose of land. In addition, where both federal and state law applies, federal law is superior. The Supreme Court has ruled that the proprietary power together with the supremacy clause implies that the federal government may reserve water attached to federal lands (*reserved water rights*), thus exempting this water from state law in important ways.

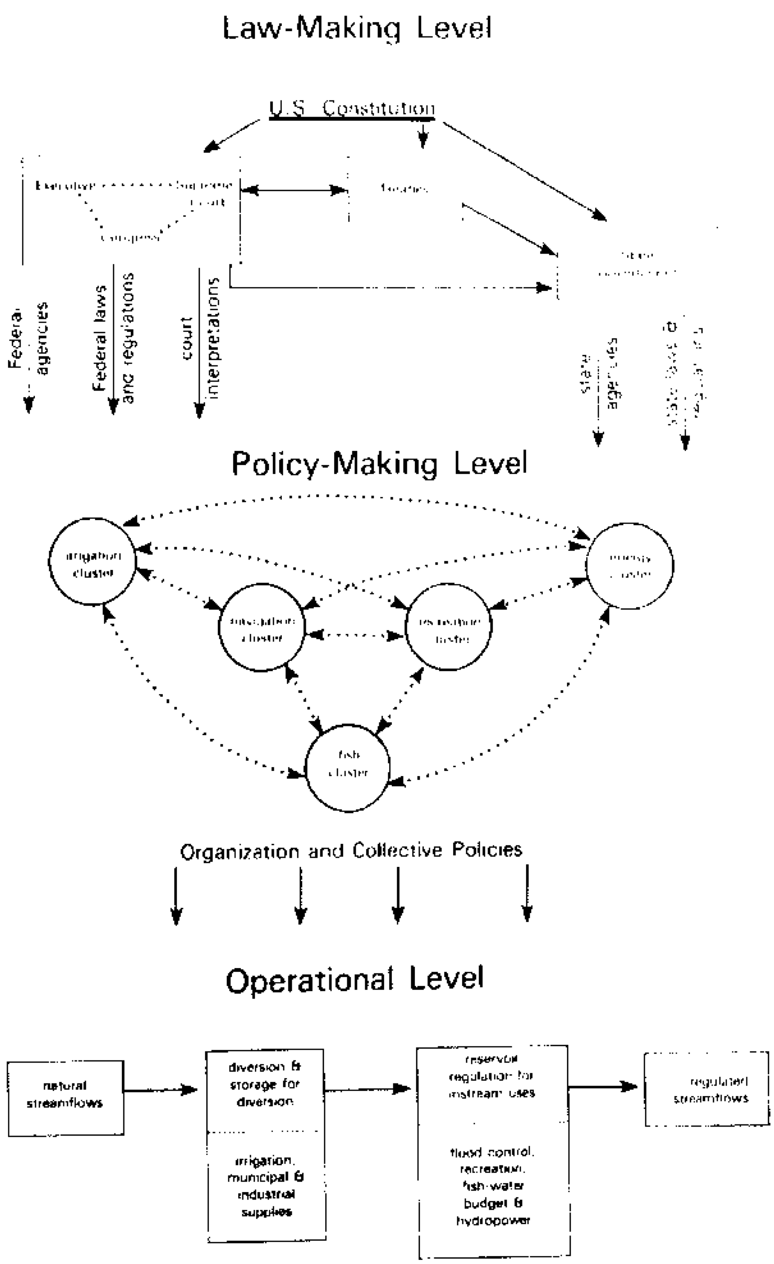
Based on these three powers, especially the commerce power, Congress has passed a number of laws affecting the Columbia River. An important group of laws creates the federal agencies responsible for developing and managing the Columbia. In effect, these laws are charters which define what an agency may or may not do.

The major federal agencies are: 1) the Army Corps of Engineers (Corps); 2) the Bureau of Reclamation (USBR); 3) the Bonneville Power Administration (BPA); and 4) the Federal Energy Regulatory Commission (FERC). The Corps and USBR are the major federal owners of dams, reservoirs, and hydropower generators on the Columbia. The Corps is authorized to build multipurpose projects (power, navigation, flood control, recreation, fish) and also to regulate the dams and reservoirs of other agencies for navigation and flood control. Originally, the major interest of the USBR was in irrigation, but it is now also a major power producer. The BPA builds and operates transmission lines and markets almost all the power produced by Corps and USBR projects in the Northwest. BPA may not own or operate power generators. Together, the Corps, USBR, and BPA operations constitute the Federal Columbia River Power System (FCRPS).

Besides the agencies that comprise the FCRPS, other federal agencies have management responsibilities over the river. The Federal Energy Regulatory Commission issues licenses under which

[7]Work began on the dams before the general welfare clause was recognized. In fact the legislation supporting these New Deal projects was declared unconstitutional. Work continued under other authority.

Figure 2. An Overview of Management and Control of the Columbia River System.



non-Federal agencies can build and operate hydropower dams. FERC must also approve BPA electricity rates. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service have responsibility for fishery regulation, research, and development. The Bureau of Land Management, U.S. Forest Service, and National Park Service manage federal lands in the Columbia basin watershed. The Soil Conservation Service is concerned with soil erosion and water quality and also with some irrigation projects.

Besides creating and supervising agencies that participate in Columbia River management, Congress makes laws that directly regulate how the river is to be managed and used. Some of these laws are concerned with the environment. Several acts affect the Columbia River's anadromous fish.[8] Some provide funding for hatcheries and other enhancement projects; others specify how the fish should be managed. More general environmental legislation includes the Wild and Scenic Rivers Act, the National Environmental Policy Act (NEPA), and the Endangered Species Act. NEPA requires Environmental Impact Statements (EIS) before federal money can be used on any project or program that would have a major impact on the environment. The Wild and Scenic Rivers Act has made certain streams "off limits" for hydropower development. Finally, if the Endangered Species Act were invoked to protect salmon and steelhead, possible ramifications could include suspension of harvests and drastic revisions in hydropower operations.

The most recent federal legislation has been the 1980 Pacific Northwest Electric Power Planning and Conservation Act (Power Planning Act). This act gave the BPA more authority to buy power but also created an interstate Power Planning Council responsible for creating power, fish, and wildlife plans that BPA must follow unless exempted by Congress. The Power Planning Act will be discussed further in later sections.

Indian Treaty Rights

Native Americans have significant water and fishing rights. These rights derive from two sources: explicit treaty provisions protecting fishing rights and from the federal reserved water rights doctrine mentioned earlier. In the Pacific Northwest, treaty fishing rights have been especially important. Early treaties explicitly reserved the right to fish when the tribes ceded their lands to the U.S. government. Judges have ruled that these treaties entitle Indians to: 1) fish on accustomed sites regardless of land ownership; 2) a share of up to one-half of the harvestable Columbia River fishery; and 3) some protection of the fish habitat in order to maintain a fishery.[9]

In the past, Indian rights had little effect on Columbia River management. They have had more influence on fishery management (propagation, harvesting) than on questions of water management (dam construction or reservoir operations). Recent developments, especially the Phase II decision, suggest possible increases in the influence of Indian fishery rights. For example, the fish water budget discussed later probably owes some of its force to the underlying Indian rights as well as to provisions of the Power Planning Act. Still, Indian rights are in a state of flux, and their full impact awaits additional negotiation, implementation, and probably further testing in the courts.

State Water Rights and Other State Laws

Except where federal law supercedes them, state laws govern how water can be used. State water law is especially important for irrigation. Each state has a distinct body of law, but water laws in the Pacific Northwest are similar. Basic water law is constructed around the *appropriation doctrine*. This principle gives rights to the first party to divert water and put it to *beneficial use*. The first or senior appropriator is guaranteed his full allotment before junior appropriators can use any: "first in time – first in right." Rights are lost if not exercised or if not put to beneficial use. Historically, water rights were rarely attached to instream uses such as power or fishing.[10]

Each state has developed its own water code. State water laws require a water user to apply for a license

[8]Pacific Northwest Electric Power Planning and Conservation Act of 1980, Fish and Wildlife Coordination Act of 1934 (as amended), the Magnuson Fishery Conservation and Management Act (1976), the Mitchell Act (1938), and the Salmon and Steelhead Conservation and Enhancement Act of 1980.

[9]These decisions are popularly known as Winans (U.S. v. Winans, 198 U.S. 371 [1905]), Boldt (or Phase I) and Orrick (or Phase II). The later two are called Phase I and II because they are two parts of the same case: U.S. v. Washington, 384 F. Supp. 312 (W.D. Wash. 1974) and U.S. v. Washington, 506 F. Supp. 187 (W.D. Wash. 1980). Phase I has been affirmed by the U.S. Supreme Court in Washington v. Passenger Fishing Vessel Ass'n., 443 U.S. 658 (1979).

[10]A major exception is rights given to Idaho Power Company at Swan Falls, a source of recent controversy.

TABLE 1. SOME MAJOR STATE AGENCIES WITH WATER RELATED RESPONSIBILITIES

Agency	Major Water Related Responsibilities
Idaho Public Utilities Commission	Regulate investor-owned utilities.
Idaho Department of Fish and Game	Manage, research, and regulate fisheries.
Idaho Department of Water Resources	Administer state water laws.
Montana Public Services Commission	Regulate investor-owned utilities.
Montana Environmental Quality Control	Policy, research.
Montana Department of Fish, Wildlife, and Parks	Manage, research, and regulate fisheries.
Montana Department of Natural Resources and Conservation	Administer state water laws. Manage, research, and license energy and natural resources.
Oregon Public Utilities Commission	Regulate investor-owned utilities.
Oregon Department of Energy	Research, forecast, license.
Oregon Department of Environmental Quality	Research, policy, regulation concerning water quality.
Oregon Department of Fish and Wildlife	Manage, research, and regulate fisheries.
Oregon Department of Water Resources	Administer state water laws.
Washington State Energy Office	Research, policy planning.
Washington State Energy Facility Site Evaluation Committee	License energy projects.
Washington Department of Game	Manage, research, and regulate sports fisheries.
Washington Department of Fisheries	Manage, research, and regulate commercial fisheries.
Washington Department of Ecology	Administer state water laws.

Source: Compiled by author.

from a state agency. The agency then decides if the proposed use is beneficial and if the quantity of water requested is justified. States may attach conditions to water licenses. They may also set aside water for public uses. Although instream uses generally are not granted to individuals, states are beginning to provide protection in the form of minimum flows (Washington's Columbia River Instream Resources Protection Program, for example).

Besides creating basic water law, states create the laws and regulations governing local water and utility districts. State law governs the purpose, formation, and practices of irrigation districts and public utility districts, for example. States also regulate fishing, hunting, and recreation and state agencies manage lands for these purposes. Table 1 shows some major state agencies and their areas of responsibility.

Once the basic rules have been established, middle-level policy decisions must be made to guide day-to-day operations.

Policy and the Federal Government

The federal government affects Columbia River policy through three important avenues: 1) presidential policy; 2) the congressional authorization process; and 3) the appropriation-budget process. Federal agencies are ultimately responsible to the president. Each new president may have a different approach to similar problems. For example, under Roosevelt's New Deal, federal agencies (the Corps and USBR) were the main water project developers. In contrast, under Eisenhower's "Partnership" policy the Mid-Columbia dams and some Snake River dams were built by non-federal organizations (public utilities and private industry, respectively).

The second influence is the congressional authorization process. Each major new Corps or USBR project must go through a series of steps involving various studies and hearings. Ultimately Congress must pass a law explicitly authorizing the Corps or Bureau to construct the project. But authorization is not enough. The sponsoring agency must then go through a third process in order to have money appropriated.[11] Many more projects are authorized than are built. For example, the Columbia Basin Project has been authorized to irrigate over one million acres, but money has been appropriated for construction to service only about one-half that acreage.

The politics of authorization and appropriation involve what political scientists call the iron or power triangle. This consists of: 1) the interest group advocating a project; 2) a congressional subcommittee specializing in the area; and 3) the relevant federal agency. A functioning iron triangle may often make policy without regard to other interests, agencies, or even the President.

These processes are common to all issues in which the federal government is involved. Specific policy decisions concerning the Columbia tend to be made within several water use clusters.

[11]Since 1974 the BPA has been exempt from the appropriation process. It finances operations and construction projects from its own budget. However, BPA is still subject to congressional oversight. It must submit its budget to Congress, and it must get approval for certain major expenditures. Since 1980 it is further subject to the provisions of the Power Planning Act.

Irrigators are the major consumptive users of the Columbia River. Given the large streamflow, industrial and municipal water supplies account for relatively little of the water that is diverted and consumed. Power and fish are the most significant instream users. Therefore, focus on irrigation, power, and fish tells much of the story.

Irrigation Policy

Irrigation policy centers around new irrigation development and expansion of old projects.[12] Figure 3 shows primary areas of potential expansion. Two major issues are access to water and access to finance. The mainstem Columbia River flow is so huge that physical lack of water is not generally a constraint. Furthermore, under state water laws consumptive users may generally appropriate water with little regard to instream uses such as fish and hydropower.[13] Therefore legal access to water is not usually an issue to irrigators using mainstream sources.

In contrast, irrigation expansion faces major obstacles on some of the tributaries, notably the Yakima and the Snake. On the Yakima, conflicts with Indian fishing rights are significant. On the Snake, the conflict is with hydropower. When water is diverted for irrigation it is lost to hydropower. Even water which finds its way back into the river at downstream points (return flows) has skipped dams and hence failed to generate the power it might have. In Idaho this conflict has been focused around the Idaho Power Company's rights to water at Swan Falls. These hydropower rights even put some present irrigators in danger of losing their water rights. The conflict caused by increasing demands on the water not only pits irrigation against hydropower and fishing interests, but also pits old irrigators against new.

Since irrigators have historically had ready access to water, the major problem has been financing. Most large irrigation projects involve federal financing as well as construction. Traditionally irrigators have

[12]Another set of policy issues concerns the financing of old projects, the price of water, and size restrictions on farms.

[13]For example, the water needed to complete the Columbia Basin project was set aside in 1938 under state water law (R.C.W. 90.40). Whereas new water applications will be subject to restrictions to protect instream uses (Washington's Columbia River Instream Resources Protection Program), Columbia Basin project water is protected by its 1938 application date.

Figure 3. Columbia River Basin Primary Areas of Future Irrigation Development.

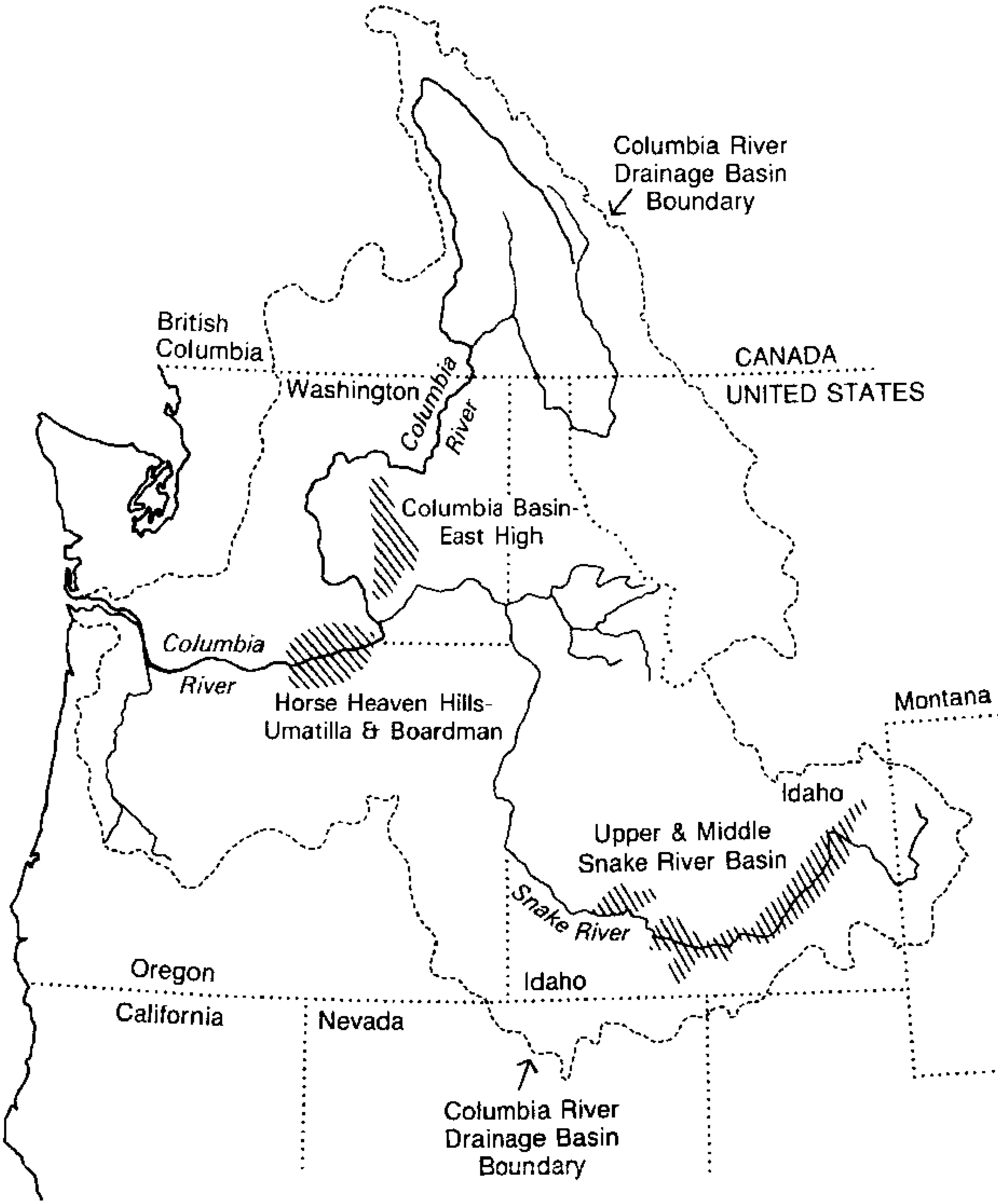
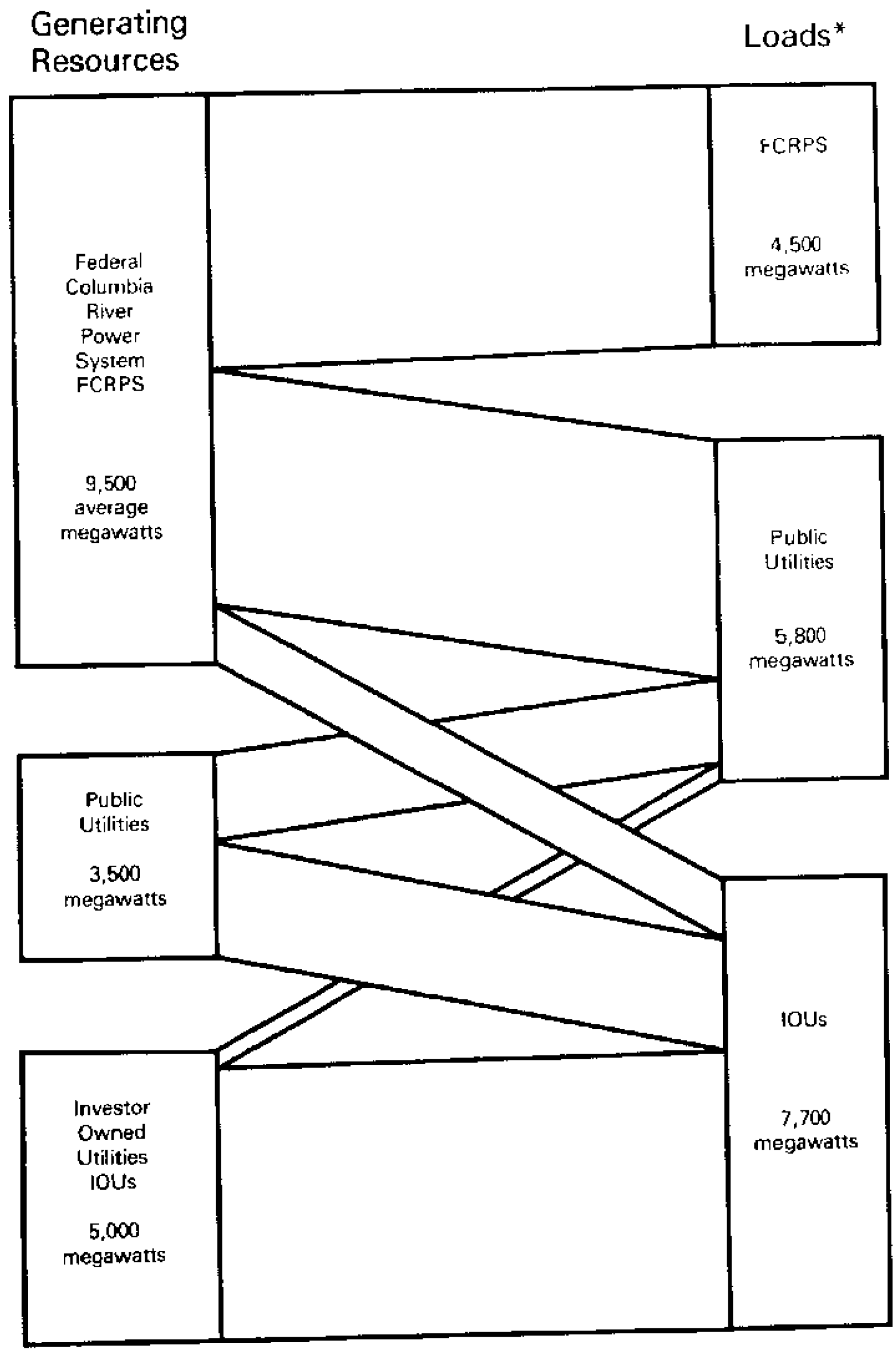


Figure 4. Approximate Generation and Loads, Pacific Northwest Utilities.



*includes losses and exports to Pacific Southwest.

Source: PNWCC *Long Range Forecast* (1982), NWPP Operations Review for 81-82 (1983), BPA Annual Report (1982), and author's interpolations.

been subsidized in order to promote economic expansion.[14] The result is a demand for federal projects far in excess of the available budget. Irrigation policy thus often becomes a matter of the politics of the federal appropriation process described earlier. Where irrigation is privately developed, state policy and the economic feasibility of pumping are more important.

Energy Policy

The energy industry in the Pacific Northwest is a complex web with three major types of power suppliers: the Federal Columbia River Power System (BPA, Corps, and USBR), the investor-owned utilties (IOUs), and the public utilities (municipals, cooperatives, and public utility districts – PUDs).[15] Figure 4 shows the web of electricity generation and distribution. All systems are tied together by the BPA's high-voltage transmission grid which distributes federal power and *wheels* (transmits) power for other utilities.

Until the recent passage of the Power Planning Act, planning and policy were made by the cluster of utilities (including the federal system) with some oversight by Congress and the states. BPA has always been a principle actor. The Pacific Northwest Utilities Conference Committee (PNUCC) served as the major arena for debate. In particular, PNUCC played an important part in policy about future power needs and the resources to meet rising demand. PNUCC's major function was to develop forecasts of expected energy demand on a 10- and 20-year base. For years, PNUCC's forecasts were de facto official regional forecasts. Under terms of the Power Planning Act, the Power Planning Council will now be developing forecasts.[16]

Once demand is predicted, the next step is to prepare to meet the demand. Before the Power Planning Act, no one utility or group was responsible for meeting the projected need. In the late 60s and early 70s, BPA assisted in the formation of a group of utilities called the Joint Power Planning Council (JPPC). The JPPC identified the plants needed to meet future needs. The Joint Power Planning Council plan was called the Hydro-Thermal Power Plan (HTPP). The HTPP was energy policy for the Pacific Northwest between about 1968 and 1973. Table 2 shows the seven HTPP projects and other Northwest thermal projects. It involved construction of a number of large thermal power plants with the BPA to help with financing and transmission. Originally 20 plants were planned. The HTPP fell apart because: 1) rising energy costs lowered growth in demand and therefore need for some of the projects; and 2) an Internal Revenue Service ruling inhibited BPA's ability to finance projects. The final blow to the HTPP came as a result of lawsuits against BPA. BPA was enjoined from participating in the HTPP until it completed Environmental Impact Statements about its role in the program.

The Northwest Power Planning Act was initiated to rectify the problems resulting when the HTPP fell apart. The utilities (and BPA) sought legislation which would enable the region to meet what was then perceived to be continuing growth in load and possible future energy shortages. Among the major issues which the industry wanted to address were: 1) some federal (BPA) role in financing very expensive new thermal projects; 2) sharing of cheap federal power to which public utilities had been given preference; and 3) assurance that Bonneville's Direct Service Industry (DSI) customers would have a continuing source of energy. In the debate over the legislation, concerns over public accountability, energy conservation, and especially fish and wildlife impacts emerged. The act which eventually passed addresses all these concerns. It is something of a constitution for Pacific Northwest energy planning and Columbia River fish and wildlife policy. Major provisions of the act:

1. Establish a regional Power Planning Council comprising two representatives from each of four states (Idaho, Montana, Oregon, Washington). The Council is a unique institution in American government since it is an interstate organization but it has responsibilities regarding federal agencies. The Council is responsible for creating a regional Energy and Conservation Plan which includes a Fish and Wildlife Program. The energy plan must give preference to conservation and renewable resources.

2. Give BPA the responsibility for meeting the load of any regional utility which requests power. BPA is also

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[14]Irrigators pay no interest for their portion of the capital costs of federal water projects. Furthermore, power revenues pay most of the capital costs.

[15]Excellent descriptions of energy policy in the Pacific Northwest can be found in Lee et al. (1980) and Norwood (1981).

[16]Other utility and independent researchers have been making energy forecasts recently. See, for example, Berney et al. (1982). BPA also intends to make formal annual forecasts from now on. Meanwhile PNUCC will resumably continue to make its forecasts. We will, therefore, have three regional forecasts.

TABLE 2. MAJOR NORTHWEST THERMAL POWER PLANTS.[1]

Plant[2]	Location	Fuel	Principal Sponsors[3]	Total Capacity (Megawatts)[4]	Status
Hanford	WA	Nuclear	WPPSS	860	Existing
Centralia I & II*	WA	Coal	PP&L, WWP	1,400	Existing
Jim Bridger*	WY	Coal	PP&L, IPCo	2,000	Existing
Colstrip I & II	MT	Coal	TMPCo, PSP&L	660	Existing
Trojan*	OR	Nuclear	PGE	1,130	Existing
Boardman*	OR	Coal	PGE	530	Existing
WNP 2*	WA	Nuclear	WPPSS	1,100	Existing
WNP 1*	WA	Nuclear	WPPSS	1,250	Postponed
WNP 3*	WA	Nuclear	WPPSS	1,240	Postponed
WNP 4	WA	Nuclear	WPPSS	1,250	Terminated
WNP 5	WA	Nuclear	WPPSS	1,240	Terminated
Colstrip III & IV	MT	Coal	TMPCo, PSP&L	1,400	Under Construction

[1]Source: BPA Final Role E:S (1980), modified by author.
[2]Plants marked with an asterisk (*) were part of Phase I of the Hydro-Thermal Power Program.
[3] IPCo = Idaho Power Company
PGE = Portland General Electric Company
PP&L = Pacific Power & Light Company
PSP&L = Puget Sound Power & Light Company
TMPCo = The Montana Power Company
WPPSS = Washington Public Power Supply System
WWP = Washington Water Power
[4]Actual average energy produced will be less because some capacity is for loads outside the region, and plants must be shut down for periodic maintenance.

given authority to "acquire resources" to meet those loads. BPA still may not actually own or build plants, but it may acquire the output of the plants on long-term contracts which give BPA the right to schedule the output. This expands BPA's potential role as the regional electricity wholesaler.

3. Require BPA's power acquisitions conform to the Power Planning Council's energy, fish, and wildlife plans, except in certain carefully defined circumstances. The relationship between the Council and BPA (also the Corps and other federal agencies) is complicated, however. The Council may not directly order BPA to do things. BPA implements the plan according to its interpretation; however BPA must submit major purchases to the Council. BPA and the Council must also follow procedures that encourage public participation.

4. Guarantee public utilities continued first call on cheap federal hydropower. However, domestic and rural consumers of investor owned utilities also may get this cheap power through a complicated energy swapping arrangement. Rates to traditional preference customers are not supposed to increase by more than they would have without the legislation.

5. Guarantee the Direct Service Industries (DSIs) continued access to federal power. However, rates will increase and no new DSIs beyond the existing (or already promised) ones are allowed.

As it turned out, the Pacific Northwest currently has an energy surplus, not the shortage contemplated in the Power Planning Act. The region has, therefore, had to face issues which were not addressed in the Act such as the termination of WPPSS

(Washington Public Power Supply System) power plants and the ensuing financial mess. The Act has, however, helped defuse some energy issues (such as access of IOU domestic and rural customers to federal power). Another major accomplishment is that it establishes a regional decision-making and planning system for energy and fish and wildlife. An example of the impact is the water budget for fish which will be discussed later.

Fishery Policy

Until recently fishery policy had little impact on river management. Fishery policy was mainly concerned with harvest in the ocean and river and propagation at hatchery and natural sites. While fishery interests were very concerned about how water management affected upstream and downstream migration and spawning habitats, their influence was largely restricted to passage problems at dams, and even here their influence was moderate. Fed by heightened environmental sensitivities and by Indian fishing rights decisions in the courts, fishery use has recently attained more recognition.

Among major concerns of fishery interests has been the downstream passage of juvenile salmon (*smolts*). Smolt migration is affected by mortality at dams either from going through the turbines or over the spillways. Smolt migration is also impaired by the long period it now takes to get through the slow-moving pools behind the dams. Early attempts to ameliorate this problem included spilling water at dams (which is usually less harmful than passage through turbines) and transportation by barge or truck for release below Bonneville (which helps both dam passage and migration time). The drought of 1973 dramatized the serious impact of slow migration on smolt passage. By 1975, plans began for added water flow during the spring migration period. The Power Planning Council's Fish and Wildlife Program establishes a fish "water budget" which formally incorporates this waterflow into streamflow management.

COLUMBIA RIVER OPERATIONS

Operational decisions in managing the Columbia River are made in three stages: 1) decisions to divert water for irrigation and other consumptive uses; 2) setting reservoir and river flow limits; and 3) management for hydropower (see Figure 5).

Consumptive (Out of Stream) Uses

In principle anyone with a valid water right simply withdraws the quantity of water needed for irrigation or other consumptive use. On tributaries with high demand for water, such as the Yakima, some process of apportionment between users may be needed. In practice, users must also have the physical means (wells, pumps, canals) and the financial capacity to take the water.

Surface water is often taken through large scale projects such as the Columbia Basin Project. These projects require complicated administrative and logistical apparatus. For example, operation of the Columbia Basin Project involves coordinating the water requests of individual users with the distribution system managed by three irrigation districts and the main canals and reservoirs operated by the Bureau of Reclamation or in common. Once the water season starts, orders for water are taken each day and the appropriate amount of water is released in the main canals and distributed to users by ditch-riders and water masters of the irrigation districts.

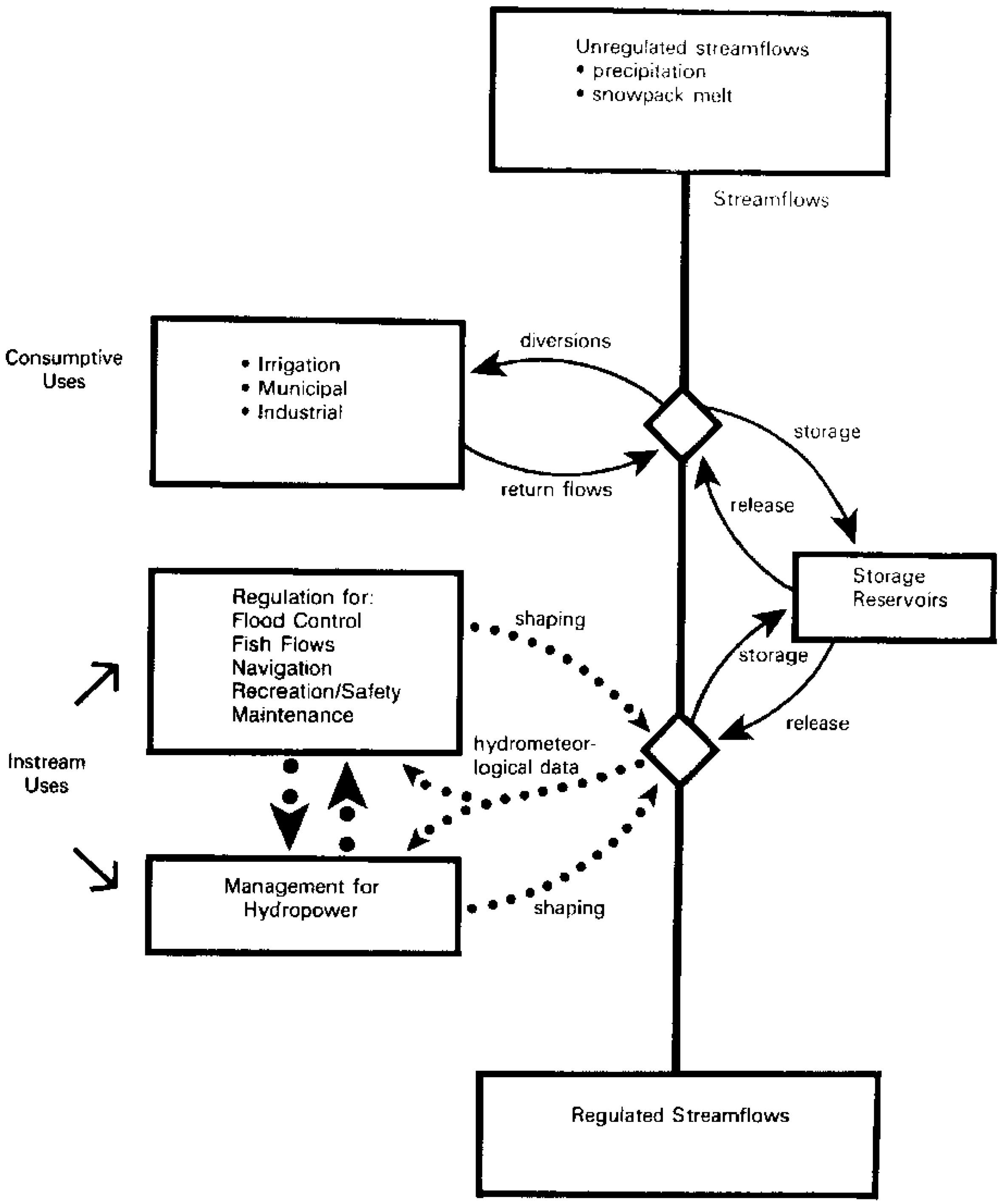
Although large-scale projects like the Columbia Basin Project are very important, especially in Washington, most land in the Pacific Northwest is irrigated in smaller developments by single farmers or small groups. Much of this acreage is watered from wells. Well water is withdrawn by the irrigator according to individual calculations of cost and benefits, under the supervision of state water administration.

Table 3 shows the extent of irrigation in the three Pacific Northwest states.

Reservoir and River Flow Limits

The Corps of Engineers is the focus for the next stage, that of setting limits on reservoir levels and streamflows. Each project owner (including the USBR, PUDs, and some IOUs) manages its own reservoir, but the Corps has supervisory power in the realm of flood control and navigation. It also owns many of the major river projects (see appendix). The Corps manages reservoirs by setting limits on how BPA or other power operators may use reservoirs

Figure 5. Schematic Diagram of Columbia River Streamflow Management.



Source: Constructed by author.

TABLE 3. IRRIGATED ACRES IN THREE NORTHWEST STATES, 1980, AND POTENTIAL ADDITIONAL DEVELOPMENT, 2000, IN THOUSANDS OF ACRES.

	Ground[1]	Surface[1]	Combination[1]	Total[1]	USBR Served[2]	Potential Additional[3]
Washington	428.0	1519.2	4.4	1951.6	1051.0	958.0
Oregon	330.6	1982.3	25.0	2337.9	524.9	335.0
Idaho	1233.7	2633.5	182.7	4049.9	1693.5	920.0
NW Total	1992.3	6135.0	212.1	8339.4	3269.4	2213.0

[1]Irrigated Lands in the Pacific Northwest, 1980. Prepared by the Land Resource Committee of the PNRBC for the Depletions Task Force of the Columbia River Water Management Group, 1981.
[2]United States Bureau of Reclamation, *1980 Annual Report.*
[3]Whittlesey, N.K., et al. *Energy Tradeoffs and Economic Feasibility of Irrigation Development in the Pacific Northwest, 1981.* Bulletin 0896, Agricultural Research Center, WSU.

and streamflows for generation.[17] These include project operating limits listed in manuals whose writing begins with the design of the project. Adjustments in the form of "hard" and "soft" constraints are made by the Corps' Operations Center (Reservoir Control Center in Portland) and transmitted to the BPA's Operations Center (Dittmer Control Center in Vancouver, Washington).

The major concern of the Corps is flood control. Of all the water uses, flood control has the highest priority. Usually, however, operations for flood control are consistent with other uses, notably power. Flood control regulations or "rule curves" are generated by computer models based on past experience and revised according to current weather and water runoff projections. A flood control rule curve indicates what elevation a reservoir must have to leave room for incoming floodwaters.

Management for Hydropower

The final stage of Columbia River operations is hydropower production. Control for hydropower is administratively complex because of the large number of entities involved. It is also logistically complicated due to coordinating a large hydraulic system with the region's other power sources and matching both to energy demand. Due to the importance of hydropower, the next paragraphs describe hydropower management in some detail.

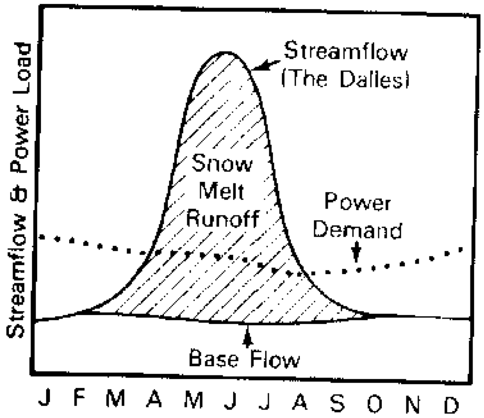
Physical aspects of hydropower management. While Columbia River hydropower provides three-quarters of the Pacific Northwest's electrical needs, the river flow is not naturally suited to this task. Adjustments must be made to match hydropower production with thermal production and energy demand. Two characteristics of the natural river system determine the adjustments which must be made.

First, the natural streamflow of Columbia River peaks in the spring when the snow melts. The highest demand for electricity occurs in the winter, however, when electricity is used for heating. To some extent winter loads can be met by increased thermal (nuclear and coal) production. However, it is not economic to build thermal plants which remain idle most of the year. Their large capital costs must be paid even during periods of inactivity. Water, in contrast, can be stored from the heavy spring runoff for use during the following winter's peak load period. This process of *shaping* the streamflow to energy demand is illustrated in Figure 6.

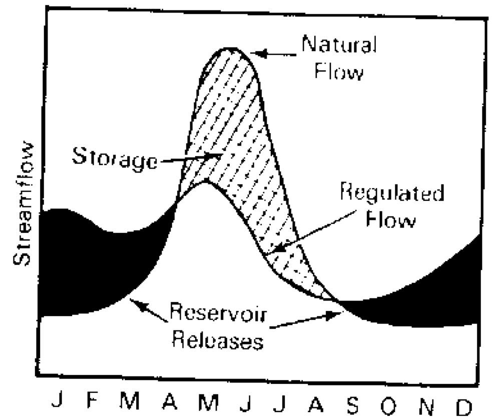
The second characteristic of the natural streamflow is its large year-to-year variation in volume. Adding to the problem is the difficulty of predicting, until well into the year, what the runoff for a particular year will be. This variation and unpredictability make the Columbia River an undependable source of power. Some river systems are able to greatly minimize uncertainty by storing large quantities of water from abundant years for use dur-

[17]BPA markets Corps and USBR generated power in the Pacific Northwest. Also BPA schedules power production for these plants based on memoranda of agreement and consultation with the other two federal agencies. Therefore, the Corps and USBR actually operate the reservoirs, but they follow BPA leadership for power production.

Figure 6. Natural and Regulated Streamflows.



Annual Natural Streamflow and Power Demand Patterns



Effect of Reservoir Regulation on Flows at The Dalles

Source: BPA, 1977

ing drought. Storage for the Columbia River, however, amounts to only some 40% of annual average streamflow in contrast to 386% for the Colorado or 310% for the Upper Missouri.[18] Therefore, other methods must be used to adapt to these yearly fluctuations.

The task of matching hydropower production to thermal production and energy demand, and of dealing with the two difficulties just described is undertaken in three steps: 1) annual (seasonal) operations planning; 2) intermediate/monthly operations planning; and 3) daily scheduling and dispatch. The major overall decisions are made during the annual planning process.

Annual planning shapes hydropower production to the seasonal pattern of electricity use and establishes a level of electricity which can be assured (dependable or *firm energy*). The key activity is formulation of a number of guides, called rule curves, by which storage reservoirs will be regulated.

To assure that the energy they are expecting the hydropower system to produce will be guaranteed, the energy planners explore the historical records to find how much water would be available during a "worst-case" drought. This worst-case scenario, together with whatever water would be available from storage, establishes a minimum level of water which will assuredly be available to produce electricity. The historical period of drought is called the *critical period*. The amount of energy which can be produced using these minimum streamflows and storage water is called dependable or firm energy. In normal years, streamflows will be higher, making possible production of *surplus* or secondary energy.

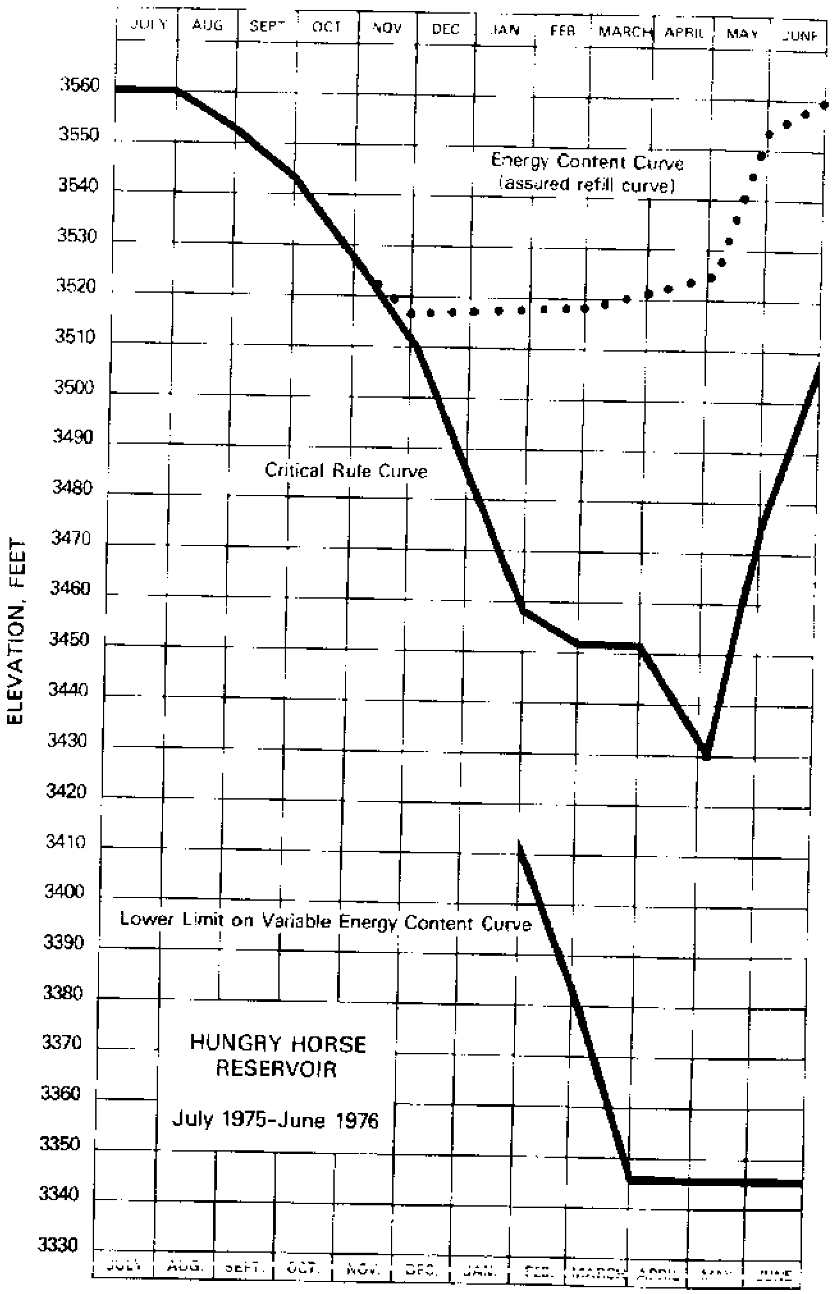
The *critical rule curve* describes, on a month-to-month basis, how reservoirs must be operated to use critical period (minimum) streamflows and storage to produce energy shaped to seasonal use. Critical rule curves are specified for each reservoir in terms of a monthly minimum elevation in feet. Figure 7 shows a critical rule curve for a reservoir. In effect, the critical rule curves ration water so that operators do not draft their reservoirs too deeply early in the year and then have too little left if critical (drought) conditions should occur later.[19]

Once critical rule curves are calculated to establish the amount of firm energy, another set of curves is calculated to guide overall energy production, firm and nonfirm. The premise of this phase of planning is to assure that reservoirs will be filled by the end of the year. (Critical rule curves would empty all reservoirs by the end of the critical period.) First an

[18]BPA, 1977.

[19]Critical rule curves are also specified for each utility and for the overall, coordinated Pacific Northwest system by converting feet to units of energy and adding up the energy available for each reservoir.

Figure 7:
CRITICAL RULE CURVE AND ENERGY CONTENT CURVE ELEVATIONS



Source: BPA Draft Role EIS (1977) Appendix A *assured refill curve* is calculated based on past records. The assured refill curve, if followed, will guarantee that the reservoir will be refilled 95% of the time. (The assured curve is sometimes also called the base *energy content curve*.)

Note in Figure 7 that the base energy content curve is even more conservative than the critical rule curve; it permits even less water to be drawn out of reservoirs. However, as the year progresses, information about snowpack, weather, and streamflow makes predictions about actual streamflows possible. In typical years, expected streamflows will be higher than drought conditions allowing reservoir operators to draft their reservoirs deeper than the assured refill curve or the critical rule curve and still guarantee that reservoirs will refill. Revised regulations based on such predictions are called variable refill or *variable energy content curves*.

This introduction to the language and concerns of energy planners simplifies and omits many details. Keep in mind that while the discussion has been largely in terms of one reservoir, in actuality engineers must devise an annual plan that coordinates all the reservoirs on the Columbia River. The task becomes very complicated indeed.

Other considerations such as flood control and the fish water budget must be factored into the hydropower rule curves. These concerns are superimposed on the hydropower regulations in the form of hard and soft constraints. For example, flood control rule curves require reservoir operators to reduce elevations to make room for possible spring floods. Flood control instructions take precedence. So an operator must evacuate the reservoir, if so directed, even if the dam must spill water instead of produce salable hydropower.

The fish water budget also takes precedence over energy requirements. The water budget requires energy operators to allow more spring runoff to pass through; that is, to store less water for the winter season. While these streamflows may often be used to produce hydropower, this output is at a period of low demand. It must be sold at low prices, while more expensive energy is bought in the winter to replace what might otherwise have been produced from stored water.

The various rule curves constitute the core of annual operations planning. As noted before, annual planning is done on a coordinated basis for the entire Pacific Northwest. Once annual planning is completed, operational activity returns to the individual utilities, including the BPA-managed Federal Columbia River Power System. The individual utilities then undertake intermediate planning and daily scheduling in accordance with the regional annual operations plan and various agreements. We now turn to a brief description of the institutions which facilitate the coordinated operation of the utilities.

Institutional aspects of hydropower management. Three agreements provide the basic institutional structure for coordinating the regional utilities. Figure 8 shows these agreements and the arrangements they establish.

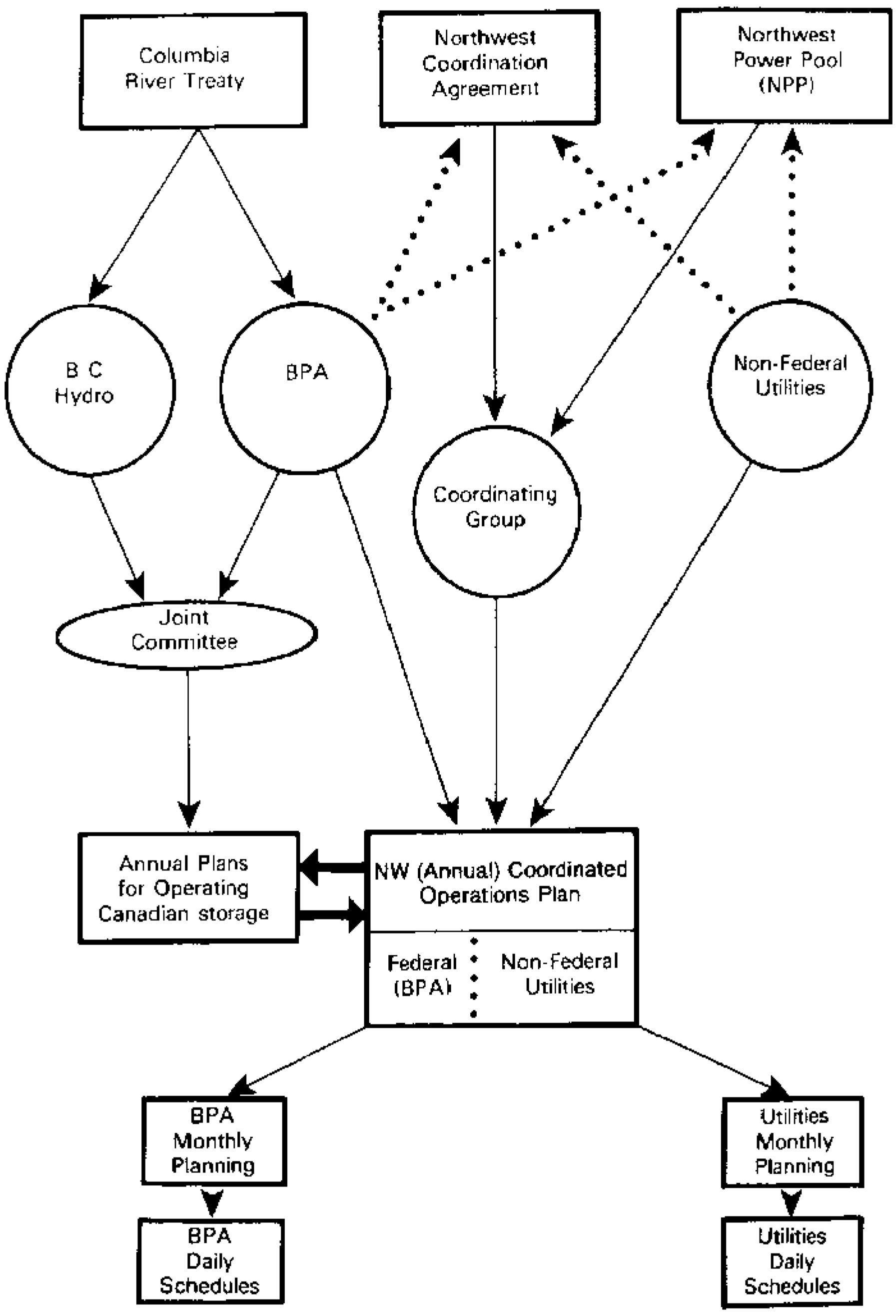
The Columbia River Treaty is an international treaty; it provides for the construction, financing, and operation of the three large storage reservoirs in Canada and one in the United States which extends into Canada (see Fig. 1 and appendix). These Canadian projects provide almost half the total storage on the Columbia.

The other two major agreements are the framework for coordinating operation of all the other dams and reservoirs. The Northwest Coordination Agreement is a formal contract which binds its members to certain procedures, including some described previously. The Northwest Power Pool (NPP) is a voluntary association which also establishes a set of agreed-upon procedures.

The annual planning process described earlier is orchestrated by the Coordinating Group, engineers working for the Northwest Power Pool. These engineers coordinate regional annual operations for the Northwest Power Pool and the Coordination Agreement simultaneously. Their planning is based on data provided by the individual utilities. The process itself involves a series of steps in which data and results are communicated back and forth between the Coordinating Group and individual utilities. BPA and British Columbia Hydro and Power Authority plan separately for the Canadian storage projects, but these plans are coordinated with and incorporated into the regional plan.

This framework allows the production facilities of all Pacific Northwest utilities (hydro and thermal) to be integrated as if there were one giant utility. At the same time the separate utilities maintain their individuality. Implementation is made possible by transfers of energy between utilities. This allows use of generating resources according to the most efficient regional plan, regardless of ownership. If utility A needs power but its reservoir is not scheduled for drawdown, it can get power elsewhere which it will return later.

Figure 8. Management Structure for Pacific Northwest Energy Operations Planning.



Source: Constructed by author. Dotted lines indicate membership.

SUMMARY

Columbia River management is a complicated system composed of many people and organizations involved at several levels. Fed by precipitation and snowpack melt, the streamflow is managed daily at the operational level to regulate storage and diversions for consumptive uses and instream uses. These day-to-day operations are guided by middle-level policy decisions focused around competing use areas such as navigation, irrigation, power, or fish. These policy decisions are made, by the respective jurisdictions and agencies, within a context of rules established at the law-making level.

The Northwest Power Planning Act calls for most competing uses to be taken into account. It also mandates broadened citizen participation in management decisions. Those immediately involved in the three levels of decision-making have access and knowledge which make their voices carry more weight than the average citizen. Ultimately, however, all residents of the Pacific Northwest have much at stake either as consumers of electricity or as users of other Columbia River resources – fish, irrigation, navigation, recreation, municipal and industrial water supply, or aesthetics. By outlining and explaining the three levels of decision-making, this publication has attempted to provide an introductory roadmap for more effective participation in management of the Columbia River.

APPENDIX

Acronyms Used

BPA – Bonneville Power Administration
CRIRPP – Columbia River Instream Protection Program (Washington)
DSI – Direct Service Industry
EIS – Environmental Impact Statement
FCRPS – Federal Columbia River Power System
FERC – Federal Energy Regulatory Commission
HTPP – Hydro-Thermal Power Program
IOU – Investor Owned Utility
JPPC – Joint Power Planning Council
NEPA – National Environmental Protection Act
NMFS – National Marine Fisheries Services
NPP – Northwest Power Pool
PNRBC – Pacific Northwest River Basins Commission (defunct)
PNUCC – Pacific Northwest Utilities Conference Committee
PUD – Public (Peoples) Utility District
USBR – United States Bureau of Reclamation

Glossary*

Anadromous Fish. Species of fish that reproduce in fresh water but mature in the ocean such as salmon and steelhead trout.

Appropriation Doctrine. The water rights principle that assigns rights to the first party to appropriate (divert) water and put it to beneficial use: "first in time, first in right."

Assured Refill Curve. In hydropower operational planning, the guideline which, if followed, assures that reservoirs will be refilled given a severe drought condition (energy content curve).

Beneficial Use. A principle that requires water be used in a socially approved manner or else be lost. Usually defined by state law.

Capacity. In power operations, the greatest load which a piece of equipment can safely serve.

Critical Period. Maximum firm energy-producing capability of the present system under "worst case" conditions using lowest historic streamflows and current storage capacity. The critical period most used in current planning reflects the 42½ months of lowest water conditions on record (August 16, 1928, through February 1932).

Critical Rule Curve. In hydropower operational planning, the guideline which, should the historically worst case (most severe drought) occur, rations drawdown of water so firm loads can be met throughout the period.

Energy. The ability to do work; the average power produced over time (average generation). Measured in kilowatt (megawatt) hours or average kilowatts (megawatts).

Energy Content Curve. In hydropower operational planning, the guideline which, if followed, assures that reservoirs will be refilled given a severe drought condition (assured refill curve).

Firm Energy. Energy intended to have assured availability to the customer. In hydropower, firm energy is calculated using the critical rule curves.

Load. The amount of electrical energy to be delivered at a given point.

Reserved Water Rights. Water rights set aside by the U.S. government to meet needs on lands the federal government reserves for public uses including Indian reservations.

Rule Curves. Graphic guides to the use of stored water which define the rights, limitations and obligations for the reservoir.

Shaping. Using storage to adjust the pattern of power production to the pattern of power load.

Smolts. Juvenile salmon and steelhead during their migration down river to the ocean.

Surplus Energy. Energy that does not have assured availability; it is available under non-drought conditions (non-firm energy, secondary energy).

Variable Energy Content Curve. In hydropower, the reservoir guideline which allows drawdown of the reservoir for energy production, provided a 95% probability of refilling the reservoir can be predicted in the last half of the water year (variable refill curve).

Wheeling. Use of transmission facilities of one utility to transmit the power of and for another system.

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*Source: BPA, 1977; Public Power Planning Council, 1981; Northwest Power Planning Council, *Fish and Wildlife Program*, 1983; and author.

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COLUMBIA-SNAKE RIVER SYSTEM MAJOR DAMS AND RESERVOIRS

Project	Stream	Owner/ Sponsor[1]	Storage Capacity (sfd.)[2]	Plant Capacity Maximum (MW)	Authorized Purpose[3]
1. Bonneville	Columbia	CE	71,500	960	P,R,N
2. The Dalles	Columbia	CE	26,470	2,047	P,R,N
3. John Day	Columbia	CE	269,700	2,484	P,R,N,F,PS,I
4. McNary	Columbia	CE	93,300	1,127	P,R,N
5. Priest Rapids	Columbia	Grant Co. PUD	22,400	912	P,R
6. Wanapum	Columbia	Grant Co. PUD	81,171	986*	P
7. Rock Island	Columbia	Chelan Co. PUD	5,547	681*	P
8. Rocky Reach	Columbia	Chelan Co. PUD	18,150	1290*	P,R
9. Wells	Columbia	Douglas Co. PUD	37,500	820	P
10. Chief Joseph	Columbia	CE	97,000	2,482	P,R
11. Grand Coulee	Columbia	USBR	2,638,000	6,525*	P,N,F,PS,I
12. Keenleyside (Arrow Lakes)	Columbia	BC Hydro	3,580,900		F,PS
13. Mica (Kinbasket Lake)	Columbia	BC Hydro	3,556,000	1,840	P,F,PS
14. Duncan	Duncan	BC Hydro	705,800		F,PS
15. Libby	Kootenai	CE	2,487,300	483	P,R,N,F,PS
16. Boundary	Pend Oreille	Seattle City Light	13,644	655	P,R
17. Albeni Falls	Pend Oreille	CE		49	P,R,N,F,PS
18. Cabinet Gorge	Clark Fork	WWP	21,560	230	P
19. Noxon Rapids	Clark Fork	WWP	116,300	554	P,PS
20. Kerr	Flathead	TMPCo.	614,700	180	P,PS
21. Hungry Horse	S. Fk. Flathead	USBR	1,515,000**	328	P,N,F,PS,I
22. Chandler	Yakima	USBR		12.9	P
23. Roza	Yakima	USBR		13.0	P,I
24. Ice Harbor	Lower Snake	CE	12,500	695	P,R,N
25. Lower Monumental	Lower Snake	CE	10,100	932	P,R,N,I
26. Little Goose	Lower Snake	CE	25,000	932	P,R,N
27. Lower Granite	Lower Snake	CE	26,700	932	P,R,N,F
28. Dworshak	N. Fk. Clearwater	CE	1,016,000	460	P,R,N,F,PS
29. Hells Canyon	Snake	IPCo	5,900	450	P
30. Oxbow	Snake	IPCo	2,500	220	P
31. Brownlee	Snake	IPCo	490,125	675	P,F,PS
32. Black Canyon	Payette	USBR	9,800	10	P,F,I
33. Boise Diversion	Boise	USBR			P,I
34. Anderson Ranch	Boise	USBR	213,300	34.5	P,F,PS,I
35. Minidoka	Snake	USBR	48,000	15.6	P,PS,I
36. Palisades	Snake	USBR	605,000	135	P,F,PS,I
37. Pelton	Deschutes	PGE	1,915	108	P
38. Round Butte	Deschutes	PGE	138,260	300	P,PS
39. Big Cliff	No. Santiam	CE	1,150	21	P,RR
40. Detroit	No. Santiam	CE	160,500	115	P,R,N,F,PS,I,W
41. Foster	So. Santiam	CE	14,150	23	P,F,I,RR
42. Green Peter	Mid Santiam	CE	156,300	92	P,R,N,F,PS,I
43. Cougar	McKenzie	CE	76,750	28.8	P,R,N,F,PS
44. Dexter	Willamette	CE	2,430	17.2	P,RR
45. Lookout Point	Willamette	CE	168,200	138	P,R,N,F,PS,I,W
46. Hills Creek	Willamette	CE	121,670	34.5	P,R,N,F,PS,I,W
47. Merwin	Lewis	PP & L	132,970	145	P,PS

COLUMBIA-SNAKE RIVER SYSTEM MAJOR DAMS AND RESERVOIRS—CONTINUED

Project	Stream	Owner Sponsor[1]	Storage Capacity (sfd.)[2]	Plant Capacity Maximum (MW)	Authorized Purpose[3]
48. Yale	Lewis	PP & L	95,600	132	P,PS
49. Swift #1	Lewis	PP & L	225,360	268	P,PS
50. Mayfield	Cowlitz	Tacoma City Light	10,778	384	P,RR
51. Mossyrock	Cowlitz	Tacoma City Light	704,089	133	P,F,PS
52. Swan Falls	Snake	IPCo	3,450	12	P
53. C.J. Strike	Snake	IPCo	20,000	89	P
54. Bliss	Snake	IPCo	1,200	80	P
55. Lower Salmon Falls	Snake	IPCo	2,800	70	P
56. Upper (A&B) Salmon Falls	Snake	IPCo	600	39	P
57. Shoshone Falls	Snake	IPCo	280	12.5	P
58. Twin Falls	Snake	IPCo	450	10.0	P
59. American Falls[4]	Snake	USBR	753,837	--	I,F,PS
		IPCo	--	92.3	P

SOURCE: Northwest Power Pool, *Operations Review for 1981-82*, Feb. 1983, Table F; and BPA, *Multipurpose Dams of the Pacific Northwest*, Sept. 1982

[1]CE—Corps of Engineers
IPCo—Idaho Power Company
PGE—Portland General Electric Company
PP&L—Puget Power & Light Company
TMPCo—The Montana Power Company
USBR—Bureau of Reclamation
WWP—Washington Water Power Company

[2]Sfd (second-foot-day)—Volume of water which passes a point in a day if the rate is one cubic foot per second (cfs). One acre foot = .50417 sfd.

[3]F—flood control
I—irrigation
N—navigation
P—power
PS—power storage
R—recreation
RR—reregulation for up-stream dam
W—water supply

[4]Idaho Power Company owns the generating plant located at the USBR's American Falls project.

*Pre-encroached: actual capacity reduced from that shown by loss of head due to encroachment of downstream pools or tailwaters of indicated projects.
**BPA uses storage capacity of 1,593,600 sfd in power studies.

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