PATTERNS OF WATER RESOURCE DECISION-MAKING: MINIMUM STREAM FLOWS IN THE WILLAMETTE BASIN

by

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PATTERNS OF WATER RESOURCE DECISION-MAKING: MINIMUM STREAM FLOWS IN THE WILLAMETTE BASIN

ABSTRACT: Oregon's minimum stream flow program is intended to protect certain instream flow values by maintaining sufficient stream flows to support aquatic life and to minimize pollution. The increasing demand for consumptive uses of water, as well as certain deficiencies in the laws, policies, and administration of the program, bring into question the ability to adequately protect instream flows and values. An analysis and evaluation of the minimum stream flow program in the Willamette Basin is used to illustrate some of the institutional characteristics and organizational relationships that influence the decision-making process and the allocation of public resources. Suggestions are made for areas of needed research, as well as for program improvements.

INTRODUCTION

A growing conflict in the State of Oregon, as well as in many other parts of the United States, concerns the allocation of surface water between diversionary and instream uses. The management of water resources in the western United States has traditionally emphasized the diversion and utilization of surface water to promote agricultural, industrial, and community growth. Such development has often reduced the quantity, and subsequently the quality, of the natural flows of streams. As the demand for diversionary and consumptive uses of water has increased, a greater concern has been

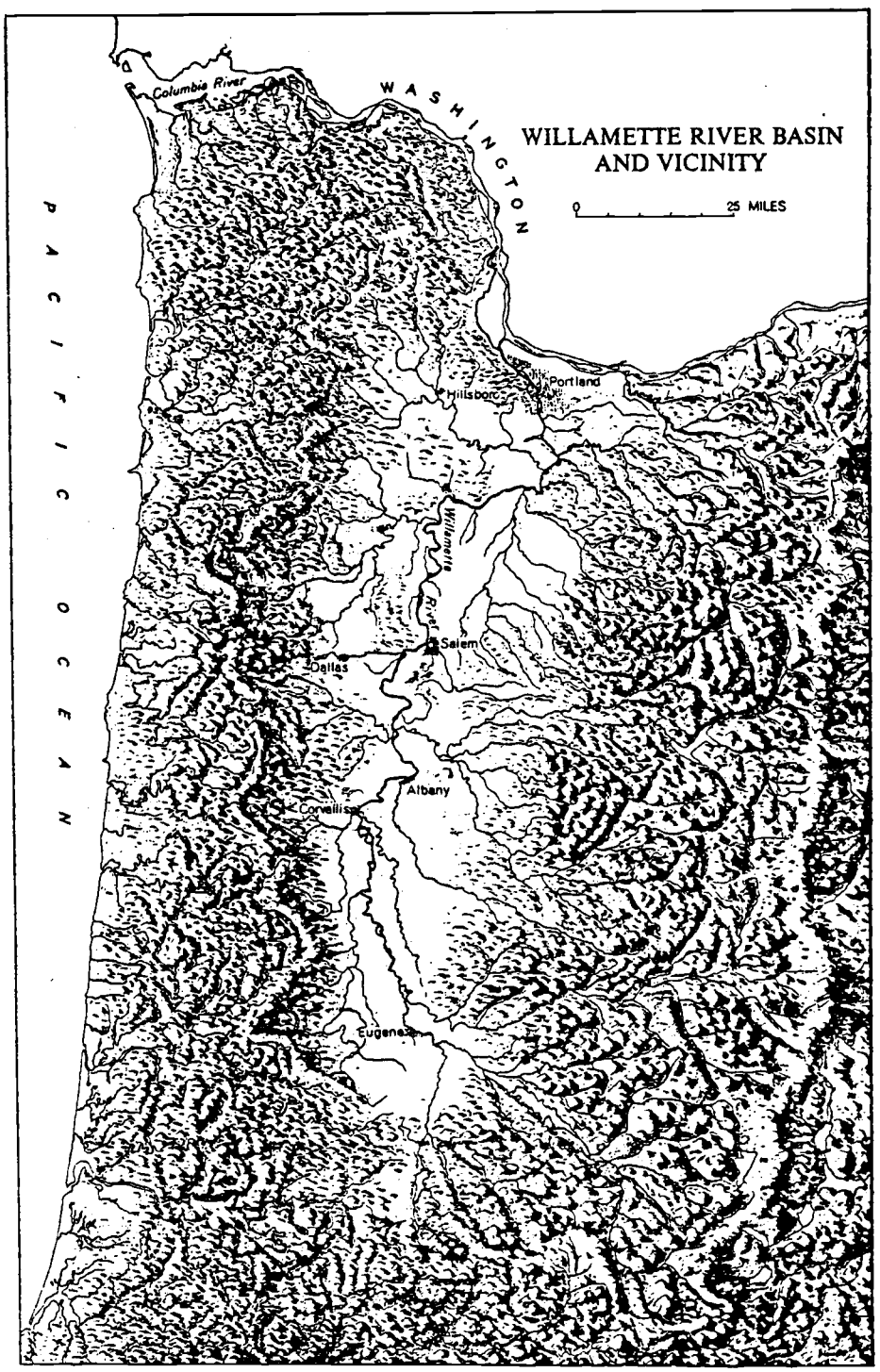
shown for instream flow values and uses. These include the maintenance or enhancement of aquatic and riparian ecosystems, fish and wildlife populations, recreation activities, waste assimilation or water quality, aesthetic values, as well as the traditional uses of navigation and hydroelectric generation. While there are multiple and competing values and interests involved in allocating water between instream and diversionary uses, the issue is made more complex by conflicts that may exist, even among instream uses. Certain hydroelectric power production operations may adversely affect anadromous fish life, alter recreation potential, or affect flows for navigation and water quality. In addition, the decision-making process for instream flow needs is complicated by the fact that the authority over allocation and regulation of the water resource is divided between state and federal agencies.

As social values regarding the use of water resources change, resource management institutions must be able to respond to various conflicting demands and hydrological interdependencies. Oregon was the first state to make a major effort to quantify instream flow requirements for streams using analytical evaluation procedures from a viewpoint other than reservoir releases (Milhous and Grenney, 1981, p. 132). While Oregon has been recognized nationally as a leader in the science of instream flow requirements, it has become apparent that there are several deficiencies in the policies and administration of the state's minimum stream flow program. Certain institutional actions or inaction by individual decision-makers seem to impede the establishment and enforcement of minimum stream flows

and make even the most sound water policies and programs ineffective. It is recognized that many variables (biological, hydrological, technological, economic, social, political, legal) condition the allocation of surface water among competing users. Institutional arrangements, however broadly defined, also represent an important variable requiring analysis in the context of water resources management.

The purpose of this paper is to analyze and evaluate the minimum stream flow program as it has been implemented in the Willamette Basin. As the state's largest, most complex, and most developed river system, the Willamette Basin (Figure 1) can be used to illustrate some of the factors that impede the implementation and maintenance of a successful minimum streamflow program. While it is hoped that such a study will clarify some of the strengths and weaknesses in the state-wide minimum stream flow program, it is also intended to briefly examine stream flow problems that are unique to the Willamette Basin. An early objective of this study was to map the patterns of minimum streamflow locations in the Willamette Basin: those points that were recommended, those that were implemented, and those points that were considered but rejected for one reason or another. Due to time constraints, it was not possible to determine precisely those minimum stream flow recommendations that were actively considered but rejected by the State Water Resources Board (predecessor of the Water Policy Review Board). However, the locations of all recommended minimum stream flows, as well as the location of those that have been approved and implemented, have been

Figure 1.


WILLAMETTE RIVER BASIN
AND VICINITY
0 25 MILES
Columbia River
WASHINGTON
PACIFIC OCEAN
Portland
Hillsboro
Willamette River
Salem
Dallas
Albany
Corvallis
Eugene

mapped; and possible explanations will be given for those patterns and spatial variations. It is hoped that such an analysis can be used to explain some of the characteristics of the policy and decision-making process, highlight the nature of some of the institutional and organizational relationships, and promote a better understanding of the allocation of public resources.

Decisions about the use of public resources are made within the framework of institution, and it is important to attempt to understand how institutional arrangements are formed and how they evolve in response to changing needs and demands for water. While the study of institutions is advocated as an approach to the explanation of geographical patterns (Flowerdew, 1982), it has been shown that for water resources management, the usages and meaning of "institutions" and "institutional factors," etc., are often unclear and uncertain (Wengert, 1973). In addition, there are many barriers to research on institutional arrangements that limit the ability to provide a satisfactory departure point for description, explanation, prediction, and prescription about the water management process (Mitchell, 1975). This paper in no way attempts to systematically analyze all the institutional factors that influence the decisions on minimum stream flows in the Willamette Basin. Such a study would have to assess the many interactions between legislation and regulations, administrative structures, economic and financial arrangements, political structures and processes, and historical and traditional customs and values (Mitchell, 1979, p. 282). Rather, the aim is to highlight the range of variables and interrelationships that influence

the decision-making process, as well as to emphasize that institutional arrangements are comprised of much more than just agencies or administrative units. Institutions have been broadly defined as, "a cluster of customs, laws, or ways of behaving and organizing behavior around problems of life in society" (Kaynor and Howards, 1971, p. 1118). Such a definition recognizes that there are significant social-psychological factors involved in the "institutional" influence on water resource decision-making. In the case of minimum stream flows for the Willamette Basin, geophysical constraints may initially dictate what alternative decisions are considered, and organizational or administrative characteristics can be examined to explain some of the decisions which have been made; but ideologies, attitudes, perceptions, motivations, and individual idiosyncracies may be the last factors that tip the scales one way or the other.

LEGAL AND ADMINISTRATIVE BACKGROUND

Although the riparian doctrine was an important part of Oregon water law in the early years of statehood, by the turn of the century, Oregon courts had given judicial recognition to the appropriative system of water rights (Hutchins, 1971, p. 218). As in much of the West, a valid appropriation required diversion and application of the water to a recognized beneficial use, on a relatively continuous basis through the years, and was not to interfere with the rights of prior appropriators. This system of temporal priority and beneficial use thus spawned the western water law cliches: "first in time, first in right," and "use it or lose it."

The prior appropriation doctrine, derived from the customs of mining camps and early irrigators, proved to be an effective technique for encouraging exploitation of the West's natural resources and consistent with the "open-the-West" ethic of the late nineteenth century. In some areas, it was believed that water should be utilized even to the point of completely drying up streams, otherwise it would be "wasted." While water supplies were generally adequate for the needs of early settlers in Oregon, as the population increased it became evident that a system had to be instituted in order to better determine water rights and to control the use of water resources under those rights. The 1909 Surface Water Code, passed by the legislature, regulated the use of the state's surface water and specified that, "all waters within the state from all sources of water supply belongs to the public" (ORS 537.110). Water flowing in the stream channel is thus considered a public resource; but when an amount of water is appropriated and diverted by an individual, this public resource becomes private property (albeit with usufructuary restrictions). A fundamental question is then raised concerning the appropriation system and instream flow values: Who benefits and who pays when public waters are diverted for private purposes?

In a general sense, the commitment to the appropriation doctrine and the system of private rights for water was an affirmation of a public policy favoring the market allocation of water resources (Huffman, 1980, p.3). Economic optimization is also frequently used as the criterion by which water uses are judged. However, several potential water services and uses are unlikely to be realized in a

system of exclusive market allocation. Due to interdependencies in the hydrological system and the failure of the market to meet the requirements of publicly desirable but non-vendible water services (primarily instream uses), government becomes more involved in water allocation.

Oregon's Response to Instream Flow Values

In the early 1950's, applications for water use permits were received by the State Engineer at double the rate prior to World War II; and permits had been issued for more water than minimum flows provided on most Oregon streams (Oregon State Water Resources Committee, 1955, p. III). The Legislative Assembly, in 1953, created a Water Resources Committee to conduct a study and to make recommendations that would lead to a coordinated system of water resources development. A major result of this study was the establishment of the State Water Resources Board in 1955, which was directed to develop beneficial water use programs for Oregon's eighteen major drainage basins. Oregon water law defines ten types of beneficial water use: domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, fish life, and pollution abatement (ORS 536.300). In addition, the law states that, "The maintenance of minimum perennial streamflows sufficient to support aquatic life and to minimize pollution shall be fostered and encouraged if existing rights and priorities under existing laws will permit" (ORS 536.310).

When the state establishes a minimum stream flow at a particular stream location, it is given a priority date and administered like a

water right. If the flow at that location drops below the designated minimum streamflow, an upstream appropriator with a water right junior to the date of establishment of the minimum streamflow is subject to a temporary curtailment of his or her water right. This enforcement is performed in the field by the state watermasters. A senior appropriator or a person who has a water right priority date issued before the establishment of the minimum stream flow may continue to divert water from that stream, even though the flow is less than the designated minimum flow. Since most minimum streamflows were adopted in the 1960' and early 1970's, appropriators with water rights issued before this time are not subject to any curtailment of their designated use. In addition, appropriations for domestic and livestock use are exempt from minimum flow provisions; and, in some basins, water for municipal use, storage, or irrigation of noncommercial gardens of one-half acre or less may also be exempt (Oregon Water Resources Department, 1980).

In an attempt to better coordinate Oregon's conflicting water policies, the legislature in 1975 established the Water Resources Department (WRD) by combining the State Water Resources Board and the State Engineer's Office. The WRD now consists of the Water Policy Review Board (WPRB), the Water Resources Director, and all the staff and assistants working under the Director. The WPRB, consisting of seven members appointed by the Governor, is charged with progressively formulating "an integrated, coordinated program for the use and control of all the water resources of this state" (ORS 536.300), and the Director is responsible to the WPRB for the

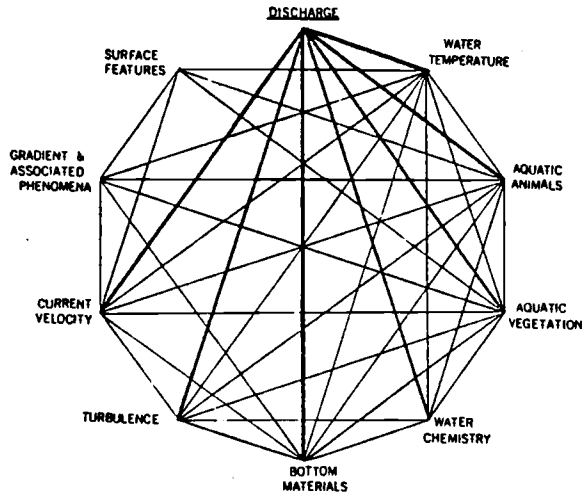
administration of such duties.

Like the State Water Resources Board before it, the WPRB develops and issues basin programs that act as guidelines for future use; and such program policies are binding on all other state agencies and public corporations (ORA 536.360). Three methods of the WPRB to implement its policies affect streamflows: 1) Withdrawing unappropriated waters from appropriation for all or any uses (ORS 536.410); 2) Classifying or reclassifying water sources as to their highest and best uses and future quantities of use (ORS 536.340); and 3) Setting minimum perennial streamflows sufficient to support aquatic life or minimize pollution (ORS 536.310). These three methods will be discussed in more detail in the context of the Willamette Basin, but it should be noted here that the WPRB's policies and orders can only affect unappropriated water. The WPRB has no power to modify, set aside, or change the priority on any existing water rights (ORS 536.320).

Minimum Stream Flow Recommendations

Although great strides are being made in understanding stream ecosystem dynamics (Cummins, 1974; Vannote et al., 1980; Minshall et al., 1983), the complexity of lotic, or flowing water, ecological systems makes it difficult to assess the impacts of stream flow changes on them. Figure 2 illustrates a few major interactions between stream flow, or discharge, and the aquatic environment. The Oregon Department of Fish and Wildlife (ODFW) is given the responsibility for recommending to the Water Policy Review Board adequate streamflows to support aquatic life. Oregon was one of

Figure 2. Stream Flow and the Aquatic Environment



Major interactions between stream discharge and the aquatic environment. Arrows have not been included since many of the relationships are two-way.

(Source: Giger, 1973, p. 8)

the first western states to study minimum stream flow requirements of salmonids, and the recommendations from ODFW are based on the biological needs of the various salmonid species present in the stream. Salmonid habitat is conditioned by factors such as the flow regime, channel structure and material, food web relationships, and water quality. Reduced stream flows reduce habitat by affecting food, space, and shelter, as well as increasing stream temperature and lowering dissolved oxygen levels.

The early minimum flow recommendations made by the Oregon Wildlife Commission were single-value minimum stream flows for the summer low-flow season. These were basically judgement decisions based on a general knowledge of the life history of fish species

and the suspected influence of various discharges on the different life stages (Giger, 1973, p. 88; Rousseau, 1976, p. 79). As a better understanding of the biological requirements was gained, the methods became more detailed; and efforts were made to determine specific streamflow requirements of fish life for each season of the year. While several habitat characteristics were assessed, stream depth and velocity became the principal criteria used to determine flows to meet the requirements for passage, spawning, incubation, and rearing (Oregon Department of Fish and Wildlife, n.d., p. 6). Statewide, minimum streamflow recommendations were made for more than 1,600 stream locations between 1961 and 1974, at a cost of well over $500,000 (Rousseau, 1976, p. 80). To date, only about 400 of these recommendations have been established in the water use programs (Sexson, 1982).

The quantities of water recommended as minimum stream flows by ODFW are not necessarily the flows adopted by the WPRB. The recommendations are tempered by data provided by WRD concerning the hydrologic character of the streams, as well as the remaining unappropriated water. In the early 1960's, minimum perennial stream flows established by the State Water Resources Board for unregulated streams were sometimes based on "the average of the three lowest flow months of the critical year of record adjusted to reflect water rights that have come into existence since that year," (Oregon State Water Resources Board, 1963, p. 9). A recent point of public concern has centered on the probability factor used by the WPRB for determining the availability of unappropriated water for minimum

stream flow use. That is, the unappropriated water had to be in the channel four out of five years, or 80% of the time, before the WPRB would consider it for minimum stream flows, as opposed to the requirement that it be there 50% of the time which, apparently, was used in some cases (Sexson, 1983). Recent state legislation, Senate Bill 226, would have required specification and adoption as a rule any hydrologic method that the WRD used in determining their minimum stream flow recommendations. The bill, which was supported by the ODFW, would have emphasized that the WRD/WPRB should use the biological criteria as a base, rather than an arbitrary hydrologic method that does not in all cases consider the fishery needs of particular streams (Rousseau, 1983). The bill was passed by the Senate, but died in committee in the House upon adjournment of the Legislative Assembly. However, the Water Policy Review Board is currently involved in adopting rules on this subject, as well as rules for the formulation, revision and modification of basin programs, and is holding public hearings concerning the drafting of these administrative rules. While cases can be made for the use of different probabilities, the 80% rule is the one likely to be adopted (Kline, 1983).

THE WILLAMETTE RIVER BASIN

The Willamette River Basin is the largest, most complex, and most developed river system within the state of Oregon. The basin covers only 12% of the state's area, yet contains almost 70% of Oregon's population (U.S. Bureau of Reclamation, 1975, p. 355).

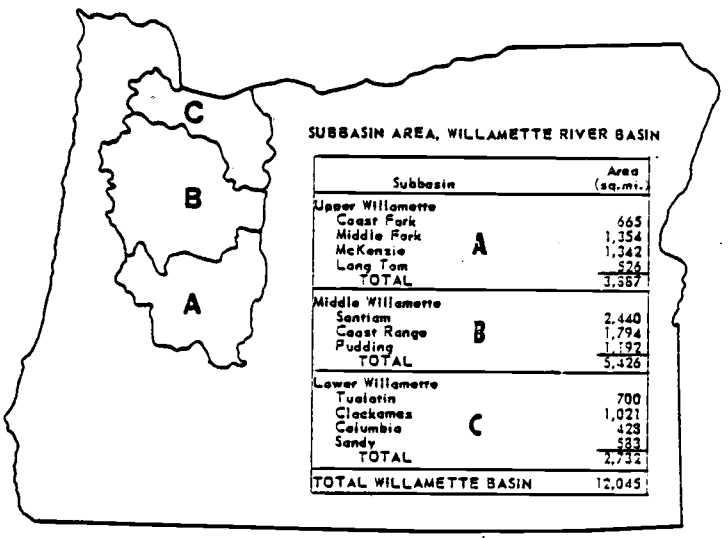
While it is relatively water-abundant compared to many parts of the state and nation, it is also characterized by rather extreme variability in streamflows, with very low flows occurring in the July-to-October period in some parts of the basin. Conflicts exist concerning seasonal water demands for power generation, irrigation, recreation, fishery requirements, and other uses; and water quality problems in the basin have largely been associated with low flows. Due to the blockage by dams of much of the Columbia Basin, the Willamette Basin becomes extremely important for maintenance of the anadromous fisheries. Yet, flow diversions for out-of-stream uses on over-appropriated reaches of water have reduced the number of streams once suitable for rearing of salmonids, while land use activities such as logging, road construction, agriculture, and urbanization have further reduced fish and wildlife habitat. Assuming that population growth and economic development will be increasing in this basin, conflicts over water resources will intensify. For these reasons, and other to be discussed, it is important to examine and understand the problems of implementing and maintaining minimum stream flows in the Willamette River Basin.

Setting

Three distinct physiographic units: the Willamette Valley, the Coast Range, and the Cascade Range make up the 12,045-square-mile Willamette River Basin. Eleven major subbasins are divided among the Upper, Middle, and Lower Willamette Basins for the purpose of basin water-use programs. The Upper Willamette includes the Coast Fork, Middle Fork, McKenzie, and Long Tom subbasins;

the Middle Willamette includes the Santiam, Coast Range, and Pudding subbasins; and the Lower Willamette contains the Tualatin, Clackamas, Columbia, and Sandy subbasins (Figure 3). Including the

Figure 3. Subbasin Areas.



(Source: State Water Resources Board, 1967)

Sandy River Basin, the 7.7 million acres drained by the Willamette includes nearly five million acres of forest land, about half in federal ownership and half privately owned (Oregon State Water Resources Board, 1967, p. 9). The valley, almost 150 miles long, has been a key factor in Oregon's growth and development, with the major population and industrial centers located along the river. The basin population increased 19% between 1976 and 1980, to total 1,707,000 people, and is projected to reach 2,140,900 by the year

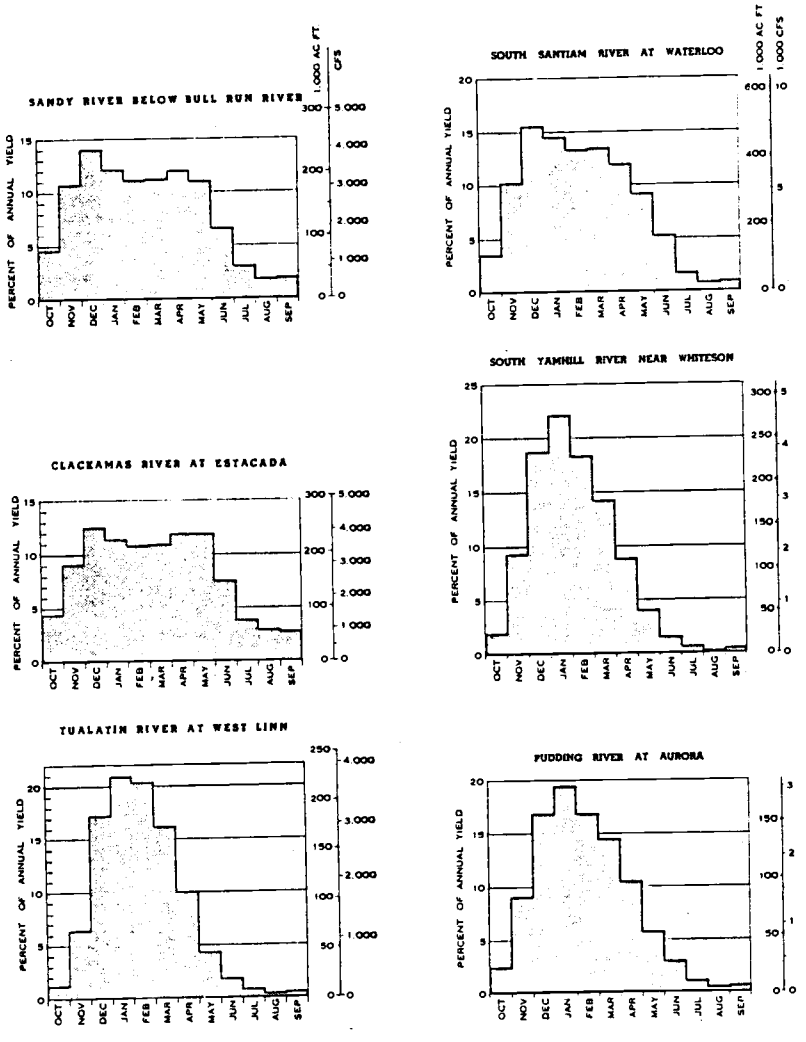
1990 and 2,513,000 by the year 2000 (Oregon Department of Environmental Quality, 1981, p. 39).

Water Supply Characteristics

While the Willamette Valley has been the most productive agricultural region in Oregon and many of the state's higher-valued crops are grown there, it has been noted that no other farming area in the country has a pattern of such wet winters associated with such dry summers (Highsmith, 1956, p. 101). The average annual stream discharge of about 27.4 million acre-feet from the Willamette and Sandy basins (State Water Resources Board, 1967, p. 24) reinforces the traditional conception of an overly-abundant water supply. However, conflicts arise in some subbasins since the highest demand for water coincides with the lowest streamflow levels between July 1 and September 30, when less than 5% of the annual water yield may occur (Figure 4).

Stream flow characteristics vary from the east side of the basin to the west. Streams originating in the Coast Range closely reflect rainfall patterns, with increased flows starting in October, peaking in January, and dropping rapidly and uniformly to reach a low flow in August. The lower reaches of these west-side streams are sluggish, with very low minimum discharges and high temperatures. Much of the area west of the Willamette River is underlain by fine-grained sedimentary rock and valley fill material that inhibits infiltration and groundwater movement so that little is released to streams as base flow. From the east, stream flows out of the Cascade Range have higher minimum discharges and a more uniform temperature and flow

Figure 4. Monthly Distribution of Annual Yield for Selected Stations.



(Source: Oregon State Water Resources Board, 1967, p. 26)

rate. This is due to augmentation from snowmelt, a high groundwater storage capability, and the porous, permeable nature of the underlying rock formations. Most of the fedreral reservoirs are located on these Cascade tributaries.

MINIMUM STREAM FLOWS IN THE WILLAMETTE BASIN

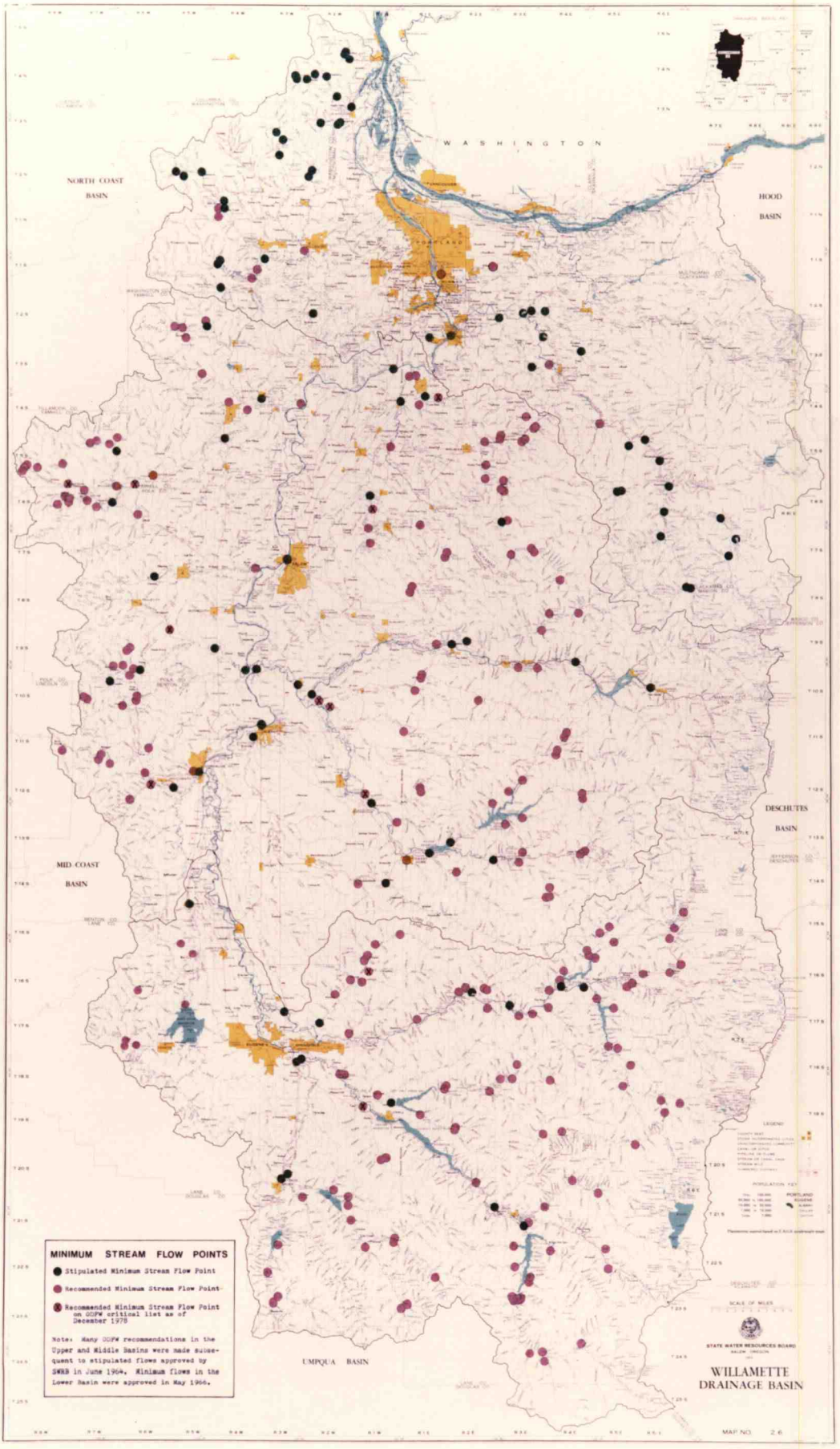
According to Doerksen et al. (1975, p. iii), instream flow methodology should be considered as a water resource allocation process. This would include: technological determinations of needs for the instream and out-of-stream uses, flow recommendations and decisions in the legal-political arena, establishment of flow levels under the law, and maintenance and monitoring of the reserved flows. It thus becomes important to analyze and evaluate agency authority and capability to effectively implement, monitor, and enforce any reserved stream flow levels. In the Willamette Basin, there are no less than twenty-two federal and state agencies with some concern over the water resources (Appendix D). In addition, city and county governments, water conservation and irrigation districts, fishing and recreation interests, environmental groups, and industrial users all have a stake in the decision-making process. Smith (1973, p. 128) identified seven different levels of input and jurisdiction that are pertinent for Willamette Basin water-resources planning: local community, supra-community, county, supra-county, state, supra-state, and federal. Also, since the Willamette is an important subbasin of the Columbia system, fishery management and hydroelectric power interdependencies raise remote but relevant

considerations. This complex interrelationship is obviously characterized by groups and agencies with different levels of influence, authority, intensity of interest, use orientations, and behavioral roles towards instream flows.

Spatial Pattern of Minimum Stream Flow Decisions

In order to illustrate the nature and extent of the minimum stream flow program in the Willamette Basin, the location of the recommended minimum stream flow points, as well as the stipulated or approved points, were mapped (Figure 5). The data were selected from Oregon State Water Resources Board (1961, 1963b, 1965), Hutchison and Aney (1964), Hutchison et al. (1966), Willamette Basin Task Force (1969), and Oregon Water Resources Department (1980). Excluding the Sandy Basin, approximately 342 minimum stream flow recommendations were made by the Oregon State Game Commission (now ODFW) between 1961 and 1966. This number includes thirty-three recommendations given in 1961 for the Upper Willamette Basin that were later revised in 1966 as the methodology improved. The Sandy Basin is excluded from this part of the study since no minimum stream flow stipulations were issued there. Although the State Game Commission did make twenty-five recommendations for the Sandy subbasin (Hutchison and Aney, 1964), flows from the Sandy River and its tributaries, with a few exceptions, have been withdrawn from further appropriations by legislative action (ORS 538.150, 200, 251). Waters of almost the entire Bull Run drainage, about 102 square miles, are reserved by law for exclusive use as the City of Portland's water supply (ORS 538.420).

Figure 5.


WASHINGTON
NORTH COAST BASIN
HOOD BASIN
DESCHUTES BASIN
MID-COAST BASIN
UMPQUA BASIN
MINIMUM STREAM FLOW POINTS
Stipulated Minimum Stream Flow Point
Recommended Minimum Stream Flow Point
Recommended Minimum Stream Flow Point on ODFW critical list as of December 1978
Note: Many ODFW recommendations in the Upper and Middle Basins were made subsequent to stipulated flows approved by SWRB in June 1964. Minimum flows in the Lower Basin were approved in May 1966.
LEGEND
STATE WATER RESOURCES BOARD
SALEM, OREGON
WILLAMETTE DRAINAGE BASIN
MAP NO. 26

A total of ninety-six minimum stream flow points have been stipulated throughout the Willamette Basin (Appendix A). An examination of Figure 5 reveals that these are unevenly distributed between the Lower, Middle, and Upper Willamette Basins. Fifty of the ninety-six minimum stream flow points (52%) are located in the Lower Basin, while thirty-two (33%) are located in the Middle Basin, and only fourteen (15%) are found in the Upper Basin. This disparity can be partially explained by factors relating to water resource development in the basin, the temporal context of decision-making, improvements in recommendations, water availability, and fishery considerations. To provide a better understanding of minimum stream flow patterns and problems in the basin, these factors are briefly examined.

Water Resources Development and Instream Flows: U.S. Army Corps of Engineers

An important control on streamflows of the Willamette River and some of its major tributaries is the system of dams and reservoirs operated by the U.S. Army Corps of Engineers. Thirteen multiple-purpose dams were constructed as a part of the Willamette Basin Project between 1941 and 1968. Approved originally by the Flood Control Act of 1938 (PL 75-544), these projects are authorized for flood control, irrigation, navigation, and power production. In addition, minimum stream flows were established by the Corps downstream at reservoirs to help maintain fish life, and benefits were claimed for stream purification resulting from navigation releases during the summer. These stream purification benefits were measured

as the savings resulting from deferring construction of "preliminary and final treatment works" for fifteen communities that were dumping their sewage into the Willamette River, and were estimated to be $90,000 dollars per year over the fifty-year amortization period of the reservoirs (U.S. Congress, 1938, p. 86).

Since water quality problems of the Willamette Basin were, and are, largely associated with low flows, severe problems resulted from the untreated pulp and paper mill wastes, cannery effluents, and municipal sewage that were discharged into the river. In summer months, dissolved oxygen (DO) levels were often near zero at Portland; and in August, 1944, an oxygen block (less than 5 ppm DO) extended upstream as far as river mile sixty (Fish and Wagner, 1950, p. 3). The cleanup of the Willamette River has been well documented (Gleeson, 1972; Council on Environmental Quality, 1973), but dissolved oxygen levels are still a major problem in summer months. While the Willamette is the largest river in the U.S. on which all point-source discharges receive secondary treatment (Rickert et al., 1980, p. 1), it is the minimum flow releases for "navigation" that are critical for water quality maintenance. Since the mid-1950's, the Corps of Engineers has attempted to maintain a minimum flow of 6000 cfs at Salem, upon which the water quality program for the river is predicated. For conditions in the mid-1970's, flow augmentation was more important for meeting DO standards than any increased amount of waste water treatment (Rickert, 1981, p. 207). The dependency on low-flow augmentation from federal reservoirs is critical; yet, legally, no releases can be made expressly to meet

water quality conditions. While the State has stipulated minimum stream flows downstream from the federal reservoirs to ensure minimum natural flows, as well as to protect up to a specified amount released from storage, the State has no authority over what those storage releases will be. Except for release of the natural inflow and the Corps' adopted minimum-flow release at each dam site, the Corps of Engineers is not required (and in some cases may not be permitted) to furnish additional flows that may be desired for water quality or fishery purposes. For the 6000 cfs minimum stream flow at Salem, up to 4700 cfs (78%) could be supplied from storage to augment a 1300 cfs natural minimum flow. However, according to the Oregon Department of Environmental Quality (1976, p. 18), there is no legal guarantee that the necessary 6000 cfs will be maintained; they consider that it comes now only by "gentlemen 's agreement" between state and federal agencies.

It must be understood that the federal dams in the Willamette Basin are operated as a system, in coordination with the rest of the Columbia Basin projects operated by the Corps of Engineers' North Pacific Division. From the Reservoir Control Center in Portland, the daily regulation is guided by the authorized purposes and release schedules established for each reservoir. Federal and state agencies with the highest concern for instream flow needs often have no regulatory authority over the resource. However, through administrative bargaining and memorandums of agreement, fisheries agencies can request that the Corps consider certain instream flow needs in their operations. The ODFW has made several agreements with the

Corps of Engineers for specific flows and temporal releases in the Willamette Basin (Nelson et al., 1978, p. 102). Such agreements must always be compatible with authorized functions and operating procedures. For example, the stepped pattern of flow augmentation, with increasing releases towards late summer and early fall, coincides with the Bonneville Power Administration's need for hydroelectric power from the Willamette system at that time of year (U.S. Army Corps of Engineers, 1980, pp. 3-19).

On the other hand, fisheries agencies and other groups find that the Corps of Engineers can be unresponsive to certain instream flow requests. As was noted by Congress, the major objections to plans of dam development in the Willamette Basin were expressed by fishery interests (U.S. Congress, 1950, p. 1738). Besides the blockage of some of the best anadromous fish production areas, a major concern was the reduced streamflows downstream during the reservoir filling season in February through May, when some species of anadromous fish ascend the main-stem Willamette River and tributaries. The maintenance of adequate stream flows for fish was a consideration in scheduling the regulation of reservoirs, and minimum flows were adopted by the Corps for both the filling season and low-water season (Table 1). However, there appears to be some uncertainty and controversy over the Congressional mandate that the maintenance of those minimum flows will take precedence over the scheduled rate of reservoir filling if the water supply is inadequate to meet both needs. After reductions in minimum flows caused significant fishery losses in 1977, both the National Marine Fisheries Service and the

Table 1.

Minimum Flows Adopted for Preservation of Fish
by U.S. Army Corps of Engineers

Location	Mean Monthly Flows in CFS			
	Filling Season February-June		Low-water Season July-November	
	Minimum observed* (1926-45)	Adopted minimum for fish	Minimum observed (1926-45)	Adopted minimum for fish
Cottage Grove Dam	55	75	11	50
Dorena Dam	140	190	20	100
Hills Creek Dam	510	100	196	100
Fall Creek Dam	125	30	17	30
Couger Dam	425	300	141	200
Blue River Dam	164	30	16	30
Fern Ridge Dam	73	50	9	30
Green Peter Dam	447	500**	51	300
Detroit Dam	1245	1000	445	750
Monroe	100	50	12	30
Waterloo	862	600	111	600
Mehama	1750	300	495	300

*Minimum observed flow is for May rather than for the period February-June.
**Green Peter minimum regulated for May=450 cfs; for June=300 cfs.
(Source: United States Congress, 1950, p. 2073)

U.S. Fish and Wildlife Service felt that fisheries unnecessarily took the brunt of the low-flow conditions, while "incidental" project purposes benefitted (U.S. Army Corps of Engineers, 1980, p. 6-10, p. 6-13).

State Action on Willamette Basin Stream Flows

As was previously mentioned, the basin water-use programs developed by the Water Policy Review Board act as a guideline for future water use and provide direction to the state regulatory agencies. A stream flow can be affected by three methods: 1) Withdrawing unappropriated waters from appropriation for any and all uses; 2) Classifying water sources as to their highest and best uses and future quantities of use; and 3) Setting minimum perennial stream flows sufficient to support aquatic life or minimize pollution.

The WPRB has been extremely reluctant to use its withdrawal powers. They have been used only three times statewide, one being to protect fish passage over Willamette Falls at Oregon City (Sherton, 1981, p. 393). In June, 1965, the SWRB withdrew from further appropriation 430 cfs of unappropriated water released from storage for this purpose (Oregon State Water Resources Board, 1967, p. 71). While withdrawal power seems like an effective method for restricting future appropriations of remaining unappropriated water, it will most likely rarely be employed, since Board members, past and present, believe that the legislature intended it to be used only on a temporary basis rather than as a permanent control measure (Lane, 1983).

The second method, classifying streams to restrict water uses, is a water-management tool similar to zoning of land (Rousseau, 1976, p. 83). An unrestrictive classification would allow appropriations for all ten beneficial uses, while future consumptive uses could be restricted by excluding irrigation, municipal, industrial, or mining uses. The most restrictive classifications in the Willamette system are found in the Upper McKenzie and Tualatin subbasins. Even the most restrictive classification, though, must still allow appropriations for human and livestock uses (ORS 536.310).

The third method, setting minimum perennial streamflows, is seemingly desirable but is beset by procedural, political, and practical problems that can make it ineffective for preventing undesirable flow depletions. The adoption of the minimum stream flow program in the Willamette Basin will be discussed below.

One other potential method of preserving instream flows is that of withdrawal by the Oregon legislature. This also can only be done where unappropriated water remains and does not affect vested rights. Most such withdrawals were made before 1955; and since it is difficult to get the legislature to take such action, it has been used very sparingly. In the Willamette Basin, it has been used for Silver Creek in Marion County, Hackett Creek in Clackamas County, and for limitations on Johnson Creek in Multnomah and Clackamas counties (ORS 538.120, 160, 170).

Stipulation of Minimum Perennial Stream Flows

An important explanation for the pattern and varying flow values of the State's stipulated minimum stream flows in the Willamette Basin relates to the early development of the minimum streamflow methodology and the temporal framework of decision-making. The disparity in the distribution of stipulated flows between the Upper, Middle, and Lower Basins is due in part to the year that the basin reports and water use programs were issued by the SWRB. Since "nowhere else in the world" was there anything comparable to Oregon's statewide minimum stream flow program, it was a learning process that improved rapidly over the years (Lane, 1983).

Fourteen stipulated minimum flow points in the Upper Willamette Basin (only 15% of the total) were the first to be approved in the Willamette system. The recommendations developed by the Game Commission for the SWRB's 1961 basin report were single-value flows for the low-flow season that were rather crude and inadequate for the Board to base their decision on (Oregon State Water Resources Board, 1961,

p. 40). Recognizing the many uncertainties involved in the process, the SWRB approved only a few minimum stream flows — but at locations lower in the river systems that attempted to protect entire subbasins. While the original basin program was adopted in 1962, it was modified in June, 1964, which is the priority date for these single-valued minimum flows. At the time these flows were considered, the Game Commission estimated that salmon produced in the Upper Basin contributed at least 40% to the Lower Willamette sports catch (Oregon State Water Resources Board, 1961, p. 37); yet several years later, the Board admitted that the established minimum flows, in some cases, did not adequately protect the aquatic life (Oregon State Water Resources Board, 1967, p. 72).

In the Middle Willamette Basin, the Game Commission Studies were made concurrently with the SWRB's basin investigation in 1963; and 132 recommendations were made (Willamette Basin Task Force, 1969). These were based on more sophisticated data and field measurements, and listed minimum flow values for each month of the year. The Board stipulated twenty-nine minimum stream flows in the Coast Range, Santiam, and Pudding Subbasins, plus three flows on the main-stem Willamette at Albany, Salem, and Wilsonville. It is curious that all of the adopted minimum stream flows in the Middle Willamette were for single-value low flows, since monthly recommendations had been provided. While the Board had better data for decision-making, the results were similar to those on the Upper Basin. State minimum stream flow stipulations were most often located near the mouths of the large, regulated tributaries or below the dams controlled by the

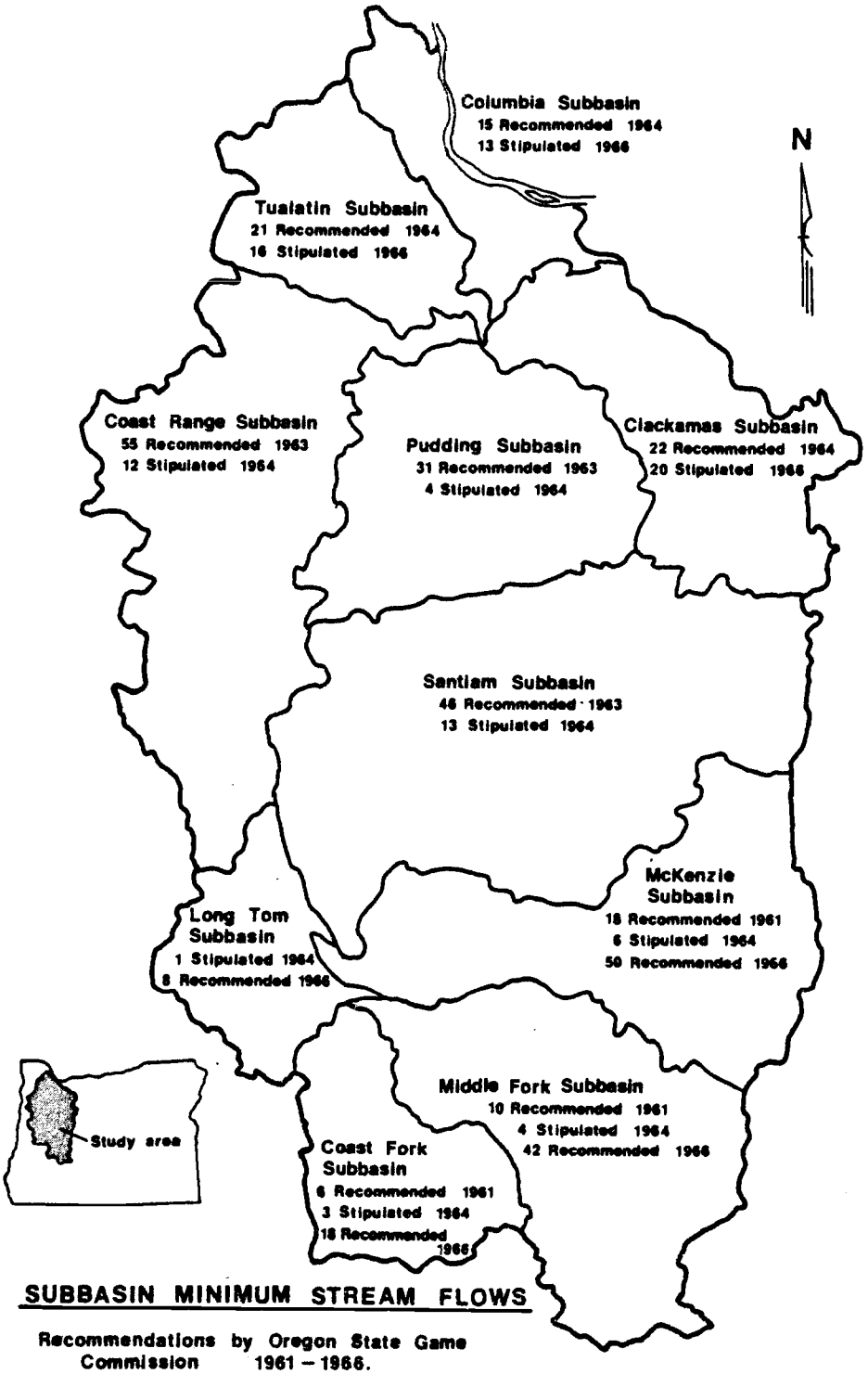
U.S. Army Corps of Engineers.

Minimum flow recommendations for the Lower Willamette Basin were submitted in 1964 to the Board (Hutchison, 1964), and these were also in a monthly or semi-monthly form. Excluding the Sandy River subbasin, fifty-eight recommendations were made. The Board completed their basin investigation in 1965 and, with the adoption of the water use program in May, 1966, fifty minimum stream flow points were stipulated. These minimum stream flow points are substantially different from the rest of the Willamette Basin in that many are located on smaller tributaries and usually have two or more flow values for different periods of the year (Appendix A). Although two new personalities were involved in the SWRB decision-making for the Lower Basin and five members of the seven-member Board were from the Willamette Valley, the close correlation between minimum stream flow recommendations and stipulations must be due, in part, to increased confidence in the program's methodology. The stipulated flow values were often the same, or close to the same, as those flow values recommended. Also, since the Clackamas River was once considered to be the best spring chinook stream in the state (Willamette Basin Task Force, 1969, p. II-111), there perhaps was impetus to protect the remaining aquatic habitat by approving twenty of the twenty-two recommendations in that subbasin. Figure 6 shows the number of stipulated and recommended minimum stream flows for the entire Willamette Basin by subbasin areas.

Conflicts and Program Problems

A study by the Oregon Department of Environmental Quality (1978)

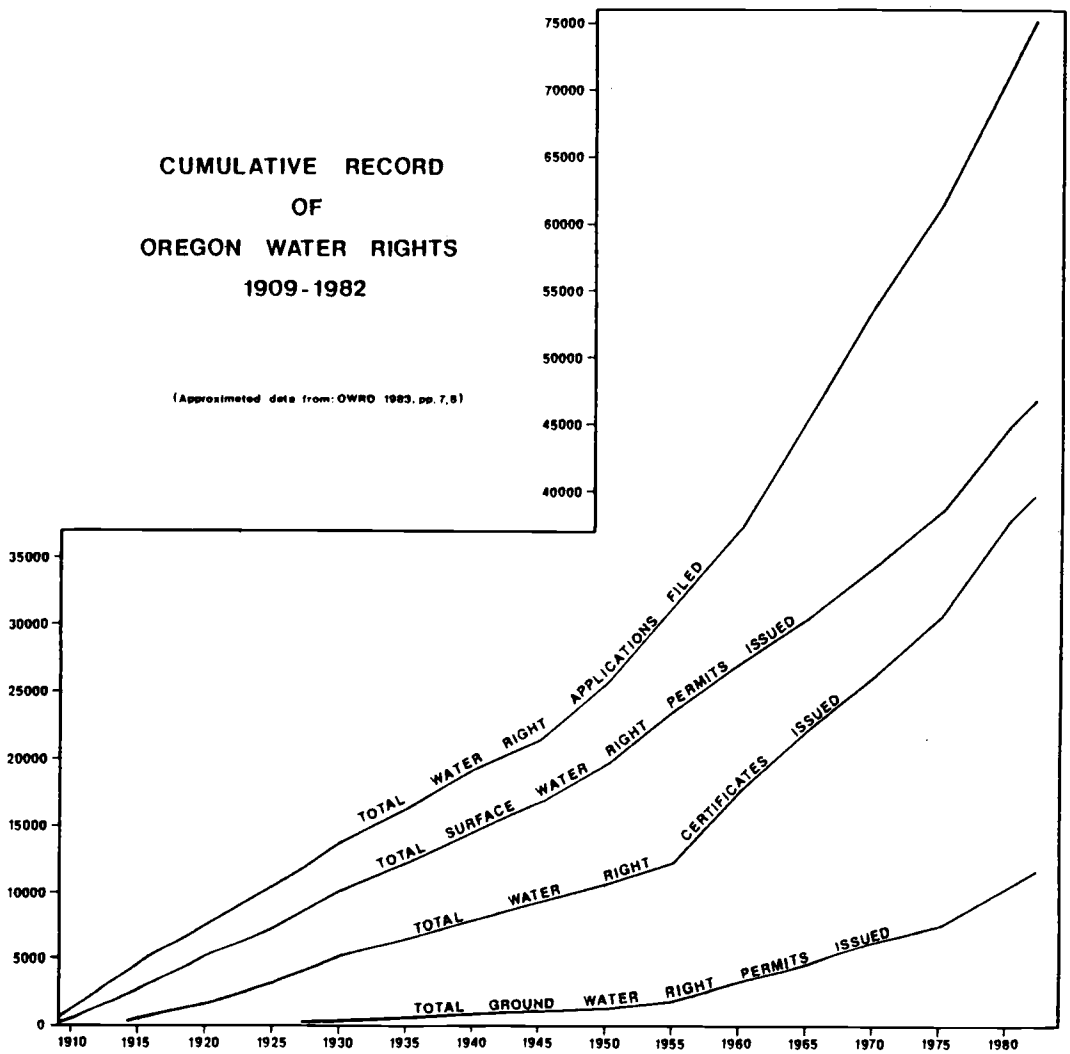
Figure 6.


Columbia Subbasin
15 Recommended 1964
13 Stipulated 1966
N
Tualatin Subbasin
21 Recommended 1964
16 Stipulated 1966
Coast Range Subbasin
55 Recommended 1963
12 Stipulated 1964
Pudding Subbasin
31 Recommended 1963
4 Stipulated 1964
Clackamas Subbasin
22 Recommended 1964
20 Stipulated 1966
Santiam Subbasin
46 Recommended 1963
13 Stipulated 1964
McKenzie Subbasin
18 Recommended 1961
6 Stipulated 1964
50 Recommended 1966
Long Tom Subbasin
1 Stipulated 1964
8 Recommended 1966
Middle Fork Subbasin
10 Recommended 1961
4 Stipulated 1964
42 Recommended 1966
Coast Fork Subbasin
6 Recommended 1961
3 Stipulated 1964
18 Recommended 1966
Study area
SUBBASIN MINIMUM STREAM FLOWS
Recommendations by Oregon State Game Commission 1961 – 1966.
Stipulated Minimum Flows by Oregon State Water Resources Board 1964, 1966. (+ 4 mainstem MSF points)
Note: Stipulated flow values and locations may differ from those recommended.
0 10 20 mi.

resulted in the development of several maps that indicated generalized locations of stream-flow-related problems. Plate 4 illustrated where water withdrawals and consumptive uses of water were perceived to result in insufficient stream flows to sustain existing water rights and to meet other desired uses. Other maps delineated streams with perceived severe water-temperature and low-dissolved-oxygen problems. The composite of these maps indicates that water uses in many stream segments in the Willamette Basin have a high potential for conflict. Fishery agencies contend that urban, industrial, and agricultural growth poses serious threats to salmonid habitat in the Willamette River system (Oregon Department of Fish and Wildlife, 1982, p. F-12). While industrial and urban development interests seek increased dilution flows and fishery interests fight to increase fishery habitat potential, the Water Resources Department is perceived as fostering water diversions for consumptive uses. Figure 7, showing the cumulative number of water-right applications, permits, and certificates, would tend to support this perception.

Over thirty years ago, it was noted that, in a number of the smaller Willamette tributaries, appropriations for consumptive uses of water exceeded the minimum monthly flows by several times (U.S. Congress, 1950, p. 2016). The Tualatin, Yamhill, Pudding, Molalla, Luckiamute, Marys, and Long Tom Rivers were especially affected. More recently, the U.S. Army Corps of Engineers (1979, p. 12) stated that the Clackamas River could easily become an issue of regional concern because its water rights not only over-appropriate available water but many of them precede the date of establishment of minimum

Figure 7.


CUMULATIVE RECORD
OF
OREGON WATER RIGHTS
1909-1982
(Approximated data from: OWRD 1983, pp. 7,8)
TOTAL WATER RIGHT APPLICATIONS FILED
TOTAL SURFACE WATER RIGHT PERMITS ISSUED
TOTAL WATER RIGHT CERTIFICATES ISSUED
TOTAL GROUND WATER RIGHT PERMITS ISSUED
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980

streamflows. It is, of course, true that not all water rights are exercised simultaneously and that many senior rights are for more water than could possibly be used, thus often leaving "appropriated" water in the stream. However, since the stipulated minimum stream flows can only affect junior water-right holders, indiscriminate issuance of permits reduces the effectiveness of the program by creating a larger group in opposition to having their water cut off. Two or three hundred junior water-right holders can put tremendous economic and political pressure on a watermaster to delay enforcement, or on the WPRB to suspend, a minimum stream flow. It is often easier to quantify the monetary loss of a crop reduction due to irrigation water being cut off than it is to put a monetary figure on the losses to the aquatic ecosystem.

Enforcement remains as one of the biggest problems of the program. The entire Willamette Basin, as well as the area westward to the coast, is covered by the district's four watermasters — each with the responsibility of regulating thousands of water rights. Only about a third of the ninety-six minimum stream flow points in the basin are located at an active gaging station, thus requiring time-consuming field investigation and flow calculations for effective enforcement. With an increasing number of junior water-right holders to regulate, a lack of stream-gaging stations and monitoring, and watermasters sympathetic to local interests, effective enforcement becomes extremely difficult.

One enforcement problem with state-wide implications has developed on Clear Creek in the Clackamas subbasin. The major issue is

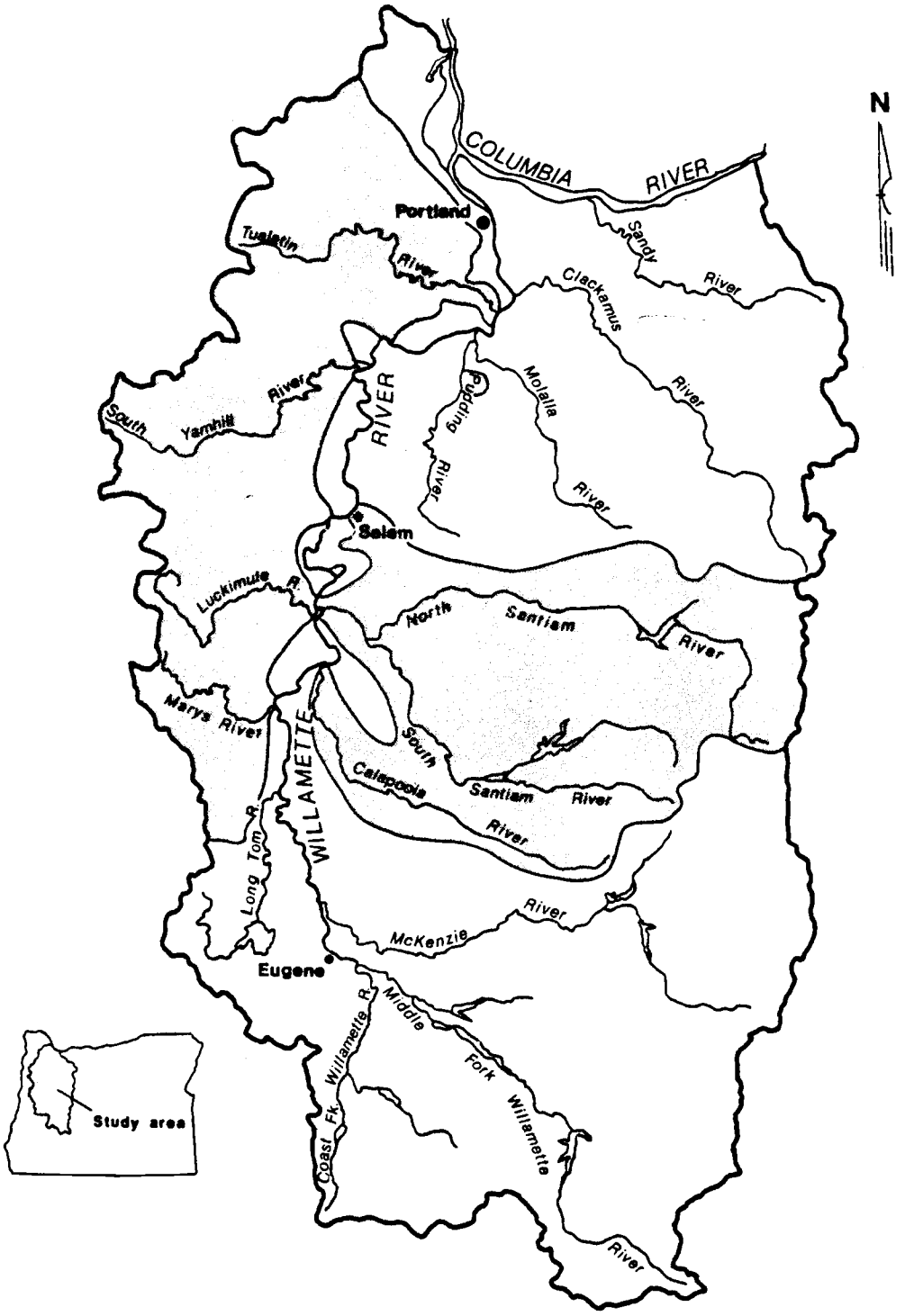
whether minimum stream-flow standards should be enforced only at the State's designated measuring points or also between the points. While the intent of the Board's policy is to maintain a continuous minimum stream flow on Clear Creek, a portion of the stream has been reduced to a trickle by an appropriator, while at the measuring points the minimum flow is being met. The latest in a series of opinions from the Oregon Attorney General stated that the appropriator cannot reduce the natural flow to "a trickle" or dry it up entirely, even though the permit to divert water has been issued (Webb, 1983). It remains to be seen if this opinion will be upheld or can be applied to other streams.

The uncertain water rights status in the Willamette Basin, due to lack of adjudication, makes it more difficult to assess the need for instream flow-protection measures. Many unused rights have not been removed from the records, and other rights may be in excess of actual diversion. The Oregon Water Resources Department (1983, p. 9) estimates that the adjudication of the Willamette Basin is now 37.8% completed. Figure 8 shows the adjudicated areas. Adjudication is a time-consuming and expensive process; but the longer it is delayed, the more difficult and costly it becomes. Until the power claims dating back to 1912, on the lower Willamette, for over 30,000 cfs are adjudicated, all subsequent upstream claims and rights are uncertain (Federal Water Pollution Control Administration, 1967, p. 35).

Perhaps one of the biggest problems is the failure of the Board to act. While budget cutbacks have certainly hindered the Water Resources Department and the Water Policy Review Board from carrying

Figure 8.

Adjudication Status of the Willamette River Basin



out many of their administrative, regulatory, planning, data-gathering, and policy-making functions, the lack of leadership, direction, and willingness to address the growing conflicts between instream and diversionary uses of water has resulted in calls for wholesale changes in Oregon's water policies and programs. As headlines began to reveal an apparent water-resource "crisis" (Churchill, 1983; Ashcom, 1983), the legislature was faced with measures ranging from water-right permit moratoriums, to creation of inter-agency task forces, to abolition of the Water Policy Review Board. Revisions in Oregon's water policy and regulatory practices became a major thrust of the 1983 Oregon Legislature (Hayes, 1983).

RECOMMENDATIONS

As two respected scholars in the field of water-resource management have observed, "crisis" is not really an appropriate term for discussing problems of water availability (Wolman, 1976; Castle, 1983). While substantial challenges must be met, the problems of water quantity and quality are perpetual. However, there seems to be a certain inertial quality about human behavior that inhibits change required by any situation of less-than-critical importance. "Policy-by-crisis" has figured significantly in the development and management of water resources in the Willamette Basin. The successful cleanup of the Willamette River occurred only after a "near-crisis" situation threatened human health and desired uses of the river. Secondary wastewater treatment and, especially, the low-flow augmentation from federal reservoirs has temporarily allowed that

crisis to pass. While perceived crisis situations are a sure way to encourage innovation and break down incremental policy-making, institutional inertia will inhibit consideration of longer-term solutions to the fundamental causes of water-resource management problems. As Craine (1969) has pointed out, disconformities in the units of water supply, demand, and jurisdiction are at the heart of water-resource problems.

Federal jurisdiction and control of water resources is a key element in minimum stream-flow problems of the Willamette Basin and should be receiving more attention and study. The operation of a system of multiple-purpose reservoirs is a complex task requiring trade-offs and periodical assessments of changes in social, economic, and political values. In particular, attention should be given to the size of the water rights held by the Bureau of Reclamation, which acts as the federal marketing agency for federally-stored water. The agency has filed for 1,640,000 acre-feet of stored water, which is the total conservation storage capacity for all eleven Corps reservoirs that are authorized for irrigation in the Willamette Basin (U.S. Army Corps of Engineers, 1980, p. 2-29a). The irrigated acreage under contract is only a fraction of what was once planned, and part of this water may be of higher value if given legal status for other uses. However unlikely a reallocation may seem to be, reauthorization studies should continue to explore the adequacy of the "gentlemen's agreement" to meet the minimum stream flow at Salem.

The State minimum stream-flow program has been under extensive critical analysis in the last two years, and recent legislation has

given the program a renewed impetus. Senate Bill 225 will require the WPRB to consider seventy-five minimum-stream-flow recommendations, nominated by the Department of Environmental Quality and the Department of Fish and Wildlife, and make decisions by January 1, 1986. Potential candidate-streams for consideration in the Willamette Basin are listed in Appendix B.

While significant improvements have been legislatively mandated for Oregon's minimum-stream-flow program, its effectiveness remains in doubt for streams where no unappropriated water is available. One recent study has recommended that Oregon recognize appropriative water rights for instream uses, authorizing state agencies such as the DEQ and the ODFW to appropriate water on behalf of the public (Sherton, 1981). Appropriative water rights for instream flows would have an advantage over the administrative rules of the WPRB in that they could be applied on streams that are already entirely allocated or over-appropriated. The purchase or donation to the State of a senior, consumptive water right could transfer some water for instream use.

More rigorous use of the stream-classification and withdrawal powers may be a better approach than setting minimum stream flows, in that it addresses the allocation of water before major conflicts arise. More restrictive classifications during summer months, such as in the Tualatin Basin, could also be utilized in critical areas. To prevent future conflicts between consumptive and non-consumptive uses of water on streams that are already over-appropriated, more thorough scrutiny of water-right applications is necessary. The ODFW

and WRD do have an inter-agency agreement which provides environmental review of new appropriations prior to approval (Fredd, 1980, p. 18).

On an annual basis, the Willamette system is water-abundant, yet conflict and competition arise over a very small percentage of the total yield. For many streams, providing water for instream use will have to coincide with means of conserving water for that use. While small, upstream reservoirs that are compatible with fishery runs may be suitable for some streams, other conservation methods may be more economical. Whether one views water conservation as storing spring runoff, minimizing waste, improving efficiency in use, or reducing demand, each is only a part of total water management.

Funding for the Water Resources Department, which was less than two-tenths of one percent of the State's General Fund Budget (Sexson, 1982), was increased by twenty percent for the next budget period (Hayes, 1983). This will go partly to resurrect the computerized water-rights data system, which should help in operating the minimum-stream-flow program. Increased funding should also be sought for more stream gages, which could be pursued jointly with the ODFW.

Just as important as all of these suggestions, improvements should be made in efforts to educate the public as to the benefits of instream flows, as well as to increase methods for acquiring public input for the decision-making process. Instream-flow considerations involve complex and technical questions, but if the Water Policy Review Board's public input comes mainly from water-right holders and those interested in more water appropriations, other valid interests will not be represented.

CONCLUSION

Oregon's minimum-stream-flow program was a pioneering effort in the recognition and protection of instream flow values. As implemented in the Willamette Basin, the characteristics and patterns of the minimum-stream-flow points reflected successive stages in the development of the program, as well as physical and institutional constraints. The abundance of water in the basin is tempered by its seasonal variability; and, with increasing agricultural, industrial, and urban development, conflicts between diversionary and instream uses will intensify. While water policy in general--and minimum stream-flows in particular--are receiving attention from the legislature, the press, and the public, and while new legislation has been passed, it seems likely that even greater changes will be made in the near future. A joint water-policy committe of the legislature will be holding hearings on proposals for complete revisions in the State's water laws. The importance of the system of federal reservoirs for for maintaining water quality and fish runs will also necessitate a closer look at those operations and at water allocations. As with many common-property resource problems, instream flow-maintenance will require compromises and flexibility for effective conflict resolution.

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APPENDICES

Appendix A

Appendix A

STIPULATED MINIMUM STREAM FLOWS
Willamette River Basin

Stream Point	Flow (cfs)
Coast Fork Subbasin	
Coast Fork Willamette River above Row River	15 + up to 100SR
Row River at mouth	40 + up to 150SR
Coast Fork Willamette River at mouth	40 + up to 250SR
Middle Fork Subbasin	
Middle Fork Willamette River at gage 14-1455	285 + up to 690SR
North Fork of Middle Fork Willamette River at gage 14-1475	115
Fall Creek at gage 14-1510	40 + up to 470SR
Middle Fork Willamette River at mouth	640 + up to 1475SR
McKenzie Subbasin	
South Fork McKenzie River at mouth	200 + up to 230SR
Blue River at mouth	30 + up to 350SR
McKenzie River at gage 14-1625, near Vida	1400 + up to 580SR
Gate Creek at mouth	20
Mohawk River at gage 14-1650	20
McKenzie River at gage 14-1655	1025 + up to 700SR

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flow (cfs)
Long Tom Subbasin	
Long Tom River at gage 14-1700, at Monroe	up to 370SR
Santiam Subbasin	
Calapooia River at gage 14-1720	30 + up to 340SR
Calapooia River at gage 14-1735	20 + up to 340SR
South Santiam River at gage 14-1850, below Cascadia	50
Middle Santiam River at gage 14-1865, near Foster	110 + up to 260SR
Wiley Creek at mouth	10
South Santiam River at gage 14-1875, at Waterloo	170 + up to 930SR
North Santiam River at gage 14-1780, near Detroit	345
North Santiam River at gage 14-1815, at Niagara	500 + up to 640SR
Little North Santiam River at gage 14-1825, near Mehama	40
North Santiam River at gage 14-1830, at Mehama	580 + up to 640SR
North Santiam River at gage 14-1841, near Jefferson	430 + up to 640SR
Santiam River at gage 14-1890, at Jefferson	330 + up to 1570SR
Santiam River at mouth	320 + up to 1570SR
Coast Range Subbasin	
Marys River at gage 14-1710, near Philomath	10
Marys River at mouth	5

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flow (cfs)	
Coast Range Subbasin (continued)		
Luckiamute River at gage 14-1895, near Hoskins	10	
Luckiamute River at gage 14-1900, at Pedee	20	
Luckiamute River at gage 14-1905, near Suver	25	
Luckiamute River at mouth	20	
Rickreall Creek at gage 14-1907, near Dallas	5	
South Yamhill River at gage 14-1925, near Willamina	20	
Willamina Creek at gage 14-1930, near Willamina	20	
South Yamhill River at gage 14-1940, near Whiteson	15	
North Yamhill River at gage 14-1970, at Pike	10	
Yamhill River at gage 14-1975, at Lafayette	15	
Pudding Subbasin		
Pudding River at gage 14-2010, near Mt. Angel	10	
Pudding River at gage 14-2020, at Aurora	35	
Molalla River at gage 14-1985, near Wilhoit	35	
Molalla River at gage 14-2000, near Canby	60	
Clackamas Subbasin		
Lowe Creek at mouth	2 (Ju 01-Oc 31)	8 (Nv 01-Jn 30)
Pinhead Creek at mouth	50 (Jn 01-Oc 31)	75 (Nv 01-Ma 31)

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flow (cfs)
Clackamas Subbasin (continued)	
Clackamas River at gage 14-2080, at Big Bottom	150 (Ju 01-Se 15) 240 (Se 16-Jn 30)
Collawash River at mouth	75 (Ju 16-Se 15) 250 (Se 16-Ma 31) 200 (Jn 01-Ju 15)
East Fork Collawash River at mouth	10 (Au 01-Se 30)
Elk Lake Creek at mouth	15 (Au 01-Se 30)
Hot Springs Fork of Collawash River at mouth	15 (Ju 16-Se 15) 75 (Se 16-Ju 15)
Oak Grove Fork of Clackamas River at mouth	10 (Au 01-Se 30)
Clackamas River at gage 14-2095, above Three Lynx	400 (Ju 01-Se 15) 640 (Se 16-Jn 30)
Roaring River at mouth	40 (Ju 01-Oc 15) 100 (Oc 16-Jn 30)
Fish Creek at mouth	15 (Ju 01-Oc 31) 60 (Nv 01-Jn 30)
Fish Creek at Wash Creek	3 (Au 01-Se 30)
Wash Creek at mouth	3 (Ju 16-Oc 31) 25 (Nv 01-Jn 15) 10 (Jn 16-Ju 15)
Eagle Creek at mouth	40 (Ju 16-Oc 31) 125 (Nv 01-Ma 31) 100 (Jn 01-Ju 15)
North Fork Eagle Creek at mouth	10 (Au 01-Oc 31) 45 (Nv 01-Ma 31) 30 (Jn 01-Jn 30) 20 (Ju 01-Ju 31)
Deep Creek at mouth	10 (Ju 16-Oc 31) 35 (Nv 01-Ma 31) 20 (Jn 01-Ju 15)
North Fork Deep Creek at mouth	1 (Au 01-Oc 31) 20 (Nv 01-Ma 31) 3 (Jn 01-Ju 31)

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flows (cfs)
Clackamas Subbasin (concluded)	
Tickle Creek at mouth	4 (Ju 01-Oc 31) 30 (Nv 01-Ma 31) 6 (Jn 01-Jn 30)
Clear Creek at mouth	20 (Au 01-Se 30) 40 (Jn 01-Ju 31)
Clear Creek above Viola	15 (Ju 16-Se 30) 25 (Jn 01-Ju 15)
Tualatin Subbasin	
Tualatin River at river mile 70	10 (Ju 16-Nv 15) 65 (Nv 16-Ma 31) 20 (Jn 01-Ju 15)
Seine Creek at mouth	2 (Ju 01-Nv 15) 25 (Nv 16-Ma 31) 8 (Jn 01-Jn 30)
Tanner Creek at mouth	1 (Au 01-Se 30) 9 (Nv 15-Ma 31)
Gales Creek at mouth	12 (Ju 16-Oc 31) 100 (Nv 01-Ma 31) 35 (Jn 01-Ju 15)
Gales Creek at river mile 12	8 (Se 01-Oc 15) 70 (Nv 15-Ma 31)
Beaver Creek at mouth	1 (Ju 16-Nv 15) 17 (Nv 16-Ma 31) 3 (Jn 01-Ju 15)
Little Beaver Creek at mouth	1 (Au 01-Se 30)
North Fork Gales Creek at mouth	1.5 (Ju 16-Nv 15) 25 (Nv 16-Ma 31) 3 (Jn 01-Ju 15)
South Fork Gales Creek at mouth	1 (Ju 16-Nv 15) 20 (Nv 16-Ma 31) 2 (Jn 01-Ju 15)
East Fork Dairy Creek at river mile 13	12 (Ju 16-Nv 15) 50 (Nv 16-Ma 31) 25 (Jn 01-Ju 15)

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flows (cfs)
Tualatin Subbasin (continued)	
Denny Creek at mouth	2 (Au 01-Nv 15) 15 (Nv 16-Ma 31) 3 (Jn 01-Ju 31)
Plentywater Creek at mouth	1 (Au 01-Nv 15) 5 (Nv 16-Ma 31) 2 (Jn 01-Ju 31)
McKay Creek at river mile 15.5	4 (Au 01-Se 30) 36 (Nv 16-Ma 31)
East Fork McKay Creek at mouth	2 (Au 01-Se 30)
McFee Creek at Gulf Canyon Creek	2 (Au 01-Se 30) 12 (Nv 15-Ma 31)
Tualatin River at gage 14-2075	See page 52a.
Columbia Subbasin	
Milton Creek at Salmon Creek	25 (Nv 01-Ap 30)
Cox Creek at mouth	6 (Nv 01-Ap 30)
Salmon Creek at mouth	5 (Nv 01-Ap 30)
North Scappoose Creek at mouth	5 (Ju 16-Oc 31) 40 (Nv 01-Ma 31) 20 (Jn 01-Ju 15)
Alder Creek at mouth	1 (Ju 01-Oc 31) 8 (Nv 01-Ma 31) 3 (Jn 01-Jn 30)
Cedar Creek at mouth	1 (Ju 01-Oc 31) 6 (Nv 01-Ma 31) 3 (Jn 01-Jn 30)
Chapman Creek (Lizzie Creek) at mouth	1 (Ju 01-Oc 31) 6 (Nv 01-Ma 31) 3 (Jn 01-Jn 30)

Appendix A: STIPULATED MINIMUM STREAM FLOWS - Willamette River Basin (continued)

Stream Point	Flows (cfs)
Columbia Subbasin (continued)	
North Fork North Scappoose Creek at mouth	1 (Ju 16-Oc 31) 7 (Nv 01-Ma 31) 3 (Jn 01-Ju15)
Sierkes Creek (Deep Creek) at mouth	.5 (Jn 16-Oc 31) 7 (Nv 01-Jn 15)
South Fork North Scappoose Creek at mouth	1 (Ju 01-Oc 31) 8 (Nv 01-Ma 31) 4 (Jn 01-Jn 30)
South Scappoose Creek at Raymond Creek	5 (Ju 01-Oc 31) 25 (Nv 01-Ma 31) 12 (Jn 01-Jn 30)
Gourlay Creek at mouth	.5 (Ju 16-Oc 31) 10 (Nv 01-Ma 31) 2 (Jn 01-Ju 15)
Raymond Creek at mouth	.5 (Ju 16-Oc 31) 8 (Nv 01-Ma 31) 1 (Jn 01-Ju 15)
Mainstem Willamette River	
Willamette River at Albany gage 14-1740	1750 + up to 3140SR
Willamette River at Salem gage 14-1910	1300 + up to 4700SR
Willamette River at Wilsonville gage 14-1980	1500 + up to 4700SR
Willamette River at Willamette Falls	1500 + up to 4700SR

Source: Oregon Water Policy Review Board, Willamette River Basin Programs for Upper Willamette River Basin, November 10, 1980; Middle Willamette River Basin, June 22, 1964; and Lower Willamette River Basin, December 9, 1980.

SR = Water released from storage
Ap = April; Ma = May; Jn = June; Ju = July; Au = August; Se = September; Oc = October; Nv = November

The Tualatin River or its tributaries above USGS-State Engineer Gage No. 14-2075 (SW 1/4, Section 34, Township 2 South, Range 1 East) at West Linn, Oregon, in the amounts specified:

Month	Effective From May 25, 1966 For Natural Flows of the Tualatin River Below:	Effective From April 15, 1970 For Natural Flows of the Tualatin River Below:	As Adopted April 19, 1975 From Water Released From Henry Hagg Lake (Scoggins Reservoir) For Amounts Up To:	As Adopted April 19, 1975 From Total 1/ Water Released From Storage For Amounts Up To:
October	30 cfs	90 cfs 2/	15 cfs	250 cfs
November	30 cfs	110 cfs	250 cfs	
December	30 cfs		250 cfs	
January	30 cfs		250 cfs	
February	30 cfs		250 cfs	
March	30 cfs		250 cfs	
April	30 cfs		250 cfs	
May	30 cfs	85 cfs	250 cfs	
June	20 cfs	130 cfs 2/	20 cfs	250 cfs
July (1-15)	20 cfs	40 cfs 2/	75 cfs	250 cfs
July (16-31)	15 cfs	30 cfs 2/	75 cfs	250 cfs
August	15 cfs	30 cfs 2/	75 cfs	250 cfs
September	15 cfs	25 cfs 2/	60 cfs	250 cfs

1/ Includes water diverted through Oswego Canal as measured at USGS-State Engineer Gage No. 14-2070 (NW 1/4, Section 20, Township 2 South, Range 1 East) near Lake Oswego, Oregon.

2/ As modified April 19, 1975

The aforementioned flows will be measured at USGS-State Engineer Gage No. 14-2075 and those flows adopted in 1970 and 1975 shall be maintained to the mouth of the Tualatin River.

Appendix B

Appendix B

WILLAMETTE BASIN MINIMUM STREAM FLOWS ON ODFW CRITICAL LIST AS OF DECEMBER 20, 1978

Middle Willamette Basin

Little Luckiamute River at Hwy. 223, near Monmouth

Greasy Creek at mouth, near Philomath

Abiqua Creek at mouth, near Mt. Angel

Milk Creek at mouth, near Canby

Crabtree Creek at mouth, near Crabtree

Hamilton Creek at mouth, near Lebanon

Thomas Creek at mouth, near Jefferson

Agency Creek at mouth, near Grande Ronde

Mill Creek at mouth, near Sheridan

Upper Willamette Basin

Mill Creek at mouth (tributary to Mohawk River)

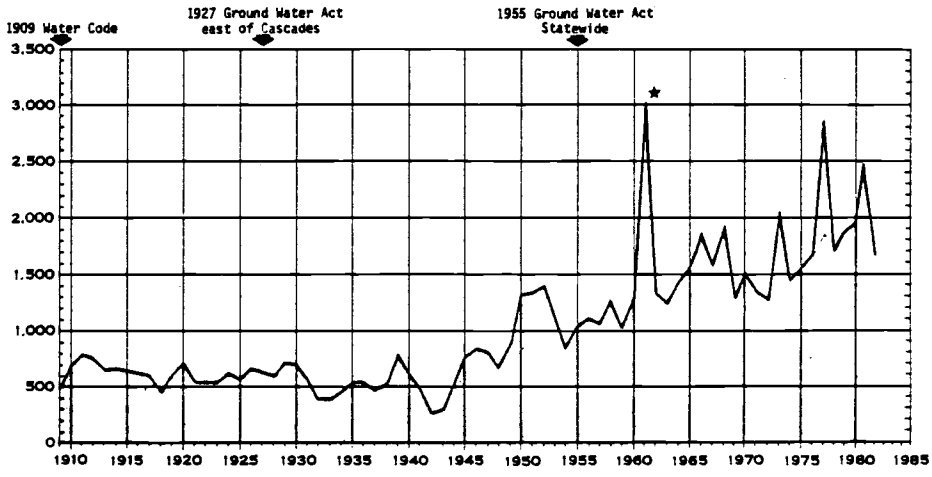
Lost Creek at mouth (tributary to Middle Fork Willamette River)

(Source: Corbett, 1983)

Appendix C

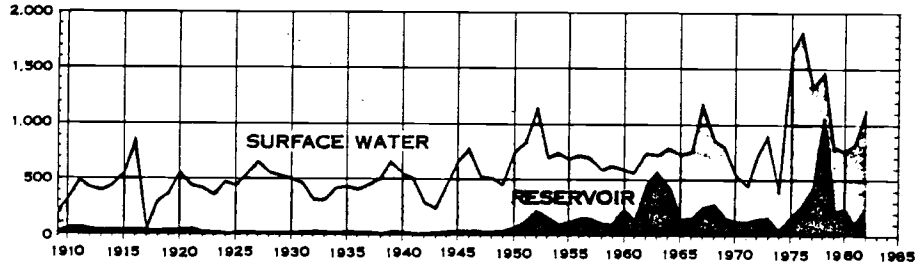
Appendix C

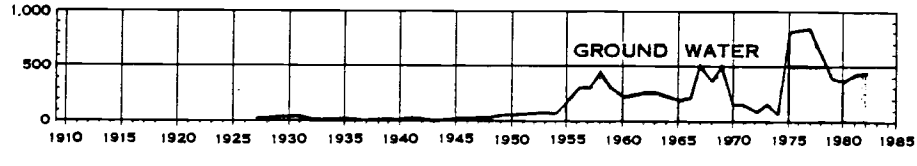
WATER RIGHT APPLICATIONS FILED



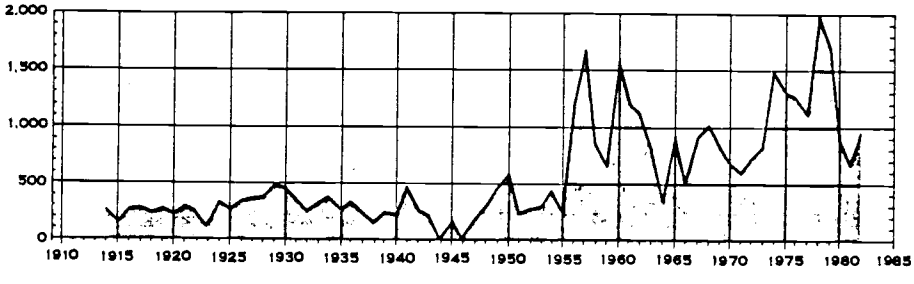
★ Includes approximately 1800 BLM ponds

WATER RIGHT PERMITS ISSUED





WATER RIGHT CERTIFICATES ISSUED



Appendix D

Appendix D

MAJOR FEDERAL AGENCIES CONCERNED WITH

WILLAMETTE BASIN MINIMUM STREAM FLOWS

Agency	Nature of Authority	Major Instream Interest
Federal Energy Regulatory Commission	Licensing	Hydroelectric Power
Bonneville Power Administration	Physical Regulation	Hydroelectric Power
Army Corps of Engineers	Construction and Management	Navigation, Flood Control
Bureau of Reclamation	Storage Rights Marketing Agency, Physical Regulation (Scoggins)	Irrigation Diversion
Fish and Wildlife Service	Study and Recommend	Fish and Wildlife Habitat
National Marine Fisheries Service	Study and Recommend	Anadromous Fish
Geological Survey	Study and Recommend	All Uses
Forest Service	Land Management	Water Quality, Fish and Wildlife, Recreation, Aesthetics
Bureau of Land Management	Land Management	Water Quality, Fish and Wildlife, Recreation, Aesthetics
Soil Conservation Service	Study and Recommend	Irrigation Diversion
Environmental Protection Agency	Administrative Regulation, Enforcement	Water Quality

Appendix D (continued)

OREGON AGENCIES CONCERNED WITH WILLAMETTE BASIN MINIMUM STREAM FLOWS

Agency	Nature of Authority	Major Instream Interest
Water Policy Review Board	Basin Program Formulation	All
Water Resources Department	Administrative Regulation, Enforcement of Water Rights	All
Department of Fish and Wildlife	Study and Recommend, Some Administration, Regulation	Fish and Wildlife
Department of Environmental Quality	Study and Recommend, Administrative Regulation	Water Quality
Land Conservation and Development Commission	Administrative Regulation	Fish and Wildlife Habitat, Gravel Mining
Department of Transportation	Study and Recommend, Scenic Waterway Consultation and Management	Aesthetic, Recreation
Department of Forestry	Develop and Enforce Forest Practice Rules	All
Department of Human Resources - Health Division	Drinking Water System Inspection, Study and Recommend	Water Quality
Department of Energy - Energy Facility Siting Council	Study and Recommend	Hydroelectric Power
Department of Econonic Development - Port Division	Study and Recommend	Navigation, Water Quality
Soil & Water Conservation Commission	Study and Recommend	Irrigation Diversion