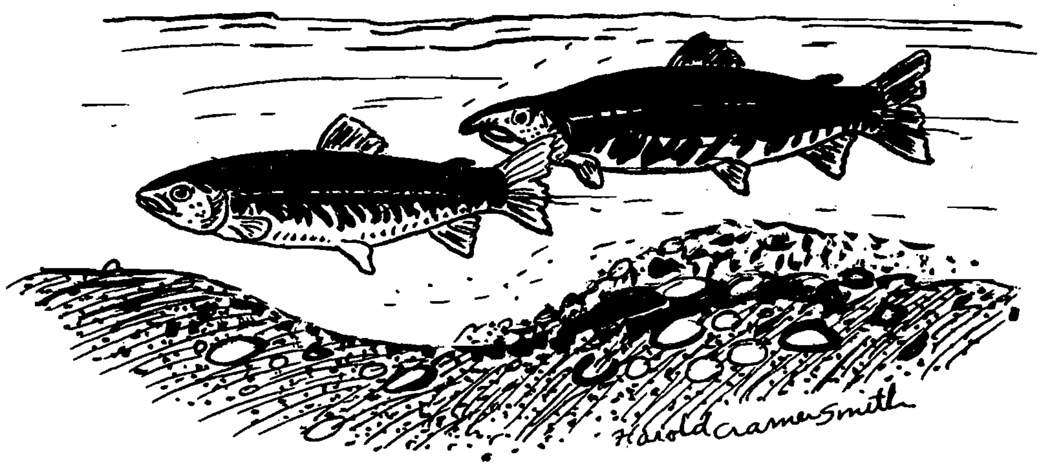
# Basin Investigations



LOWER WILLAMETTE BASIN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# THE FISH AND WILDLIFE RESOURCES OF THE LOWER WILLAMETTE BASIN, OREGON, AND THEIR WATER USE REQUIREMENTS

A Report with Recommendations to the
OREGON STATE WATER RESOURCES BOARD

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OREGON STATE GAME COMMISSION
Basin Investigations Section

FEDERAL AID TO FISH RESTORATION
Progress Report

Fisheries Stream Flow Requirements
Project F-69-R-1, Job Number 2

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## P L A T E S

## INTRODUCTION

The Oregon State Game Commission's Basin Investigations Section began study in the Lower Willamette Basin relevant to this report in the spring of 1962. Most intensive field work was conducted in 1963. Primary objectives were to define water problems and needs associated with the basin's fish and wildlife resources and to submit findings and recommendations to the State Water Resources Board. This will enable the Board to give consideration to these needs along with other beneficial water uses when developing a comprehensive program for the area.

Results of the study are contained in this report. A similar report concerning the fish and wildlife resources of the Middle Willamette Basin was completed in February 1963. Study will continue in the Upper Willamette Basin in 1964 to provide complete coverage of the Willamette system.

Resumés of the resources--including abundance, distribution and value of various species--tabulations of data, and explanations of methods employed in the field studies are contained. One of the most important inclusions is the list of recommended minimum stream flows for fish production found in Appendix I.

Field surveys were conducted primarily by James M. Hutchison, Gary M. Hewitt and Wernald H. Christianson, Aquatic Biologists, and Ronald J. Sloan, Student Trainee. Personnel of the Fish Commission of Oregon, State Sanitary Authority, State Water Resources Board and U. S. Geological Survey cooperated with the development of some study aspects.

## FISH RESOURCES OF THE LOWER WILLAMETTE BASIN

### WILLAMETTE RIVER

#### Species Occurrence and Distribution

The most common anadromous fish entering the Willamette River are spring chinook and coho (silver) salmon, steelhead trout and shad. Accurate population calculations are available only for spring chinook, although substantial numbers of the other three species are known to exist.

Numbers of spring chinook entering the river each year are determined by Oregon Fish Commission counts at the Willamette Falls ladder, a cooperative analysis by the Oregon Fish Commission and Oregon Game Commission of the sport catch, and estimation of escapement into the Clackamas River. Since calculations of total chinook migration began in 1946, runs have been relatively uniform with the 48,100 fish total in 1963 being close to the 50,300 fish 18-year average (Hasselman and Stout, 1964). These data are presented in Table 1.

Willamette Falls ladder counts are not conducted during the major portions of adult coho (silver) salmon and steelhead trout migrations; consequently, it is difficult to determine sizes of these runs. Observations of sport catches and spawning of the two species indicate that numbers of each in the Willamette system above the falls are somewhat below those of spring chinook.

The size and timing of salmon and steelhead runs are closely associated with water quality of the lower Willamette River and passage of adults over Willamette Falls. Degree of successful passage of juvenile downstream migrants through several turbines at the falls also affects numbers of returning fish. These factors will be discussed in more detail later in this report.

Fall chinook salmon and sea-run cutthroat trout also enter the river, but knowledge is limited regarding distributions or sizes of these populations. Most or all of the fall chinook go into the Clackamas River.

Large numbers of shad are found in the lower river each spring, particularly in the section immediately below Willamette Falls. None are known to ascend the falls, although some may do so.

Despite poor summer water qualities, high populations of rough fish and warm-water game fish exist in the Willamette River both above and below the falls. Trap nets placed in the Portland harbor in the summer of 1961 by Game Commission and State Sanitary Authority personnel caught shad, white sturgeon, brown bullhead,

TABLE 1

Escapement and Sport Catch of Willamette River
Spring Chinook Salmon, 1946-1963

| Year | Willamette Falls Escapement (calculated) | Clackamas R. Escapement (estimated) | Sport Catch Below Willamette Falls | Total Run (calculated) | Sport Catch as Per Cent of Run |
|---|---|---|---|---|---|
| 1946 | 53,000 | 3,000 | 12,600 | 68,600 | 18 |
| 1947 | 45,000 | 2,000 | 12,000 | 59,000 | 20 |
| 1948 | 30,000 | 1,800 | 8,500 | 40,100 | 21 |
| 1949 | 27,000 | 1,800 | 9,100 | 37,900 | 24 |
| 1950 | 14,500 | 1,500 | 8,800 | 24,800 | 35 |
| 1951 | 34,300 | 2,000 | 13,300 | 49,600 | 27 |
| 1952 | 52,200 | 2,800 | 12,500 | 67,500 | 19 |
| 1953 | 76,400 | 4,000 | 16,400 | 96,800 | 17 |
| 1954 | 31,100 | 1,800 | 11,500 | 44,400 | 26 |
| 1955 | 22,000 | 1,500 | 9,000 | 32,500 | 28 |
| 1956 | 58,600 | 3,000 | 16,000 | 77,600 | 21 |
| 1957 | 39,300 | 2,000 | 11,500 | 52,800 | 22 |
| 1958 | 45,200 | 2,100 | 15,500 | 62,800 | 25 |
| 1959 | 31,900 | 3,000 | 18,500 | 53,400 | 35 |
| 1960 | 14,400 | 1,800 | 8,000 | 24,200 | 33 |
| 1961 | 18,900 | 2,200 | 6,400 | 27,500 | 23 |
| 1962 | 26,000 | 3,000 | 9,100 | 38,200 | 24 |
| 1963 | 30,300 | 4,000 | 13,600 | 48,100 | 28 |
| Average | 36,000 | 2,400 | 11,800 | 50,300 | 24 |

TABLE 2

A Comparison of Willamette River Spring Chinook Salmon Sport Fishery Data, 1946-1963

| Year | Angling Intensity in Man Days | Average Catch per Day | Angling Effort per Salmon in Days | Average Fish Weight in Pounds |
|---|---|---|---|---|
| 1946 | 61,900 | 0.20 | 5.0 | 17.0 |
| 1947 | 91,900 | 0.12 | 8.3 | 16.3 |
| 1948 | 83,600 | 0.10 | 10.0 | 16.5 |
| 1949 | 85,500 | 0.11 | 9.4 | 18.2 |
| 1950 | 73,400 | 0.12 | 8.3 | 16.6 |
| 1951 | 92,600 | 0.14 | 7.0 | 17.2 |
| 1952 | 91,100 | 0.13 | 7.7 | 16.8 |
| 1953 | 102,800 | 0.16 | 6.3 | 18.6 |
| 1954 | 104,100 | 0.11 | 9.2 | 18.6 |
| 1955 | 77,700 | 0.12 | 8.6 | 15.9 |
| 1956 | 84,100 | 0.19 | 5.3 | 18.4 |
| 1957 | 95,500 | 0.12 | 8.3 | 16.1 |
| 1958 | 137,900 | 0.11 | 8.9 | 18.2 |
| 1959 | 134,100 | 0.14 | 7.2 | 19.1 |
| 1960 | 92,300 | 0.09 | 11.6 | 16.4 |
| 1961 | 75,100 | 0.09 | 11.7 | 15.6 |
| 1962 | 74,000 | 0.12 | 8.1 | 16.8 |
| 1963 | 84,800 | 0.16 | 6.2 | 19.0 |
| Average | 91,244 | 0.13 | 7.7 | 17.3 |

black crappie, white crappie, yellow perch, bluegill sunfish, warmouth bass, carp, chiselmouth, squawfish, Columbia River chub, coarsescale sucker, and Pacific lamprey. Most of these species and others also exist in the river above the falls. Table 3 lists fish species and their general distributions in the basin.

## Angler Effort and Catch

Heaviest sport angling pressure in the lower Willamette River is exerted upon spring chinook salmon. This fishery takes place almost entirely below Willamette Falls, extending from a dead line below the falls to the river's mouth and throughout Multnomah Channel (Willamette Slough). It is the most concentrated inland salmon fishery and receives more chinook angling pressure than any Oregon river, with the possible exception of the Columbia.

Angling for this fish is conducted primarily from boats. Some bank angling occurs at the mouth of the Clackamas River and at the Black Point just below Willamette Falls. Most fishing takes place in the months of March, April and May, just before and during the period of heaviest upstream migration.

This is the only Willamette River fishery for which total catch calculations are made. Census of the fishery was initiated in 1941 and 1942 by the U. S. Fish and Wildlife Service and resumed in 1946 as a joint study by the Oregon Game and Fish Commissions. The present method consists of obtaining an estimate of the salmon catch per boat per day multiplied by the number of boats fishing each day during the entire season. Basic data are obtained from airplane counts of boats fishing on various days throughout the season and catch records from cooperating moorage operators. For the 18-year period beginning in 1946, anglers have caught an average of 11,800 spring chinook annually and have required 7.7 days of effort to catch each salmon. Tables 1 and 2 include effort and catch figures.

Coho salmon and steelhead trout angling is concentrated mainly just below Willamette Falls and at the mouth of the Clackamas River. Both boat and bank

TABLE 3

Known Fish Species Present and Their Distribution in the Lower Willamette Basin

| Species | Abb.[1/] | General Distribution |
|---|---|---|
| **Catfish**[2/] | | All introduced. |
| Black bullhead | BlB | Introduced into main stem Columbia, possibly other streams. |
| Brown bullhead | BrB | Very common in most lowland lakes and streams. |
| Channel catfish | CC | Introduced into Columbia and Willamette main stems. |
| Yellow bullhead | YB | Planted locally; abundant in Willamette Valley. |
| **Lamprey** (2 species) | L | Most streams; spawn in similar areas as do steelhead |
| **Minnows** | | |
| Carp | Cp | Introduced. Common in most lowland lakes, streams. |
| Chiselmouth | Clm | Lowland streams and sloughs. |
| Columbia River chub | CRC | Main stem Columbia and Willamette; possibly lower Tualatin. |
| Goldfish | GF | Introduced. Scattered throughout basin. |
| Oregon chub | OC | Main stem Willamette; possibly lower Tualatin. |
| Redside shiner | RsS | Very common in lowland streams extending into some higher streams. |
| Squawfish | Sq | Common in many lowland lakes and streams. |
| Tench | T | Introduced. Columbia main stem; probably lower Willamette. |
| **Perch** | | |
| Yellow perch[2/] | YP | Introduced into many lowland lakes and streams. |
| **Salmonids**[2/] | | |
| Brook trout | EB | Introduced. High lakes and streams (see App. III). |
| Brown trout | Br | Introduced. Harriet Lake; a few in upper Clackamas and Sandy systems. |
| Chinook salmon, fall | ChF | Lower Clackamas, Sandy and Scappoose systems, Tanner Creek. |
| Chinook salmon, spring | ChS | See Plate 3. |
| Chum salmon | CS | Columbia River; possibly Beaver Cr. (Sandy R.), Milton Cr. and Tanner Cr. |
| Cutthroat trout, coastal | Ct | Most streams in basin. |
| Cutthroat trout, spotted | SCt | Introduced. A few high lakes. |
| Dolly Varden trout | DV | A few in upper Clackamas and Sandy systems. |
| Golden trout | GT | Introduced. A few high lakes (see Appendix III). |
| Kokanee salmon | K | Introduced. A few lakes (see Appendix III). |
| Pink salmon | PS | Columbia River. |
| Rainbow trout | Rb | Planted in many streams and lakes (see Appendix III) |
| Silver salmon | Sil | See Plate 2. |
| Steelhead | St | See Plate 1. |
| Whitefish | Wf | Many lakes and streams of cooler temperature. |

Table 3 (continued)

| Species | Abb. | General Distribution |
|---|---|---|
| Sculpins (cottids) | Cot | Very common in all streams and some lakes. |
| Shad 2/ | Sh | Introduced. Main stem Columbia, lower Sandy and Willamette Rivers. |
| Smelt, Columbia River | Sm | Main stem Columbia, lower Sandy River. |
| Stickleback, three-spined | Skb | Many lowland streams and lakes. |
| Sturgeon (2 species) 2/ | Sg | Main stem Columbia and Willamette Rivers. |
| Suckers (2 species) | Su | Most lowland lakes and streams; up some rivers. |
| Sunfish 2/ | | All introduced. |
| Bass, largemouth | LB | Most lowland waterways. |
| Bass, smallmouth | SB | Main stem Columbia and Willamette; possibly other waters. |
| Bluegill sunfish | BG | Most lowland waterways. |
| Crappie, black | BC | " " " |
| Crappie, white | WC | " " " |
| Green sunfish | GS | Known only in Blue Lake, May spread to other waters. |
| Pumpkinseed | PK | Many lowland waterways. |
| Warmouth bass | Wm | " " " |
| Troutperch | TP | Most lowland streams. |

1/ Abbreviations used in other tables.

2/ Species defined as "game fish" in 1963-64 Oregon Game Code.

methods are popular. Fishing pressure as compared to the spring chinook fishery is moderate. Coho salmon angling occurs primarily in November and December, and steelhead angling from December until the beginning of spring chinook season.

Moderate to heavy shad fishing exists in the river directly below Willamette Falls in May, June and July. This fishery is gaining in popularity, a trend that will continue if present high shad numbers endure.

Angling for sturgeon is light to moderate in the river throughout the basin. It is conducted during much of the year, with heaviest pressure in spring months. Most fishing occurs at Oregon City. There, sturgeon anglers may frequently be seen fishing from the railing alongside Highway 99E near the center of town.

Warm-water game fish bear considerable angling pressure. This can be attributed both to substantial fish numbers and to proximity of the lower river to the state's largest population center. Excluding the Sauvie Island area, which will be discussed in the Columbia Subbasin section, the river above Willamette Falls experiences the greater fishing pressure.

Commercial fishing is not presently permitted for salmonids in any basin stream except the Columbia River. Sport and commercial fishing for anadromous species is extensive in the portion of the Columbia River encompassed by the Lower Willamette Basin boundaries.

## Factors Influencing the Resource

Willamette Falls Passage Problems Willamette Falls is located in the Willamette River near Oregon City at river mile 26.8.[1/] Its height varies radically with changes in river flow and from tailwater fluctuations caused by backwater from the Columbia River.

Problems exist at the falls which affect successful upstream and downstream passage of anadromous fish. The falls created an obstacle to adult salmon and steelhead trout even before man began alterations there in the nineteenth century.

1/ Stream miles referred to in this report were obtained from State Water Resources Board Map No. 2C.8.

Installation of turbines for power generation added injuries and mortalities of downstream migrant fish.

Improvement of both upstream and downstream fish passage and protective facilities is presently needed. Preliminary studies were completed on evaluation of existing upstream passage facilities at the falls, including recommendations for improvements, in 1960 for the Oregon Fish Commission (Holmes and Bell, 1960). A study to investigate engineering considerations relating to improved passage of downstream migrant fish was made for the Oregon Game Commission in 1962 (Cornell and others, 1962). It is expected that these two studies will form sound basis for realization of needed corrective measures.

Provision of upstream passage facilities at the falls began about 1885. The present ladder, located near the center of the falls, was built in 1904. Since then several alterations have been made; however, it remains largely inadequate. During periods of high river flow excessive water velocities in the fishway prevent fish passage. Conversely, during low flow periods the water is diverted to turbines, causing inadequate volumes to pass over the falls to attract fish to the fishway entrances (Holmes and Bell, 1960).

Most of the turbines discharge a short distance below the falls into a bay-like area on the west bank known as the "Cul-de-sac". High numbers of fish are attracted into this blind alley by this large water volume, compounding the difficulties encountered by fish in finding the ladder entrances.

Another hazard is created by certain water conditions associated with a large pothole known as the "Wet Hole". This deep, natural depression is situated near the base of the falls along the east bank. When the lower river level recedes below the rim of the hole, adult chinook frequently are trapped, unable to escape unless they are salvaged or tailwater level rises again.

Downstream migrants have difficulty in achieving safe passage past the falls because a major portion of the river flow passes through the power turbines during times of downstream migration. The Oregon Game Commission conducted studies at the falls in 1960 and 1961 to determine injuries and mortalities suffered by downstream migrants passing through the turbines of Crown Zellerbach Corporation, Portland General Electric Company and Publishers' Paper Company. Results revealed that the percentage of mortality experienced varied with each installation and operating condition. All three installations tested produced definite mortalities and injuries. Kills ranged from 7.7 to 100 per cent of the fish which passed through them.

Water Quality Pollution influencing fish and other aquatic organisms is more critical in the Willamette River than in any other large Oregon stream. Sources are most numerous in the river area from Willamette Falls to the mouth, although several important pollutant contributors exist in the river system above the falls. Cumulative effect of pollution becomes progressively more acute toward the mouth.

The most detrimental effect of Willamette River pollution upon fish is the lowering of the water's dissolved oxygen content. This is the oxygen utilized by fish in respiration. Dissolved oxygen concentration of five parts per million is considered minimal for proper survival of salmonids.

Dissolved oxygen concentrations less than five parts per million occur for extensive periods each year. The most prolonged periods occur in the Portland harbor where below minimal concentrations extend through most of July, August and September--often from June into October. These low levels not only influence health and survival of fish, but also limit or delay entry of anadromous fish, particularly coho salmon, into the river system. Vast potentials for such species as summer steelhead and fall chinook exist in streams of the Willamette drainage. Successful introduction of such fish will not be possible, however, without further pollution abatement.

The State Sanitary Authority maintains an active program in monitoring river quality, recommending pollution control measures and enforcing water pollution laws. This agency is working toward eventual maintenance of a minimum of five parts per million dissolved oxygen in the lower Willamette River. Minimum dissolved oxygen values measured in the Portland harbor by the State Sanitary Authority since 1953 are given in Table 4.

TABLE 4

Monthly Averages of Lowest Dissolved Oxygen Values
Expressed in Parts per Million, Recorded in Portland Harbor 1/

| Year | June | | July | | August | | September | | October | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1953 | - | - | 2.7 | (2.0) | 1.5 | (0.7) | 1.9 | (0.9) | 5.1 | (3.2) |
| 1954 | 6.7 | (6.7) 2/ | 5.5 | (3.8) | 2.9 | (2.7) | 4.3 | (3.2) | 5.1 | (5.1) |
| 1955 | 7.2 | (5.9) | 5.6 | (4.1) | 3.0 | (2.2) | 3.8 | (3.3) | - | - |
| 1956 | - | - | 4.0 | (2.5) | 3.0 | (2.6) | 4.3 | (4.2) | 5.1 | (3.8) |
| 1957 | 3.6 | (2.8) | 2.4 | (0.8) | 1.5 | (0.6) | 3.0 | (1.4) | 5.0 | (2.9) |
| 1958 | 4.8 | (1.8) | 4.4 | (2.9) | 3.4 | (2.4) | 4.5 | (3.8) | 5.9 | (5.7) |
| 1959 | 4.7 | (2.9) | 4.3 | (1.5) | 2.9 | (2.2) | 5.2 | (3.1) | 8.7 | (8.7) |
| 1960 | 5.8 | (5.2) | 4.4 | (3.5) | 3.6 | (3.0) | 4.8 | (4.3) | 5.4 | (3.7) |
| 1961 | 4.6 | (3.0) | 3.4 | (1.9) | 2.6 | (1.8) | 5.0 | (4.1) | 6.4 | (5.1) |
| 1962 | 6.1 | (5.2) | 4.4 | (3.5) | 3.6 | (2.8) | 3.6 | (2.7) | 5.5 | (3.8) |
| 1963 | 4.5 | (2.5) | 4.5 | (3.4) | 3.2 | (2.0) | 3.0 | (2.0) | 4.8 | (3.4) |

1/ Source: Oregon State Sanitary Authority.
2/ Monthly minimums are shown in parentheses.

Included in Table 5 are weekly water temperatures and dissolved oxygen values obtained in the river at six locations between Canby and Portland harbor in 1963.

Next to dissolved oxygen, summer and fall water temperature is probably the water quality factor most limiting the health and survival of fish in the lower Willamette River. Water temperatures below 65° F. are generally considered best for rearing salmonids. Table 6 shows water temperatures recorded in the Portland harbor by the State Sanitary Authority since 1953. From this it can be seen that temperatures exceeding 65° F. (18.3° C.) have occurred each year since 1953 in July, August and September. Temperatures exceeding 75° F. (23.9° C.) have been recorded during portions of six of the 11 years since 1953. Temperatures

TABLE 5

Weekly Dissolved Oxygen ($DO_2$) and Water Temperature (°C) Measurements Obtained at Six Locations in the Lower Willamette River by the State Sanitary Authority, 1963 1/

| Dates | Canby Ferry | | Marina Mart | | Sportcraft | | Oswego | | Steel Bridge | | S.P.&S.-R.R. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $DO_2$ | °C | $DO_2$ | °C | $DO_2$ | °C | $DO_2$ | °C | $DO_2$ | °C | $DO_2$ | °C |
| May 21 | 8.0 | 18 | 7.8 | 18 | 8.9 | 17 | - | - | 8.3 | 17 | 8.2 | 17 |
| 28 | 7.6 | 16 | 7.3 | 16 | 7.9 | 16 | 7.9 | 16 | 7.4 | 16 | 6.8 | 16 |
| June 4 | 7.3 | 16.5 | 7.2 | 16.5 | 7.5 | 16.5 | 7.1 | 16.5 | 5.5 | 17 | 4.9 | 17 |
| 11 | 7.9 | 17 | 7.3 | 17 | 7.9 | 17 | 7.8 | 17 | 6.9 | 16 | 6.5 | 16 |
| 18 | 6.4 | 23 | 6.1 | 22 | 5.6 | 22 | 5.2 | 21 | 4.5 | 20 | 4.7 | 20 |
| 25 | 7.5 | 17 | 6.2 | 17 | 5.8 | 18 | 5.3 | 17 | 4.0 | 18 | 2.5 | 19 |
| July 2 | 8.0 | 18 | 7.0 | 17 | 6.5 | 17 | 6.3 | 18 | 5.4 | 17 | 5.1 | 17 |
| 9 | 7.0 | 19 | 6.7 | 20 | 6.6 | 19 | 6.5 | 19 | 5.7 | 18 | 5.8 | 18 |
| 16 | 6.5 | 20 | 6.4 | 20 | 6.3 | 20 | 5.9 | 19 | 5.7 | 18 | 4.8 | 18 |
| 23 | 5.6 | 20 | 6.0 | 20 | 5.7 | 20 | 5.7 | 20 | 4.4 | 19 | 3.6 | 19 |
| 30 | 6.4 | 21 | 5.7 | 20 | 6.1 | 20 | 5.2 | 20 | 4.4 | 20 | 3.9 | 20 |
| Aug. 6 | 5.8 | 21 | 5.6 | 20 | 5.9 | 21 | 5.5 | 20 | 4.3 | 20 | 4.2 | 20 |
| 13 | 5.8 | 22 | 4.8 | 22 | 5.1 | 22 | 4.5 | 22 | 3.7 | 21 | 3.1 | 21 |
| 20 | 6.9 | 21 | 6.0 | 21 | 5.7 | 21 | 5.1 | 21 | 2.5 | 21 | 2.5 | 21 |
| 27 | 5.2 | 19 | 5.5 | 20 | 5.9 | 20 | 5.7 | 20 | 4.2 | 20 | 2.9 | 20 |
| Sept. 3 | 6.3 | 20 | 4.2 | 20 | 5.6 | 20 | 6.1 | 20 | 2.9 | 19 | 2.8 | 19 |
| 10 | 3.4 | 21 | 4.1 | 21 | 4.8 | 21 | 4.6 | 21 | 4.4 | 20 | 3.7 | 20 |
| 17 | 4.8 | 18 | 3.9 | 18 | 3.8 | 18 | 5.2 | 18 | 2.6 | 19 | 2.0 | 19 |
| 24 | 4.3 | 18 | 4.0 | 18 | 4.7 | 18 | 4.8 | 17 | 3.9 | 16.5 | 3.4 | 17 |
| Oct. 1 | 7.1 | 18 | 6.8 | 18 | 6.6 | 18 | 5.8 | 18 | 4.4 | 18 | 3.4 | 17 |
| 9 | 6.9 | 16 | 6.4 | 16 | 6.4 | 16 | 6.4 | 16 | 5.2 | 16.5 | 4.3 | 17 |
| 16 | 6.3 | 16 | 6.3 | 15.5 | 6.3 | 15.5 | 6.2 | 15.5 | 4.7 | 16 | 3.9 | 16 |
| 23 | 8.1 | 14 | 7.3 | 13 | 7.7 | 13 | 7.6 | 13 | 5.7 | 14 | 5.2 | 14 |
| 29 | 7.8 | 12 | 8.0 | 12 | 8.3 | 12 | 8.4 | 11.5 | 8.3 | 11 | 7.8 | 12 |
| Nov. 5 | 8.4 | 11 | 8.1 | 11 | 8.7 | 11 | 8.4 | 11 | 6.9 | 11 | 5.8 | 11 |
| 13 | 9.2 | 10 | 10.0 | 10 | 10.4 | 10 | 10.5 | 10 | 10.5 | 10 | 10.2 | 10 |
| 20 | 9.8 | 9 | 9.7 | 9 | 11.6 | 9 | 11.7 | 9 | 11.0 | 9 | 11.1 | 9 |
| Dec. 3 | 10.4 | 6 | 10.3 | 6 | 11.9 | 6 | 11.6 | 6 | 11.3 | 5.5 | 11.0 | 6 |

1/ Additional measurements, including other water quality factors, at these and other Willamette River locations were obtained in 1963 and in prior years.

TABLE 6

Maximum Water Temperatures (°C) Recorded in Portland Harbor, 1/

| Year | June | July | August | September | October |
|---|---|---|---|---|---|
| 1953 | - | 20.0 | 23.0 | 20.0 | 17.0 |
| 1954 | 13.0 | 22.0 | 21.0 | 20.0 | 15.0 |
| 1955 | 15.0 | 20.0 | 22.0 | 20.0 | - |
| 1956 | - | 25.0 | 24.0 | 21.0 | 16.0 |
| 1957 | 20.5 | 23.0 | 22.5 | 22.0 | 17.0 |
| 1958 | 21.5 | 27.5 | 26.0 | 21.0 | 17.0 |
| 1959 | 20.0 | 25.5 | 23.0 | 19.0 | 14.0 |
| 1960 | 21.0 | 26.0 | 24.0 | 19.0 | 17.0 |
| 1961 | 22.0 | 25.0 | 25.0 | 20.0 | 17.0 |
| 1962 | 21.0 | 24.0 | 22.0 | 20.0 | 17.0 |
| 1963 | 22.0 | 21.0 | 22.0 | 22.0 | 19.0 |

1/ Source: Oregon State Sanitary Authority

of the latter magnitude can force fish to seek more favorable habitat in other river areas, contribute to fish disease problems, and actually cause some mortalities.

Toxic materials discharged into the river can cause direct fish kills. Few actual fish kills have been recorded. This is probably because pollution, with resulting low dissolved oxygen values, and warm temperatures are not prevalent during major periods of anadromous fish migrations, and the remaining fish are driven from the area by advancing poor water quality factors before mortalities occur. On the other hand, large size of the area coupled with rapid decomposition of fish in warm water may be obscuring some fish kills caused by pollution and toxicants.

Pollution of the river is from a multitude of sources. Municipalities and paper processing mills are the main contributors. Four pulp mills, located at Salem, Newberg, West Linn and Oregon City, are responsible for the major sources of biochemical oxygen demand. Present waste disposal facilities at these mills are not generally adequate to maintain desirable dissolved oxygen levels for fish. All cities on the main river have been ordered by the State Sanitary Authority to provide secondary treatment or the equivalent of 85 per cent BOD (biological oxygen demand) removal for their wastes. The following statement from the 1962 annual report of that agency is whole-heartedly supported by the Oregon Game Commission:

> "In order to maintain satisfactory bacteriological and dissolved oxygen conditions in the waters of the main Willamette it will be necessary that all municipalities provide secondary treatment, that the oxygen demand of the pulp mill and other industrial wastes be further reduced and that minimum stream flows be regulated and augmented as much as possible."

## TUALATIN SUBBASIN

### Species Occurrence and Distribution

The coho salmon is the most numerous and widespread anadromous fish found in the Tualatin system. The Oregon Fish Commission estimates the present Tualatin run to average about 6,000 fish.

Steelhead and cutthroat trout are the only other anadromous species known to exist in the drainage. Less than 500 steelhead are known to enter the Tualatin River. Definite reasons for such low numbers are difficult to pinpoint but are probably closely associated with poor summer rearing conditions. In recent years steelhead have been recorded in the river to Lee Falls (river mile 74.7) and in tributaries East Dairy, Gales and Scoggin Creeks. Several spawning steelhead were observed in Gales Creek when making spawning flow studies in the spring of 1962.

Cutthroat trout enter the Tualatin River each winter to spawn. These fish are both sea-run and Willamette River resident forms. Runs are normally moderate. Smaller resident cutthroat trout occur throughout the year in most streams in moderate to high numbers. They are most plentiful in the headwater streams possessing cool summer temperatures.

Known and suspected coho and chinook salmon and steelhead trout distributions in Lower Willamette Basin streams are illustrated on Plates 1, 2 and 3 in the appendix. Distribution data for construction of the plates were obtained from Oregon Game Commission and Oregon Fish Commission records.

Spring chinook salmon were seen spawning in Gales Creek in September 1945 (Parkhurst and others, 1950). No subsequent records of chinook in the Tualatin system have been received. Scarcity of cool summer resting pools for adults is suspected to have contributed to the disappearance of this species. Spawning potential for salmon and steelhead is good, with best gravel supplies located in East Dairy, Gales, McKay and Scoggin Creeks, and in the Tualatin River in the vicinity of Cherry Grove.

Several warm-water game and rough species are common throughout the area. Highest populations occur in the main stem Tualatin River and its larger tributaries, being most concentrated in the lower reaches of each. Lake Oswego, through which Tualatin River water is diverted, also contains substantial populations of these species.

Angler Effort and Catch

Trout angling pressure, generally moderate, is directed toward native cutthroat trout and hatchery-reared fish. Stocking of legal-sized rainbow and cutthroat is conducted each year in the larger streams of the subbasin (Appendix III).

Limited angling for coho salmon takes place each fall and early winter. Angling for this fish and for migratory cutthroat is presently permitted in the main stem Tualatin below Highway 219 bridge.

Warm-water game fish receive moderate angling pressure. Most pressure is directed upon the lower Tualatin River. Table 7 lists information concerning the more important warm-water fishing areas in the Lower Willamette Basin. Yellow perch, bluegill sunfish, crappies, bullhead catfish and largemouth bass are most commonly caught in these areas. Lake Oswego and other low elevation lakes frequently lack public access, yet they receive considerable angling pressure from landowners and local residents.

TABLE 7

Popular Angling Areas for Warm-Water Game Fish in the Lower Willamette Basin

| Water | County | Acres | Public Access | Known Game Fish Present | Location |
|---|---|---|---|---|---|
| Benson Lake | Mult. | 40 | Yes | WC, LB, Rb | Near Multnomah Falls on Columbia R. highway |
| Blue Lake | Mult. | 125 | Yes | LB, Rb, BC, BG, GS | Three miles northwest of Troutdale and 1 mile south of Columbia R. |
| Borrow Pit | Wash. | 2 | Yes | LB, BG | Junction of Gales Cr. Road and Highway 6 |
| Burnham Pond | Col. | 3 | Yes | LB, BG | At Goble northwest of St. Helens |
| Bybee Lake | Mult. | 200 | Yes | WC, LB, BG, Brb | 2 miles southeast of the Willamette R. junction with Columbia R. |
| Columbia R. | Col. & Mult. | - | Yes | Several salmonids and warm-water species | Entire river and adjacent ponds and sloughs |
| Columbia Slough Pond #5 | Mult. | 6 | Yes | Brb, YP, Wm | Immediately to the east of N.E. 47th St. in Portland |
| Columbia Slough Pond #6 | Mult. | 10 | Yes | Brb, YP, Wm | Immediately to the east of N.E. 33rd St. in Portland |
| Fairview Lake | Mult. | 110 | Limited | LB, BC, BG, GS | Immediately adjoining Blue Lake on the south |
| Lake Oswego | Clack. | - | No | Several warm-water species. Some young anadromous species | Just off Highway 43 at town Lake Oswego |
| Mirror Lake | Mult. | 50 | Yes | WC, BrB, LB, BG | Rooster Rock State Park on Highway 30 |
| Oak Grove Lake | Mult. | - | Yes | BC, WC, Wm, BrB, LB | In town of Oak Grove |
| Ramsey Lake | Mult. | 150 | Yes | WC, BrB, YP, BG, LB | Immediately east of the junction of the Willamette R. and the Columbia R. |
| Sauvie Island (see Fig. 7) | Col. & Mult. | approx. 3,000 | Yes | Mixture of warm-water game fish | Ten miles northwest of Portland |
| Smith Lake | Mult. | 400 | Yes | WC, LB, BG, BrB | Bordered on east by N. Portland Road and on south by Columbia Slough |
| Vanport Sloughs | Mult. | 100 | Yes | | In old Vanport housing area south of P.I. Building, west of N. Denver Avenue |
| Bayan Slough | Mult. | - | Yes | BG, Wm, WC, PK, BrB | One of Vanport Sloughs |
| Force Lake | Mult. | - | Yes | Wm, BG | " " " " |
| Mud Slough | Mult. | - | Yes | Wm, BG | " " " " |
| Tualatin R. | Mult. | - | Yes | Several salmonids & warm-water species | Lower portions of Tualatin R. |
| Willamette R. | Mult. & Clack. | - | Yes | Several salmonids & warm-water spp. Sh, Sg | Entire river within basin. Most angling is above Willamette Falls |

Factors Influencing the Resource

Dams and Barriers  Critical fish passage problems are created by a dam on the Tualatin River at river mile 3.8 (Figure 1). This structure's purpose is to divert water to Lake Oswego. The canal headgate is at river mile 6.8. Only about six feet high when splash boards are installed, the dam nevertheless forms a complete barrier to upstream coho salmon passage during low flow periods. Fish passage is not possible until the splash boards are removed or washed out by fall freshets. A wooden ladder which was located at the north end of the dam was washed away in the spring of 1959 and has not been replaced. Limited amounts of water escape from the dam in summer and fall months, preventing successful upstream passage of coho salmon through the 3.8-mile lower river section, particularly in years with delayed fall rains.

A minimum flow of 20 cubic feet per second (cfs) through this area in October and November has been proposed by the U. S. Fish and Wildlife Service (Tualatin Project, Oregon, 1963) to provide upstream passage for silver salmon. In conjunction with other field surveys, detailed studies of river flows below the dam were made by Oregon Game Commission personnel at two flow volumes (obtained from a U.S. Geological Survey gage 1.8 miles above the mouth) in the summer of 1963. The entire area was inspected either on foot or from a rubber boat. From these studies it was determined that a flow of 20 cfs through this river section would be an absolute minimum for coho salmon or steelhead passage and that 30 cfs would be more desirable (Figure 2).

A 20-foot natural falls is located directly below a 20-foot dam at the outlet of Lake Oswego. The dam and falls provide head for a powerplant which receives the lake outflow at a point a short distance below the falls. Since Tualatin River water passes through the lake, adult coho salmon of Tualatin system origin are attracted each fall from the Willamette River into the lake outlet (Sucker Creek). Some of these fish have been salvaged in several past

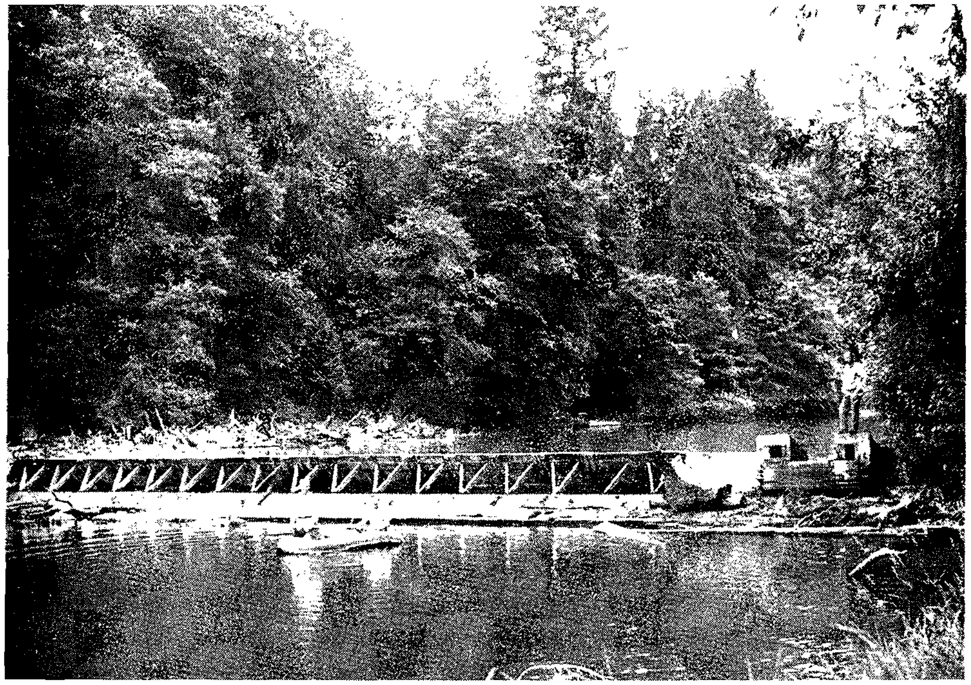


Figure 1. Lake Oswego diversion dam on Tualatin River, river mile 3.8. August 5, 1963.

Figure 2. Tualatin River at river mile 0.25 showing conditions at low flow (approximately 31 c.f.s.). August 5, 1963.

years by Oregon Fish Commission personnel.

If salmon, and occasional steelhead, continue to concentrate below the falls, possible solutions to the problem are: more intensive harvest by sport anglers; continued salvaging; construction of a barrier at the mouth of Sucker Creek to prevent fish entry; construction of fish passage facilities at the lake outlet. Attainment of proposed improvements to lower Tualatin River passage flows and to passage facilities over Willamette Falls could assist in alleviating the fish concentration problem in Sucker Creek.

Lee Falls forms another major barrier to anadromous fish. This 12-foot natural falls is in the Tualatin River near river mile 75. Provision of passage facilities is not considered feasible because another impassable barrier, Haines Falls, is located two miles farther upstream. No other barriers of major significance to anadromous fish exist in the subbasin.

Water Quantity Severe water shortages which limit salmonid survival exist in many Tualatin drainage streams. Only headwater streams normally possess acceptable summer water quantities. The flow deficiencies are typical of those found in other Willamette tributaries from the west.

In the Tualatin system consumptive water uses critically deplete summer and fall flows. Consumptive surface water rights currently exist for approximately 400 cubic feet per second. Over 80 per cent of this water is for irrigation purposes.[1/] Heaviest withdrawal of irrigation water is from the main stem Tualatin River. This water is most commonly removed from the river channel with electric or gasoline driven pumps. Extensive sections of the river from Gaston (river mile 65) downstream become dry or intermittent every summer.

Low, warm rearing flows in the river and several of its tributaries create one of the greatest known limiting factors on anadromous fish numbers. It has been mentioned previously that poor summer conditions are suspected to have been

1/ From State Water Resources Board records.

a major cause for spring chinook salmon extinction in the drainage. Coho (silver) salmon and steelhead have maintained runs largely because the adults do not require summer residency, and a number of their progeny, either by adaptation or necessity, rear in headwater streams.

Water Quality High water temperatures in summer months are more predominant in lower portions of Tualatin subbasin streams than in most other Willamette River tributary systems originating in the Coast Range. These temperatures are a direct result of depleted flows and low stream gradients within the Willamette Valley floor. The low gradients and flows cause reduced water velocities and subsequent extended exposure of flows to warm weather conditions.

Tualatin River temperatures frequently exceed 70° F. A maximum temperature of 76° F. was recorded by a thermograph installed at river mile 69.5 in August 1963 by the Oregon Fish Commission. Temperatures near this extreme have been known to cause mortalities to young coho salmon in other Oregon streams. Stream temperatures and flows measured in numerous subbasin streams in 1962 and 1963 are included in Appendix II.

Dissolved oxygen levels below 5 parts per million are common in lower portions of the Tualatin River during summer and fall months. Although these levels are often below salmonid tolerance limits, warm-water game fish have been able to maintain substantial populations in this river area. Reduced, warm, slow-moving flows are the principal causes for these low dissolved oxygen concentrations. Pollution sources are few; however, any pollution coupled with existing poor quality flows could be seriously detrimental to all fish life. The State Sanitary Authority has conducted rather extensive water quality studies in the Tualatin River for several years.

CLACKAMAS SUBBASIN

## Species Occurrence and Distribution

The Clackamas River supports substantial runs of steelhead trout and coho and spring chinook salmon. Numbers of adults of these species counted over the North Fork Dam (river mile 30) since November 1957 are presented in Table 8. Timing of these runs is shown in Figure 3.

TABLE 8

Upstream Migrant Fish Counts, North Fork Dam
Clackamas River

| Year 1/ | Coho (silver) salmon | Chinook Salmon | Steelhead |
|---|---|---|---|
| 1958 | 620 | 475 | 1,648 |
| 1959 | 522 | 578 | 556 |
| 1960 | 1,330 | 287 | 1,148 |
| 1961 | 2,185 | 370 | 2,204 |
| 1962 | 2,189 | 666 | 4,365 |
| 1963 | 3,121 | 616 | 2,242 |

1/ Runs are listed in the year they terminate.

The coho run is estimated by the Fish Commission to average 14,000 fish annually. These fish spawn mainly in the river system below River Mill Dam (river mile 23.4). The average count over North Fork Dam since 1957 is 1,661 adults. Much larger proportions of the spring chinook and steelhead runs spawn in the river system above North Fork Dam. A run of fall chinook spawns primarily in the lower river and Eagle Creek. Although of undetermined magnitude, this run is presently considered to be small. Figure 4 illustrates when adult anadromous fish are present or spawning in Lower Willamette Basin streams.

Resident cutthroat trout and whitefish exist in moderate numbers throughout the watershed. Cutthroat numbers are highest in headwater areas. Sea-run cutthroat trout are common in the lower river system. Limited numbers of Dolly Varden, eastern brook and brown trout are widely scattered in the drainage. Dolly Varden are indigenous, while brown trout remain from early plantings. Eastern brook trout

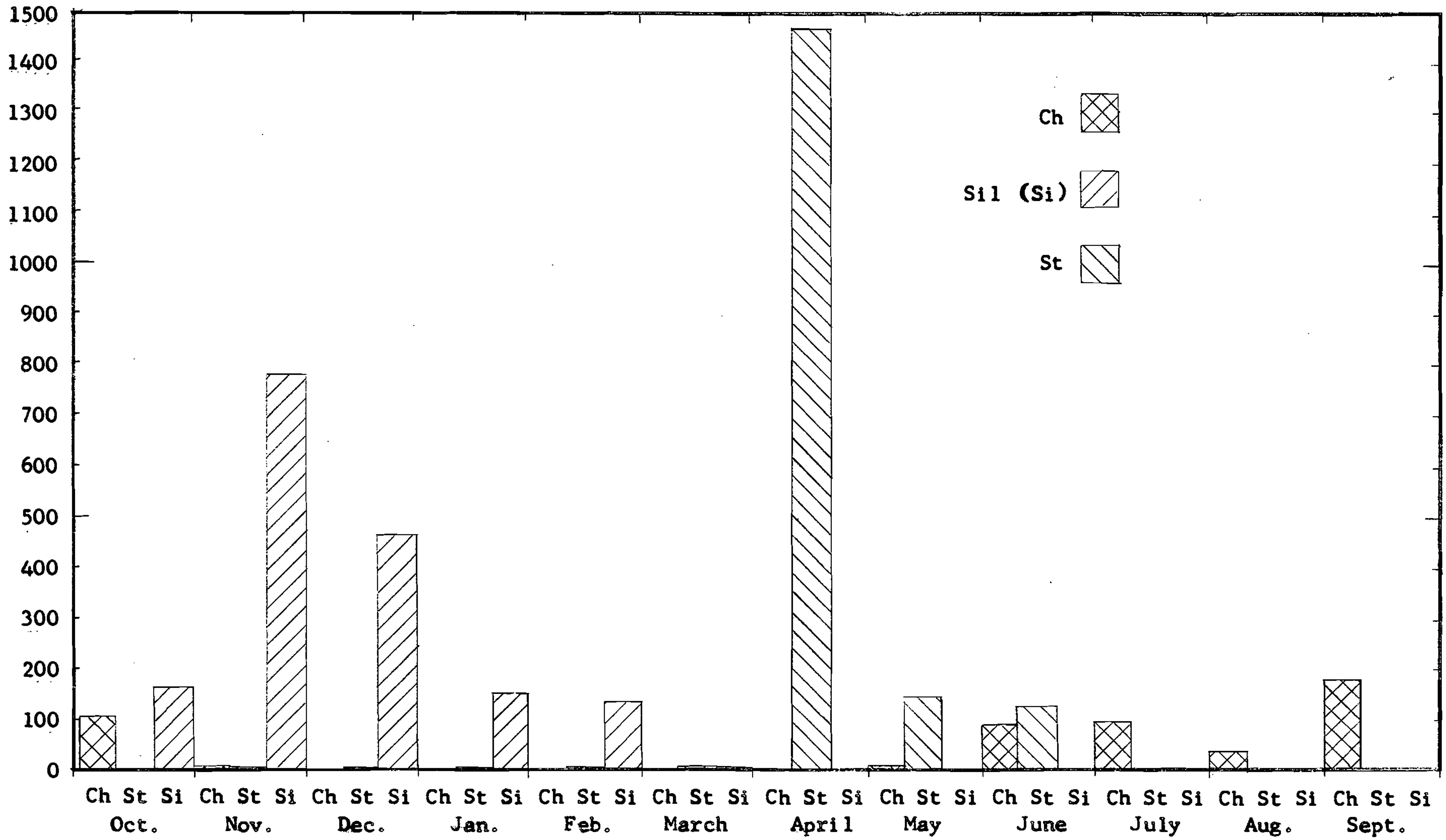



Figure 3. Average numbers and timing of adult anadromous fish runs; North Fork Dam, Clackamas River, 1957 through the 1962-63 migratory season.

PERIODICITY CHART, ANADROMOUS FISH SPAWNING

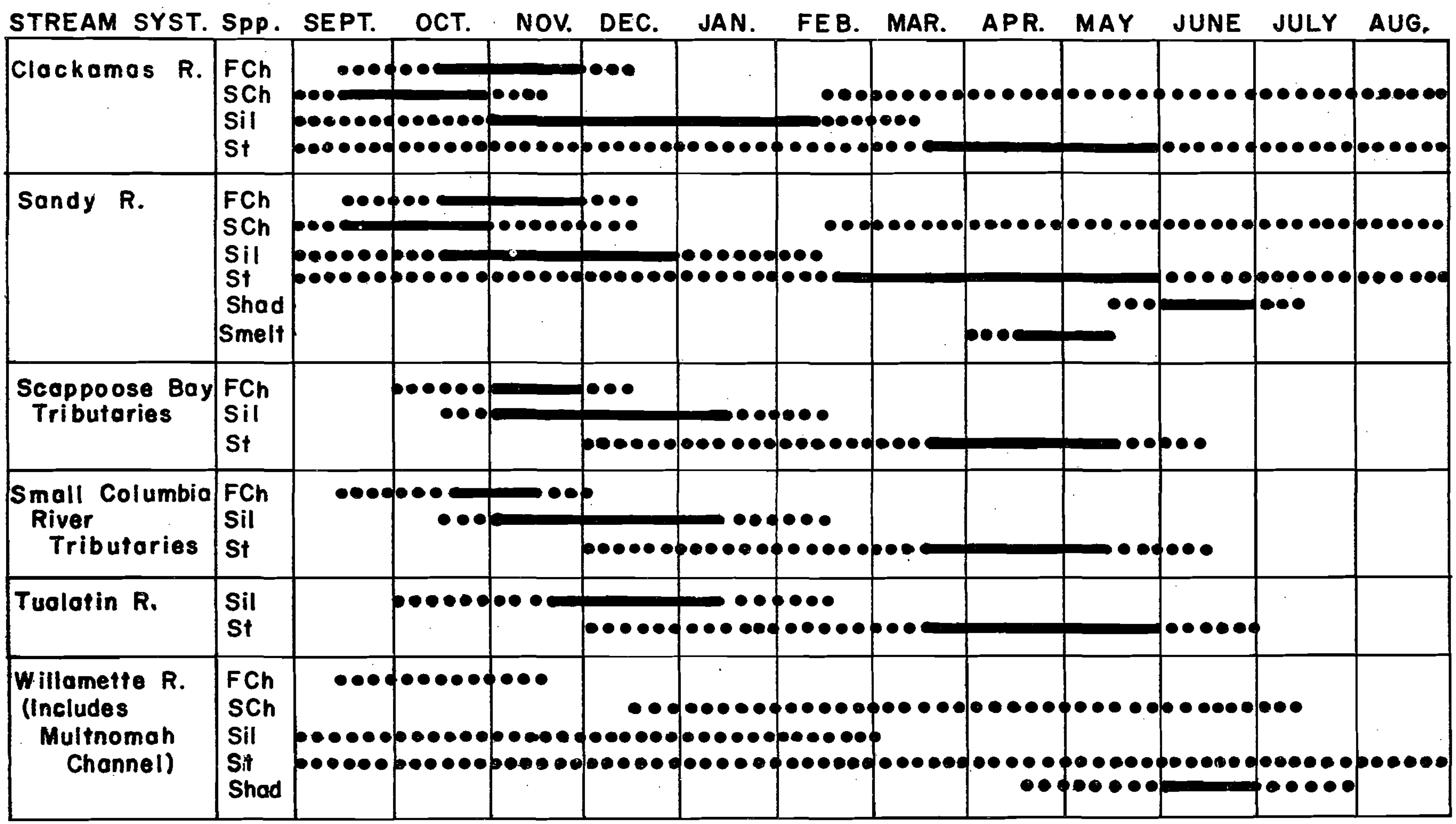



Figure 4. Periodicity chart showing when adult anadromous fish are present or spawning in Lower Willamette Basin streams. The dotted line indicates presence of adults in the streams, and the solid line indicates periods of heaviest spawning.

occur largely as the result of escapements from plantings in Cascade lakes.

Cool stream temperatures create unfavorable habitat for most warm-water game fish, consequently their numbers are low. Temperatures have the same effect on most rough fish, although suckers are able to exist in rather high numbers. Suckers are plentiful in North Fork Reservoir and the river downstream. Carp and squawfish are common in the river below River Mill Dam.

Angler Effort and Catch

Highly popular fisheries for steelhead trout and coho and spring chinook salmon extend from the mouth of the Clackamas River upstream to Cazadero Dam. Of the three, the steelhead fishery is the fastest-growing. Angling for this species is conducted generally from December into May.

Coho fishing takes place from October through December, and chinook fishing in spring months concurrent with the Willamette River chinook fishery. The heavy chinook angling pressure occurring at the mouth of the Clackamas has previously been mentioned. Both boat and bank fishing for salmon and steelhead is employed in the main stem. Boat angling for spring chinook and steelhead is becoming an increasingly popular method.

Stream trout fishing is concentrated mainly upon hatchery-reared rainbow trout. The Clackamas River system receives greater numbers of legal-sized trout than any other Oregon stream exclusive of the McKenzie River. In excess of 100,000 rainbow are stocked each year, most of these in the system above North Fork Reservoir (Appendix III). Resultant angling pressure is extremely high. Moderate angling for resident cutthroat trout takes place in upper portions of most streams.

Timothy Lake, Harriet Lake and many smaller high Cascade lakes also receive considerable angling pressure. Rainbow trout make up the bulk of the Timothy Lake catch. Some cutthroat trout and kokanee are taken there as well. Rainbow and brown trout are the most commonly caught species in Harriet Lake. Eastern brook trout is the predominant species in the other Cascade lakes. Data concerning the high elevation lakes, including fish present, are given in Appendix IV. Basin creel census data are presented in Appendixes V and VI.

Factors Influencing the Resource

Water Quantity Stream and lake water quantities are generally acceptable for fish life. This is fortunate considering the many water use requirements normally associated with an area of such high human population. Consumptive use of Clackamas system water is minimal. Most of this is for municipal purposes.

Extensive nonconsumptive water use exists for power generation. Portland General Electric Company has hydroelectric plants at four locations along the main stem Clackamas River between river miles 23.4 and 47.8. With one exception, this use does not now adversely affect fish life to a large degree. This exception is the extreme daily fluctuation of Clackamas River flows below river mile 47.8, and particularly downstream from River Mill Dam (river mile 23.4). Several detrimental effects result, the most important of which are the retarding of food production, the fluctuating of flow conditions on spawning fish and their redds, the stranding of some fish, and the endangering of anglers and other recreationists.

One of the most apparent effects on fish is the subjection of spawning spring chinook salmon to highly fluctuating water depths and velocities. These extreme flow variations not only discourage spawning but, by lowering intragravel water permeability and dissolved oxygen concentrations, can also result in poor egg survival. At times, redds dug on a gravel bar a short distance below River Mill Dam have actually been exposed.

Whenever possible it would be desirable to establish minimum flow regimens compatible with power use in the river below River Mill Dam, especially during fish spawning periods. In the 1960 water year, momentary flow extremes recorded by a U. S. Geological Survey gage located just below the dam were 55,200 cfs on

November 24 and 55 cfs on March 10. Both extremes occurred in periods of anadromous fish spawning. Daily flow fluctuations of several hundred cubic feet per second are common in the lower river solely as the result of River Mill power-peaking operations.

A cursory fish and redd count conducted from the mouth to River Mill Dam in the fall of 1963 revealed that substantial numbers of spring chinook salmon spawn throughout this area. Heaviest spawning was within a short distance of the dam. This information is presented in Table 9.

TABLE 9

Cursory Counts of Spring Chinook Salmon and Redds, Clackamas River from River Mill Dam to the Mouth, October 1963 1/

| Number of Chinook | | | No. of | |
|---|---|---|---|---|
| Alive | Dead | Total | Redds | Location |
| 17 | 37 | 54 2/ | 10 | 0.1 mile below River Mill Dam. |
| 6 | 0 | 6 | 1 | 0.3 mile below River Mill Dam. |
| 0 | 2 | 2 | 0 | 1.0 mile below River Mill Dam. |
| 1 | 0 | 1 | 0 | River mile 19.5 |
| 0 | 1 | 1 | 0 | River mile 19.0 |
| 0 | 9 (1) 3/ | 9 | 0 | From river mile 14.5 to 19.0 |
| 5 | 0 | 5 | 2 | 0.3 mile above Barton Park. |
| 9 | 1 | 10 | 3 | First riffle above Barton Park |
| 2 | 0 | 2 | 1 | 1.0 mile below Carver bridge. |
| 0 | 1 | 1 | 0 | River mile 2.0 |
| Totals | | | | |
| 40 | 51 | 91 | 17 | |

1/ An unknown, though probably small, percentage of the total fish and redds present was observed.

2/ Most of these fish were counted using SCUBA gear. Remainder of counts were made from a boat.

3/ Number in parenthesis is a jack salmon included in total.

Water Quality Water quality problems affecting fish are few. As a rule, good water qualities accompany the prevalently acceptable water quantities.

Water temperatures, except in an occasional low elevation stream, are within proper limits for salmonid production. Summer stream temperatures and flows measured in many subbasin streams in 1962 and 1963 are included in Appendix II.

Pollution is at a minimum. When pollution does occur, effluents are usually dissipated by stream flows of good quantity and quality. Active and past logging and road building activities in the upper watershed have not substantially altered water qualities. A few gravel washing operations along the lower Clackamas River periodically cause increased river turbidities which are not conducive to best salmonid production or angling.

Dams and Barriers Three large hydroelectric dams exist in the main stem Clackamas River between river miles 23.4 and 30.0. The structures, River Mill, Cazadero and North Fork, are operated by Portland General Electric Company.

Of the three dams, North Fork is the largest and most recently constructed. The 206-foot concrete structure was completed in 1958. Located at river mile 30, it is the uppermost of the three dams. Its fish passage facilities are integrated with those of Cazadero and River Mill Dams situated 1.7 and 6.6 miles downstream, respectively. Upstream migrant fish enter a collection system below Cazadero Dam and are passed above it and North Fork Dam by way of a 1.7-mile ladder. Downstream migrants leave North Fork Reservoir either by the spillway, the penstocks or a special collection system at the head of the ladder. Migrants utilizing the latter exit are transported by the ladder to Cazadero Dam where they are bypassed into a pipeline and returned to the river below River Mill Dam. Those fish emigrating via the spillway or penstocks must pass over the spillways or through the penstocks of the two dams downstream.

Cazadero Dam, built in 1904, was completely impassable for nearly 35 years until a fish ladder was constructed in 1939. This obstruction was probably responsible for the complete elimination of upper Clackamas River anadromous fish runs (Willis, Collins and Sams, 1960). The new ladder, which bypasses both Cazadero and North Fork Dams, appears to be successful in passing salmon and steelhead. A company financed evaluation study directed by the Federal Power Commission is currently under way.

River Mill, lowermost of the three dams, was completed in 1911. It is approximately 80 feet high. The original concrete ladder, except for the entrance, remains almost unchanged, being extremely steep, narrow and winding (Figures 5 and 6). The ladder by present fish passage standards is quite inadequate for anadromous fish use.

The dam and ladder particularly hinder spring chinook salmon runs. During spring months spring chinook in western Oregon normally ascend to cooler water areas in the upper portions of streams. There they reside in deep pools throughout the summer before spawning in September and October. A majority of the Clackamas spring chinook spend summer months in the river below River Mill Dam and do not ascend the ladder until just prior to spawning. Many reside in the large pool beneath the dam where they must ripen in unaccustomed water temperatures and are subject to poaching which has become a problem. A number of these fish never do ascend the ladder since maturation is completed prior to favorable passage conditions. They are forced to drop downstream to spawn within a short distance of the dam. A high percentage of dead female chinook examined during the 1963 spawning count (Talbe 9) possessed full, unspawned egg skeins. This may have been a direct or indirect result of excessive delay at River Mill Dam. It is regrettable that such a poor fish ladder is located just downstream from another of modern design. The effects of severe daily flow fluctuation upon salmon in this river section have been described.

A few other small dams exist in some Clackamas River tributaries. Fish passage facilities are not adequate in all cases. At least one dam which

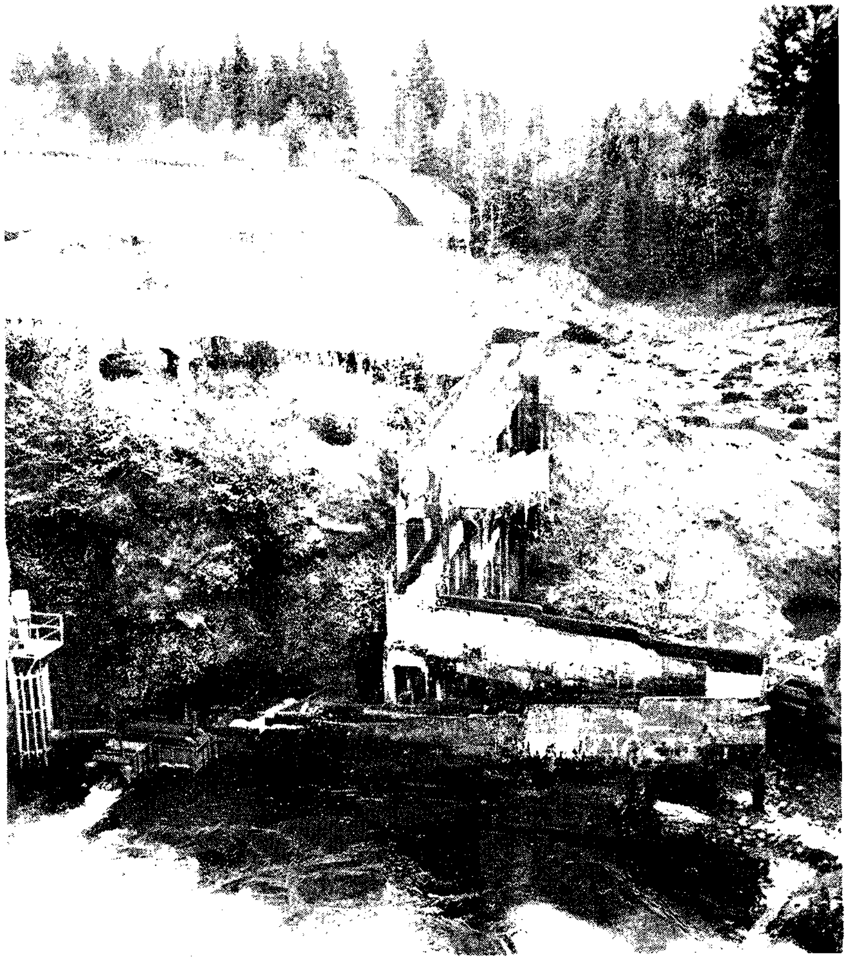


Figure 5. Fish ladder at River Mill Dam. April 1963.

Figure 6. View of River Mill ladder from top of dam showing narrow, steep, circuitous route. April 1963.

influenced anadromous fish passage existed in the lower Clackamas River prior to 1900.

Two Portland General Electric Company dams on Oak Grove Fork are located above the range of anadromous fish. The lower dam forms a 23-acre impoundment, Harriet Lake, from which water is diverted to Oak Grove powerhouse on the Clackamas River. The upper dam creates Timothy Lake, a highly popular trout fishing impoundment approximately 1,200 acres in size. Water from Timothy Lake is released to augment Harriet Lake.

Natural barriers to fish are present in several Clackamas tributaries. Major falls impassable to anadromous fish are located in the South Fork Clackamas River near river mile 0.6, North Fork Clackamas River near river mile 2.5, Roaring River near river mile 1.0, Collawash River near river mile 7.0, Oak Grove Fork Clackamas River near river mile 4.0, Eagle Creek just above Eagle Creek Fish Hatchery, Fish Creek about 1.0 mile above Wash Creek, Hot Springs Fork Collawash River near river mile 6.0, and Clear Creek just above Little Clear Creek. Provision of fish passage facilities over two of the falls, on Collawash River and its tributary Hot Springs Fork, may be feasible.

## COLUMBIA SUBBASIN

### Species Occurrence and Distribution

Important anadromous fish streams of this subbasin, excluding the Columbia and Willamette Rivers, are Johnson, Milton and Scappoose Creeks. Coho salmon and steelhead are common in these three stream systems. Fall chinook maintain a light to moderate run in Scappoose Creek. Chum salmon have been recorded in Milton Creek, and small numbers may spawn in other streams.

Nonmigratory cutthroat trout occur in upper sections of most streams which maintain adequate summer flows. In addition, legal-sized cutthroat or rainbow trout are stocked each year in Johnson, Milton and Scappoose Creeks to supplement natural production and increase the angler catch.

Rough fish and warm-water game fish numbers are high in Multnomah Channel and in the lakes and sloughs associated with Sauvie Island and the Columbia and Willamette Rivers. Rough fish are also common in the lower portions of the larger creeks.

Angler Effort and Catch

Trout angling is generally moderate and directed mainly toward hatchery trout stocked in Johnson, Milton and Scappoose Creeks. Lower portions of these three streams are open to salmon and steelhead fishing and receive some pressure.

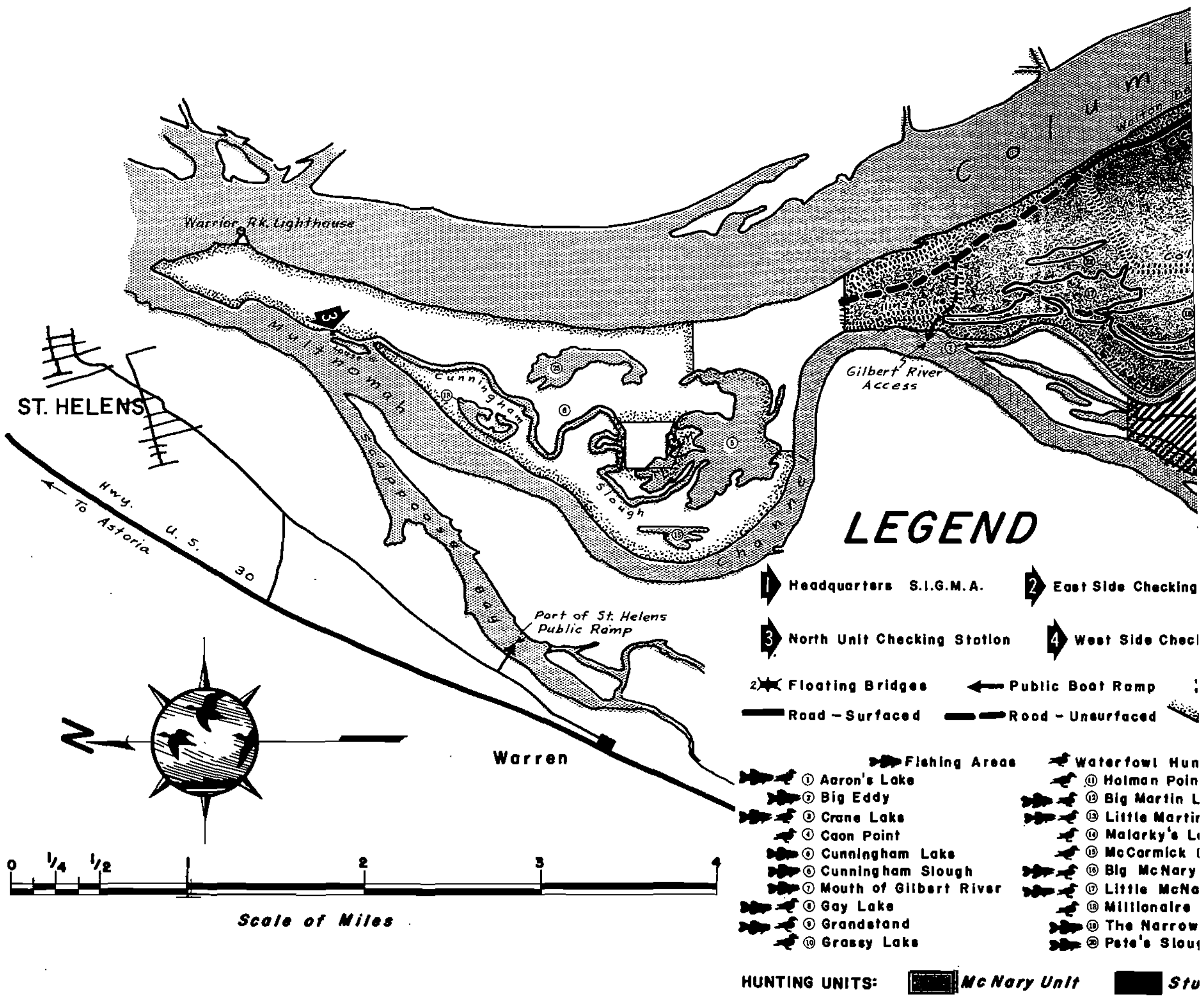
Heavy angling pressure is exerted upon warm-water game fish. Sauvie Island receives the greatest numbers of these anglers. Popular fishing areas on Sauvie Island are shown in Figure 7.

Factors Influencing the Resource

Most subbasin streams experience summer flows of inadequate water quantity and/or quality for salmonid production. The conditions prevail because drainage areas are rather small and in low-elevation, highly populated areas. Consumptive water uses are frequently heavy. Of these, municipal and irrigation uses are the largest. Anadromous fish populations are maintained largely because summer rearing conditions are more favorable in upper areas of some streams.

Water quality problems affecting fish are severe in Scappoose Bay. This large bay at the mouth of Scappoose Creek enters the lower Multnomah Channel near St. Helens. Two large industries, Kaiser Gypsum softboard plant and Crown Zellerbach Pulp and Paper Company, are located in the vicinity of the bay. Both are significant sources of organic wastes. A critical dissolved oxygen depletion problem exists in Scappoose Bay during summer and fall months, which is caused primarily by organic effluents from the Kaiser Gypsum plant. Low dissolved oxygen levels and toxic materials have caused several past fish kills in Scappoose Bay.

Figure 7. SAUVIE ISLAND GAME MANAGEMENT AREA



Large portions of the Willamette River's anadromous fish runs enter the system via Multnomah Channel. The channel has poor water qualities in late summer months because of several pollution sources--the most severe being around Scappoose Bay--and because it receives Willamette River flows during this period. When the Columbia is in flood its waters join the Willamette flows in Multnomah Channel. This markedly improves the channel's water quality.

## SANDY SUBBASIN

### Species Occurrence and Distribution

The Sandy River system ranks close to the Clackamas drainage in numbers of anadromous fish produced. Coho salmon and steelhead trout possess the largest runs. Substantial runs of spring and fall chinook salmon also exist.

Counts of all salmon and steelhead ascending Marmot (Big Sandy) Dam are obtained by the Oregon Game Commission with a combination trap and electronic counter in the fish ladder. Steelhead and spring chinook have been enumerated since 1954 and coho since 1958. These counts are presented in Table 10.

TABLE 10

Adult Fish Counts Over Marmot Dam Ladder
Sandy River

| Year 1/ | Spring Chinook Salmon | Coho (Silver) Salmon | Steelhead |
|---|---|---|---|
| 1954 | 400 | - | 2,200 |
| 1955 | 5 | - | 1,581 |
| 1956 | 0 | - | 2,240 |
| 1957 | 10 | - | 2,054 |
| 1958 | 78 | 264 (222) 2/ | 3,166 |
| 1959 | 304 | 330 (247) | 2,359 |
| 1960 | 23 | 68 (34) | 1,612 |
| 1961 | 37 | 1,670 (568) | 3,124 |
| 1962 | 65 | 1,769 (212) | 4,045 |
| 1963 | 122 | 1,458 (452) | 3,326 |

1/ Runs are listed in the year they terminate.

2/ Numbers in parentheses are jacks included in total.

Greater than half of the river system's steelhead spawn above Marmot Dam (river mile 30). Less than half of the coho salmon spawn above the dam. Probably more spring chinook spawn below the dam than above it. Nearly all fall chinook spawn in the larger streams of the system below Marmot Dam. An occasional adult is counted through the ladder. Little information is available regarding size of the fall chinook run, although observations of spawning salmon made in the lower 13 miles of Sandy River during flow studies in October and November 1963 revealed substantial numbers of this race.

A remnant run of summer steelhead exists in the system. For the past several years adult summer steelhead have been recorded in the pool beneath the City of Portland's headworks dam on the Bull Run River.

A small run of chum salmon was recorded in Beaver Creek, a lower Sandy River tributary, in 1952 (Pirtle, 1953).

The Sandy River has long been Oregon's largest producer of eulachon or Columbia River smelt. However, the river is subject to years or periods of several years without smelt runs. There has been no recorded run since 1957. Table 11 lists smelt run information compiled since 1919. When runs occur the fish enter the river to spawn from mid-March to mid-April and are most concentrated in the lower few miles.

Large numbers of shad enter the lower Sandy River during the spawning migration each spring. They, like smelt, do not normally swim far up the river although both shad and smelt have been recorded as high as nine miles above the mouth (Pirtle, 1953).

Resident cutthroat trout and whitefish exist throughout the Sandy drainage in moderate numbers. Highest cutthroat populations are located in headwater streams. Sea-run cutthroat trout enter the system in unknown numbers. Large plants of rainbow trout are made in streams above Brightwood (river mile 38) during each trout angling season. A few brown trout are scattered throughout the system.

TABLE 11

Sandy River Smelt Run Data, 1908-1963

| Year | Run Started | Run Ended | Remarks |
|---|---|---|---|
| 1908-1916 | - | - | No records of runs. |
| 1919 | March 29 | - | Large run of fish taken for hatchery food. |
| 1920 | No run | - | |
| 1921 | No run | - | |
| 1922 | April 11 | - | Second run began on April 17. |
| 1923 | April 4 | - | Very light because of obstruction in Sandy River. |
| 1924 | March 28 | - | Channel still blocked. |
| 1925 | March 14 | April 4 | One of longest runs. Fish Commission transferred some smelt to Clackamas River. |
| 1926 | March 12 | - | 50,000 people out. |
| 1927 | March 28 | - | Poor run. |
| 1928 | March 12 | - | |

| Year | Run Started | Run Ended | Number of Licenses Sold | License Funds Received |
|---|---|---|---|---|
| 1929 | April 9 | - | 793 | $ 396.00 |
| 1930 | March 18 | - | 5,786 | 1,893.00 |
| 1931 | No run | - | - | - |
| 1932 | March 26 | - | 193 | 96.50 |
| 1933 | No run | - | - | - |
| 1934 | March 4 | - | 1,860 | 930.00 |
| 1935 | No run | - | - | - |
| 1936 | March 27 | April 8 | 2,536 | 1,268.00 |
| | | | Also ran heavily in Columbia R. at mouth of Tanner and Eagle Creeks. | |
| 1937-1939 | No runs | - | - | - |
| 1940 | March 6 | March 18 | 2,760 | 1,380.00 |
| 1941 | March 14 | March 24 | 2,775 | 1,398.50 |
| 1942 | March 19 | April 1 | 7,699 | 3,849.50 |
| 1943 | March 25 | April 1 | 6,596 | 3,298.00 |
| 1944 | No run | - | - | - |
| 1945 | April 1 | April 15 | 17,754 | 8,876.00 |
| 1946 | March 28 | April 8 | 19,725 | 9,862.50 |
| 1947 | No run | - | - | - |
| 1948 | March 27 | April 11 | 32,422 | 16,211.00 |
| 1949 | March 24 | April 9 | 42,612 | 21,306.00 |
| 1950 | No run | - | - | - |
| 1951 | April 5 | April 10 | 25,650 | 12,825.00 |
| 1952 | - | - | 1,960 | 980.00 |
| | | | To railroad bridge and out. | |
| 1953 | April 19 | April 29 | 59,503 | 29,751.00 |
| 1954 | April 1 | April 7 | 11,662 | 5,831.00 |
| 1955 | No run | - | - | - |
| 1956 | March 29 | April 10 | 34,288 | 17,194.00 |
| 1957 | March 26 | April 1 | 26,690 | 13,345.00 |
| 1958-1963 | No runs | - | - | - |

Warm-water game fish are limited mainly to a few slough and lake areas along the Columbia River. Rough fish numbers in streams of the subbasin are low. Fish distribution work conducted in several Sandy system streams in 1963 (Appendix VII) revealed cottids and lampreys to be the nongame species of most frequent occurrence. Cool water temperatures undoubtedly contribute to low rough fish numbers much as they do in streams of the Clackamas subbasin.

Several small Columbia River tributaries between the mouth of the Sandy River and Bonneville Dam are included in the Sandy subbasin. These are all characterized by high, impassable falls near their mouths with steep gradients above the fall areas. Anadromous fish use is frequently heavy in the short, accessible sections below the falls. Coho salmon and steelhead trout are known to utilize at least nine of these streams. Fall chinook and chum salmon enter Tanner Creek. Resident cutthroat and/or rainbow trout exist in stream areas above most of the falls.

Angler Effort and Catch

Steelhead presently receive more angling pressure than other anadromous species. Total Sandy River steelhead angler effort and catch is calculated each year as part of an Oregon Game Commission steelhead research program. Condensed catch data are given in Table 12. This study was initiated in the 1954-55 angling season to evaluate and enhance the river's winter steelhead run. Large annual releases of marked yearling steelhead have been included as part of the program. The percentage of these marked fish recorded as adults in angler catches and at the Marmot Dam trap during the 1963-64 run was very encouraging.

Moderate angling takes place for coho salmon. Fishing for this species is conducted up to Marmot Dam and to Brightwood for steelhead. Boat angling is allowed only below Viking Bridge (river mile 5.8). One tributary, lower Bull Run River, is open to salmon and steelhead angling. It receives moderate pressure from steelhead anglers. Chinook salmon angling is minor and confined to the lower Sandy River.

Stream angling is popular for both native cutthroat and stocked rainbow trout. Most stocking and resultant angling are concentrated in the Sandy River system above

TABLE 12

Sandy River Steelhead Sport Fishery Statistics

| Angling Season | No. of Angler Days | Total Catch | Per cent in Catch Wild | Per cent in Catch Hatchery | Hrs. per Fish | Fish per Angler |
|---|---|---|---|---|---|---|
| 1954-1955 | 16,000 | 958 | 100 | None expected | - | 0.06 |
| 1955-1956 | 10,413 | 1,157 | 100 | None expected | 39.5 | 0.07 |
| 1956-1957 | 17,027 | 972 | 76 | 24 | 51.0 | 0.05 |
| 1957-1958 | 24,485 | 1,892 | 83 | 17 | 36.8 | 0.08 |
| 1958-1959 | 27,934 | 1,306 | 93 | 7 | 62.0 | 0.05 |
| 1959-1960 | 13,374 | 2,074 | 88 | 12 | 45.3 | 0.06 |
| 1960-1961 | 15,244 | 1,494 | 87 | 13 | 88.9 | 0.04 |
| 1961-1962 | 20,354 | 1,071 | 99 | 1 | 72.2 | 0.05 |
| 1962-1963 | 25,097 | 1,302 | 85 | 15 | 73.2 | 0.05 |

Brightwood. The main stem below this point is closed to summer trout angling because of its high value as a juvenile steelhead and salmon rearing area. Some angling for native rainbow and cutthroat trout occurs in portions of the Columbia River tributaries above the falls.

Benson, Roslyn and Trillium Lakes receive annual trout stocking and experience considerable angling pressure. A few small Cascade lakes accessible by trail are also fished (Appendix IV).

An extensive sport fishery exists for shad in the Sandy River each spring. Angling, most concentrated near the mouth, is conducted as shad enter to spawn when Columbia water floods the area. Most fishing is done with lures from boats.

When smelt enter the Sandy, throngs of people vie with one another for favorable fishing spots. Fishing is conducted primarily in the lower three miles of the river. Dip nets are most commonly used to catch this highly valued food fish. The legal limit per person is 25 pounds a day.

Factors Influencing the Resource

Water Quantity Most subbasin streams possess high elevation, well-forested upper watersheds. Consumptive use of surface water in the Sandy River drainage is low, presently totaling about 60 cfs exluding the Bull Run system. All of these rights are for withdrawals from tributaries; none are from the river itself.[1/] Consequently, flows for salmonid production are generally adequate throughout the year.

Flows from the river and its tributaries, with a few exceptions, have been withdrawn by legislative act from further appropriation except for stock, domestic, municipal and public park or recreational purposes. Flows in most of the small Columbia River tributaries in the subbasin also have been withdrawn from all uses other than fish culture. The Bull Run watershed has been reserved for exclusive municipal use by the City of Portland. To protect water quality, most of this watershed is closed to public entry. This eliminates all fishing and hunting in a large portion of the subbasin.

Water quantity problems which affect fish are of much importance and concern. These result primarily from the nonconsumptive use of Sandy River system flows for power generation. The most critical problems result from extreme daily fluctuations of the Sandy River below the mouth of the Bull Run River in summer and fall months caused by the Bull Run powerhouse. This Portland General Electric Company installation is located on the lower Bull Run River. Problems created closely parallel those which occur on the Clackamas River below River Mill Dam. They will be described in more detail in the Spawning Flow section of this report.

Another problem from use of Sandy River flows for power generation arises as substantial water volumes are diverted at Marmot Dam into a canal for eventual use at Bull Run powerhouse. In summer and fall months, the amount of water diverted commonly exceeds that permitted to pass over the dam. Resulting flows between Marmot Dam and the mouth of the Bull Run River 11.5 miles downstream sometimes drop

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1/ From records of the State Water Resources Board.

below desirable volumes for rearing, spawning and upstream passage of salmonids. This river section is an important rearing area for juvenile salmon and steelhead, and contains many of the river's best summer resting pools for adult spring chinook salmon.

Study in 1963 revealed that a minimum release of 50 cfs at Marmot Dam during summer and fall months would be adequate for rearing in this river section. This is assuming that water appropriations and flows of tributary streams in the area concerned remain relatively unchanged. The minimum flow recorded by a U. S. Geological Survey recorder located one-quarter mile below Marmot Dam from 1916 to 1919 was 4 cfs during September 17-29, 1918, and probably resulted from diversion at the dam. It is believed that flows of this extreme no longer occur although volumes less than the recommended 50 cfs are known to occur.

Water Quality Adequate water qualities for salmonid production exist in nearly all streams. Pollution sources detrimental to fish are few. A woolen mill at Troutdale discharges effluents into the Sandy River which may be harmful to aquatic life. Moderate to high natural siltation of the Sandy and some of its upper tributaries occurs during summer and fall months resulting from snow and glacier runoff. These silt loads may have detrimental effects upon stream productivity, fish health and production.

Stream temperatures are predominantly favorable for salmonids. The Oregon Game Commission maintained a thermograph in the Marmot Dam fish ladder from February to June 1961, and September 1961 to April 1962 to correlate upstream fish movement with water temperatures. Another thermograph was installed at the same location in the summer of 1963 to obtain records during the rearing period. From January to June 1953 the Game Commission collected temperature data in the river near river mile 2.0 in an effort to correlate water temperatures with the smelt runs. These records are presented in Tables 13 and 14. The Oregon Fish Commission maintained a thermograph in the Sandy River near Troutdale in the summer of 1963. The maximum temperature recorded was 71° F. in early August.

## TABLE 13

### WATER TEMPERATURES IN DEGREES FAHRENHEIT OF SANDY RIVER NEAR THE MOUTH

Type of Instrument: Thermograph (Taylor) Stream or Impoundment: Sandy R. Location: 0.5 mile below Highway 30

Dates covered: January 29 to June 4, 1953 Source: OSGC Pirtle

| Day | January Max. | January Min. | February Max. | February Min. | March Max. | March Min. | April Max. | April Min. | May Max. | May Min. | June Max. | June Min. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 42 | 40 | 40 | 35 | 48 | 40 | 46 | 43 | 52 | 49 |
| 2 | | | 41 | 40 | 36 | 34 | - | - | 47 | 44 | 51 | 50 |
| 3 | | | 43 | 40 | 40 | 35 | - | - | 52 | 45 | 52 | 48 |
| 4 | | | 42 | 42 | 46 | 39 | - | - | 54 | 49 | 52 | 50 1/ |
| 5 | | | 43 | 41 | 45 | 41 | - | - | 55 | 51 | | |
| 6 | | | 43 | 40 | 44 | 38 | - | - | 47 | 46 | | |
| 7 | | | 44 | 43 | 47 | 39 | 44 | 41 | 52 | 49 | | |
| 8 | | | 43 | 40 | 49 | 40 | 42 | 41 | 48 | 46 | | |
| 9 | | | 40 | 37 | 46 | 41 | 44 | 40 | 50 | 48 | | |
| 10 | | | 40 | 36 | 45 | 43 | 46 | 41 | 48 | 46 | | |
| 11 | | | 42 | 40 | 44 | 42 | 45 | 43 | 48 | 46 | | |
| 12 | | | 41 | 39 | 45 | 41 | 44 | 42 | 49 | 46 | | |
| 13 | | | 42 | 40 | 43 | 39 | 44 | 42 | 48 | 47 | | |
| 14 | | | 42 | 40 | 41 | 37 | 47 | 42 | 50 | 47 | | |
| 15 | | | 40 | 38 | 41 | 40 | 46 | 42 | 47 | 46 | | |
| 16 | | | 40 | 38 | 41 | 39 | 45 | 44 | 47 | 45 | | |
| 17 | | | 39 | 37 | 41 | 37 | 47 | 43 | 47 | 46 | | |
| 18 | | | 40 | 37 | 41 | 39 | 48 | 43 | 47 | 47 | | |
| 19 | | | 40 | 38 | 46 | 40 | 51 | 46 | 48 | 46 | | |
| 20 | | | 41 | 38 | 44 | 40 | 51 | 47 | 49 | 39 | | |
| 21 | | | 41 | 37 | 42 | 40 | 49 | 47 | 48 | 46 | | |
| 22 | | | 41 | 37 | 41 | 40 | 46 | 45 | 48 | 45 | | |
| 23 | | | 39 | 35 | 46 | 40 | 47 | 44 | 47 | 45 | | |
| 24 | | | 40 | 33 | 45 | 41 | 49 | 43 | 47 | 44 | | |
| 25 | | | 41 | 35 | 44 | 41 | 49 | 47 | 50 | 45 | | |
| 26 | | | 41 | 35 | 45 | 40 | 47 | 46 | 48 | 47 | | |
| 27 | | | 43 | 38 | 44 | 42 | 47 | 45 | 47 | 45 | | |
| 28 | | | 42 | 37 | 47 | 44 | 45 | 43 | 48 | 47 | | |
| 29 | 42 | 41 | | | 47 | 42 | 44 | 42 | 48 | 47 | | |
| 30 | 42 | 41 | | | 44 | 41 | 46 | 42 | 49 | 46 | | |
| 31 | 42 | 41 | | | 43 | 39 | | | 50 | 45 | | |
| Averages | 42.0 | 41.0 | 41.3 | 38.2 | 43.6 | 39.6 | 46.4 | 43.2 | 48.7 | 45.9 | 51.7 | 49.2 |

1/ Thermograph was removed in June when Columbia River water backed up the Sandy River and covered the recording site.

TABLE 14

WATER TEMPERATURES IN DEGREES FAHRENHEIT OF SANDY RIVER AT MARMOT DAM

Type of Instrument Thermograph (Taylor) Stream or Impoundment Sandy Location Marmot Dam, river mile 30.

Dates covered February 24 to June 19, 1961; Sept. 20, 1961 to April 22, 1962 and May 9 to October 10, 1963

Source OSGC, W. Stout

| Day | February Max. | February Min. | March Max. | March Min. | April Max. | April Min. | May Max. | May Min. | June Max. | June Min. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 43 | 41 | 48 | 43 | 47 | 45 | 60 | 50 |
| 2 | | | 42 | 40 | 46 | 44 | 47 | 44 | 59 | 51 |
| 3 | | | 41 | 39 | 46 | 42 | 45 | 43 | 60 | 52 |
| 4 | | | 42 | 40 | 46 | 40 | 43 | 41 | 61 | 52 |
| 5 | | | 41 | 40 | 46 | 40 | 44 | 41 | 56 | 53 |
| 6 | | | 41 | 39 | 47 | 41 | 45 | 43 | 54 | 50 |
| 7 | | | 44 | 40 | 48 | 41 | 47 | 43 | 56 | 47 |
| 8 | | | 43 | 41 | 44 | 43 | 48 | 44 | 54 | 49 |
| 9 | | | 44 | 41 | 44 | 42 | 47 | 45 | 51 | 49 |
| 10 | | | 42 | 40 | 45 | 42 | 47 | 44 | 56 | 47 |
| 11 | | | 43 | 41 | 47 | 43 | 46 | 43 | 55 | 50 |
| 12 | | | 43 | 40 | 46 | 43 | 47 | 44 | 59 | 49 |
| 13 | | | 43 | 42 | 44 | 42 | 47 | 44 | 61 | 50 |
| 14 | | | 44 | 42 | 47 | 41 | 48 | 45 | 63 | 53 |
| 15 | | | 44 | 42 | 50 | 43 | 49 | 45 | 65 | 54 |
| 16 | | | 45 | 42 | 49 | 44 | 54 | 46 | 66 | 56 |
| 17 | | | 44 | 43 | 46 | 44 | 52 | 46 | 65 | 55 |
| 18 | | | 46 | 41 | 44 | 41 | 55 | 46 | 64 | 55 |
| 19 | | | 44 | 42 | 42 | 39 | 56 | 47 | - | 55 |
| 20 | | | 43 | 42 | 44 | 39 | 53 | 47 | | |
| 21 | | | 46 | 41 | 45 | 42 | 51 | 46 | | |
| 22 | | | 44 | 43 | 41 | 39 | 50 | 46 | | |
| 23 | | | 45 | 42 | 42 | 40 | 49 | 46 | | |
| 24 | 44 | - | 45 | 42 | 46 | 42 | 54 | 45 | | |
| 25 | 42 | 40 | 44 | 42 | 45 | 42 | 55 | 47 | | |
| 26 | 43 | 40 | 43 | 41 | 50 | 43 | 53 | 49 | | |
| 27 | 43 | 40 | 44 | 39 | 49 | 42 | 54 | 47 | | |
| 28 | 43 | 41 | 47 | 40 | 50 | 44 | 53 | 47 | | |
| 29 | | | 47 | 40 | 46 | 45 | 53 | 48 | | |
| 30 | | | 47 | 42 | 48 | 44 | 52 | 49 | | |
| 31 | | | 45 | 44 | | | 56 | 47 | | |
| Averages | 43.0 | 40.2 | 43.8 | 41.1 | 46.0 | 42.0 | 49.9 | 45.3 | 59.2 | 51.4 |

Table 14 (continued)

Type of Instrument Thermograph (Taylor) Stream or Impoundment Sandy R. Location Marmot Dam, river mile 30.

Dates covered 9-20-61 to 4-22-62 Source OSGC

| Day | September Max. | September Min. | October Max. | October Min. | November Max. | November Min. | December Max. | December Min. | January Max. | January Min. | February Max. | February Min. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | 55 | 48 | 45 | 43 | 44 | 43 | 42 | 40 | 43 | 40 |
| 2 | | | 55 | 49 | 44 | 42 | 44 | 43 | 43 | 40 | 44 | 40 |
| 3 | | | 56 | 49 | 46 | 44 | 43 | 42 | 44 | 41 | 42 | 40 |
| 4 | | | 56 | 50 | 44 | 41 | 44 | 42 | 42 | 41 | 43 | 41 |
| 5 | | | 55 | 49 | 43 | 40 | 44 | 42 | 44 | 41 | 43 | 40 |
| 6 | | | 55 | 50 | 44 | 41 | 42 | 41 | 44 | 43 | 42 | 41 |
| 7 | | | 50 | 47 | 44 | 41 | 41 | 40 | 44 | 43 | 42 | 41 |
| 8 | | | 49 | 43 | 45 | 42 | 42 | 40 | 44 | 42 | 44 | 42 |
| 9 | | | 49 | 46 | 45 | 41 | 40 | 38 | 42 | 39 | 44 | 42 |
| 10 | | | 50 | 48 | 47 | 44 | 38 | 33 | 38 | 37 | 44 | 42 |
| 11 | | | 48 | 47 | 44 | 43 | 36 | 33 | 40 | 37 | 43 | 40 |
| 12 | | | 50 | 48 | 43 | 41 | 38 | 36 | 40 | 39 | 43 | 41 |
| 13 | | | 54 | 49 | 43 | 40 | 40 | 37 | 40 | 39 | 44 | 42 |
| 14 | | | 56 | 52 | 45 | 42 | 39 | 37 | 39 | 39 | 44 | 42 |
| 15 | | | 55 | 51 | 40 | 38 | 41 | 39 | 41 | 39 | 44 | 42 |
| 16 | | | 53 | 49 | 39 | 36 | 41 | 40 | 40 | 39 | 43 | 42 |
| 17 | | | 49 | 45 | 40 | 37 | 40 | 39 | 40 | 38 | 43 | 42 |
| 18 | | | 51 | 45 | 42 | 39 | 40 | 39 | 38 | 36 | 43 | 40 |
| 19 | | | 49 | 46 | 41 | 40 | 41 | 40 | 36 | 33 | 43 | 41 |
| 20 | 54 | - | 46 | 45 | 41 | 39 | 43 | 41 | 33 | 33 | 44 | 40 |
| 21 | 53 | 50 | 45 | 43 | 42 | 39 | 43 | 41 | 34 | 33 | 42 | 38 |
| 22 | 54 | 47 | - | 44 | 44 | 42 | 43 | 42 | 33 | 33 | 40 | 39 |
| 23 | 54 | 47 | Not | | 44 | 43 | 43 | 43 | 34 | 33 | 39 | 37 |
| 24 | 53 | 46 | changed | | 43 | 42 | 43 | 42 | 37 | 34 | 37 | 34 |
| 25 | 54 | 48 | this | | 41 | 39 | 42 | 41 | 40 | 38 | 37 | 34 |
| 26 | 53 | 47 | week. | | 41 | 39 | 42 | 41 | 41 | 39 | 36 | 33 |
| 27 | 54 | 46 | | | 43 | 41 | 42 | 40 | 41 | 40 | 36 | 33 |
| 28 | 53 | 51 | 45 | - | 44 | 43 | 44 | 41 | 41 | 38 | 35 | 33 |
| 29 | 51 | 48 | 45 | 41 | 44 | 43 | 44 | 43 | 42 | 39 | | |
| 30 | 50 | 47 | 46 | 41 | 44 | 43 | 43 | 41 | 43 | 40 | | |
| 31 | | | 46 | 42 | | | 42 | 41 | 42 | 39 | | |
| Averages | 53.0 | 47.7 | 50.7 | 46.4 | 43.2 | 40.9 | 41.7 | 40.3 | 40.6 | 38.2 | 42.4 | 39.4 |

Table 14 (continued)

Type of Instrument Thermograph (Taylor) Stream or Impoundment Sandy R. Location Marmot Dam, river mile 30.

Dates covered 9-20-61 to 4-22-62 Source OSGC

| Day | March Max. | March Min. | April Max. | April Min. |
|---|---|---|---|---|
| 1 | 36 | 35 | 44 | 41 |
| 2 | 36 | 34 | 44 | 42 |
| 3 | 36 | 34 | 46 | 40 |
| 4 | 39 | 36 | 44 | 42 |
| 5 | 40 | 38 | 45 | 42 |
| 6 | 41 | 39 | 44 | 42 |
| 7 | 41 | 39 | 43 | 41 |
| 8 | 41 | 39 | 43 | 41 |
| 9 | 40 | 37 | 43 | 41 |
| 10 | 40 | 38 | 46 | 41 |
| 11 | 41 | 38 | 48 | 40 |
| 12 | 43 | 37 | 49 | 42 |
| 13 | 44 | 37 | 49 | 43 |
| 14 | 44 | 38 | 49 | 43 |
| 15 | 44 | 38 | 46 | 43 |
| 16 | 44 | 40 | 49 | 41 |
| 17 | 46 | 39 | 50 | 43 |
| 18 | 45 | 39 | 51 | 44 |
| 19 | 45 | 41 | 48 | 45 |
| 20 | 44 | 40 | 45 | 43 |
| 21 | 40 | 39 | 50 | 43 |
| 22 | 43 | 40 | - | 43 |
| 23 | 43 | 40 | | |
| 24 | 42 | 41 | | |
| 25 | 43 | 41 | | |
| 26 | 43 | 41 | | |
| 27 | 42 | 40 | | |
| 28 | 45 | 39 | | |
| 29 | 47 | 40 | | |
| 30 | 47 | 40 | | |
| 31 | 48 | 40 | | |
| Averages | 42.4 | 38.6 | 46.5 | 42.1 |

Table 14 (continued)

Type of Instrument Thermograph (Partlow) Stream or Impoundment Sandy River Location Marmot Dam ladder, left bank in the top pool of the ladder. River mile 30 Dates covered 5-9-63 to 10-10-63 Source OSGC, Basins

| | May | | | | June | | | | July | | | | August | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Water | | Air | | Water | | Air | | Water | | Air | | Water | | Air | |
| Day | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| 1 | | | | | 53 | 50 | 57 | 50 | 56 | 47 | 59 | 43 | 59 | 53 | 72 | 49 |
| 2 | | | | | 51 | 47 | 51 | 44 | 55 | 51 | 59 | 49 | 58 | 54 | 70 | 47 |
| 3 | | | | | 47 | 45 | 48 | 43 | 59 | 49 | 65 | 46 | 58 | 57 | 64 | 52 |
| 4 | | | | | 48 | 46 | 48 | 45 | 57 | 52 | 60 | 50 | 59 | 57 | 68 | 55 |
| 5 | | | | | 48 | 46 | 48 | 44 | 58 | 51 | 65 | 49 | 59 | 58 | 58 | 53 |
| 6 | | | | | 47 | 45 | 48 | 43 | 57 | 52 | 58 | 52 | 59 | 58 | 66 | 54 |
| 7 | | | | | 47 | 45 | 48 | 44 | 53 | 51 | 53 | 50 | 59 | 57 | 70 | 49 |
| 8 | | | | | 48 | 47 | 49 | 46 | 54 | 50 | 56 | 48 | 59 | 57 | 72 | 50 |
| 9 | 44 | 44 | | | 49 | 46 | 50 | 43 | 63 | 51 | 54 | 50 | 59 | 57 | 61 | 57 |
| 10 | 45 | 44 | 43 | 34 | 56 | 45 | 60 | 42 | 52 | 50 | 52 | 49 | 59 | 56 | 71 | 54 |
| 11 | 44 | 43 | 42 | 38 | 57 | 49 | 63 | 46 | 56 | 48 | 54 | 49 | 60 | 57 | 73 | 53 |
| 12 | 43 | 42 | 44 | 39 | 56 | 52 | 64 | 53 | 60 | 50 | 63 | 51 | 61 | 59 | 69 | 58 |
| 13 | 47 | 42 | 54 | 34 | 60 | 50 | 68 | 50 | 63 | 54 | 67 | 53 | 60 | 58 | 61 | 57 |
| 14 | 50 | 43 | 59 | 38 | 62 | 51 | 73 | 50 | 61 | 54 | 59 | 54 | 58 | 57 | 64 | 54 |
| 15 | 48 | 46 | 52 | 43 | 64 | 54 | 76 | 54 | 55 | 52 | 58 | 51 | 58 | 55 | 68 | 49 |
| 16 | 52 | 43 | 59 | 39 | 63 | 55 | 74 | 55 | 57 | 50 | 61 | 48 | 59 | 56 | 69 | 49 |
| 17 | 56 | 45 | 74 | 42 | 63 | 53 | 73 | 52 | 56 | 52 | 59 | 51 | 59 | 57 | 67 | 50 |
| 18 | 57 | 48 | 73 | 50 | 62 | 54 | 79 | 52 | 61 | 53 | 66 | 49 | 58 | 57 | 62 | 51 |
| 19 | 58 | 48 | 79 | 38 | 60 | 54 | 64 | 54 | 61 | 53 | 60 | 49 | 58 | 57 | 60 | 53 |
| 20 | 60 | 39 | 83 | 56 | 58 | 52 | 59 | 51 | 60 | 55 | 62 | 55 | 57 | 56 | 59 | 52 |
| 21 | 59 | 39 | 71 | 51 | 52 | 49 | 51 | 46 | 62 | 55 | 67 | 54 | 56 | 55 | 57 | 52 |
| 22 | 59 | 49 | 56 | 50 | 51 | 48 | 51 | 46 | 62 | 54 | 60 | 50 | 57 | 55 | 63 | 53 |
| 23 | 52 | 47 | 56 | 46 | 50 | 48 | 50 | 47 | 59 | 50 | 66 | 46 | 55 | 54 | 57 | 52 |
| 24 | 52 | 47 | 54 | 46 | 50 | 48 | 50 | 47 | 58 | 45 | 60 | 53 | 54 | 53 | 52 | 46 |
| 25 | 54 | 46 | 58 | 45 | 54 | 49 | 54 | 43 | 59 | 53 | 61 | 50 | 54 | 53 | 55 | 46 |
| 26 | 52 | 46 | 54 | 42 | 56 | 48 | 55 | 40 | 61 | 53 | 66 | 47 | 56 | 53 | 62 | 47 |
| 27 | 56 | 46 | 63 | 44 | 53 | 49 | 54 | 43 | 63 | 56 | 72 | 51 | 57 | 55 | 63 | 47 |
| 28 | 56 | 47 | 70 | 44 | 50 | 48 | 50 | 46 | 61 | 57 | 65 | 54 | 57 | 55 | 63 | 47 |
| 29 | 59 | 50 | 66 | 48 | 50 | 47 | 59 | 45 | 60 | 56 | 59 | 53 | 58 | 55 | 65 | 49 |
| 30 | 56 | 50 | 56 | 50 | 53 | 48 | 54 | 45 | 57 | 55 | 59 | 53 | 58 | 56 | 56 | 53 |
| 31 | | | | | | | | | 57 | 54 | 57 | 49 | 56 | 56 | 56 | 54 |
| Averages | 52.8 | 45.4 | 60.3 | 43.9 | 53.9 | 48.9 | 57.6 | 47.0 | 58.3 | 52.0 | 60.7 | 50.2 | 57.9 | 55.9 | 63.6 | 51.3 |

Table 14 (continued)

Type of Instrument Thermograph (Partlow) Stream or Impoundment Sandy River Location Marmot Dam ladder, left bank in the top pool of the ladder. River mile 30. Dates covered 5-9-63 to 10-10-63 Source OSGC Basins

| | September | | | | October | | | |
|---|---|---|---|---|---|---|---|---|
| | Water | | Air | | Water | | Air | |
| Day | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. |
| 1 | 56 | 55 | 57 | 53 | | | | |
| 2 | 58 | 56 | 63 | 54 | | | | |
| 3 | 59 | 56 | 70 | 48 | 55 | - | 56 | - |
| 4 | 60 | 57 | 70 | 52 | 55 | 52 | 50 | 48 |
| 5 | 60 | 58 | 65 | 52 | 52 | 50 | 52 | 48 |
| 6 | 60 | 57 | 65 | 50 | 52 | 50 | 51 | 44 |
| 7 | 59 | 57 | 64 | 54 | 52 | 48 | 53 | 42 |
| 8 | 62 | 55 | 69 | 52 | 53 | 50 | 54 | 44 |
| 9 | 62 | 58 | 70 | 55 | 53 | 52 | 57 | 49 |
| 10 | 62 | 57 | 61 | 57 | 53 | 52 | 56 | 48 |
| 11 | 57 | 54 | 61 | 50 | | | | |
| 12 | 60 | 55 | 63 | 53 | | | | |
| 13 | 60 | 56 | 55 | 57 | | | | |
| 14 | | | | | | | | |
| 15 | | | | | | | | |
| 16 | | | | | | | | |
| 17 | | | | | | | | |
| 18 | | | | | | | | |
| 19 | | | | | | | | |
| 20 | | | | | | | | |
| 21 | | | | | | | | |
| 22 | | | | | | | | |
| 23 | | | | | | | | |
| 24 | | | | | | | | |
| 25 | | | | | | | | |
| 26 | | | | | | | | |
| 27 | | | | | | | | |
| 28 | | | | | | | | |
| 29 | | | | | | | | |
| 30 | | | | | | | | |
| 31 | | | | | | | | |
| Averages | 59.6 | 56.2 | 64.1 | 52.8 | 53.1 | 50.6 | 53.6 | 46.1 |

Dams and Barriers Major artificial barriers affecting anadromous fish are Marmot Dam, the Portland municipal water supply dam on the Bull Run River, and a dam on the Little Sandy River.

Marmot Dam is located on the Sandy River at river mile 30 (Figure 8). The approximately 30-foot structure, although laddered, is believed to cause some delay to upstream migration of salmon and steelhead. Additional ladder steps, plus attraction water facilities, were constructed by Portland General Electric Company in 1956.

Link-belt screens were installed in the Marmot diversion canal just below the dam in 1951 to prevent fish losses. After installation, efficiency was considered good, but repairs were made in 1963 to prevent fish losses which first became evident in 1961. Efficiency will be reassessed in 1964. Downstream migrant fish were trapped in the screen bypass in the spring of 1963 as part of the Game Commission's steelhead research program. Table 15 lists fish numbers and species which were collected at the screen during this period.

TABLE 15

Downstream Migrant Fish Diverted into Bypass Trap at
Marmot Dam Canal Screen, Sandy River, March 21 to June 27, 1963

| Dates | Steelhead | Coho (Silver) Salmon | Chinook Salmon | Other Game Species | Nongame Species |
|---|---|---|---|---|---|
| March 21-31 | 51 (6) 1/ | 165 | - | Rb 1<br>Ct 26 | Cot 8<br>L 4 |
| April | 634 (47) | 381 | 5 | Rb 14<br>Ct 75<br>Br 2<br>Wf 1 | Cot 2<br>L 1 |
| May | 16,502 (133) | 5,166 | 124 | Rb 123<br>Ct 240<br>Br 1 | Cot 1<br>L 7 |
| June 1-27 2/ | 8,062 (22) | 3,372 | 40 | Rb 53<br>Ct 289 | - |
| Totals | 25,249 (208) | 9,084 | 169 | 825 | 23 |

1/ Numbers in parentheses are spawned-out adults included in total.

2/ Trap did not operate on June 15, 16, 17, 22, 23 and 24. Only steelhead numbers for these days were calculated and are included in the total of steelhead for June.

The Bull Run River dam (Headworks dam) is a low, unladdered concrete structure located at river mile 6.2, or 0.2 mile below Bull Run Reservoir #2. This dam, which diverts Portland municipal water, forms the upper limit of anadromous fish in that river. The pool beneath the dam is where adult summer steelhead are observed each summer.

A 15-foot unladdered concrete dam is located in the Little Sandy River at river mile 1.7 (Figure 9). This structure intercepts flows of both the Little Sandy River and Marmot Canal and diverts them to the Bull Run powerhouse via Roslyn Lake. Total diversion is made except during high flow periods when some spill occurs. As a result, few anadromous fish are attracted into the stream. Occasionally adult steelhead are observed below the dam in spring months. Coho spawning was recorded in the lower mile in 1963. With adequate flows this section could provide spawning and rearing for numerous salmon and steelhead. Also, provision of a ladder at the dam would make several additional miles of good spawning area available. If this were done, screening of the canal would be necessary to prevent fish losses.

Natural barriers to anadromous fish exist in a few streams. The foremost is a series of high falls on Salmon River near river mile 14. All of the Columbia Gorge tributaries have high falls near their mouths which form the upper limits of anadromous fish use. In most other subbasin streams, particularly those of the upper Sandy River system, steep gradients rather than falls prevent further fish access

## FISH DISTRIBUTION STUDY

In the summer of 1963, a fish distribution study was conducted in the Lower Willamette Basin similar to that made in the Middle Willamette Basin in 1962. The primary purpose was to obtain more detailed information on distribution of anadromous salmonids. Other objectives were to obtain rough fish and game fish distribution data for application to the concurrent stream flow study, for application in future water developments or uses, and to indicate relative fish

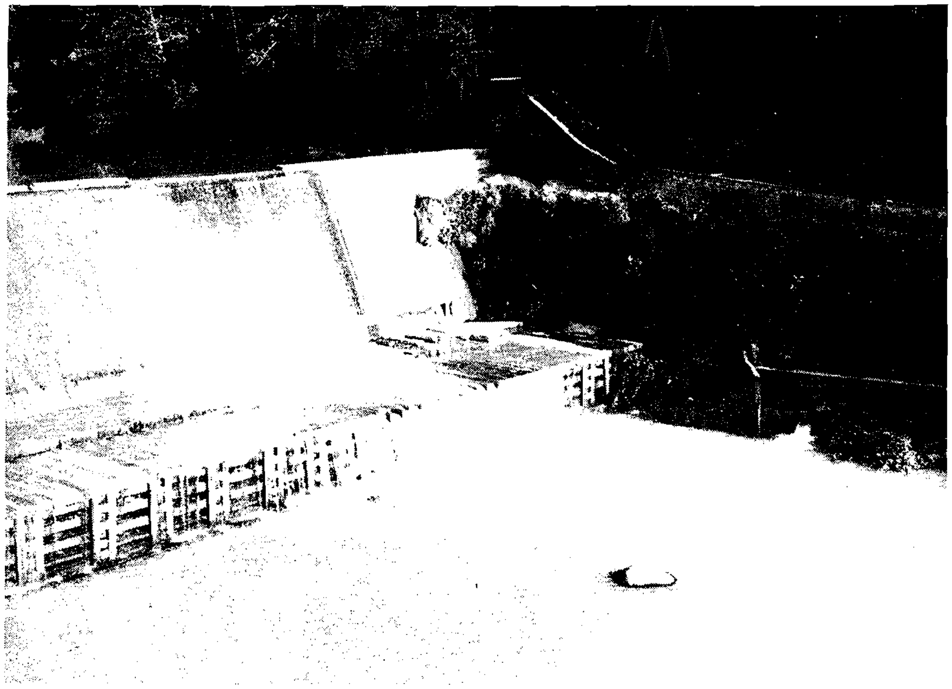

Figure 8. Marmot Dam showing fish ladder on south bank, river mile 30. July 1963.

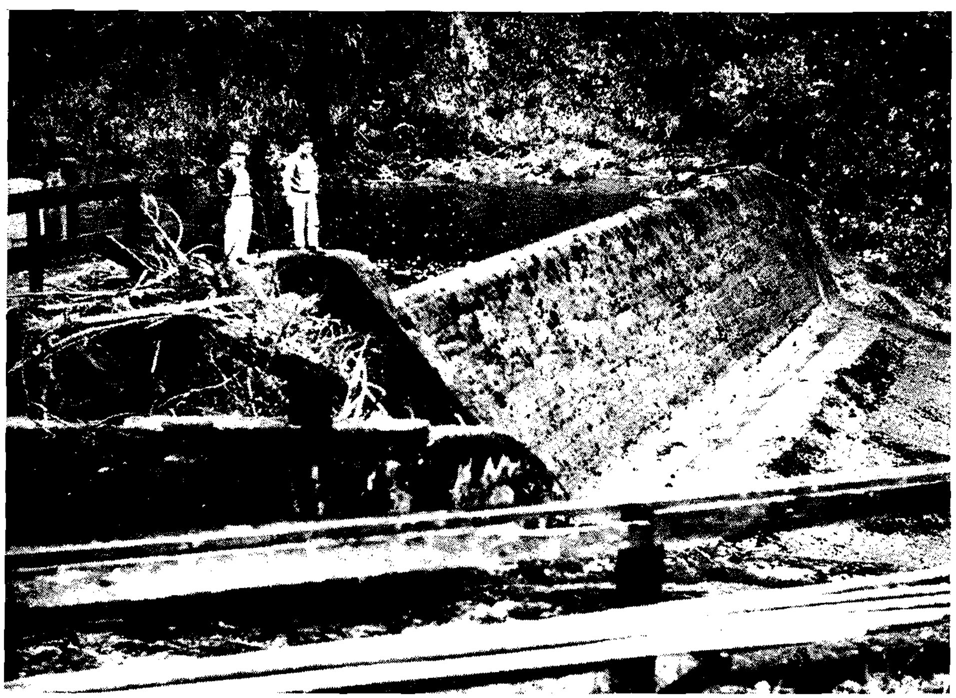

Figure 9. Little Sandy River Dam with diversion canal in foreground, river mile 1.7. November 21, 1963.

numbers and stream values for individual fish species.

Sufficient time was not available to study all basin drainage systems. Streams selected were those in which fish distribution information was most lacking.

Electrofishing gear was used for most fish collection. This consisted primarily of a 115-volt A.C. gasoline generator connected to a pulsator capable of emitting A.C. or D.C. at various voltage settings. The gear proved to be highly successful for collection in all except the larger streams. Some use of seines was made in areas difficult to reach with the electric equipment.

As in previous studies, the numbers of sampling stations on each stream were dictated by stream lengths. A number of stations were sampled in areas above falls to check on types of fish present and the possibility that anadromous fish might have negotiated the falls.

Study results assisted in construction of the anadromous fish plates in the appendix. Detailed results of the fish distribution study are presented in Appendix VII.

## STREAM FLOW STUDY

Flows affecting fish were studied in major streams of the basin from March 1962 to February 1964. Study emphasis was placed on determining minimum flow volumes for both rearing and spawning of anadromous species. The most important result was the formulation of recommended minimum flows for game fish maintenance. These are presented by semimonthly periods for individual streams in Appendix I.

Insufficient time occasionally did not permit adequate studies to formulate complete flow requirements for all portions of the year. This shortage of time, plus the high number of streams in the basin, likewise prohibited study in every stream possessing important or potentially important fish populations or habitat.

Recommended volumes are based primarily upon biological requirements of salmonids. These requirements were described in a prior report [1/] and will be discussed briefly in the rearing and spawning flow sections of this report. Present water uses and existing stream flows were also considered in forming the recommendation Water uses were determined from field observations and State Water Resources Board records. Flow information was obtained from field measurements conducted during the study period and from U. S. Geological Survey records.

Most recommended flows are below the average stream discharges for the periods listed, with the possible exceptions expected to occur in lower elevation streams in late summer and early fall. The recommendations are intended to protect the normally existent waters from excessive appropriations which would result in lesser amounts being available for anadromous fish production needs. While the listed flows are primarily those for anadromous species, generally they will adequately accommodate resident game species as well. Also, though not necessarily the best volumes for angling, these flows if present would provide sufficient water for this purpose.

Recommendations for flows which would provide for the development of each stream's full potential (optimum flows) were not made. Neither are these volumes intended to represent the most desirable amounts for release from present or future impoundments. If the probability occurs for provision of flows above the listed minimums in any stream, additional study should be conducted to determine best volumes for fish life.

Wherever possible the flow locations shown in Appendix I have been designated at mouths or confluences of streams, U. S. Geological gage sites or some easily recognizable landmark. The flows listed for each location are those which should always arrive at and depart from the designated point and do so without regulation which would cause drastic variations from the recommended volumes in portions of

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1/ "The Fish and Wildlife Resources of the South Coast Basin, Oregon, and Their Water Use Requirements, December 1962."

the stream. It is realized that such variations occur below powerhouses in sections of the Clackamas and Sandy Rivers and would be difficult to minimize.

Water quantities in the portions of the Columbia and Willamette Rivers within the basin, excluding associated water quality problems, are generally considered adquate for salmonid production. Due to the large size and complexity of water quality problems in these two rivers, no flow recommendations are included in this report. Unless pollution in the Willamette River is lessened, greater summer and fall releases of good quality water from upstream storage will be necessary to provide acceptable flows for fish and other aquatic organisms in this river.

Rearing and spawning flows in the lower Clackamas River and rearing flows in the lower Sandy River will require further study before recommendations for fish can be made. Tentative study of these flows is planned during 1964.

## REARING FLOWS

Streams important and potentially important to anadromous fish were examined periodically throughout the summer rearing period in 1963. During these visits existing stream flows and temperatures were measured and sections of the streams were studied to determine minimum volumes necessary for rearing. Recommended minimum rearing flows derived from the studies are included in Appendix I. Although stream rearing of most anadromous fish juveniles occurs throughout the entire year, summer and early fall months are those usually considered in "rearing flow" discussions. The existing rearing flow volumes and accompanying temperatures measured during the 1963 investigations, plus a few in 1962, are presented in Appendix II. Current meters were employed in making many of the flow measurements. Modified versions of standard U. S. Geological Survey techniques were often employed; however, accuracy was considered relatively high.

The size and health of a population of young salmon or steelhead during stream residency is dependent upon certain essential rearing conditions. Adequate food, shelter and a suitable medium in which to live are the three basic environmental conditions required for successful rearing. These requirements rely upon stream flows of proper quantity and quality. Without flows of proper quantity and quality, any or all of the basic requirements may not be satisfied. The exclusion of but one necessary requirement can be sufficient to have limiting effects upon a fish population.

It was determined during rearing flow studies conducted in the South Coast Basin in 1961 and 1962 that certain minimum volumes normally fulfill food, shelter and suitable medium requirements. To satisfy these basic rearing requirements it was determined that each stream must possess a particular "live" flow over its entire length. This live flow should have a minimum depth of between one and two tenths of a foot over a substantial portion of each riffle regardless of stream size. Such a flow satisfies one basic requirement, i.e. food, and at the same time normally satisfies the other two, i.e. shelter and a suitable medium in which to live, with possible exceptions created by undesirable water qualities. A flow of this depth enables juvenile salmonids to move between pool areas, to avoid predation and/or crowded conditions, and provides adequate flow for downstream migration (Hutchison, 1962). It is not necessary to provide this minimum depth over the entire area of every riffle as long as sufficient flow is present to provide the needed passage and food production conditions. This concept was incorporated in Lower Willamette Basin rearing flow studies.

The type of flow described in the previous paragraph is not always adequate to provide acceptable water quality; however, no effort was made to include such consideration in the flow recommendations. To attempt to do so would be difficult and would create a lack of uniformity in selection of the recommended minimum volumes. With few exceptions, adequate water qualities would be expected to accompany the recommended quantities. Streams which experience water quality problems with existent flows have been mentioned.

Methods for measurement of stream rearing requirements for salmonids are still largely in the formulative stages. It is probable that actual measurement of some of the integrated factors concerned with rearing will never be attainable and that flow analysis relevant to fish needs will of necessity continue to rely upon indices and judgment based on knowledge of fish, their environmental requirements and familiarity with each stream. Studies of factors related to rearing are presently being conducted by several groups directed from Oregon State University and by the Water Resources Section of the Oregon Fish Commission. The latter agency is specifically investigating effects of stream flows upon rearing.

## SPAWNING FLOWS

To determine stream flows necessary for anadromous fish spawning, sections of major spawning areas were examined in each stream studied. Investigations were conducted whenever possible at times of actual spawning. More than one investigation on an individual stream was often necessary due to presence of more than one fish species and to varying winter flow conditions.

Measurements of the two primary criteria considered--water depth and velocity over available spawning gravel--were obtained with current meters. Minimum water depth for chinook salmon spawning was considered to be 0.8 of a foot, while coho (silver salmon and steelhead require at least 0.6 of a foot of water. Proper spawning velocities for all three species were considered to range between 1.0 and 2.5 feet per second as measured 0.4 of a foot from the stream bottom. These criteria were selected as the result of measurements of numerous redds of the species concerned by Oregon Game Commission personnel and other fishery workers.

In determining recommended minimum spawning flows included in Appendix I, the desirable depths and velocities described above were required over substantial portions of each stream's spawning areas. Fish species for which the spawning flows are recommended may be ascertained by referring to the salmon and steelhead distribution plates in the appendix. Spawning periods for the anadromous species present in each major stream system were shown in Figure 4.

In three streams, upper Clackamas River, lower Sandy River and Gales Creek, detailed studies utilizing gravel transects were undertaken to determine desirable spawning flows for salmon and/or steelhead. It may have been more desirable to base all spawning flow recommendations on data developed with transects; however, to do so much more time and effort would have been required than was available. Discussion of the studies conducted on the three streams follows.

Clackamas River Spawning Flow Study

A technique known as the "average velocity analysis" (Sams and Pearson, 1963) was used in the upper Clackamas River in 1963 to determine optimum spawning flows for spring chinook. Ten transects were established on representative gravel bars in or near the "Big Bottom" area between river miles 57.4 and 65.3. The average velocity method employs the following formula:

$$V = \frac{F}{WD}$$

V = Average water velocity in feet per second over the entire transect at a given flow.

F = Total flow in cubic feet per second.

W = Width of the transect in feet at a given flow.

D = Average depth in feet of the transect at a given flow.

Stream width and average depth over each transect were measured at four different volume flows. These four flows were obtained from U.S. Geological Survey gage #2080 at river mile 64.8. Average water velocities over individual transects were then computed using the above formula. The means of the average velocities over all transects at each flow were plotted with the total flows to form a curve (Figure 10). This curve illustrates the average velocity-volume flow relationship. The optimum spawning flow is determined from the point where the

SPAWNING FLOW DETERMINATION, UPPER CLACKAMAS RIVER
SPRING CHINOOK SALMON

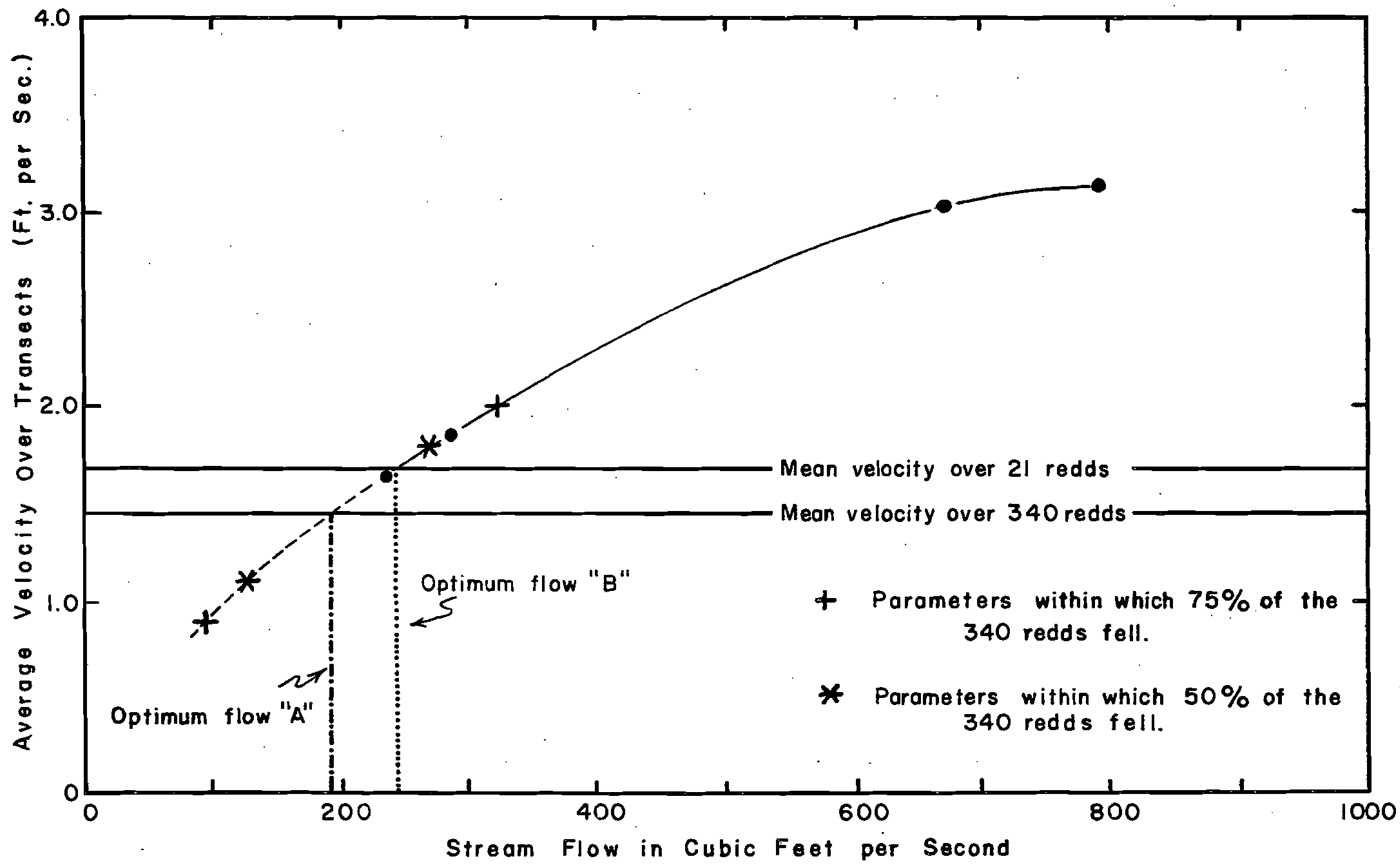



Figure 10. Spawning flow determination for spring chinook salmon in the upper Clackamas River using average velocity analysis. Optimum flows at U.S.G.S. gage 14-2080. Optimum flow "A" based upon measurement of 340 spring chinook redds in Willamette Valley streams (see Table 16); optimum flow "B" based upon measurement of 21 spring chinook redds in the Clackamas River system (Table 17).

curve intercepts the average water velocity at which spring chinook spawn.

The average velocity at which spring chinook spawn was determined by measuring water velocities over 340 redds in several streams of the Willamette River system (Table 16). It might be most desirable to use velocities from the Clackamas River system only. For this reason velocities over the 21 redds measured in this system above the uppermost flow regulation (Three Lynx powerhouse) were plotted in Figure 10 separately from the 340 redds. The Clackamas system redd measurements are presented in Table 17. Average water velocities over the Clackamas redds were higher than those over the 340 redds mainly because Clackamas system flows are greater during the time of spring chinook spawning than flows in most of the other streams, enabling the salmon to select deeper, faster-moving water in which to spawn.

In using the average velocity method, assumption is made that water depths over the gravel bars for fish spawning and upstream passage will be adequate at the projected flow. This assumption is valid if the transects are carefully selected. Several spring chinook were observed on three of the Clackamas River transects during transect measurements conducted at a flow of 235 cfs. This volume afforded adequate water depth for both passage and spawning. The 240 cfs flow projected from the 21 redds is considered to be a truer optimum spawning flow than the projected 190 cfs flow from the 340 redds (see Figure 10).

The Big Bottom area has been considered as a potential damsite. If a dam is constructed, the data included here would be valuable in establishing proper flow releases for anadromous fish spawning. However, the Big Bottom area contains much of the river system's best spawning gravel for anadromous fish. Construction of such an impoundment would inundate large quantities of excellent spawning gravel.

Sandy River Spawning Flow Study

There are extensive gravel bars for anadromous fish spawning in the lower Sandy River. This river section experiences considerable use by spawning spring

TABLE 16

Water Depths and Velocities Measured over 340 Spring Chinook Salmon Redds in Willamette River System Streams, 1961-1963[1]

| Water Depth[2] (feet) | No. of Redds | Average Velocity [2] (feet per second) | No. of Redds |
|---|---|---|---|
| 0.3 | 7 | 0.45 | 3 |
| 0.4 | 9 | 0.5 | 1 |
| 0.5 | 11 | 0.6 | 4 |
| 0.6 | 26 | 0.7 | 10 |
| 0.7 | 32 | 0.8 | 15 |
| 0.8 | 30 | 0.9 | 21 |
| 0.9 | 47 | 1.0 | 23 |
| 1.0 | 45 | 1.1 | 25 |
| 1.1 | 29 | 1.2 | 25 |
| 1.2 | 24 | 1.3 | 29 |
| 1.3 | 9 | 1.4 | 24 |
| 1.4 | 22 | 1.5 | 15 |
| 1.5 | 10 | 1.6 | 24 |
| 1.6 | 8 | 1.7 | 27 |
| 1.7 | 8 | 1.8 | 23 |
| 1.8 | 8 | 1.9 | 20 |
| 1.9 | 7 | 2.0 | 14 |
| 2.0 | 5 | 2.1 | 5 |
| 2.1 | 0 | 2.2 | 14 |
| 2.2 | 0 | 2.3 | 3 |
| 2.3 | 1 | 2.4 | 5 |
| 2.4 | 1 | 2.5 | 3 |
| 2.5 | 1 | 2.6 | 3 |
| | | 2.7 | 1 |
| | | 2.8 | 1 |
| | | 2.9 | 0 |
| | | 3.0 | 1 |
| | | 3.1 | 1 |
| Means 1.03 | | 1.46 | |

1/ Of the 340 total redds, Fish Commission personnel measured 270 and Game Commission personnel 70. Measurements were obtained from Clackamas, Little North Santiam, McKenzie, Molalla and South Santiam River systems.

2/ Measured one foot upstream from each redd.

TABLE 17

Water Depths and Velocities Measured over 21 Spring Chinook Salmon Redds in Upper Clackamas River System, 1963 1/

| Stream | Date | Redd Number | Water Depth (feet) | Average Velocity (feet per second) |
|---|---|---|---|---|
| Clackamas River above Three Lynx powerhouse | 9-25-63 | 1 | 1.4 | 1.99 |
| | 9-26-63 | 2 | 1.9 | 1.95 |
| | " | 3 | 1.9 | 2.18 |
| | " | 4 | 1.1 | 3.04 |
| | 9-30-63 | 5 | 1.1 | 1.32 |
| | " | 6 | 1.2 | 1.50 |
| | " | 7 | 1.2 | 1.25 |
| | 10-1-63 | 8 | 1.4 | 1.29 |
| | " | 9 | 1.4 | 1.27 |
| | " | 10 | 0.9 | 1.38 |
| | " | 11 | 0.8 | 1.16 |
| | " | 12 | 2.4 | 1.83 |
| Collawash River | 10-2-63 | 13 | 1.2 | 3.11 |
| | " | 14 | 1.0 | 2.38 |
| | " | 15 | 1.2 | 1.41 |
| | " | 16 | 1.7 | 1.27 |
| | " | 17 | 1.7 | 1.38 |
| | " | 18 | 0.8 | 1.21 |
| | " | 19 | 0.6 | 1.07 |
| | " | 20 | 0.9 | 0.72 |
| Hot Springs Fork Collawash River | 10-2-63 | 21 | 1.0 | 2.71 |
| | Means | | 1.28 | 1.69 |

1/ These 21 redds are included in the 340 redds in Table 16. Measurements made one foot upstream from each redd.

and fall chinook salmon. Some coho (silver) salmon and steelhead trout also utilize this area.

A spawning flow study was conducted between river miles 6 and 11 in the fall of 1963. Objectives were to determine optimum flows for chinook salmon spawning and to investigate effects of severe river fluctuations upon reproduction. Optimum flow was determined by the "average velocity analysis" method as used in the upper Clackamas River. Seven gravel transects were established. One was later discarded because high flows bypassed it via another channel. Total flows were determined by adding volumes recorded by U. S. Geological Survey gage #1425 at river mile 17.7 to measured flows of tributaries entering the river below the gage.

Transect measurement was complicated by extreme diurnal river fluctuations caused by the Bull Run powerhouse. Crest travel time of water releases from the powerhouse was determined by use of temporary staff gages placed just above and below the section of river containing the transects. In this way it was possible to measure the transects early in the morning before releases reached the study area or after the release crests reached the area and stabilized.

Figure 11 shows the average velocity-volume flow relationship curve constructed from measurement of the transects at three volume flows. An optimum flow of 510 cfs was projected using the 340 spring chinook redd measurements obtained from Willamette Valley streams (Table 16). Numerous water depths and velocities were measured over lower Sandy River chinook redds, but few were representative due to rapid river fluctuations. Figures 12, 13 and 14 show one of the transects at each of the three flows at which transect measurements were made.

On October 11, 1963, flow extremes in the transect area were approximately 100 cfs and 855 cfs. Maximum water depth fluctuations between these two extremes determined with staff gages placed on riffles were 1.43 feet at Buck Creek (river mile 12.7) and 1.20 feet at Dabney Park (river mile 5.9). Crest travel time of the releases, beginning at 6 a.m. at the Bull Run powerhouse, took 3 hours 50 minutes to reach Buck Creek and 6 hours 20 minutes to reach Dabney Park. Rise time from start to crest was from 20 to 30 minutes at both locations.

Water velocities and/or depths over spring chinook redds were measured at both flow extremes. Water measured over a redd near Buck Creek was 0.4 foot deep with an average velocity of approximately 0.50 foot per second at 100 cfs and 1.3 feet deep with an average velocity of 3.04 feet per second at 855 cfs. An adult female chinook was observed on the redd at each flow extreme but was not seen digging at either flow. Water depth over a redd at river mile 4.5 varied

SPAWNING FLOW DETERMINATION, LOWER SANDY RIVER
SPRING CHINOOK SALMON

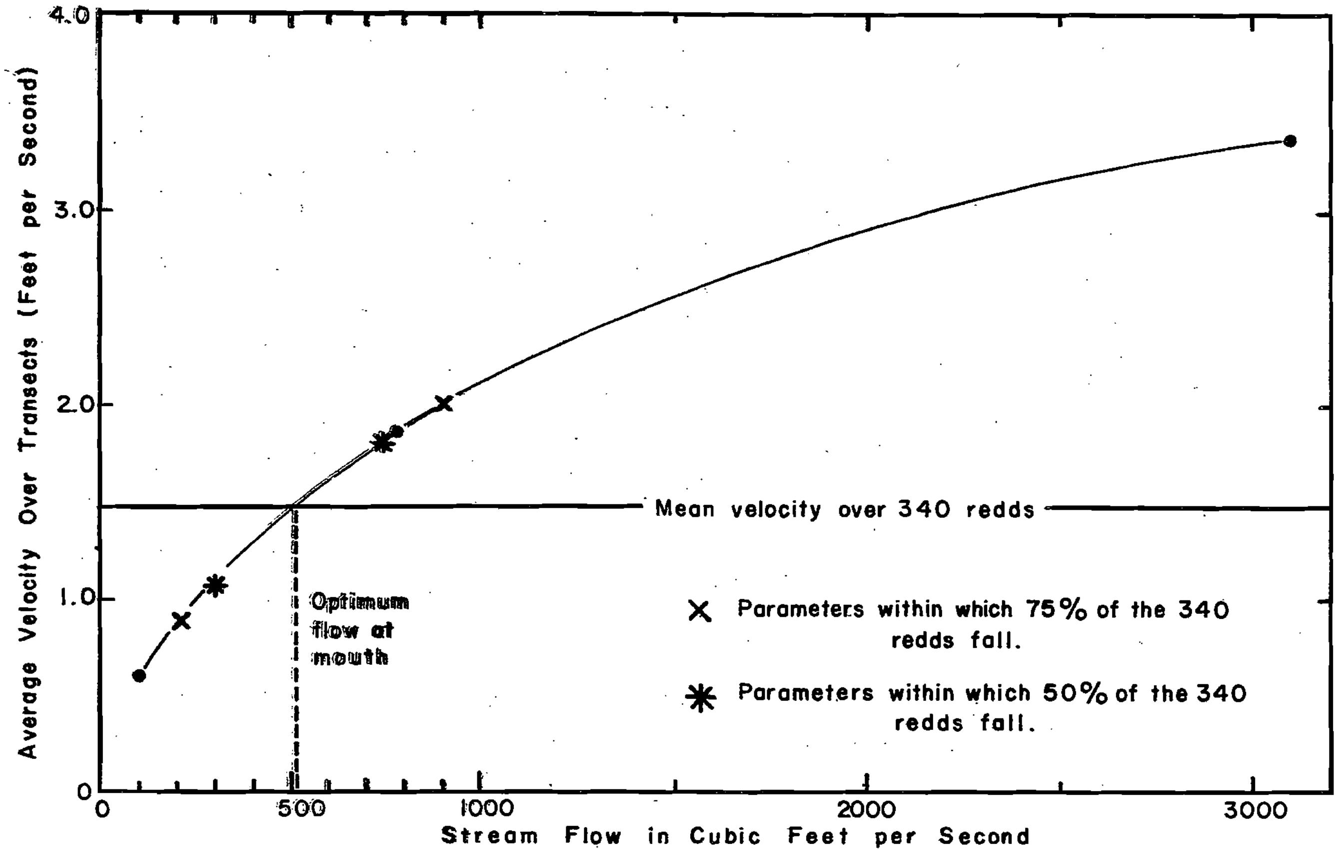



Figure 11. Spawning flow determination for spring chinook salmon in the lower Sandy River using average velocity analysis. Optimum flow at mouth is based upon measurements of 340 spring chinook redds in Willamette Valley streams (see Table 16).

Figure 12. Lower Sandy River spawning gravel transect at flow of 100 c.f.s. Oct. 11, 1963.

Figure 13. Same transect at flow of 775 c.f.s. October 17, 1963.

Figure 14. Same transect at flow of 3,100 c.f.s. November 21, 1963.

from 0.5 to 1.2 feet on October 17 at similar flow extremes. Of 25 chinook salmon redds measured once at varying flow stages in the study area in October, the lowest average water velocity was approximately 0.5 foot per second and the highest was 4.14 feet per second. Water depths varied from 0.5 to 2.7 feet. A few other redds were seen in deeper water at high flows, but excessive velocities prohibited measurement.

Two chinook were observed in the river near Buck Creek at a flow of 100 cfs attempting to swim upstream over a riffle. Both fish finally gave up and returned to a shallow pool below. Water over the entire riffle was shallow and it is doubtful if the fish could have passed upstream without increased flow.

As a result of the extreme diurnal river fluctuations, many of the redds observed had long, narrow shapes and were situated near the upper breaks of riffles. Spawning females had apparently moved either upstream or downstream on the same riffle to compensate for the high water fluctuations which resulted in the unusual configuration of the redds. It would be desirable to make a more definitive study in this area to determine effects of these fluctuations upon the success of salmon and steelhead spawning and egg and fry survival.

Gales Creek Spawning Flow Study

The Gales Creek system possesses some of the Tualatin drainage's best spawning gravel. The stream bed is composed primarily of excellent spawning gravel above stream mile 4. Large numbers of coho salmon utilize the system. Fish distribution work conducted in the summer of 1963 showed that Gales Creek is one of the Tualatin River tributaries most heavily used by steelhead. Good spawning potential for chinook salmon which were once present also exists.

A study was conducted in the spring of 1962 to determine proper spawning flows for steelhead and coho salmon. The "usable width" method as used in several Middle Willamette Basin streams was employed.

Eleven spawning gravel transects were established in two sections of the creek. The two sections have different characteristics. The upper, between stream miles

12 and 13, is narrow and fast-moving. The lower section between stream miles 9 and 10.5 is wider and generally slower. Iller Creek and Clear Creek, two important tributaries, enter Gales Creek in the lower section. Six transects were established in the upper section and five in the lower.

Water depths and velocities were measured across each transect at four different flow levels. The criteria used in making flow recommendations for most other basin streams were employed. Any parts of the transects not covered by at least 0.6 foot of water flowing at a velocity between 1.0 and 2.5 feet per second were not considered usable for coho salmon or steelhead spawning. The velocity measurements were taken 0.4 foot from the stream bottom, the area in which fish swim while constructing a redd. Widths of usable gravel thus determined were plotted with the measured total flows to form two curves (Figure 15). These curves illustrate the flow-usable spawning gravel relationship in the two study sections.

Because of the narrow conformation of the upper section, flows larger than approximately 85 cfs resulted in a reduction of usable gravel area due to excessive water velocities. Stream volumes in the lower section, being less confined, were favorable for spawning over a greater flow range.

As a result of the study, flows of 70 cfs and 100 cfs in the upper and lower sections, respectively, were selected as proper amounts for coho salmon and steelhead spawning. Iller and Clear Creeks were determined to require 13 cfs and 15 cfs, respectively, for spawning (see Appendix I) by the regular, less detailed flow analysis method used on most basin streams. These volumes added to the recommended 70 cfs of the upper section produce a flow in the lower section which approximates the 100 cfs recommended there.

On April 25, 1962 measured flows were 75 cfs in the upper section and 98 cfs in the lower section. A few steelhead were observed spawning in both stream sections, further indicating that such flows were suitable for spawning.

PER CENT UTILIZABLE SPAWNING GRAVEL, GALES CREEK
STEELHEAD AND SILVER SALMON

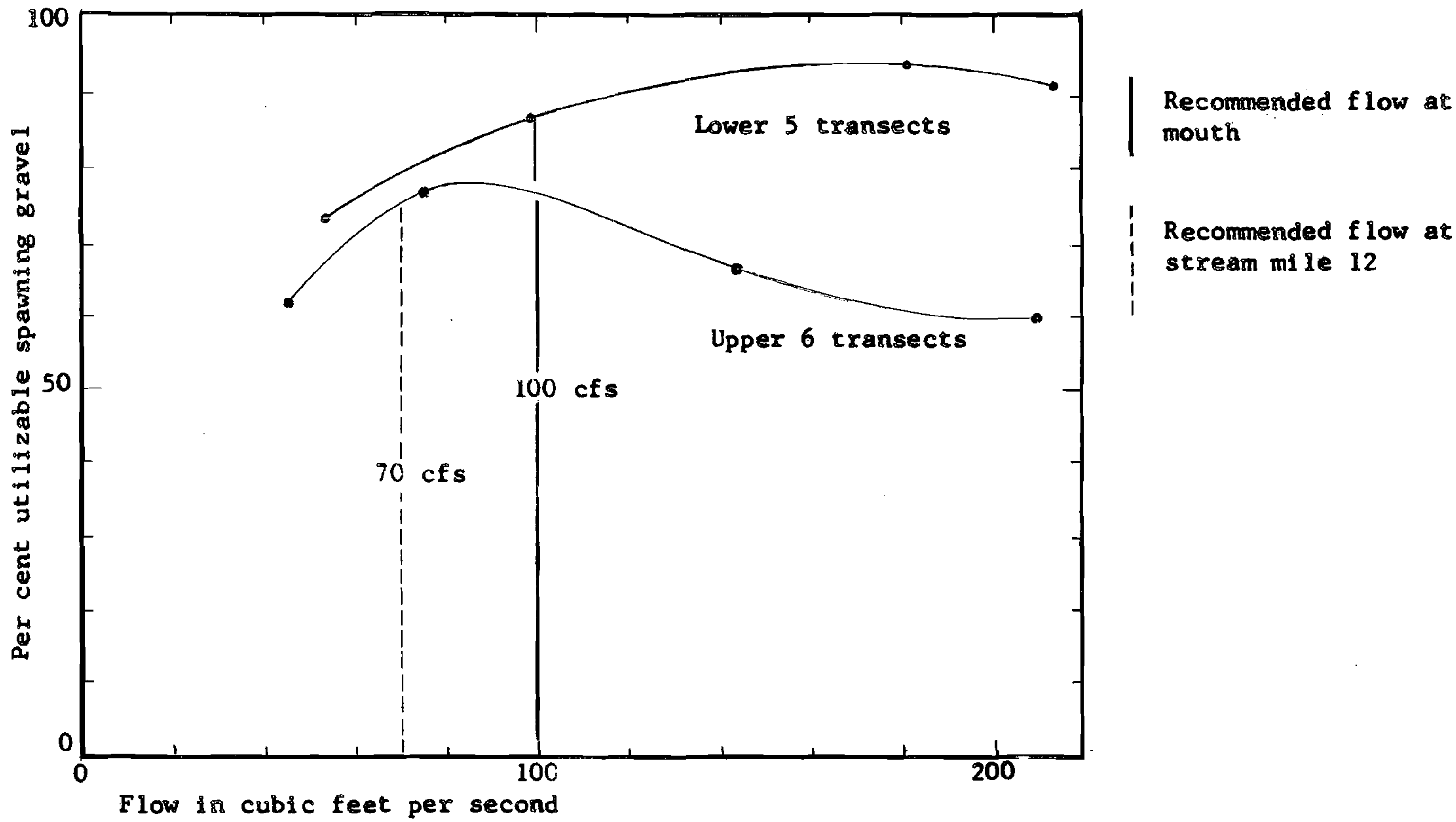



Figure 15. Per cent of gravel utilizable for steelhead trout and silver salmon spawning in Gales Creek as measured at 11 transects (usable width method).

# GAME RESOURCES OF THE LOWER WILLAMETTE BASIN

## GENERAL

The land use pattern of the Lower Willamette Basin ranges from that of the densely populated metropolitan-industrial area of the City of Portland to the virgin timber and nearly inaccessible wilderness of the Bull Run Reserve only a few miles distant. As far as game is concerned, however, the most important land areas are the many acres of valley bottom, mixed crop lands, marginal farm lands, and cutover or burnt-over timberlands. Waterfowl and upland game are the most important game products of the valley lands of this basin and deer are of greatest importance in the timbered areas.

The Bull Run Reserve, Portland's municipal water supply, encompasses over 100,000 acres of forested land (Figure 16). Game present include deer, grouse and mountain quail. No public access is permitted.

Foreseeable population growth in this basin would greatly increase public requirements for harvestable quantities of game. More intensive management of the land and water areas for upland game, big game and waterfowl production so as to offset the constant decline in habitat land available can do much to satisfy these needs.

## BIG GAME

Forest edges, scattered wood lots and timber regrowth area are the primary producing lands for the important blacktail deer populations of the Lower Willamette Basin. These deer populations have provided over 60,000 man-days of recreation annually (Table 18) with an annual harvest of about 4,000 animals. Hunting pressure is partially manipulated through use of four management units involved in the Lower Willamette Basin (Table 19). Hunter pressure, deer harvest and percentage of success for a portion of the basin is shown in Figure 17.

Coastal or Roosevelt elk are found primarily along the western edge of the basin and in the headwaters of the Clackamas drainage. Their numbers are relatively few

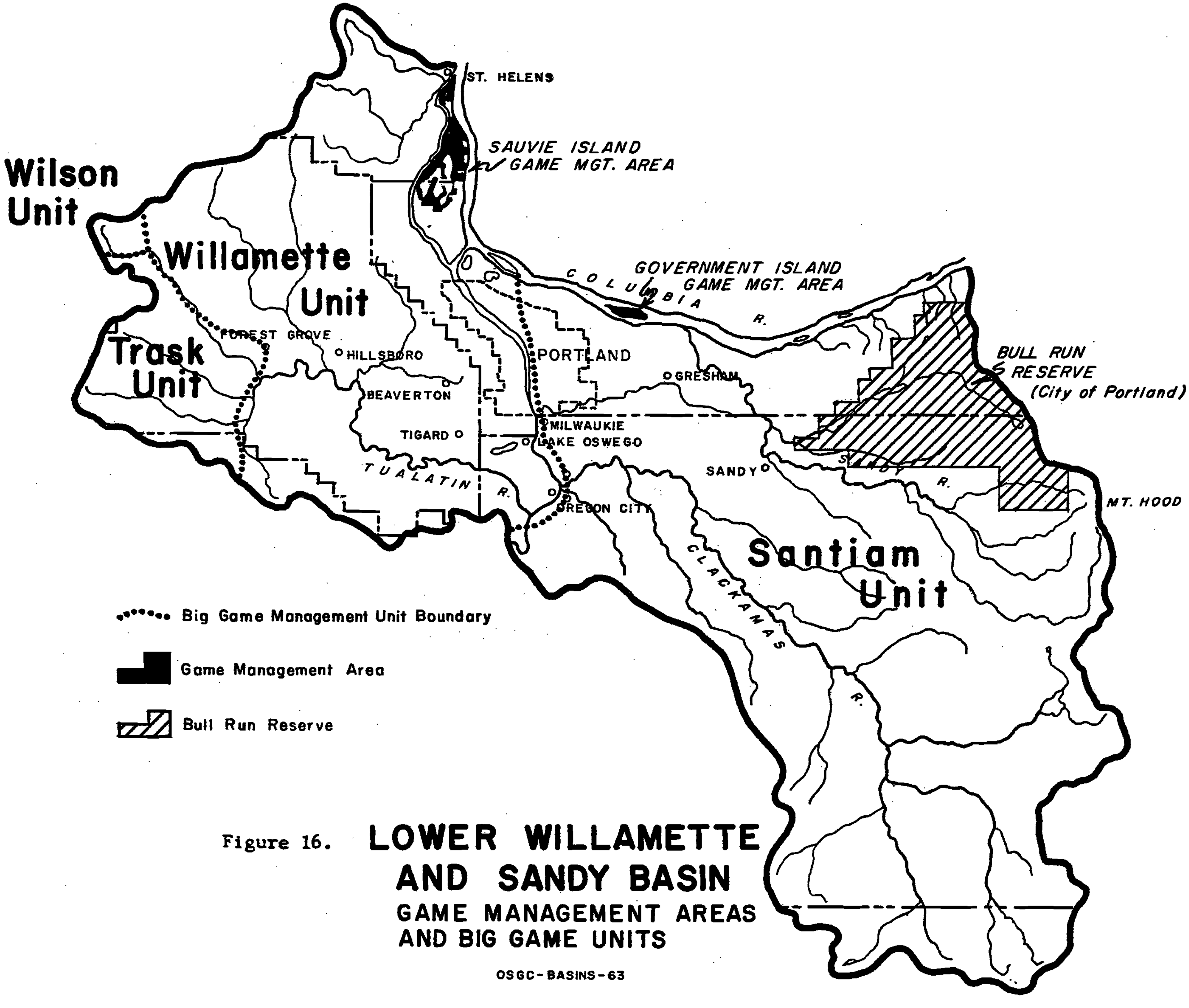



Figure 16. **LOWER WILLAMETTE AND SANDY BASIN**

**GAME MANAGEMENT AREAS AND BIG GAME UNITS**

OSGC-BASINS-63

TABLE 18

1962 and 1963 Deer Seasons, Lower Willamette Basin

| Game Management Unit | Estimated Hunters* 1962 | Estimated Hunters* 1963 | Estimated Harvest* 1962 | Estimated Harvest* 1963 | Days Hunted per Deer Killed 1962 | Days Hunted per Deer Killed 1963 | Estimated Hunter-days 1962 | Estimated Hunter-days 1963 |
|---|---|---|---|---|---|---|---|---|
| Santiam | 3,460 | 3,290 | 1,950 | 1,420 | 15 | 18 | 29,250 | 25,560 |
| Willamette | 2,500 | 2,420 | 2,040 | 1,520 | 14 | 17 | 28,560 | 25,840 |
| Trask | 1,500 | 1,640 | 920 | 850 | 9 | 12 | 8,280 | 10,200 |
| Wilson | 100 | 130 | 60 | 60 | 9 | 10 | 540 | 600 |
| Totals | 7,560 | 7,480 | 4,970 | 3,850 | - | - | 66,630 | 62,200 |

*1962 and 1963 random hunter survey returns by game management unit prorated according to estimated hunting pressure in basin.

TABLE 19

Big Game Management Units, Lower Willamette Basin

| Game Management Unit | Total Unit Area (sq.mi.) | Unit Area in Basin Sq. Miles | Unit Area in Basin Per Cent | Hunting Pressure in Basin Deer (%) | Hunting Pressure in Basin Elk (%) |
|---|---|---|---|---|---|
| Santiam | 4,180 | 1,640 | 39 | 25 | 40 |
| Willamette | 1,730 | 800 | 46 | 65 | 0 |
| Trask | 1,000 | 130 | 13 | 20 | 5 |
| Wilson | 510 | 30 | 6 | 2 | 0 |
| Total | - | 2,600 | - | - | - |

GENERAL DEER SEASON DATA, WASHINGTON COUNTY AND WILLAMETTE GAME MANAGEMENT UNIT

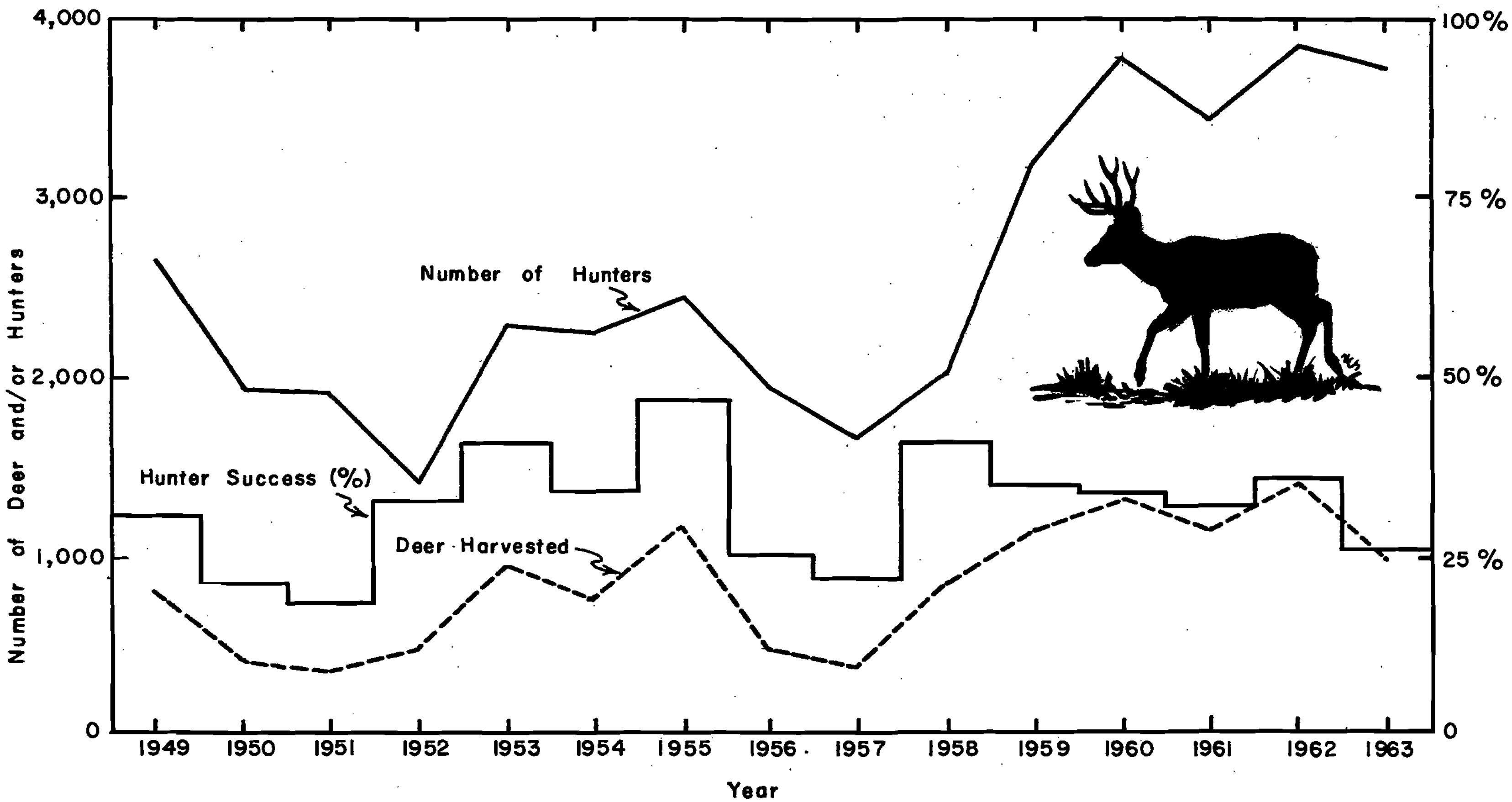



Figure 17. General Deer Season Data, Washington County (1949-1959) and Willamette Game Management Unit (1960-1963). Based on hunter report card returns (1949-1959) and random hunter survey (1959-1963). Prior to 1952 bucks only season. The figures from the Willamette Game Management Unit are generally comparable to the Washington County data since nearly the same geographical hunting area is included in both subdivisions. This area is quite representative of the Lower Willamette Basin as a whole.

| | |
|---|---|
| 15-year total harvest: | 12,431 deer |
| 15-year average harvest: | 829 deer |
| 15-year average number of hunters: | 2,573 |
| 15-year average hunter success: | 31% |

and scattered, however, with an estimated annual harvest of less than 10 animals (Table 20).

Whitetail deer are occasionally seen in a few scattered areas primarily along the Columbia River.

TABLE 20

1962 and 1963 Elk Seasons, Lower Willamette Basin

| Game Management Unit | Estimated Hunters* 1962 | Estimated Hunters* 1963 | Estimated Harvest* 1962 | Estimated Harvest* 1963 |
|---|---|---|---|---|
| Santiam | 44 | 42 | 3 | 3 |
| Willamette | 0 | 0 | 0 | 0 |
| Trask | 2 | 3 | 1 | 2 |
| Wilson | 0 | 0 | 0 | 0 |
| Totals | 46 | 45 | 4 | 5 |

*1962 and 1963 random hunter survey returns by game management unit prorated according to estimated hunting pressure in basin.

Since big game are frequently dependent upon the limited areas of habitat in stream valleys, particularly during the winter, there is a potential conflict between some water resource developments and big game populations. When water storage project inundate many acres of valley floor, there is often an irreplaceable loss of important winter big game habitat. During severe weather with heavy snows these valley areas are used by wintering game from many miles of surrounding higher country. Elimination of a small amount of productive winter range can adversely affect big game populations over a much wider area. Even with these western Oregon herds the quality of habitat in lower elevation ranges frequently is the factor limiting populations.

The greatest potential for future big game production appears to exist in the Clackamas River drainage. Present and proposed timber clear cuttings will provide highly productive though short-term deer habitat. The outlook is that increasing rates of timber cutting and associated road construction will greatly increase the big game production and hunter utilization of this area. Nevertheless, these increased game populations will be highly dependent upon lowland and valley floor forage supplies during severe winters. Large water storage impoundments can and will seriously reduce low elevation big game winter range in the Clackamas drainage.

## UPLAND GAME

Upland game species of the Lower Willamette Basin fall into three broad groups--farm land game, woodland game and migratory game. The farm land game species are the most important with the ringneck pheasant being the leader of this group. Upland game production on the basin's farm lands is very high with a correspondingly high hunter pressure.

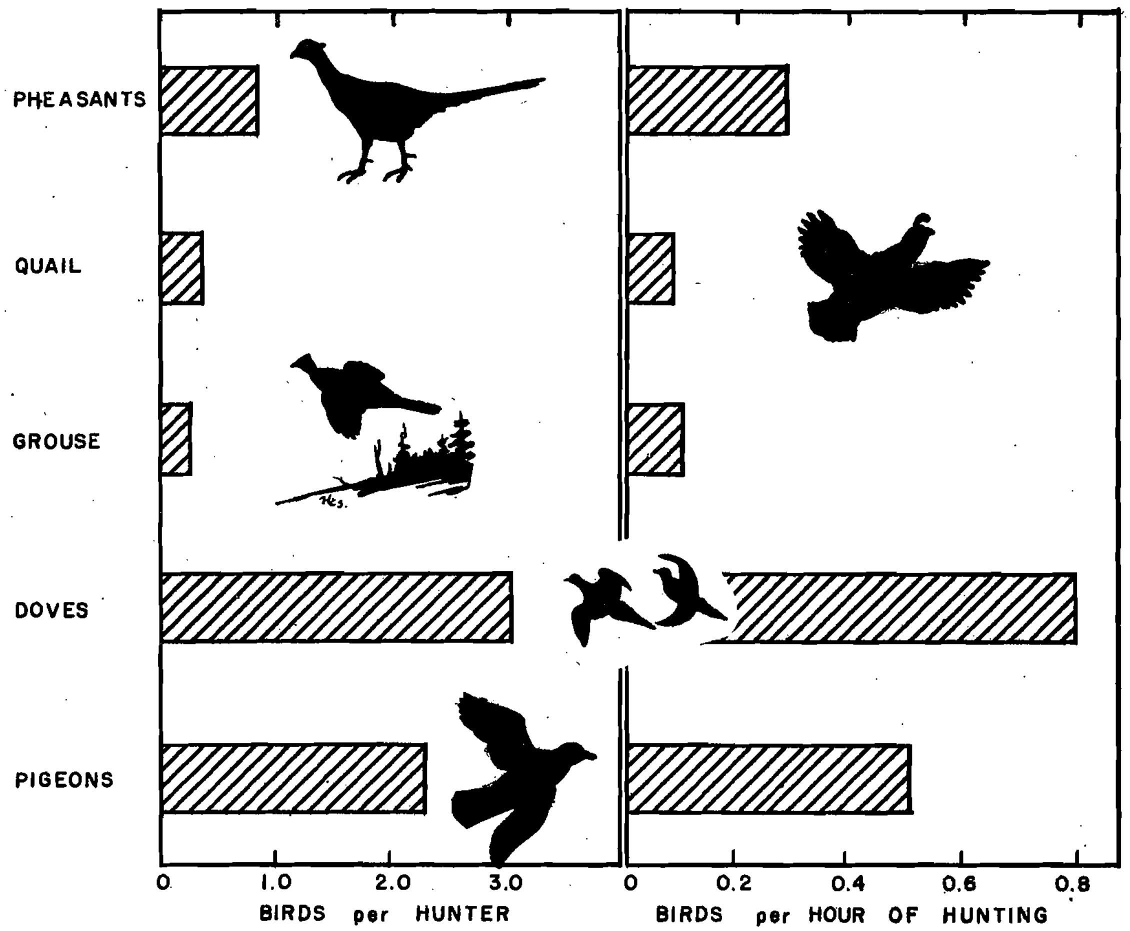
The pheasant is the most popular upland game bird of the basin, but there are also important populations of valley quail, mourning doves and band-tailed pigeons available for the hunter (Figure 18). Mourning doves and band-tailed pigeons are migratory but are well utilized by the hunter during the September seasons. Doves and pigeons provide some of the most productive hunting in the basin in terms of numbers of birds available.

Woodland game species include ruffed grouse, blue grouse and mountain quail. Hunting pressure is relatively light despite periodically high populations.

## WATERFOWL

Waterfowl hunting is popular in the Lower Willamette Basin primarily due to the presence of attractive waterfowl habitat on Sauvie Island in close proximity to the state's center of population. Since 1949, when acquisition of the Sauvie Island Game Management Area began, the area has steadily increased in popularity. Over 9,000 hunter-days were recorded in 1963, with the average since 1949 exceeding 7,800. Average success during the period was over 1.7 birds per man-day (Figure 7, page 30, and Figure 19, page 68).

UPLAND GAME HUNTER SUCCESS
LOWER WILLAMETTE BASIN




| | 1962 | 1961 | 1960 | 1959 | 1958 | 1957 | Mean |
|---|---|---|---|---|---|---|---|
| **Ringneck Pheasant** | | | | | | | |
| Hunters Checked | 39 | 75 | 75 | 53 | 89 | - | |
| Birds per Hunter | 1.0 | 0.8 | 0.9 | 0.9 | 0.8 | - | 0.88 |
| Birds per Hour | 0.2 | 0.3 | 0.5 | 0.4 | 0.1 | - | 0.3 |
| **Valley and Mountain Quail** | | | | | | | |
| Hunters Checked | 39 | 52 | - | - | - | - | |
| Birds per Hunter | 0.5 | 0.2 | - | - | - | - | 0.35 |
| Birds per Hour | 0.1 | - | - | - | - | - | 0.1 |
| **Ruffed and Blue Grouse** | | | | | | | |
| Hunters Checked | 5 | 23 | 13 | 11 | 34 | - | |
| Birds per Hunter | 0.2 | 0.3 | 0.1 | 0.2 | 0.5 | 0.8 | 0.35 |
| Birds per Hour | 0.1 | 0.2 | 0.04 | 0.1 | 0.1 | - | 0.11 |
| **Mourning Dove** | | | | | | | |
| Hunters Checked | 4 | 33 | - | - | - | - | |
| Birds per Hunter | 1.0 | 3.6 | 3.3 | 4.6 | 2.8 | - | 3.06 |
| Birds per Hour | 0.3 | 1.3 | - | - | - | - | 0.8 |
| **Band-tailed Pigeon** | | | | | | | |
| Hunters Checked | 136 | 44 | 62 | 130 | 90 | - | |
| Birds per Hunter | 2.3 | 1.4 | 2.9 | 2.9 | 2.2 | - | 2.34 |
| Birds per Hour | 0.4 | 0.3 | 0.6 | 0.9 | 0.6 | - | 0.56 |

Figure 18. Upland game hunter success in the Lower Willamette Basin, averages of opening week and hunter-check data from 1958 to 1962. Pheasant hunters were the most numerous in the basin as a whole even though more individual pigeon hunters were checked due to the concentrated nature of this hunting.

WATERFOWL SHOOTING GROUND SUCCESS, SAUVIE ISLAND GAME MANAGEMENT AREA

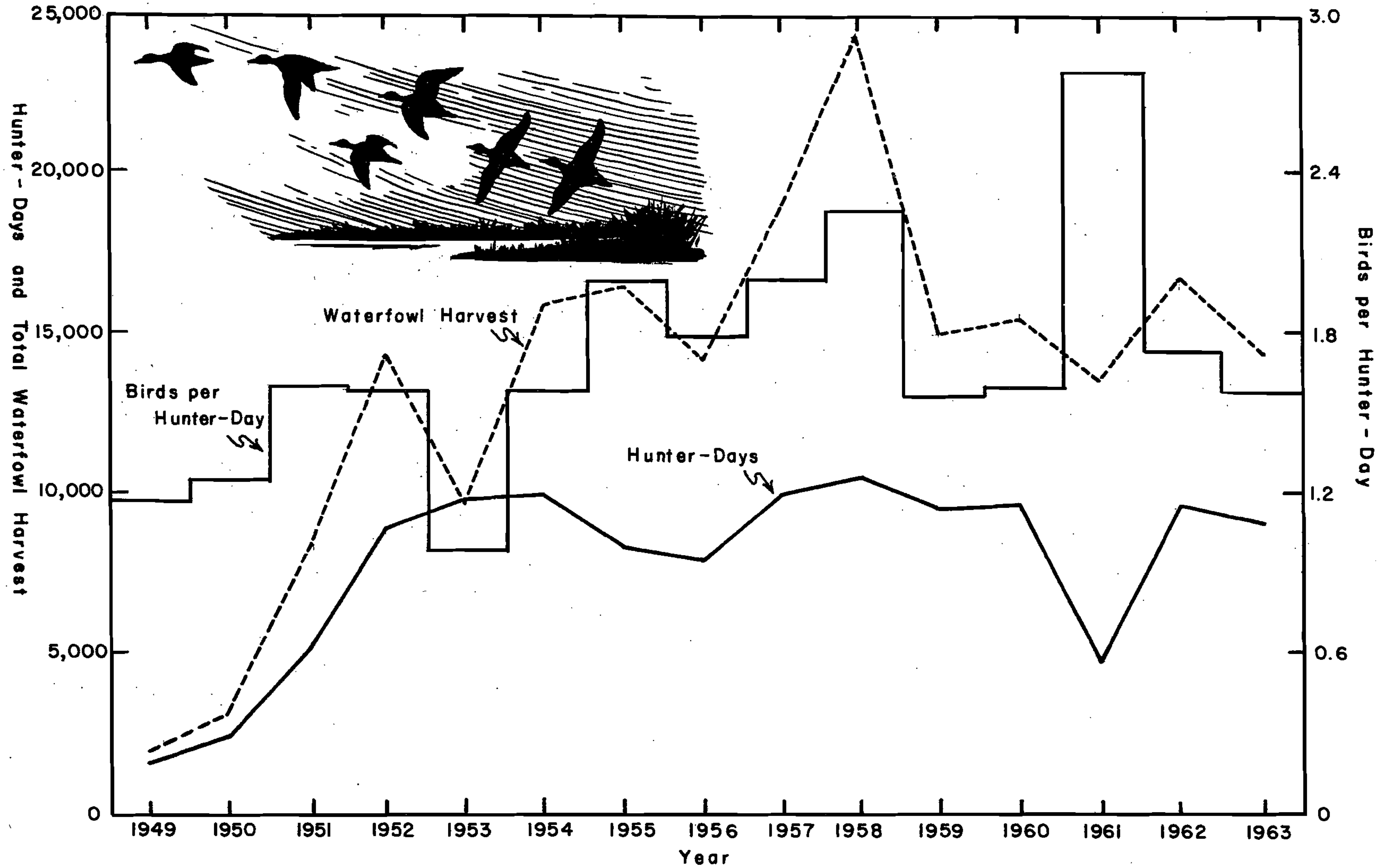



Figure 19. Summary of shooting ground success at Sauvie Island Game Management Area, 1949-1963.
15-year total: 117,088 hunter days 202,480 total harvest
15-year average: 7,806 hunter days 13,480 total harvest 1.73 birds per hunter day

Between 100,000 and 400,000 wintering waterfowl are found in this basin each year during the annual nation-wide waterfowl inventory (Figure 20). Mallards, widgeons and pintails are the most prevalent species though substantial numbers of snow geese, Canada geese and greenwing teal are also counted (Figure 21 and Tables 21 and 22).

Generally waterfowl require a dependable supply of relatively clean water in the form of rivers, sloughs, marshland and ponds. Presently these requirements appear to be adequately met in the basin except in certain areas of excessive pollution. Future water developments, such as lowland storage projects, can effectively increase available waterfowl habitat. Conversely, certain practices such as stream bank revetment, channel straightening and wetland drainage can reduce or eliminate productive bird habitat.

FURBEARERS

Though of relatively minor importance, furbearers are a recognized resource of the Lower Willamette Basin. Based on the 1962-63 season trapper catch reports, beaver were the most valuable furbearer with around 800 pelts bringing in over $8,000. Other animals trapped included otter, mink, muskrat, raccoon, skunk, weasel, opossum, fox, bobcat, coyote and nutria. Total pelt value for the 1962-63 season is estimated at $11,600. This represents the reported catch of around 70 trappers in the area.

Water pollution, wetland drainage, water storage projects, poor watershed management and habitat destruction through stream channel work all tend to reduce furbearer production. Furbearer habitat is frequently enhanced through reduction of pollution, stabilizing of stream flows and construction of small impoundments.

ANNUAL WINTER WATERFOWL INVENTORY
LOWER WILLAMETTE BASIN

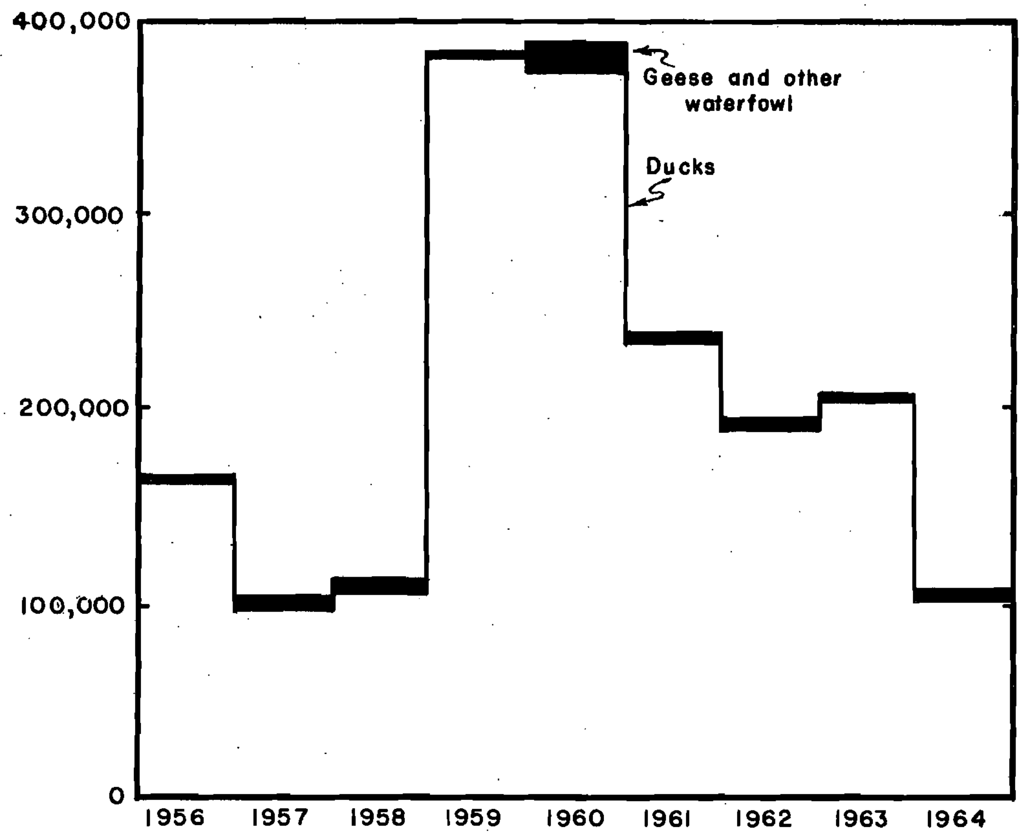



Figure 20. Annual winter inventories of waterfowl in Clackamas, Columbia, Multnomah and Washington Counties.

PERIODIC COUNTS OF WATERFOWL, SAUVIE ISLAND GAME MANAGEMENT AREA

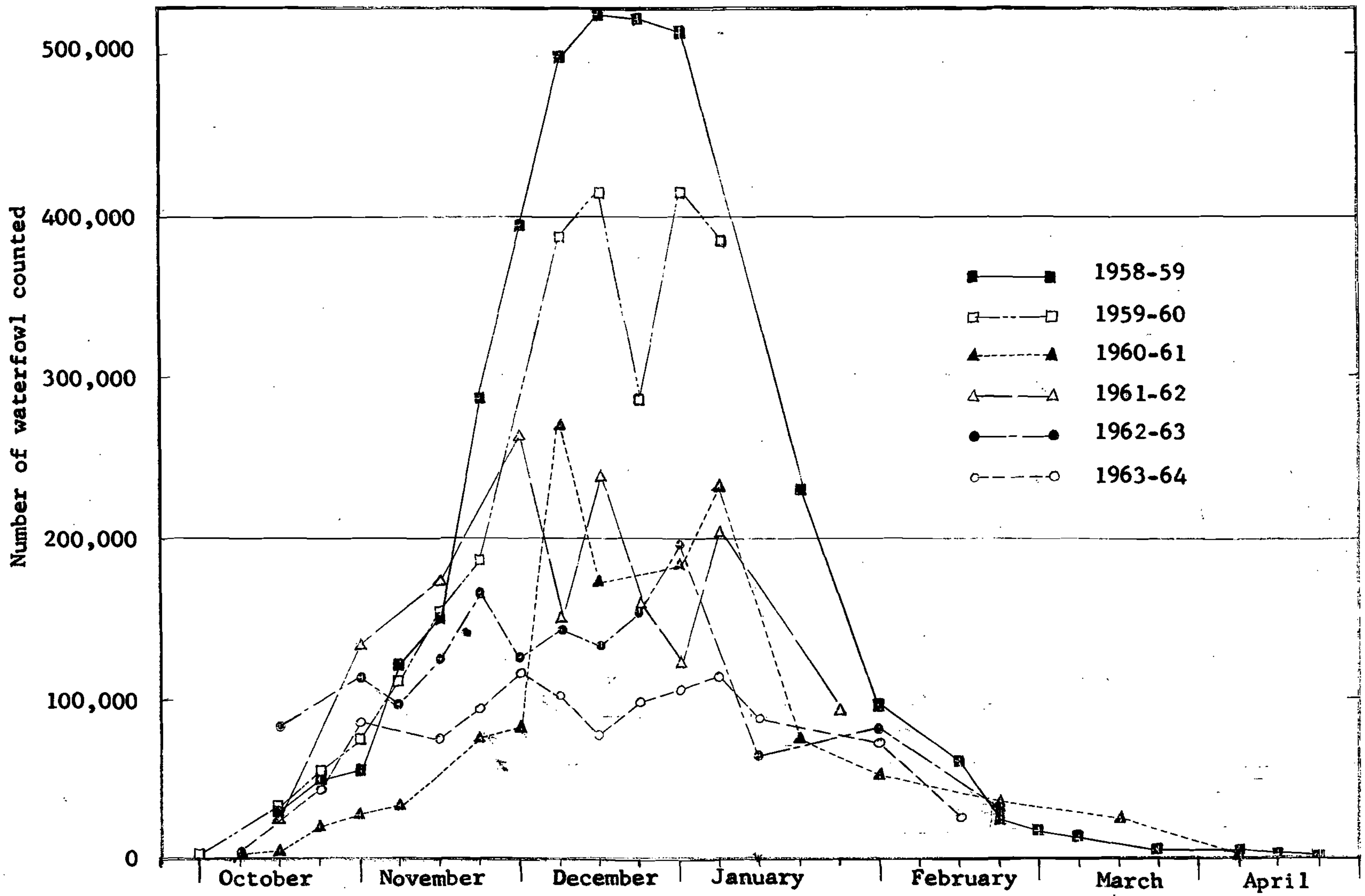



Figure 21. Regular counts of all waterfowl on the Sauvie Island Game Management Area were made during the winter months of 1958-1964. Hunting is permitted on parts of the area usually from October through December. (See also Table 22.)

TABLE 21

Lower Willamette Basin Waterfowl Population
Annual Winter Waterfowl Survey, Clackamas, Columbia,
Multnomah and Washington Counties, 1956-1964

| Species | 1964 | 1963 | 1962 | 1961 | 1960 | 1959 | 1958 | 1957 | 1956 |
|---|---|---|---|---|---|---|---|---|---|
| **Ducks** | | | | | | | | | |
| Mallard | 30,706 | 61,789 | 78,506 | 145,455 | 125,375 | 201,010 | 23,452 | 18,200 | 39,080 |
| Gadwall | 35 | - | - | - | - | 3 | - | 4 | - |
| Widgeon | 18,528 | 72,113 | 32,557 | 48,527 | 121,675 | 137,120 | 51,551 | 55,920 | 55,575 |
| GW teal | 1,385 | 700 | 2,475 | 10 | 2,513 | - | 2,967 | 1,130 | 685 |
| Shoveller | 17 | 100 | - | 126 | 6 | - | 53 | 165 | - |
| Pintail | 50,735 | 67,409 | 68,675 | 25,011 | 125,525 | 44,020 | 27,573 | 15,845 | 43,505 |
| Wood duck | - | 6 | - | - | - | - | - | - | - |
| Redhead | - | 2 | - | - | - | - | - | - | - |
| Canvasback | 180 | 48 | 55 | 31 | - | - | - | 40 | - |
| Scaup | 12 | 100 | 6 | - | 1 | 32 | - | 216 | 101 |
| Ringneck | 55 | - | - | 21 | 19 | - | - | 120 | - |
| Bufflehead | 46 | 19 | 41 | 40 | 30 | 1 | - | 37 | 10 |
| Goldeneye | 6 | 5 | - | - | - | - | - | 8 | 1 |
| Ruddy duck | 181 | 27 | 9 | 35 | 30 | 28 | - | 15 | 11 |
| Scoter | - | - | - | - | - | - | - | 430 | - |
| Merganser | 69 | 75 | 12 | - | 45 | 45 | 88 | 634 | 6 |
| Unidentified | 1,065 | 3,103 | 8,008 | 16,000 | 2,270 | - | 1,800 | 3,200 | 23,550 |
| Total Ducks | 103,020 | 205,496 | 190,344 | 235,256 | 377,489 | 382,259 | 107,484 | 95,964 | 162,524 |
| **Geese** | | | | | | | | | |
| Snow | - | - | 50 | - | 175 | 125 | 120 | 150 | 150 |
| Canada | 1,445 | 2,160 | 1,150 | 1,625 | 4,825 | 415 | 3,151 | 2,640 | 1,735 |
| L. Canada | - | - | 1,000 | - | 5,300 | - | - | - | - |
| Cackling | 1,335 | 2 | - | - | 250 | - | 909 | 110 | 325 |
| Whitefront | - | - | - | - | - | - | - | 74 | - |
| Total Geese | 2,780 | 2,162 | 2,200 | 1,625 | 10,550 | 540 | 4,180 | 3,964 | 2,210 |
| Wh. swan | 534 | 613 | 920 | 620 | 284 | 55 | 98 | 100 | 78 |
| Coot | 1,234 | 401 | 475 | 1,188 | 1,215 | 200 | 471 | 4,250 | 534 |
| Total Waterfowl | 107,568 | 208,672 | 193,939 | 238,689 | 389,538 | 383,054 | 112,233 | 103,288 | 165,346 |

TABLE 22

Periodic Counts of Waterfowl, Sauvie Island Game Management Area

| Month | Week | Year 1963-64 | 1962-63 | 1961-62 | 1960-61 | 1959-60 | 1958-59 |
|---|---|---|---|---|---|---|---|
| September | 4 | | | | | 1,675 | |
| October | 1 | 3,540 | | | 1,225 | | |
| " | 2 | | 81,750 | 25,202 | 4,549 | 31,224 | 34,796 |
| " | 3 | 43,592 | | | 20,123 | 57,830 | 51,517 |
| " | 4 | 85,204 | 113,895 | 133,494 | 29,427 | 76,940 | 57,051 |
| November | 1 | | 98,490 | | 33,640 | 110,137 | 121,773 |
| " | 2 | 74,252 | 123,775 | 170,666 | | 157,420 | 154,083 |
| " | 3 | 93,225 | 166,315 | | 76,910 | 187,725 | 277,971 |
| " | 4 | 116,907 | 125,550 | 263,472 | 82,182 | | 395,970 |
| December | 1 | 102,025 | 141,723 | 150,665 | 270,044 | 388,270 | 498,675 |
| " | 2 | 78,797 | 133,070 | 238,138 | 172,914 | 413,916 | 528,079 |
| " | 3 | 97,866 | 153,880 | 159,017 | | 286,515 | 522,285 |
| " | 4 | 106,080 | 196,910 | 122,031 | 184,160 | 415,675 | 514,295 |
| January | 1 | 113,380 | | 202,625 | 232,345 | 385,005 | |
| " | 2 | 88,966 | 65,055 | | | | |
| " | 3 | | | | 78,409 | | 230,423 |
| " | 4 | | | 93,075 | | | |
| " | 5 | 71,180 | 83,742 | | 52,769 | | 97,963 |
| February | 1 | | | | | | |
| " | 2 | 25,600 | | | | | 62,253 |
| " | 3 | | 29,617 | | | | 26,210 |
| " | 4 | | | | 36,850 | | 19,382 |
| March | 1 | | | | | | 13,432 |
| " | 2 | | | | | | |
| " | 3 | | | | 28,840 | | 6,264 |
| " | 4 | | | | | | |
| April | 1 | | | | 1,506 | | 3,671 |
| " | 2 | | | | | | 2,314 |
| " | 3 | | | | | | 1,212 |

# CONCLUSIONS

Major conclusions and recommendations considered necessary for the maintenance, enhancement and utilization of the basin's fish and wildlife resources relevant to water uses and developments are summarized below.

## WILLAMETTE RIVER

1. Increased intensity of pollution abatement and treatment measures are necessary to improve water quality for fish life and recreational use.
2. Provision of good quality flows in the summer and fall from upstream impoundment releases should be encouraged to assist in reduction of pollution and high water temperatures in the lower Willamette River.
3. Improved passage and protection facilities at Willamette Falls for both upstream and downstream migrant fish are needed to promote anadromous fish runs.
4. Applications for future use of Willamette River water should be carefully analyzed to determine expected effects upon river quality and quantity.
5. Attempts to establish runs of such fish species as summer steelhead trout and fall chinook salmon should follow favorable advancements with items 1, 2 and 3 above.

## TUALATIN SUBBASIN

1. Minimum stream flows, particularly in summer and fall months, should be established. Achievement of proper minimum volumes would depend to a large extent upon releases from future impoundments.
2. Further water appropriations from streams presently flowing less than the listed minimums in Appendix I should be discouraged wherever possible.
3. Fish passage facilities should be provided at the Tualatin River dam, river mile 3.8. Minimum flows for fish rearing and upstream passage should be established in the river below the dam.

4. The effects of the Lake Oswego inlet canal and the falls in the lake's outlet on anadromous fish should be investigated by the fishery management agencies and proper corrections made if necessary.

CLACKAMAS SUBBASIN

1. Minimum stream flows for fish life and recreational use should be established. This is of particular importance because adequate flows presently exist in most streams, but without protection will probably not exist in the future.
2. Clackamas River water fluctuations resulting from power generation should be further studied to determine effects on fish life. The fluctuations should be minimized whenever possible, especially during periods that they are most detrimental to fish life and recreational water use.
3. Improved upstream fish passage facilities over River Mill Dam should be provided.
4. Future water storage projects should be planned so as to minimize damage to critical big game winter range.

COLUMBIA SUBBASIN

1. Further water appropriations from streams presently flowing less than the listed minimums in Appendix I should be discouraged wherever possible.
2. Pollution abatement should be intensified in Scappoose Bay and Multnomah Channel.

SANDY SUBBASIN

1. Minimum stream flows for fish life and recreational use should be established. As in the Clackamas subbasin, adequate flows presently exist in many streams but may not in future years if not given adequate protection.

2. Additional study should be conducted in the Sandy River to determine effects of fluctuations caused by Bull Run powerhouse on fish life. Fluctuations should be minimized whenever possible, particularly at times found to be most detrimental to fish and recreational use.

3. Minimum flows in the 11.5-mile Sandy River section between Marmot Dam and the mouth of the Bull Run River should be established for anadromous fish rearing, spawning and upstream movement.

4. The possibility of providing fish passage facilities over the Little Sandy River Dam and minimum flows below the dam should be investigated.

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# A P P E N D I X

Appendix 1

## Recommended Minimum Flows for Fish Life, Lower Willamette Basin

| Stream | Location | Dec-May | June | July | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| Clackamas River | Below River Mill Dam | 800 | 650 | 650 | 650 | 650 800 | 800 | 800 |
| " " | USGS gage 2095 (Three Lynx) | 640 | 640 | 400 | 400 | 400 640 | 640 | 640 |
| " " | Below Collawash River | 500 | 500 | 300 | 300 | 300 500 | 500 | 500 |
| " "/1 | USGS gage 2080 (Big Bottom) | 240 | 240 | 150 | 150 | 150 240 | 240 | 240 |
| Clear Creek | Mouth | 110 | 40 | 40 | 20 | 20 | 40 110 | 110 |
| " " | Viola | 70 | 25 | 20 15 | 15 | 15 | 25 40 | 70 |
| Collawash River | Mouth | 250 | 200 | 150 100 | 75 | 75 250 | 250 | 250 |
| E.Fk. Collawash R. | " | 30 | 30 | 20 15 | 10 | 10 | 15 20 | 30 |
| Elk Lake Creek | " | 40 | 40 | 30 20 | 20 15 | 15 | 20 30 | 40 |
| Hot Springs Fk. | " | 75 | 75 | 75 30 | 20 | 20 75 | 75 | 75 |
| Deep Creek | " | 35 | 20 | 10 | 10 | 10 | 12 | 35 |
| N. Fk. Deep Creek | " | 20 | 3 | 3 | 1 | 1 | 1 3 | 20 |
| Tickle Creek | " | 30 | 6 | 4 | 4 | 4 | 4 6 | 30 |
| Eagle Creek | " | 125 | 100 | 100 50 | 40 | 40 | 40 | 125 |
| N. Fk. Eagle Creek | " | 45 | 35 30 | 30 | 10 | 10 | 10 | 45 |
| Fish Creek | " | 60 | 60 | 25 15 | 12 | 12 | 12 15 | 60 |
| " " | Confl. of Wash Creek | 30 | 16 12 | 8 5 | 3 | 3 | 8 16 | 30 |
| Wash Creek | Mouth | 25 | 25 10 | 10 5 | 3 | 3 | 10 20 | 25 |
| Lowe Creek | " | 8 | 8 8 | 3 2 | 2 | 2 | 2 | 8 |
| Oak Grove Fk. | " | 60 | 50 30 | 20 10 | 10 | 10 | 25 40 | 60 |
| Pinhead Creek | " | 75 | 50 | 50 | 50 | 50 | 50 | 75 |
| Roaring River | " | 100 | 100 | 40 | 40 | 40 | 40 100 | 100 |
| S. Fk. Clackamas River | " | 75 | 50 30 | 25 20 | 15 | 15 | 15 20 | 75 |
| Sandy River /1 | " | 510 | -- | -- | -- | -- 510 | 510 | 510 |
| " " | Release from Marmot Dam | -- | -- | 50 | 50 | 50 -- | -- | -- |
| " " | USGS gage 1370 (Marmot) | -- | -- | -- | 300 | 300 -- | -- | -- |
| " " | Confl. of Zigzag River | 250 | 200 | 150 100 | 100 | 100 250 | 250 | 250 |
| Alder Creek | Mouth | 25 | 15 10 | 8 5 | 4 | 4 | 4 25 | 25 |
| Beaver Creek | " | 14 | 3 2 | 1 | 1 | 1 | 1 14 | 14 |
| Bull Run River | USGS gage 1400 | -- | -- | -- | 12 | 12 -- | -- | -- |
| Little Sandy R. | USGS gage 1415 | -- | -- | 25 20 | 15 | 15 | -- | -- |
| N.Fk. Bull Run R. | Mouth | -- | -- | -- | 10 | 10 | -- | -- |
| S.Fk. Bull Run R. | " | -- | -- | -- | 12 | 12 | -- | -- |
| Cedar Creek | " | 60 | 40 20 | 10 | 10 | 10 20 | 40 60 | 60 |
| Cedar Creek | " | 45 | 30 20 | 15 8 | 8 6 | 6 | 6 45 | 45 |
| Clear Fk. Sandy R. | " | 25 | 20 15 | 12 | 8 | 8 | 8 25 | 25 |

## Appendix I (continued)

SANDY R (continued)

| Stream | Location | Dec-May | June | July | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| Gordon Creek | Mouth | 50 | 30 20 | 15 | 15 | 15 | 20 50 | 50 |
| Lost Creek | Confl. of Cast Cr. | 20 | 15 | 15 12 | 12 | 12 | 12 20 | 20 |
| Salmon River | Mouth | 250 | 250 | 150 125 | 100 80 | 80 250 | 250 | 250 |
| " " | Confl. of South Fk. | 150 | 150 | 120 90 | 60 | 60 100 | 150 | 150 |
| Boulder Creek | Mouth | 30 | 20 10 | 8 | 5 4 | 3 | 3 30 | 30 |
| Cheeney Creek | " | 35 | 20 10 | 8 | 5 4 | 3 | 3 35 | 35 |
| S. Fk. Salmon R. | " | 35 | 20 10 | 8 | 5 | 5 8 | 15 35 | 35 |
| Trout Creek | " | 35 | 20 5 | 4 3 | 3 | 3 | 5 20 | 35 |
| Zigzag River | " | 200 | 150 | 100 | 75 | 75 200 | 200 | 200 |
| Camp Creek | " | 25 | 20 | 20 | 15 | 15 | 15 25 | 25 |
| Henry Creek | " | 18 | 10 7 | 4 3 | 2 | 2 | 2 18 | 18 |
| Still Creek | " | 60 | 50 40 | 30 25 | 25 | 25 60 | 60 | 60 |
| **Small streams tributary to Scappoose Bay** | | | | | | | | |
| Milton Creek | Confl. of Salmon Cr. | 25 | 10 8 | 5 4 | 3 | 3 | 3 5 | 25 |
| Cox Creek | Mouth | 6 | 3 2 | 1 0.5 | 0.5 | 0.5 | 0.5 1 | 6 |
| Salmon Creek | " | 5 | 1 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 5 |
| N. Fk. Scappoose Cr. | " | 40 | 25 20 | 20 8 | 5 | 5 | 5 7 | 40 |
| Alder Creek | " | 8 | 3 | 1 | 1 | 1 | 1 | 8 |
| Cedar Creek | " | 6 | 3 | 1 | 1 | 1 | 1 | 6 |
| Chapman Cr. (Lizzie Cr.) | " | 6 | 4 3 | 2 | 1 | 1 | 1 | 6 |
| N.Fk. of N.Fk. | " (Joins S.Fk. of N.Fk. 0.2 mi. above Mollenhoar Cr.) | 7 | 4 3 | 3 1 | 1 | 1 | 1 2 | 7 |
| Sierkes Cr. (Deep Cr.) | Mouth | 7 | 7 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 7 |
| S.Fk. of N. Fk. | " | 8 | 4 3 | 2 1 | 1 | 1 | 1 2 | 8 |
| S. Fk. Scappoose Cr. | Confl. of Raymond Cr. | 25 | 15 12 | 5 | 5 | 5 | 5 6 | 25 |
| Gourlay Cr. | Mouth | 10 | 3 2 | 2 0.5 | 0.5 | 0.5 | 0.5 1 | 10 |
| Raymond Cr. | " | 8 | 2 1 | 1 0.5 | 0.5 | 0.5 | 0.5 1 | 8 |
| **Small streams tributary to Columbia River** | | | | | | | | |
| Bridal Veil Cr. | Mouth | - | - | - | 5 | 4 | - | - |
| Horsetail Cr. | " | - | - | - | 3 | 3 | - | - |
| Latourell Cr. | " | - | - | - | 3 | 3 | - | - |
| McCord Cr. | " | - | - | - | 1 | 1 | - | - |

Appendix I (continued)

| Stream | Location | Dec-May | June | July | Aug. | Sept. | Oct. | Nov. |
|---|---|---|---|---|---|---|---|---|
| Moffet Cr. | Mouth | - | - | - | 1 | 1 | - | - |
| Multnomah Cr. | " | - | - | - | 4 | 4 | - | - |
| Onsonta Cr. | " | - | - | - | 3 | 3 | - | - |
| Tanner Cr. | To arrive at hatchery dam | - | - | - | 15 | 15 | - | - |
| Wahkeena Cr. | Mouth | - | - | - | 2 | 2 | - | - |
| Small streams tributary to Willamette River | | | | | | | | |
| Johnson Creek | USGS gage 2115 | 25 | 5 4 | 4 | 4 | 4 | 4 5 | 25 |
| Crystal Springs | Mouth | 15 | 10 | 10 | 10 | 10 | 10 | 15 |
| Tualatin R. | USGS gage 2075(West Linn) | 30 | 25 | 20 15 | 15 | 15 | 30 | 30 |
| " " | USGS gage 2035(Dilley) | 30 | 25 | 20 15 | 15 | 15 | 30 | 30 |
| " " 2/ | River mile 70 | 65 | 30 20 | 15 10 | 10 | 10 | 10 15 | 20 65 |
| Dairy Creek | Mouth | 15 | 15 | 12 10 | 10 | 12 | 15 | 15 |
| E. Fk. Dairy Cr. 2/ | River mile 13 | 50 | 30 25 | 25 15 | 10 | 10 | 10 12 | 15 50 |
| Denny Cr. 2/ | Mouth | 15 | 4 3 | 3 | 2 | 2 | 2 | 4 15 |
| Plentywater Cr. 2/3/ | " | 5 | 2 | 2 | 1 | 1 | 1 | 2 5 |
| McKay Cr. 2/ 3/ | River mile 15.5 | 36 | 18 9 | 4 | 4 | 4 | 10 18 | 36 |
| E.Fk. McKay Cr. | Mouth | 18 | 9 5 | 2 | 2 | 2 | 5 9 | 18 |
| Gales Creek 1/ | " | 100 | 50 35 | 35 15 | 12 | 12 | 12 15 | 100 |
| " " 1/ | River mile 12 | 70 | 40 25 | 15 8 | 8 | 8 | 8 20 | 40 70 |
| Beaver Creek 2/ | Mouth | 17 | 3 3 | 3 1 | 1 | 1 | 1 | 2 17 |
| Clear Creek 2/ | " | 17 | 10 6 | 3 | 3 | 3 | 3 | 5 17 |
| Iller Cr. 2/ 3/ | " | 23 | 5 3 | 2 1 | 1 | 1 | 1 2 | 2 23 |
| Little Beaver Cr. | " | 10 | 7 4 | 2 1 | 1 | 1 | 4 7 | 10 |
| N.Fk. Gales Cr. | " | 25 | 4 3 | 3 2 | 2 | 2 | 2 | 3 25 |
| S.Fk. Gales Cr. | " | 20 | 3 2 | 2 1 | 1 | 1 | 1 | 2 20 |
| McFee Cr. | Confl. of Gulf Canyon Cr. | 12 | 12 10 | 7 4 | 2 | 2 | 4 7 | 10 12 |
| Scoggin Cr. | Mouth | 40 | 25 15 | 12 6 | 6 | 6 | 15 30 | 40 |
| Seine Cr. SAIN OR | " | 25 | 10 6 | 3 2 | 2 | 2 | 2 | 3 25 |
| Tanner Cr. | " | 9 | 6 | 3 2 | 1 | 1 | 1 3 | 6 9 |

incomplete info

1/ The optimum spawning flow listed is based on Oregon Game Commission studies utilizing transects.

2/ The optimum spawning flow listed is based on Oregon Fish Commission studies.

3/ The lowest summer flow listed is the recommended minimum rearing flow based on Oregon Fish Commission studies.

APPENDIX II

Miscellaneous Flows and Temperatures Obtained in Lower Willamette Basin Streams in 1962 and 1963

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Clackamas R. | 8-22-62 | 8:15 AM | 58 | 65 | | USGS gage 14-2080 | Big Bottom gage |
| " | 7-10-63 | 9:25 AM | 48 | 51 | | " | " |
| " | 8-8-63 | 12:30 PM | 55 | 70 | | " | " |
| " | 9-5-63 | 3:20 PM | 52 | 77 | | " | " |
| " | 8-22-62 | 4:00 PM | 54 | 70 | | USGS gage 14-2095 | Three Lynx gage |
| " | 6-5-63 | 6:40 PM | 50 | 53 | | " | " |
| " | 7-10-63 | 4:30 PM | 53 | 60 | | " | " |
| " | 8-8-63 | 5:35 PM | 56 | 73 | | " | " |
| " | 9-5-63 | 2:40 PM | 53 | 79 | | " | " |
| " | 7-11-63 | 5:10 PM | 58 | 65 | | USGS gage | 1.5 miles below Carve |
| " | 8-6-63 | 10:45 AM | 62 | 64 | | " | " |
| " | 9-4-63 | 2:00 PM | 64 | 88 | | " | " |
| Big Cr. | 8-22-62 | 6:50 AM | 51 | 65 | 3 | 1.25 miles above mouth | |
| Cabin Cr. | 8-22-62 | 8:30 AM | 50 | 65 | 0.5 | 0.75 mile above mouth | |
| Clear Cr. | 8-21-62 | 9:45 AM | 67 | 73 | 20 | Mouth | |
| " | 6-14-63 | 3:30 PM | 69 | 86 | 55*1/ | " | C2 |
| " | 7-11-63 | 5:00 PM | 61 | 65 | 80 | " | D |
| " | 8-6-63 | 10:20 AM | 63 | 66 | 32* | " | C+ |
| " | 9-4-63 | 2:15 PM | 69 | 89 | 20* | " | C |
| " | 6-14-63 | 4:00 PM | 68 | 88 | 36* | Viola | C |
| " | 7-11-63 | 3:00 PM | 60 | 67 | 60* | " | D |
| " | 8-6-63 | 9:45 AM | 62 | 60 | 25 | " | C+ |
| " | 9-4-63 | 10:40 AM | 63 | 77 | 18* | " | C |
| Collawash R. | 8-22-62 | 11:15 AM | 58 | 70 | 105 | Mouth | |
| " | 6-5-63 | 2:00 PM | 48 | 53 | 480* | " | D |

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Collawash R. | 7-10-63 | 2:35 PM | 54 | 59 | 225* | Mouth | D |
| " | 8-8-63 | 2:00 PM | 63 | 88 | 108* | " | C |
| " | 9-5-63 | 4:35 PM | 65 | 78 | 58* | " | C |
| E. Fk. Collawash | 6-5-63 | 3:45 PM | 46 | 53 | 95 | Mouth | D |
| " | 7-10-63 | 12:00 N | 50 | 53 | 32* | " | D |
| " | 8-8-63 | 3:15 PM | 57 | 71 | 21 | " | C |
| " | 9-5-63 | 5:55 PM | 56 | 66 | 8* | " | C |
| Elk Lake Cr | 6-5-63 | 3:45 PM | 47 | 53 | 98* | Mouth | D |
| " | 7-10-63 | 12:15 PM | 51 | 53 | 50* | " | D |
| " | 8-8-63 | 3:00 PM | 57 | 71 | 27* | " | C |
| " | 9-5-63 | 6:00 PM | 56 | 66 | 16* | " | C |
| Hot Springs Fork | 8-22-62 | 11:30 AM | 58 | 70 | 40 | Mouth | |
| " | 6-5-63 | 5:20 PM | 48 | 55 | 196* | " | D |
| " | 7-10-63 | 1:45 PM | 54 | 54 | 112* | 0.5 mile above mouth | D |
| " | 8-8-63 | 4:15 PM | 65 | 72 | 29* | " | C |
| " | 9-5-63 | 5:05 PM | 62 | 77 | 18.3* | " | C |
| Deep Cr. | 8-21-62 | 10:30 AM | 62 | 74 | 7 | 0.6 mile above mouth | |
| " | 6-14-63 | 2:45 PM | 68 | 72 | 25* | " | C |
| " | 7-11-63 | 3:45 PM | 59 | 64 | 23* | " | D |
| " | 8-6-63 | 12:00 N | 62 | 67 | 11* | " | C |
| " | 9-4-63 | 1:40 PM | 65 | 89 | 8.7* | " | C |
| N. Fk. Deep Cr. | 8-21-62 | 11:00 AM | 68 | 75 | 0.3 | Boring | Just below mill pond ladder |
| " | 6-14-63 | 2:15 PM | 71 | 79 | 2.7* | " | 4 dead silver fingerlings in ladder C |
| " | 7-11-63 | 4:00 PM | 64 | 67 | 4* | " | D |
| " | 8-6-63 | 11:10 AM | 66 | 66 | 0.4 | " | C |
| " | 9-4-63 | 1:20 PM | 67 | 88 | 0.3 | " | Some pollution C |

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Noyer Cr. | 8-21-62 | 10:45 AM | 67 | 75 | 0.3 | Mouth | | |
| Tickle Cr. | 8-21-62 | 11:15 AM | 67 | 75 | 4 | 1.1 miles above mouth | | |
| " | 6-14-63 | 1:30 PM | 61 | 77 | 7.1* | " | | C |
| " | 7-11-63 | 4:20 PM | 58 | 67 | 10.6* | " | | D |
| " | 8-6-63 | 11:30 AM | 58 | 66 | 5.6* | " | | C- |
| " | 9-4-63 | 1:00 PM | 59 | 87 | 5.6* | " | | C |
| Eagle Cr. | 8-21-62 | 11:45 AM | 66 | 75 | 32 | 0.5 mile above mouth | | |
| " | 6-10-63 | 3:00 PM | 56 | 79 | 273* | 2.2 miles above mouth | Highway 211 | D |
| " | 7-11-63 | 12:10 PM | 53 | 59 | 261* | " | " | D |
| " | 8-6-63 | 1:15 PM | 62 | 67 | 65* | " | " | C+ |
| " | 9-4-63 | 11:30 AM | 65 | 81 | 33* | " | " | C |
| Currin Cr. | 8-21-62 | 12:15 PM | 65 | 70 | 0.2 | Highway 211 | Bridge at Heiple Jct. | |
| N. Fk. Eagle Cr. | 6-10-63 | 5:00 PM | 60 | 70 | 49* | Mouth | | D |
| " | 7-11-63 | 1:45 PM | 55 | 62 | 76* | " | | D |
| " | 8-6-63 | 12:40 PM | 60 | 65 | 20* | " | | C+ |
| " | 9-4-63 | 11:45 AM | 60 | 84 | 8.8* | " | | C |
| Fish Cr. | 8-21-62 | 3:30 PM | 62 | 70 | 10 | Mouth | | |
| " | 6-10-63 | 12:45 PM | 52 | 68 | 130* | " | | D |
| " | 7-11-63 | 9:20 AM | 52 | 54 | 103* | " | | D |
| " | 8-6-63 | 3:35 PM | 66 | 75 | 18 | " | | C+ |
| " | 9-5-63 | 1:00 PM | 62 | 79 | 15.3* | " | | C |
| " | 6-10-63 | 12:00 N | 48 | 65 | 31* | Just above Wash Cr. | | D |
| " | 7-11-63 | 10:35 AM | 50 | 59 | 17.7* | " | | D |
| " | 8-6-63 | 3:20 PM | 56 | 75 | 4 | 1.0 mile above Wash Cr. | | C+ |
| " | 9-5-63 | 1:45 PM | 56 | 78 | 4* | " | | C |
| Wash Cr. | 8-21-62 | 3:10 PM | 58 | 70 | 2.5 | 1.0 mile above mouth | | |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Temp. °F. Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Wash Cr. | 6-10-63 | 11:30 AM | 46 | 63 | 53* | 0.5 mile above mouth | D |
| " | 7-11-63 | 10:15 AM | 50 | 56 | 35* | 0.5 mile above mouth | D |
| " | 8-6-63 | 3:00 PM | 59 | 74 | 6 | " | C+ |
| " | 9-5-63 | 1:30 PM | 58 | 77 | 3.7* | " | C |
| Lowe Cr. | 6-5-63 | 11:30 AM | 43 | 53 | 23* | 0.1 mile above mouth | Poor passage thru culvert near mouth D |
| " | 7-10-63 | 10:00 AM | 48 | 51 | 6.9* | " | " D |
| " | 8-8-63 | 12:40 PM | 54 | 85 | 2.9* | " | " C+ |
| " | 9-5-63 | 3:40 PM | 54 | 72 | 2.2* | " | " C |
| N. Fk. Clackamas R. | 8-21-62 | 2:15 PM | 60 | 70 | 10 | Mouth | |
| Oak Grove Fk. | 8-21-62 | 5:20 PM | 46 | 68 | | USGS gage 14-2087 | Just below Timothy Lk. |
| " | 8-21-62 | 4:40 PM | 48 | 68 | | USGS gage 14-2090 | Just above Harriet Lk. |
| " | 6-5-63 | 6:00 PM | 46 | 53 | | " | " |
| " | 7-10-63 | 3:40 PM | 47 | 60 | | " | " |
| " | 8-8-63 | 5:00 PM | 50 | 70 | | " | " |
| " | 9-5-63 | 7:15 PM | 49 | 68 | | " | " |
| " | 9-5-63 | 8:00 PM | 51 | 64 | 6 | 1.0 mile above Timothy Lake | |
| Olallie Cr. | 8-22-62 | 10:05 AM | 42 | 70 | 42 | 1.0 mile above mouth | |
| Pinhead Cr. | 8-22-62 | 9:00 AM | 44 | 68 | 80 | 0.2 mile above mouth | |
| " | 6-5-63 | 12:10 PM | 45 | 53 | 118* | " | D |
| " | 7-10-63 | 10:25 AM | 48 | 51 | 110* | " | D |
| " | 8-8-63 | 1:00 PM | 47 | 77 | 110* | " | C+ |
| " | 9-5-63 | 3:55 PM | 47 | 81 | 102* | " | C |
| Last Cr. | 8-22-62 | 10:45 AM | 45 | 70 | 16 | 0.1 mile above mouth | |
| Pot Cr. | 8-22-62 | 8:25 AM | 46 | 65 | 2.5 | 0.25 mile above mouth | |
| Roaring R. | 8-21-62 | 3:45 PM | 54 | 70 | 40+ | Mouth | |
| " | 6-10-63 | 10:20 AM | 46 | 62 | 221* | " | D |

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Roaring R. | 7-11-63 | 9:00 AM | 49 | 54 | 131* | Mouth | | D |
| " | 8-8-63 | 6:00 PM | 57 | 68 | 68* | " | | C- |
| " | 9-5-63 | 2:15 PM | 54 | 80 | 52* | " | | C |
| Rock Cr. | 8-21-62 | 10:00 AM | 58 | 73 | 0.4 | 0.25 mile above mouth | | |
| Sandstone Cr. | 8-22-62 | 6:30 AM | 50 | 65 | 3 | 0.75 mile above mouth | | |
| S. Fk. Clackamas R. | 8-8-63 | 11:00 AM | 55 | 63 | 30* | Mouth | | C- |
| " | 9-5-63 | 11:45 AM | 56 | 69 | 21* | " | | C |
| Squirrel Cr. | 8-22-62 | 9:50 AM | 43 | 70 | 3.5 | 1.0 mile above mouth | | |
| Columbia R. Small Tributaries | | | | | | | | |
| Bridal Veil Cr. | 7-3-63 | 1:15 PM | 54 | 65 | 18.3* | 80 yds. below falls | 1 spawned-out St | C |
| " | 8-7-63 | 11:00 AM | 53 | 63 | 9* | " | | C |
| " | 9-3-63 | 3:30 PM | 58 | 89 | 5.2 | " | | C |
| Horsetail Cr. | 7-3-63 | 3:00 PM | 54 | 74 | 6.9* | Old highway bridge | | C |
| " | 8-7-63 | 1:20 PM | 56 | 72 | 4.4* | " | | C |
| " | 9-3-63 | 5:15 PM | 56 | 76 | 4* | " | | C |
| Latourell Cr. | 7-3-63 | 11:45 AM | 55 | 62 | 7.9* | Latourell Falls State Park | | C |
| " | 8-7-63 | 11:25 AM | 55 | 64 | 4 | " | | C |
| " | 9-3-63 | 4:00 PM | 60 | 83 | 3.5 | " | | C |
| McCord Cr. | 7-3-63 | 3:30 PM | 57 | 77 | 5.3 | Highway 30 | | C |
| " | 8-7-63 | 1:35 PM | 58 | 74 | 2 | " | | C |
| " | 9-3-63 | 5:30 PM | 59 | 78 | 1.2 | " | | C |
| Moffet Cr. | 7-3-63 | 4:30 PM | 57 | 78 | 1.9* | Highway 30 near mouth | | C |
| " | 8-7-63 | 2:30 PM | 61 | 78 | 1 | " | | C |
| " | 9-3-63 | 5:40 PM | 59 | 70 | 1.1 | " | | C |
| Multnomah Cr. | 7-3-63 | 2:15 PM | 58 | 73 | 9.5* | 200 yds. below falls | | C |
| " | 8-7-63 | 12:30 PM | 56 | 70 | 5.3* | " | | C |
| " | 9-3-63 | 4:35 PM | 60 | 78 | 4.3* | " | | C |

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Oneonta Cr. | 7-3-63 | 2:30 PM | 57 | 74 | 9.3* | Old highway bridge | C |
| " | 8-7-63 | 1:00 PM | 58 | 71 | 3.7* | " | C |
| " | 9-3-63 | 4:50 PM | 59 | 76 | 2.7* | " | C |
| Tanner Cr. | 7-3-63 | 4:15 PM | 54 | 78 | 5.9* | Highway 30 | Many juvenile salmonids C |
| " | 8-7-63 | 1:45 PM | 60 | 76 | 1.5 | " | Dry below highway br. C |
| " | 9-3-63 | 5:50 PM | 55 | 67 | 1.5 | Just below hatchery dam | C |
| " | 8-7-63 | 2:00 PM | 54 | 77 | 20 | Just above hatchery dam | C |
| " | 9-3-63 | 6:00 PM | 53 | 67 | 30 | Just above hatchery dam | C |
| Wahkeena Cr. | 7-3-63 | 2:00 PM | 50 | 74 | 5.8* | R.R. bridge at Wahkeena Falls picnic | grounds C |
| " | 8-7-63 | 12:00 N | 50 | 67 | 4 | " | C |
| " | 9-3-63 | 4:20 PM | 52 | 78 | 4* | " | C |
| Sandy R. | 6-6-63 | 5:45 PM | 44 | 54 | 130* | 1.0 mile below Clear Fork | D |
| " | 7-11-63 | 12:15 PM | 49 | 55 | 130 | " | D |
| " | 8-7-63 | 1:20 PM | 58 | 70 | 75 | " | C |
| " | 9-6-63 | 10:45 AM | 48 | 64 | 65 | " | Turbid C |
| " | 6-6-63 | 6:30 PM | - | 54 | 350 | 0.7 mile above Zigzag R. | D |
| " | 7-11-63 | 11:30 AM | 50 | 57 | 250 | " | Moderately turbid D |
| " | 8-7-63 | 2:00 PM | 59 | 77 | 130 | " | C |
| " | 9-6-63 | 10:05 AM | 49 | 59 | 130 | " | Turbid C |
| " | 7-11-63 | 2:00 PM | 53 | 62 | | USGS Gage 14-1370 | Marmot gage |
| " | 8-8-63 | 4:10 PM | 62 | 76 | | " | " |
| " | 7-9-63 | 9:15 AM | 57 | 63 | | River mile 6.3 | Dabney State Park |
| " | 8-8-63 | 6:05 PM | 71 | 90 | | " | " |
| " | 6-11-63 | 10:45 AM | 56 | 68 | | USGS Gage 14-1425 | 0.9 mile below Bull Run R. |
| " | 7-9-63 | 11:45 AM | 56 | 68 | | " | " |
| " | 8-8-63 | 11:00 AM | 63 | 67 | | USGS Gage 14-1425 | 0.9 mile below Bull Run R. |
| " | 9-6-63 | 6:30 PM | 63 | 72 | | " | 0.9 mile below Bull Run R. Turbid. |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Alder Cr. | 9-12-62 | 10:30 AM | 51 | 63 | 5 | 0.2 mile above mouth | Highway 26 | |
| " | 6-6-63 | 10:15 AM | 46 | 52 | 26* | " | " | I |
| " | 7-9-63 | 1:30 PM | 51 | 62 | 17.6* | " | Small diversion beneat br.(taking no water) | I |
| " | 8-7-63 | 10:20 AM | 55 | 64 | 6.1* | " | Highway 26 | C |
| " | 9-6-63 | 3:00 PM | 62 | 75 | 6* | " | " | C |
| Badger Cr. | 6-11-63 | 12:00 N | 56 | 70 | 15 | 0.3 mile above mouth | | C |
| Beaver Cr. | 9-12-62 | 10:15 AM | 51 | 63 | 2.4 | 0.3 mile above mouth | | |
| " | 6-11-63 | 3:30 PM | 66 | 73 | 3.2* | " | | C |
| " | 7-9-63 | 8:45 AM | 56 | 63 | 2.8* | " | | D |
| " | 8-8-63 | 6:25 PM | 63 | 86 | 1.2* | " | | C |
| " | 9-6-63 | 2:10 PM | 63 | 81 | 1 | " | | C |
| Bull Run R. | 8-22-62 | 2:30 PM | 61 | 71 | | USGS Gage 14-1400 | | |
| " | 9-12-62 | 9:45 AM | 55 | 62 | | Just above PGE powerhouse | River mile 1.5 | |
| " | 9-5-63 | 3:30 PM | 67 | 82 | | USGS Gage 14-1400 | | |
| Little Sandy R. | 6-6-63 | 8:00 PM | 49 | 54 | | USGS Gage 14-1415 | | |
| " | 7-11-63 | 3:00 PM | 55 | 63 | | " | Approx. 20 c.f.s. over PGE dam | |
| " | 8-8-63 | 4:55 PM | 64 | 75 | | " | Dry below dam | |
| " | 9-6-63 | 3:30 PM | 61 | 76 | | " | " | |
| N. Fk. Bull Run R. | 9-5-63 | 1:45 PM | 53 | 82 | 15 | Mouth | | C |
| S. Fk. Bull Run R. | 9-5-63 | 3:00 PM | 56 | 82 | 18 | " | | C |
| Cedar Cr. | 9-12-62 | 10:00 AM | 52 | 62 | 6 | 1.3 mile above mouth | First road crossing above hatchery | |
| " | 6-11-63 | 1:25 PM | 57 | 71 | 43* | " | " | C |
| " | 7-9-63 | 10:45 AM | 56 | 61 | 29* | " | " | D |
| " | 8-8-63 | 11:30 AM | 60 | 68 | 15.8* | " | " | C |
| Clear Cr. | 9-12-62 | 12:00 N | 51 | 63 | 5 | Mouth | | |
| " | 6-6-63 | 5:00 PM | 47 | 54 | 41* | " | | D |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Clear Cr. | 7-11-63 | 12:30 PM | 50 | 55 | 30* | Mouth | | I |
| " | 8-7-63 | 1:35 PM | 60 | 72 | 9.4* | " | | C |
| " | 9-6-63 | 10:15 AM | 54 | 62 | 6.3* | " | | C |
| Clear Fork Sandy R. | 7-11-63 | 12:00 N | 50 | 55 | 30* | 0.2 mile above mouth | | I |
| " | 8-7-63 | 1:05 PM | 55 | 68 | 11.5* | " | | C |
| " | 9-6-63 | 10:55 AM | 52 | 67 | 8.1* | " | | C |
| Gordon Cr. | 6-11-63 | 2:50 PM | 58 | 73 | 43* | Mouth | | C |
| " | 7-9-63 | 9:45 AM | 54 | 62 | 32* | " | | D |
| " | 8-8-63 | 5:55 PM | 66 | 85 | 20* | " | | C |
| " | 9-6-63 | 2:30 PM | 62 | 75 | 19.5* | " | | C |
| Lost Cr. | 6-6-63 | 6:00 PM | 44 | 54 | 38 | 0.5 mile above Cast Cr. | | D |
| " | 7-11-63 | 11:45 AM | 49 | 57 | 38 | " | | D |
| " | 8-7-63 | 12:30 PM | 53 | 65 | 17.5* | " | | C |
| " | 9-6-63 | 10:35 AM | 49 | 63 | 13.4* | " | | C |
| Salmon R. | 9-12-62 | 11:20 AM | 50 | 63 | 80 | 0.3 mile above mouth | Highway 26 bridge | |
| " | 6-6-63 | 11:40 AM | 47 | 52 | 500* | 0.5 mile above mouth | | D |
| " | 7-9-63 | 2:00 PM | 53 | 62 | 215* | " | | D |
| " | 8-8-63 | 3:40 PM | 65 | 80 | 180* | " | | C |
| " | 9-6-63 | 1:50 PM | 60 | 73 | 120* | " | | C |
| " | 6-6-63 | 2:00 PM | 45 | 53 | 300 | 0.5 mile above S. Fk. Salmon R. | | D |
| " | 7-9-63 | 3:15 PM | 50 | 60 | 100 | " | | D |
| " | 8-8-63 | 1:35 PM | 54 | 74 | 97* | Just above S. Fk. Salmon R. | | C |
| " | 9-6-63 | 12:35 PM | 52 | 72 | 98* | " | | C |
| Boulder Cr. | 9-12-62 | 11:40 AM | 54 | 63 | | Mouth | | |
| " | 6-6-63 | 11:00 AM | 45 | 52 | 63* | " | | D |
| " | 7-9-63 | 1:45 PM | 51 | 62 | 19* | " | | D |

| Stream | Date | Time | Temp. °F. | | Flow | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| | | | Water | Air | Cfs | | | |
| Boulder Cr. | 8-8-63 | 3:05 PM | 60 | 79 | 6.4* | Mouth | | ( |
| " | 9-6-63 | 2:30 PM | 59 | 73 | 3.5* | " | | ( |
| Cheeney Cr. | 6-6-63 | 12:30 PM | 47 | 52 | 50* | Mouth | | I |
| " | 7-9-63 | 4:00 PM | 52 | 60 | 15* | " | | I |
| " | 8-8-63 | 12:30 PM | 60 | 82 | 7.1* | " | | ( |
| " | 9-6-63 | 11:25 AM | 58 | 70 | 3.8* | " | | ( |
| S. Fk. Salmon R. | 6-6-63 | 2:30 PM | - | 53 | 60 | Mouth | | I |
| " | 7-9-63 | 3:30 PM | 50 | 60 | 14 | " | | I |
| " | 8-8-63 | 1:30 PM | 55 | 74 | 7.5* | " | | C |
| " | 9-6-63 | 12:30 PM | 53 | 72 | 5.7* | " | | C |
| Trout Cr. | 6-11-63 | 2:20 PM | 56 | 72 | 13 | 0.7 mile above mouth | | C |
| " | 7-9-63 | 10:00 AM | 53 | 63 | 7.2* | " | | D |
| " | 8-8-63 | 5:40 PM | 62 | 80 | 5.7* | " | | C |
| " | 9-6-63 | 2:50 PM | 58 | 73 | 5.6* | " | | C |
| Whiskey Cr. | 9-12-62 | 10:25 AM | 50 | 63 | 0.7 | 0.5 mile above mouth | | |
| Wildcat Cr. | 9-12-62 | 10:40 AM | 52 | 63 | 1.5 | 0.2 mile above mouth | | |
| Zigzag R. | 9-12-62 | 12:20 PM | 48 | 63 | 90 | 0.3 mile above mouth | | |
| " | 6-6-63 | 4:40 PM | 46 | 54 | 350 | " | | D |
| " | 7-11-63 | 11:15 AM | 51 | 57 | 250 | " | | D |
| " | 8-7-63 | 2:20 PM | 58 | 77 | 130* | | | C |
| " | 9-6-63 | 9:50 AM | 51 | 59 | 130* | | | C |
| Camp Cr. | 9-12-62 | 1:05 PM | 47 | 63 | 8 | Approx. 0.7 mile above mouth | Camp Cr. Forest Camp | |
| " | 6-6-63 | 3:50 PM | 45 | 53 | 55* | " | " | D |
| " | 7-11-63 | 10:45 AM | 49 | 55 | 46* | Approx. 0.7 mile above mouth | Camp Cr. Forest Camp | D |
| " | 8-7-63 | 11:10 AM | 51 | 62 | 25* | " | " | C |
| " | 9-6-63 | 8:30 AM | 50 | 59 | 18* | " | " | C |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Henry Cr. | 9-12-62 | 12:50 PM | 47 | 63 | 2 | 0.1 mile above mouth | | |
| " | 6-6-63 | 4:15 PM | 45 | 54 | 14 | 0.5 mile above mouth | | I |
| " | 7-11-63 | 11:10 AM | 48 | 56 | 8 | " | | I |
| " | 8-7-63 | 10:50 AM | 49 | 66 | 4.4* | " | | C |
| " | 9-6-63 | 8:55 AM | 49 | 51 | 2.7* | " | | C |
| Still Cr. | 9-12-62 | 12:45 PM | 50 | 63 | 16 | Mouth | | |
| " | 6-6-63 | 3:35 PM | 46 | 53 | 115* | 1.3 miles above mouth | | I |
| " | 7-11-63 | 10:15 AM | 51 | 57 | 62* | " | | I |
| " | 8-7-63 | 11:50 AM | 55 | 64 | 33* | " | | C |
| " | 9-6-63 | 9:15 AM | 52 | 52 | 32* | " | | C |
| Scappoose Bay Tributaries | | | | | | | | |
| Milton Cr. | 9-11-62 | 11:00 AM | 57 | 63 | 4 | 1.0 mile above mouth | | |
| " | " | 11:20 AM | 57 | 63 | 3 | 1.0 mile above Yankton | | |
| " | 6-4-63 | 5:30 PM | 52 | 54 | 14* | Yankton | Just below Salmon Cr. | C |
| " | 7-10-63 | 1:45 PM | 57 | 65 | 7.6* | " | Just below Salmon Cr. Slightly turbid | D |
| " | 8-6-63 | 2:05 PM | 64 | 74 | 4.6* | " | " | C |
| " | 9-4-63 | 3:45 PM | 65 | 85 | 4* | " | " | C |
| " | " | 4:10 PM | 64 | 85 | 3 | 3.0 miles above Yankton | | C |
| Cox Cr. | 9-11-62 | 11:40 AM | 54 | 63 | 1 | 0.3 mile above mouth | | |
| " | 6-4-63 | 5:10 PM | 52 | 54 | 3* | " | | C |
| " | 7-10-63 | 1:30 PM | 57 | 65 | 1.5* | " | | D |
| " | 8-6-63 | 1:50 PM | 65 | 73 | 0.8* | " | | C |
| " | 9-4-63 | 3:30 PM | 66 | 85 | 0.6 | " | | C |
| Salmon Cr. | 9-11-62 | 11:30 AM | 54 | 63 | 0.3 | 0.3 mile above mouth | | |
| " | 7-10-63 | 1:40 PM | - | 65 | 0.7 | 0.1 mile above mouth | | D |
| " | 8-6-63 | 2:15 PM | 65 | 73 | 0.5* | " | | C |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Salmon Cr. | 9-4-63 | 3:35 PM | 65 | 85 | 0.4 | 0.1 mile above mouth | C- |
| N. Fk. Scappoose Cr. | 9-11-62 | 10:35 AM | 58 | 62 | 5 | Highway 30 bridge | |
| " | 9-4-63 | 4:30 PM | 70 | 85 | 6 | " | C+ |
| " | 9-4-63 | 3:05 PM | 63 | 85 | 2.6 | Just above Chapman Cr. | C+ |
| " | 6-4-63 | 3:10 PM | 52 | 54 | 32* | 1.5 mile above mouth | C |
| " | 7-10-63 | 11:15 AM | 57 | 65 | 22* | " | D |
| " | 8-6-63 | 11:20 AM | 62 | 65 | 5.6* | " | C |
| " | 9-4-63 | 2:20 PM | 69 | 85 | 6* | " | C+ |
| Alder Cr. | 9-11-62 | 12:00 N | 55 | 64 | 1 | 0.2 mile above mouth | |
| " | 6-4-63 | 4:55 PM | 52 | 54 | 3.2 | " | C |
| " | 7-10-63 | 12:30 PM | 57 | 65 | 1.6* | " | D |
| " | 8-6-63 | 12:55 PM | 63 | 72 | 0.8* | " | C |
| " | 9-4-63 | 3:15 PM | 66 | 85 | 0.8 | " | C+ |
| Cedar Cr. | 9-11-62 | 1:15 PM | 55 | 65 | 0.7 | Mouth | |
| " | 7-10-63 | 12:15 PM | 55 | 64 | 1.6* | " | D |
| " | 8-6-63 | 12:30 PM | 60 | 70 | 0.4 | " | C |
| " | 9-4-63 | 3:00 PM | 61 | 85 | 0.4 | " | C+ |
| Chapman Cr. | 6-4-63 | 4:45 PM | 50 | 54 | 4.4* | Mouth | Lizzie Cr. on SWRB map C |
| " | 7-10-63 | 11:40 AM | 53 | 63 | 2.3* | " | D |
| " | 8-6-63 | 12:45 PM | 57 | 71 | 1.1* | " | C |
| " | 9-4-63 | 3:05 PM | 59 | 85 | 1* | " | C+ |
| N. Fk. of N. Fk. | 6-4-63 | 4:00 PM | 50 | 54 | 5.4 | Mouth | C |
| " | 7-10-63 | 12:00 N | 54 | 63 | 2.7* | " | D |
| " | 8-6-63 | 12:05 PM | 59 | 69 | 0.8* | " | C |
| " | 9-4-63 | 2:45 PM | 61 | 85 | 0.9* | " | C+ |
| Sierkes Cr. | 6-4-63 | 3:30 PM | 52 | 54 | 1.9 | " | Deep Cr. on SWRB map C |

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Sierkes Cr. | 7-10-63 | 11:30 AM | 55 | 65 | 0.8 | Mouth | | D |
| " | 8-6-63 | 11:30 AM | 57 | 66 | 0.5 | " | | C |
| " | 9-4-63 | 2:30 PM | 58 | 85 | 0.4 | " | | C- |
| S. Fk. of N. Fk. | 6-4-63 | 4:10 PM | 50 | 54 | 4.2* | Mouth | | C |
| | 7-10-63 | 11:50 AM | 53 | 63 | 3* | " | | D |
| " | 8-6-63 | 12:00 N | 60 | 68 | 1.2 | " | | C |
| " | 9-4-63 | 2:55 PM | 59 | 85 | 1.2 | " | | C- |
| S. Fk. Scappoose Cr. | 9-11-62 | 10:00 AM | 57 | 62 | 3 | Watts Rd. bridge | Near mouth | |
| " | 6-4-63 | 1:45 PM | 52 | 54 | 19* | Just above Raymond Cr. | | C |
| " | 7-10-63 | 10:00 AM | 56 | 63 | 11* | " | | D |
| " | 8-6-63 | 10:40 AM | 61 | 62 | 5.9* | " | | C |
| " | 9-4-63 | 1:40 PM | 71 | 85 | 4.6* | " | | C+ |
| " | 9-4-63 | 2:05 PM | 63 | 85 | 4 | 100 yds. below Gourlay Cr. | | C+ |
| " | 9-4-63 | 4:35 PM | 70 | 85 | - | Highway 30 bridge | Moderately turbid Smells like sewage | C+ |
| Gourlay Cr. | 9-11-62 | 2:10 PM | 55 | 64 | 1.5 | Mouth | | |
| " | 6-4-63 | 2:45 PM | 51 | 54 | 3 | " | | C |
| " | 7-10-63 | 10:35 AM | 56 | 65 | 1.3* | " | | D |
| " | 8-6-63 | 10:45 AM | 59 | 63 | 0.8 | " | | C |
| " | 9-4-63 | 2:00 PM | 65 | 85 | 1.2* | " | | C+ |
| Raymond Cr. | 9-11-62 | 1:40 PM | 58 | 64 | 1.5 | 0.25 mile above mouth | | |
| " | 6-4-63 | 1:45 PM | 52 | 54 | 2.8* | Mouth | | C |
| " | 7-10-63 | 10:15 AM | 57 | 63 | 1.6* | " | | D |
| " | 8-6-63 | 10:30 AM | 61 | 62 | 0.9* | " | | C |
| " | 9-4-63 | 1:50 PM | 68 | 85 | 0.7* | Mouth | | C+ |
| Tualatin R. | 6-7-63 | 10:30 AM | 51 | 55 | 38* | River mile 69.5 | 2.0 miles below Cherry Grove | C |
| " | 7-9-63 | 10:20 AM | 55 | 60 | 40* | " | " | D |
| " | 8-5-63 | 4:30 PM | 67 | 84 | 11* | " | " | C |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Temp. °F. Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Tualatin R. | 8-30-63 | 6:00 PM | 65 | 65 | 13.6* | River mile 69.5 | 2.0 miles below Cherry Grove | C |
| " | 6-7-63 | 12:45 PM | 55 | 59 | | USGS Gage 14-2035 | Near Dilley | |
| " | 7-9-63 | 11:30 AM | 60 | 61 | | " | " | |
| " | 8-5-63 | 5:30 PM | 72 | 78 | | " | " | |
| " | 8-30-63 | 5:10 PM | 66 | 68 | | " | " | |
| " | 6-13-63 | 9:25 AM | 68 | 63 | | USGS Gage 14-2075 | Near West Linn | |
| " | 7-2-63 | 9:45 AM | 64 | 64 | | " | " | |
| " | 7-9-63 | 4:15 PM | 64 | 60 | | " | " | |
| " | 8-5-63 | 11:15 AM | 69 | 67 | | " | " | |
| " | 8-6-63 | 3:45 PM | 72 | 74 | | " | Dissolved oxygen - 9.7 ppm | |
| " | 8-5-63 | 4:15 PM | 73 | 80 | 8 | Lee Falls | | C |
| Cedar Cr. | 9-11-62 | 4:40 PM | 60 | 64 | 1.0 | 1.0 mile above mouth | | |
| Chicken Cr. | " | 4:30 PM | 57 | 64 | 0.7 | 2.0 miles above mouth | | |
| Dairy Cr. | 8-5-63 | 2:45 PM | 69 | 78 | 18 | 2.0 miles above mouth | Highway 8 bridge | C |
| " | 8-30-63 | 4:25 PM | 67 | 70 | 28* | " | " | C+ |
| E. Fk. Dairy Cr. | 8-20-62 | 5:00 PM | 63 | 72 | 13 | River mile 13 | | |
| " | 6-7-63 | 4:45 PM | 53 | 59 | 46* | " | | C |
| " | 7-8-63 | 12:30 PM | 54 | 57 | 35* | " | Raining heavily | D |
| " | 8-5-63 | 1:35 PM | 63 | 78 | 15.5 | " | Slightly turbid | C |
| " | 8-30-63 | 1:50 PM | 60 | 67 | 14.2* | " | " | C+ |
| Denny Cr. | 8-20-62 | 5:30 PM | 57 | 70 | 4 | Mouth | | |
| " | 6-7-63 | 5:15 PM | 50 | 59 | 5.5 | " | | C |
| " | 7-8-63 | 1:05 PM | 53 | 56 | 7.7* | Mouth | | D |
| " | 8-5-63 | 2:00 PM | 55 | 79 | 2.4* | " | | C |
| " | 8-30-63 | 1:15 PM | 56 | 67 | 2.5* | " | | C+ |
| Panther Cr. | 8-20-62 | 5:45 PM | 54 | 70 | 3 | Mouth | | |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Plenty-water Cr. | 8-20-62 | 5:25 PM | 57 | 70 | 0.8 | Mouth | |
| " | 6-7-63 | 5:00 PM | 51 | 59 | 2.5 | " | C |
| " | 7-8-63 | 1:20 PM | 54 | 56 | 2.5* | " | D |
| " | 8-5-63 | 2:15 PM | 58 | 79 | 3.0 | " | C |
| " | 8-30-63 | 1:30 PM | 57 | 67 | 1.3* | " | C |
| McKay Cr. | 8-20-62 | 7:00 PM | 64 | 70 | 4 | 1.0 mile below E. Fk. | |
| " | 6-7-63 | 6:15 PM | 52 | 59 | 8.2 | 0.5 mile above E. Fk. | C |
| " | 7-8-63 | 11:45 AM | 55 | 57 | 7.9* | " | D |
| " | 8-5-63 | 12:50 PM | 60 | 77 | 1.9* | " | C |
| " | 8-30-63 | 12:00 N | 59 | 64 | 3* | " | C |
| E. Fk. McKay Cr. | 8-20-62 | 6:50 PM | 60 | 70 | 0.4 | 0.5 mile above mouth | |
| " | 6-7-63 | 6:30 PM | 52 | 56 | 2.5* | " | C |
| " | 7-8-63 | 11:00 AM | 54 | 57 | 2.3* | " | D |
| " | 8-5-63 | 12:30 PM | 59 | 77 | 0.5 | " | Many juvenile silvers observed C |
| " | 8-30-63 | 11:45 AM | 59 | 64 | 0.5* | " | C |
| Jackson Cr. | 8-20-62 | 7:20 PM | 68 | 70 | 0.8 | 0.25 mile above mouth | Irrigation use |
| W. Fk. Dairy Cr. | | | | | | | |
| Cedar Canyon Cr. | 8-20-62 | 4:10 PM | 68 | 75 | 1 | 0.75 mile above mouth | |
| Sadd Cr. | 8-20-62 | 4:00 PM | 63 | 75 | 1.5 | 1.0 mile above mouth | |
| Witcher Cr. | 8-20-62 | 4:30 PM | 64 | 72 | 0.7 | 0.5 mile above mouth | |
| Fanno Cr. | 9-11-62 | 5:20 PM | 60 | 64 | 4 | 0.5 mile above mouth | |
| Gales Cr. | 8-20-62 | 2:00 PM | 67 | 78 | - | Forest Grove | |
| " | 6-7-63 | 1:00 PM | 57 | 59 | 70* | " | C |
| " | 7-9-63 | 11:45 AM | 59 | 63 | 47* | " | D |
| " | 8-5-63 | 5:00 PM | 70 | 79 | 14.1* | " | C |
| " | 8-30-63 | 4:50 PM | 67 | 68 | 15.4* | " | C |
| Beaver Cr. | 6-7-63 | 3:15 PM | 50 | 59 | 4* | 1.0 mile above mouth | C |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| Beaver Cr. | 7-8-63 | 2:30 PM | 53 | 58 | 3.5* | 1.0 mile above mouth | D |
| " | 8-5-63 | 3:00 PM | 59 | 80 | 0.7* | " | C |
| " | 8-30-63 | 2:30 PM | 59 | 71 | 1.1* | " | C+ |
| Clear Cr. | 8-20-62 | 2:45 PM | 62 | 78 | 2.0 | 1 mile above mouth | |
| " | 6-7-63 | 2:15 PM | 51 | 59 | 13* | 0.2 mile above mouth | C |
| " | 7-9-63 | 12:45 PM | 54 | 59 | 8.8* | " | D |
| " | 8-5-63 | 4:30 PM | 63 | 79 | 3.9* | " | C |
| " | 8-30-63 | 3:40 PM | 60 | 71 | 2.7* | " | C+ |
| Iller Cr. | 8-20-62 | 2:30 PM | 65 | 78 | 0.5 | 0.2 mile above mouth | |
| " | 6-7-63 | 2:30 PM | 53 | 59 | 5.5* | " | C |
| " | 7-9-63 | 12:30 PM | 55 | 61 | 4.5* | " | D |
| " | 8-5-63 | 4:15 PM | 66 | 80 | 1.1* | " | C |
| " | 8-30-63 | 3:30 PM | 63 | 71 | 1.0* | " | C+ |
| Little Beaver Cr. | 6-7-63 | 2:45 PM | 57 | 59 | 1.8 | 0.5 mile above mouth | C |
| " | 7-8-63 | 1:45 PM | 56 | 58 | 2.3* | " | D |
| " | 8-5-63 | 2:40 PM | 65 | 80 | 0.5 | " | C |
| " | 8-30-63 | 2:15 PM | 64 | 68 | 0.7* | " | C+ |
| N. Fk. Gales Cr. | 6-7-63 | 4:00 PM | 51 | 59 | 4.5 | 0.1 mile above mouth | C |
| " | 7-9-63 | 2:20 PM | 53 | 60 | 2.6* | " | Turbid D |
| " | 8-5-63 | 3:30 PM | 64 | 80 | 1.3* | " | C |
| " | 8-30-63 | 3:10 PM | 63 | 72 | 1.7* | 0.1 mile above mouth | C+ |
| S. Fk. Gales Cr. | 6-7-63 | 3:30 PM | 50 | 59 | 3.8* | Mouth | C |
| " | 7-9-63 | 1:45 PM | 53 | 59 | 2.7* | " | D |
| " | 8-5-63 | 4:00 PM | 58 | 80 | 0.8* | " | C |
| " | 8-30-63 | 2:50 PM | 59 | 72 | 1* | " | C+ |
| McFee Cr. | 9-11-62 | 4:10 PM | 58 | 64 | | 0.75 mile above mouth | Highway 219 |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Air | Flow Cfs | Location | Remarks |
|---|---|---|---|---|---|---|---|
| McFee Cr. | 8-20-62 | 3:50 PM | 58 | 64 | 1.5 | Just above Gulf Canyon Cr. | |
| " | 8-5-63 | 6:15 PM | 64 | 80 | 2.2* | " | C |
| " | 8-30-63 | 7:00 PM | 63 | 64 | 1.9* | " | C |
| Baker Cr. | 9-11-62 | 3:30 PM | 55 | 64 | 1.2 | 0.2 mile above conflu. with McFee Cr. | |
| Gulf Canyon Cr. | 9-11-62 | 3:50 PM | 61 | 64 | 0.2 | Mouth | Large marshy area near mouth |
| Heaton Cr. | 9-11-62 | 4:00 PM | 58 | 64 | 1.5 | 0.25 mile above mouth | |
| Rock Cr. | 9-11-62 | 5:00 PM | 55 | 64 | 1.5 | 0.25 mile above mouth | |
| Scoggin Cr. | 8-20-62 | 12:00 N | 64 | 75 | | USGS Gage 14-2030 | |
| " | 6-7-63 | 12:30 PM | 55 | 59 | | " | |
| " | 7-9-63 | 10:50 AM | 58 | 60 | | " | |
| " | 8-5-63 | 3:00 PM | 65 | 78 | | " | |
| " | 8-30-63 | 6:30 PM | 64 | 65 | | " | |
| Seine Cr. | 8-20-62 | 12:25 PM | 64 | 75 | 0.8 | 0.3 mile above mouth | |
| " | 6-7-63 | 12:10 PM | 51 | 59 | 12* | " | C |
| " | 7-9-63 | 11:00 AM | 54 | 61 | 8.4* | " | D |
| " | 8-5-63 | 3:20 PM | 68 | 80 | 1.6* | " | C |
| " | 8-30-63 | 5:40 PM | 62 | 66 | 1.4* | " | C |
| Tanner Cr. | 8-20-62 | 12:30 PM | 57 | 75 | 0.5 | 1 mile above mouth | |
| " | 8-5-63 | 3:30 PM | 57 | 80 | 1.2 | 0.2 mile above mouth | C |
| " | 8-30-63 | 5:30 PM | 57 | 67 | 1 | " | C |
| Willamette R. Small Tributaries | | | | | | | |
| Johnson Cr. | 6-11-63 | 4:20 PM | 66 | 74 | 3 | 1.0 mile above Gresham | Regner Rd. C |
| " | 7-10-63 | 9:15 AM | 58 | 64 | 4.5 | " | " D |
| " | 8-7-63 | 3:15 PM | 66 | 80 | 0.5 | " | " C |
| " | 6-11-63 | 6:30 PM | 70 | 74 | 20 | 0.3 mile below Crystal Spgs. Cr. | C |
| " | 7-10-63 | 3:15 PM | 62 | 64 | 31* | " | D |

Appendix II continued

| Stream | Date | Time | Temp. °F. Water | Temp. °F. Air | Flow Cfs | Location | Remarks | |
|---|---|---|---|---|---|---|---|---|
| Johnson Cr. | 8-7-63 | 4:15 PM | - | 82 | - | 0.3 mile below Crystal Spgs. Cr. | Dissolved oxygen - 10.9 ppm | C |
| " | 8-7-63 | 4:30 PM | 71 | 84 | 3 | Just above Crystal Spgs. Cr. | Dissolved oxygen - 11.0 ppm | C |
| Crystal Springs Cr. | 6-11-63 | 6:15 PM | 62 | 74 | 13.6* | 30 yds upstream from 99E | | C |
| " | 7-10-63 | 3:45 PM | 58 | 63 | 16* | " | | D |
| " | 8-7-63 | 3:50 PM | 62 | 82 | 19* | " | | C |

1/ * : Measured with a current meter.

2/ B : Appears somewhat below (to 20 per cent) average flow for this period.
C : Appears about average flow for this period.
D : Appears somewhat above (to 20 per cent) average flow for this period.

APPENDIX III

Oregon State Game Commission Fish Releases in the Lower Willamette Basin, 1958-1963 1/

| Stream | Species | Sizes | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 |
|---|---|---|---|---|---|---|---|---|
| Abernethy Cr. | Rb | 8" & over | 1,000 | 2,020 | 1,001 | 2,004 | - | - |
| Camp Cr. | Rb | " | 6,419 | 9,288 | 7,287 | 5,970 | 5,449 | 7,538 |
| Clackamas R. | Rb | " | 152,103 | 67,892 | 76,034 | 92,308 | 88,874 | 83,570 |
| | Ct | " | 8,175 | 3,959 | - | - | - | - |
| Clackamas R., | Rb | " | - | - | 2,015 | - | 2,998 | 8,007 |
| North Fork | Ct | " | - | - | - | 2,003 | - | - |
| Clackamas R., | Rb | " | 3,750 | 3,006 | 3,001 | 3,006 | 6,208 | 7,902 |
| Oak Grove Fk. | Rb | 2-4" | - | - | 144,000 | - | - | - |
| | Ct | 8" & over | - | - | - | 3,002 | - | - |
| Clear Cr. (Clackamas R.) | Rb | " | 2,014 | 3,999 | 2,001 | 1,001 | 2,998 | 3,008 |
| Clear Cr. (Sandy R.) | Rb | " | - | - | 1,000 | 2,000 | 1,000 | 1,001 |
| Clear Fk. (Sandy R.) | Rb | " | - | - | - | - | 1,000 | - |
| Collawash R. | Rb | " | 4,998 | 5,011 | 6,769 | 7,006 | 10,005 | 19,289 |
| | Ct | " | - | - | - | 3,001 | - | - |
| Dairy Cr., E. Fk. | Rb | " | 6,032 | 5,004 | 6,831 | - | - | - |
| | Ct | " | 1,488 | 3,007 | - | 6,003 | 6,184 | 3,019 |
| Dairy Cr., W. Fk. | Rb | " | 2,011 | - | 1,530 | - | - | - |
| | Ct | " | - | 3,003 | - | 3,007 | 2,164 | 2,013 |
| Deep Cr. | Rb | " | 2,999 | 1,001 | 2,991 | 1,003 | 998 | 1,001 |
| Eagle Cr. (Clackamas R.) | Rb | " | 7,648 | 5,003 | 5,001 | - | 3,996 | 4,145 |
| Gales Cr. | Rb | " | 3,997 | 4,008 | 4,010 | 6,001 | 9,001 | 9,002 |
| Johnson Cr. | Rb | " | 2,000 | 2,000 | 992 | 2,000 | 2,001 | 2,026 |
| | St | Yearling | 14,993 | 10,030 | 19,975 | 16,960 | - | - |
| McKay Cr. | Rb | 8" & over | 1,003 | 2,002 | - | - | - | - |
| Milton Cr. | Rb | " | 2,493 | 3,506 | 3,019 | 3,002 | 2,002 | 999 |
| | Ct | " | - | - | - | - | 4,900 | 4,013 |
| | St | Yearling | - | - | - | - | 10,260 | 5,008 |
| Salmon R. | Rb | 8" & over | 4,002 | 5,662 | 4,930 | 7,402 | 9,676 | 10,107 |
| | St | Yearling | - | - | - | - | 7,984 | - |
| Sandy R. | Rb | 8" & over | 12,502 | 8,963 | 9,823 | 9,380 | 12,874 | 17,952 |
| | St | Yearling | 57,623 | 83,462 | 76,907 | 162,992 | 168,861 | 214,176 |
| Scappoose Cr. | Rb | 8" & over | - | - | - | - | 1,000 | - |
| | St | Yearling | - | - | - | - | - | 5,008 |
| Scappoose Cr., North Fork | Rb | 8" & over | 5,002 | 4,038 | 5,002 | - | - | 1,000 |
| | Ct | " | 2,021 | 2,006 | - | 2,002 | 3,000 | 3,014 |
| | St | Yearling | - | - | - | - | 10,259 | - |
| Scappoose Cr., South Fork | Rb | 8" & over | 1,000 | 1,000 | 1,998 | 1,003 | 2,004 | - |
| | Ct | " | - | - | - | 2,002 | - | 2,005 |
| | St | 2-4" | - | - | - | - | 10,225 | - |

Appendix III continued

| Stream | Species | Size | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 |
|---|---|---|---|---|---|---|---|---|
| Scoggin Cr. | Rb | 8" & over | - | 2,005 | 2,010 | 2,000 | 2,004 | 1,999 |
| Still Cr. | Rb | " | 8,761 | 7,834 | 9,006 | 13,773 | 11,135 | 11,696 |
| Tanner Cr. | Rb | " | 1,000 | 1,000 | 1,001 | 399 | 1,000 | 1,000 |
| Tualatin R. | Rb | " | 2,006 | 2,042 | 2,010 | 2,002 | 2,008 | 1,999 |
| Willamette R. | Ch | Yearling | - | - | - | 5,144 | - | - |
| Zigzag R. | Rb | 8" & over | 4,417 | 7,501 | 1,425 | 1,958 | 2,645 | 2,942 |
| **Lake 2/ 3/** | | | | | | | | |
| Benson | Rb | 6" & over | 1,004 | 2,002 | 4,000 | 7,479 | 4,008 | 6,001 |
| Blue | LB | 1" | - | - | - | 4,286 | 35,000 | 50,720 |
| | | Adults | - | - | - | 40 | - | - |
| | BC | Adults | - | - | - | 102 | - | - |
| Elk | Rb | 2-4" | - | - | 14,800 | - | 9,982 | - |
| | K | " | - | - | - | 20,029 | 19,900 | 20,247 |
| | Ct | " | 15,682 | 41,500 | - | - | - | 30,680 |
| Estacada | Rb | 4-6" | - | - | - | 32,530 | - | - |
| Haldeman Pond | LB | 1" | - | - | - | - | 4,800 | 3,220 |
| Harriet | Rb | 8" & over | - | - | - | 2,200 | - | 998 |
| | Rb | 4-6" | 6,930 | - | 9,995 | 7,636 | - | 8,785 |
| | Rb | 2-4" | - | - | - | 5,038 | 10,080 | - |
| North Fork Reservoir (Clackamas R.) | Rb | 8" & over | - | 9,763 | 6,066 | 26,879 | 8,698 | 23,469 |
| | Rb | 4-6" | - | 173,987 | 40,000 | 72,144 | - | - |
| | Rb | 2-4" | - | - | - | 110,070 | - | - |
| Roslyn | Rb | 8" & over | - | - | 5,836 | 1,050 | 9,436 | 8,004 |
| | Rb | 4-6" | - | - | - | - | 7,992 | 23,080 |
| | Rb | 2-4" | - | - | - | - | - | 14,999 |
| Salmonberry | Rb | 6" & over | 1,501 | 1,026 | - | - | - | - |
| | Rb | 4-6" | 3,040 | - | - | - | - | - |
| Timothy | Rb | 8" & over | - | - | 31,109 | - | 4,988 | - |
| | Rb | 4-6" | 125,246 | 279,805 | 19,800 | - | - | 84,826 |
| | Rb | 2-4" | - | - | 306,374 | 250,352 | 330,099 | 15,540 |
| | Ct | 0-2" | - | - | 60,346 | - | 108,800 | 109,615 |
| | EB | 2-4" | - | - | 40,040 | 102,300 | 49,950 | 25,000 |
| | K | 2-4" | -- | - | - | - | 108,821 | 197,100 |

1/ Similar stocking rates were conducted in these waters prior to 1958.

2/ High Cascade lake stocking not shown in this table is included in Appendix IV.

3/ Warm-water game fish releases for years prior to 1961 were sporadic and are not included.

APPENDIX IV

Lower Willamette Basin Cascade Lake Data 1/

| Lake | Location T. | Location R. | Location Sec. | Acres | Max. Depth (feet) | Species | Stocking Number | Stocking Frequency 2/ |
|---|---|---|---|---|---|---|---|---|
| Anvil | 5S | 8E | 17 | 1.5 | 5 | EB | 500 | Bi |
| | | | | | | Ct | - | Nat |
| Averill | 9S | 8E | 5-8 | 11.5 | 11 | EB | 1,500 | Bi |
| Baldy | 3S | 6E | 28 | 1.5 | 8 | EB | - | Exp |
| Beth | 8S | 6E | 8 | 4.5 | 35 | EB | - | Nat |
| Big Slide | 8S | 6E | 9 | 4 | 10 | EB | - | Nat |
| Big Slide, Upper | 8S | 6E | 10 | 1 | 11 | EB | 500 | Tri |
| Brook | 8S | 8E | 25 | 5 | 8 | EB | 1,000 | Bi |
| Buck | 5S | 8E | 30 | 9 | 26 | EB | 2,000 | Bi |
| Bump | 8S | 8E | 28 | 3 | 4 | EB | 500 | Exp |
| Burnt | 2S | 8E | 34 | 8 | 25 | EB | 1,000 | Ann |
| Cachebox | 8S | 6E | 18 | 1.5 | 15 | GT | 500 | Exp |
| Cast | 2S | 8E | 33 | 6.5 | 17 | EB | 1,000 | Ann |
| Clackamas | 5S | 8E | 35 | 2 | 20 | - | - | Exp |
| Clear | 5S | 4E | 14 | 1 | 5 | EB | 500 | Exp |
| Collins | 3S | 8E | 21 | 1 | 6 | EB | 1,000 | Ann |
| | | | | | | Rb | 2,000 | Ann |
| Cottonwood Meadows | 5S | 7E | 28 | 6 | 4 | EB | 1,500 | Bi |
| Cougar | 6S | 4E | 24 | 7 | 6 | EB | - | Nat |
| Cripple Creek | 5S | 7E | 19 | 15 | 4 | EB | 3,000 | Bi |
| Dinger | 5S | 8E | 9 | 15 | 4 | EB | 1,000 | Ann |
| | | | | | | Ct | - | Nat |
| Double Peaks | 9S | 8E | 9 | 4 | 13 | EB | 500 | Bi |
| Dumbell | 5S | 8E | 32 | 2.5 | 6 | EB | - | Nat |
| Eena | 3S | 8E | 13 | 1.5 | 3 | EB | 500 | Bi |
| Elk 3/ | 9S | 6E | 5 | 63 | 26 | Rb | Variable | Ann |
| | | | | | | K | " | Ann |
| | | | | | | Ct | " | Ann |
| | | | | | | EB | " | Ann |
| Emerald | 6S | 4E | 29 | 4 | 25 | Ct | - | Nat |
| Ercrama | 8S | 6E | 20 | 1.5 | 15 | GT | 500 | Exp |
| Faraday | 3S | 4E | 33 | | | Rb, K, Br, Wf, Sil, Ch, St | - | Nat |
| Finley | 8S | 8E | 3 | 1.5 | 12 | EB | 1,000 | Bi |
| First | 9S | 8E | 2 | 3 | 19 | EB | 2,000 | Bi |
| Fish | 8S | 8E | 34 | 24 | 67 | EB | 1,500 | Bi |
| | | | | | | Ct | - | Nat |
| Gannok | 3S | 8E | 28 | 4 | 6 | EB | - | Nat |
| Gibson | 9S | 8E | 24 | 30 | - | EB | 1,000 | Bi |
| Gifford | 9S | 8E | 3 | 9 | 56 | EB | 2,000 | Bi |
| Gifford, lower | 8S | 8E | 3 | 1 | 19 | EB | - | Nat |
| Harriet 3/ | 6S | 7E | 4 | 23 | 39 | Rb | Variable | Ann |
| | | | | | | Br | - | Nat |
| Head | 9S | 8E | 2 | 6 | 9 | EB | 2,000 | Bi |
| Hidden | 3S | 8E | 12 | 1.5 | 13 | EB | 900 | Nat |
| Hideaway | 5S | 7E | 21 | 12 | 30 | EB | 1,000 | Bi |
| High | 6S | 6E | 6 | 2.5 | 11 | EB | 1,000 | Tri |
| Huxley | 4S | 6E | 28 | 8.5 | 6 | EB | 750 | Exp |
| Jude | 8S | 8E | 26 | 2 | 13.5 | EB | 1,500 | Bi |

| Lake | Location T. | R. | Sec. | Acres | Max. Depth (feet) | Species | Stocking Number | Frequency |
|---|---|---|---|---|---|---|---|---|
| Kinzel | 4S | 8E | 5 | 1.5 | 5 | EB | 500 | Ann |
| | | | | | | Rb | 500 | Ann |
| Lenore | 8S | 6E | 10 | 5 | 11 | EB | - | Nat |
| Lower | 9S | 8E | 2 | 15.25 | 73 | EB | 1,500 | Ann |
| Memaloose | 5S | 5E | 31 | 8 | 5 | EB | 1,500 | Bi |
| Mirror | 3S | 8E | 23 | 7.5 | 15 | EB | 1,000 | Ann |
| | | | | | | Rb | 1,000 | Ann |
| Multipor | 3S | 8E | 24 | 1.5 | 6 | EB | 3,000 | Bi |
| Nekbobets | 9S | 8E | 10 | 2.5 | 10 | EB | 500 | Bi |
| North Fork Reservoir[3/] | 4S | 4E | 11,12,13 | 350 | | Rb, Wf, Br, Ch, St, Sil | Variable | Ann |
| Pansy | 8S | 6E | 18 | 8 | 4 | EB | 1,500 | Bi |
| Pawnee | 9S | 8E | 9 | 2.5 | 12 | EB | 1,000 | Tri |
| Plaza | 4S | 7E | 18 | 1 | 10 | EB | 1,000 | Bi |
| Pyramid | 5S | 7E | 11 | 4 | 5.5 | EB | 1,000 | Ann |
| | | | | | | Rb | 1,000 | Ann |
| Red | 9S | 8E | 8 | 6 | 7 | EB | 1,500 | Bi |
| Rimrock | 9S | 8E | 10 | 3 | 14 | EB | 1,000 | Bi |
| Rock, Lower | 5S | 7E | 8 | 8.5 | 13 | EB | 1,000 | Ann |
| Rock, Middle | 5S | 7E | 8 | 15 | 34 | EB | 1,500 | Ann |
| | | | | | | Rb | 1,500 | Ann |
| Rock, Upper | 5S | 7E | 17 | 3 | 22 | EB or Rb | 1,000 | Bi |
| Round | 8S | 7E | 17 | 9 | 20 | EB | - | Nat |
| | | | | | | Br | - | Nat |
| Roslyn[3/] | 2S | 5E | 6 | 160 | - | Rb | Variable | Ann |
| | | | | | | Br | - | Nat |
| Russ | 8S | 8E | 2 | 7 | 18 | EB | 1,000 | Bi |
| Salmon | 4S | 7E | 16 | 1.5 | 3 | EB | 500 | Exp |
| Serene | 5S | 7E | 7 | 20 | 46 | EB | 1,000 | Bi |
| | | | | | | Rb | 1,000 | Bi |
| Sheep | 9S | 8E | 4 | 3.5 | 9.5 | EB | 1,500 | Bi |
| Shellrock | 5S | 7E | 17 | 20 | 8 | EB | 1,000 | Ann |
| | | | | | | Rb | 1,000 | Ann |
| Shining | 4S | 6E | 36 | 12 | 24 | EB | 1,000 | Ann |
| Si | 8S | 8E | 33 | 3 | 10.5 | EB | 1,000 | Bi |
| Silver King | 8S | 5E | 24 | 4 | 7 | EB | 1,000 | Tri |
| Skookum | 6S | 5E | 35 | 4 | 14 | EB | 1,000 | Bi |
| | | | | | | Br | - | Nat |
| Squaw | 4S | 6E | 14 | 7 | 5 | EB | 2,000 | Bi |
| Surprise No. 1 | 5S | 6E | 27 | 3 | 15 | EB | 2,000 | Bi |
| Surprise No. 2 | 6S | 5E | 27 | 5 | 3 | EB | 1,000 | Bi |
| Surprise No. 3 | 8S | 8E | 22 | 4 | 2 | Ct | - | Nat |
| Timothy[3/] | 5S | 8E | 23 | 1,200 | 90 | EB | Variable | - |
| | | | | | | Rb | " | - |
| | | | | | | K | " | - |
| | | | | | | Ct | " | - |
| Trillium | 3S | 8E | 36 | 60 | 18 | Rb | 2,000 | Ann |
| | | | | | | EB | 5,000 | Ann |

Appendix IV continued

| Lake | Location T. | R. | Sec. | Acres | Max. Depth (feet) | Species | Stocking Number | Frequency |
|---|---|---|---|---|---|---|---|---|
| Twin, Lower | 8S | 6E | 29 | 15 | 40 | EB | - | Nat |
| Twin, Upper | 8S | 6E | 19 | 15 | 50 | EB | - | Nat |
| Veda | 4S | 8E | 2 | 3 | 14 | EB | 1,000 | Ann |
| Wall | 9S | 8E | 4 | 5 | 12 | EB | 2,000 | Bi |
| Welcome | 8S | 8E | 4 | 6 | 8 | EB | 1,000 | Bi |
| Welcome, West | 8S | 6E | 21 | 3.5 | 4 | EB | - | Nat |
| Wendy Meadows | 5S | 8E | 21 | 1 | 3 | Ct | - | Nat |
| Williams | 5S | 4E | 26 | 4 | 4 | Ct | - | Nat |
| Wind | 3S | 8E | 26 | 2.5 | 3 | EB | 500 | Bi |

1/ Table also includes Harriet and Roslyn lakes and Faraday and North Fork Clackamas Reservoirs, the basin's important lower elevation trout impoundments.

2/ Ann - stocked annually
Bi - stocked biennially
Exp - have been experimentally stocked
Tri - stocked triennially
Nat - natural reproduction

3/ Stocking rates are in Appendix III.

APPENDIX V

Lake and Stream Random Creel Census Data
Lower Willamette Basin

| Stream | 1960 Anglers Checked | 1960 Fish per Hour | 1961 Anglers Checked | 1961 Fish per Hour | 1962 Anglers Checked | 1962 Fish per Hour | 1963 Anglers Checked | 1963 Fish per Hour |
|---|---|---|---|---|---|---|---|---|
| Bull Run R. | - | - | - | - | 3 | 0.33 | - | - |
| Camp Cr. | 1 | 1.00 | 5 | 0.06 | - | - | 11 | 0.20 |
| Cedar Cr. | 4 | 1.39 | - | - | - | - | - | - |
| Clackamas R. | 296 | 0.42 | 381 | 0.42 | 202 | 0.14 | 213 | 0.21 |
| Clear Cr. | - | - | - | - | - | - | 9 | 0.44 |
| Collawash R. | 2 | 0.86 | 11 | 0.29 | - | - | 30 | 0.76 |
| Dairy Cr.,E. Fk. | 10 | 0.31 | 47 | 0.63 | 19 | 0.55 | 6 | 0.35 |
| Dairy Cr., W. Fk. | - | - | 9 | 0.70 | - | - | 3 | 0.33 |
| Deep Cr. | 1 | 0.50 | - | - | - | - | - | - |
| Eagle Cr. | 64 | 0.82 | 120 | 0.13 | 50 | 0.04 | 28 | 0.02 |
| Fish Cr. | - | - | - | - | - | - | 5 | 0.87 |
| Gales Cr. | - | - | 23 | 0.39 | - | - | 38 | 0.38 |
| Johnson Cr. | 130 | 0.06 | - | - | - | - | 13 | 0.13 |
| Lost Cr. | - | - | - | - | 14 | 1.53 | 7 | 1.29 |
| Milton Cr. | - | - | - | - | - | - | 35 | 0.98 |
| Oak Grove Fk. | 10 | 0.45 | 10 | 1.05 | 4 | 1.83 | 5 | 0.89 |
| Rock Cr. | - | - | - | - | - | - | 11 | 1.42 |
| Salmon R. | 31 | 0.75 | 51 | 0.27 | 321 | 0.02 | - | - |
| Sandy R. | 1,094 | 0.03 | 1,992 | 0.04 | 1,559 | 0.03 | 1,847 | 0.04 |
| Scappoose Cr., N. Fk. | - | - | - | - | - | - | 68 | 1.20 |
| Scappoose Cr., S. Fk. | - | - | - | - | - | - | 50 | 1.00 |
| Shellrock Cr. | - | - | - | - | 3 | 0.83 | 6 | 0.56 |
| Still Cr. | 8 | 0.72 | 27 | 1.26 | 21 | 0.56 | 40 | 1.16 |
| Trout Cr. | - | - | - | - | - | - | 4 | 2.00 |
| Tualatin R. | - | - | - | - | - | - | 8 | 0.25 |
| Willamette R. | 182 | 0.05 | - | - | - | - | 1,931 | 0.05 |
| **Lake** | | | | | | | | |
| Averill | - | - | - | - | - | - | 4 | 1.44 |
| Big Slide | - | - | - | - | 9 | 2.00 | 3 | 0.42 |
| Big Slide, Upper | - | - | - | - | 4 | 0.23 | - | - |
| Brook | - | - | - | - | - | - | 8 | 1.75 |
| Buck | - | - | 4 | 1.35 | 3 | 0.94 | 8 | 1.48 |
| Clackamas | 1 | 0.67 | - | - | - | - | - | - |
| Collins | - | - | 11 | 0.42 | 14 | 0.50 | 23 | 0.69 |
| Cougar | 6 | 0.31 | - | - | - | - | - | - |
| Cripple Cr. | 3 | 0.50 | - | - | 7 | 0.79 | 9 | 0.92 |
| Dinger | 4 | 1.10 | 5 | 0.18 | 13 | 1.48 | 8 | 1.03 |
| Dumbell | - | - | - | - | - | - | 2 | 3.75 |
| Emerald | 4 | 1.00 | - | - | - | - | - | - |
| Faraday | - | - | - | - | 64 | 0.25 | 3 | 0.20 |
| Finley | 2 | 0.25 | - | - | - | - | - | - |
| Fish | 21 | 1.22 | 5 | 0.52 | 27 | 0.33 | 6 | 0.78 |

Appendix V continued

| Lake | 1960 Anglers Checked | 1960 Fish per Hour | 1961 Anglers Checked | 1961 Fish per Hour | 1962 Anglers Checked | 1962 Fish per Hour | 1963 Anglers Checked | 1963 Fish per Hour |
|---|---|---|---|---|---|---|---|---|
| Gifford | 3 | 1.64 | - | - | 5 | 1.60 | 2 | 0.33 |
| Harriet | 14 | 0.05 | 66 | 0.37 | 41 | 0.21 | 4 | 0.85 |
| Hidden | 1 | 3.00 | - | - | - | - | 2 | 0.25 |
| Hideaway | - | - | - | - | - | - | 12 | 0.72 |
| Jude | 2 | 1.13 | - | - | - | - | 4 | 0.67 |
| Lower | 10 | 0.45 | 4 | 1.92 | 5 | 2.10 | 5 | 0.20 |
| Mirror | - | - | - | - | 15 | 0.78 | 9 | 0.27 |
| North Fork Reservoir (Clackamas R.) | 20 | 0.98 | 61 | 0.56 | 393 | 0.29 | 1,787 | 0.22 |
| Pansy | - | - | 5 | 0.59 | - | - | - | - |
| Pyramid | - | - | 5 | 1.67 | - | - | 19 | 1.06 |
| Red | - | - | - | - | 10 | 0.08 | - | - |
| Rock, Lower | 3 | 0.22 | - | - | - | - | - | - |
| Rock, Middle | 14 | 0.45 | 16 | 0.74 | 11 | 1.40 | 2 | 0.83 |
| Rock, Upper | - | - | 4 | 0.10 | - | - | 2 | 1.00 |
| Roslyn | 212 | 0.38 | 152 | 0.40 | 270 | 0.14 | 155 | 0.32 |
| Round | - | - | 5 | 1.00 | 3 | 0.50 | 15 | 0.57 |
| Russ | 4 | 0.61 | - | - | - | - | - | - |
| Salmonberry | - | - | - | - | - | - | 2 | 3.00 |
| Sauvie Island | 96 | 1.08 | 470 | 0.66 | 281 | 0.67 | 147 | 0.29 |
| Serene | 9 | 0.15 | - | - | 11 | 1.85 | 4 | 0.86 |
| Shellrock | 2 | 0.19 | - | - | - | - | 7 | 1.20 |
| Shining | - | - | 4 | 0.69 | - | - | 9 | 0.07 |
| Skookum | - | - | 4 | 0.18 | - | - | - | - |
| Squaw | - | - | - | - | - | - | 14 | 1.23 |
| Surprise #3 | - | - | - | - | 5 | 0.20 | 4 | 0.79 |
| Sturgeon | 32 | 1.50 | 41 | 0.55 | 33 | 0.55 | - | - |
| Timothy | 180 | 0.10 | 300 | 0.45 | 723 | 0.48 | 420 | 0.25 |
| Trillium | 18 | 0.95 | 117 | 0.53 | 49 | 0.21 | 102 | 0.34 |
| Twin, Lower | - | - | - | - | - | - | 10 | 1.26 |
| Twin, Upper | 4 | 3.34 | - | - | - | - | 7 | 1.89 |
| Upper | 3 | 0.50 | - | - | - | - | - | - |
| Veda | 1 | 2.00 | - | - | - | - | 7 | 0.80 |
| Welcome | - | - | - | - | 8 | 1.08 | 21 | 1.18 |
| Welcome, West | - | - | - | - | 3 | 0.33 | 6 | 1.50 |
| Williams | - | - | 6 | 1.00 | - | - | - | - |

APPENDIX VI

Lake and Stream Random Creel Census Data, Including Species and Sizes
Lower Willamette Basin, 1963

| Stream | Species | 6-8" | 8-10" | 10-12" | 12-14" | 14" & over | Total Fish | Total Anglers | Hours Fished | Fish per Angler | Hours per Fish | Fish per Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Camp Cr. | Rb | | 5 | | | | 5 | 11 | 25 | 0.5 | 5.0 | 0.20 |
| Clackamas R. | Rb | 21 | 36 | 34 | 3 | | 94 | | | | | |
| | Ct | 11 | | | | | 11 | | | | | |
| | Ch | | | | | 2 | 2 | | | | | |
| | Wf | | | | | 1 | 1 | | | | | |
| | St | | | | | 8 | 8 | | | | | |
| | | | | | | | 116 | 213 | 545 | 0.5 | 4.7 | 0.21 |
| Clear Cr. | Rb | 1 | 3 | 4 | | | 8 | 9 | 18 | 0.9 | 2.3 | 0.44 |
| Collawash R. | Rb | 17 | 22 | 29 | | | 68 | 30 | 89 | 2.3 | 1.3 | 0.76 |
| Dairy Cr., E. Fk. | Ct | | 3 | 3 | | | 6 | 6 | 17 | 1.0 | 2.8 | 0.35 |
| Dairy Cr., W. Fk. | Ct | | 1 | 2 | | | 3 | 3 | 9 | 1.0 | 3.0 | 0.33 |
| Eagle Cr. | Ch | | | | | 1 | 1 | 16 | 55 | 0.1 | 55.0 | 0.02 |
| | St | | | | | 0 | 0 | 12 | 44 | 0.0 | - | - |
| Fish Cr. | Rb | 2 | 11 | | | | 13 | 5 | 15 | 2.6 | 1.2 | 0.87 |
| Gales Cr. | Rb | 2 | 22 | 15 | | 1 | 40 | | | | | |
| | Ct | | 2 | 1 | | | 3 | | | | | |
| | St | | | | | 1 | 1 | | | | | |
| | | | | | | | 44 | 38 | 115 | 1.2 | 2.6 | 0.38 |
| Johnson Cr. | Ct | 2 | | | | | 2 | 13 | 15 | 0.2 | 7.5 | 0.13 |
| Lost Cr. | Rb | 14 | 6 | 2 | | | 22 | 7 | 17 | 3.1 | 0.8 | 1.29 |
| Milton Cr. | Rb | 6 | 6 | 3 | 1 | | 16 | | | | | |
| | Ct | 2 | 6 | 59 | | | 67 | | | | | |
| | | | | | | | 83 | 35 | 85 | 2.4 | 1.0 | 0.98 |
| Oak Grove Fork | Ct | 5 | 3 | | | | 8 | 5 | 9 | 1.6 | 1.1 | 0.89 |

Appendix VI continued

| Stream | Species | 6-8" | 8-10" | 10-12" | 12-14" | 14" & over | Total Fish | Total Anglers | Hours Fished | Fish per Angler | Hours per Fish | Fish per Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rock Cr. | Rb | | 9 | 1 | | | 10 | | | | | |
| | Ct | 6 | 1 | | | | 7 | | | | | |
| | | | | | | | 17 | 11 | 12 | 1.5 | 0.7 | 1.42 |
| Sandy R. | St | | | | | 118 | 118 | | | | | |
| | Rb | | | 1 | | | 1 | | | | | |
| | Ct | | | | | 1 | 1 | | | | | |
| | Ch | | | | | 1 | 1 | | | | | |
| | | | | | | | 121 | 1,818 | 4,510 | 0.7 | 37.3 | 0.03 |
| | Sh | | | | | 45 | 45 | 29 | 86 | 1.6 | 1.9 | 0.50 |
| Scappoose Cr., N. Fk. | Rb | | 1 | | | | 1 | | | | | |
| | Ct | 24 | 35 | 48 | | | 107 | | | | | |
| | | | | | | | 108 | 68 | 126 | 1.6 | 1.2 | 1.20 |
| Scappoose Cr., S. Fk. | Rb | 4 | 1 | | | | 5 | | | | | |
| | Ct | 23 | 44 | 1 | | | 68 | | | | | |
| | | | | | | | 73 | 50 | 130 | 1.5 | 1.8 | 1.00 |
| Shellrock Cr. | EB | | 31 | 3 | | | 34 | 6 | 11 | 5.7 | 0.3 | 0.56 |
| Still Cr. | Rb | 6 | 79 | 23 | | | 117 | 40 | 101 | 2.9 | 0.9 | 1.16 |
| Trout Cr. | Rb | 7 | 1 | | | | 8 | 4 | 4 | 2.0 | 0.5 | 2.00 |
| Tualatin R. | Rb | 1 | | | | | 1 | | | | | |
| | Ct | 1 | | | | | 1 | | | | | |
| | | | | | | | 2 | 8 | 8 | 0.3 | 4.0 | 0.25 |
| Willamette R. | Sh | | | | | 45 | 45 | 52 | 77 | 1.2 | 1.7 | 0.58 |
| **Lake** | | | | | | | | | | | | |
| Averill | EB | 2 | 15 | 5 | 1 | | 23 | 4 | 16 | 5.8 | 0.7 | 1.44 |
| Big Slide | EB | 4 | 11 | | | | 15 | 3 | 36 | 5.0 | 2.4 | 0.42 |
| Brook | EB | 3 | 65 | 39 | 5 | 2 | 114 | 8 | 65 | 14.3 | 0.6 | 1.75 |
| Buck | EB | 6 | 29 | 5 | | | 40 | 8 | 27 | 5.0 | 0.7 | 1.48 |

| Lake | Species | 6-8" | 8-10" | 10-12" | 12-14" | 14" & over | Total Fish | Total Anglers | Hours Fished | Fish per Angler | Hours per Fish | Fish per Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Collins | Rb | | 48 | 9 | 3 | | 60 | | | | | |
| | EB | 2 | | | | | 2 | | | | | |
| | | | | | | | 62 | 23 | 90 | 2.7 | 1.5 | 0.69 |
| Cripple Creek | EB | | 10 | 20 | 19 | 6 | 55 | 9 | 60 | 6.1 | 1.1 | 0.92 |
| Dinger | Ct | 4 | 2 | | | | 6 | | | | | |
| | EB | 28 | 24 | 25 | 5 | 1 | 83 | | | | | |
| | | | | | | | 89 | 8 | 86 | 11.1 | 1.0 | 1.03 |
| Dumbell | EB | | 4 | 10 | 1 | | 15 | 2 | 4 | 7.5 | 0.3 | 3.75 |
| Faraday | Rb | | 1 | | 1 | | 2 | 3 | 10 | 0.7 | 5.0 | 0.20 |
| Fish | Ct | 4 | 13 | 1 | | 1 | 19 | | | | | |
| | EB | 3 | 2 | 2 | 5 | | 12 | | | | | |
| | | | | | | | 31 | 6 | 40 | 5.2 | 1.3 | 0.78 |
| Gifford | EB | | 1 | | | 1 | 2 | 2 | 6 | 10.0 | 3.0 | 0.33 |
| Harriet | Rb | 1 | 8 | | | | 9 | | | | | |
| | Br | | | | | 2 | 2 | | | | | |
| | | | | | | | 11 | 4 | 13 | 2.8 | 1.2 | 0.85 |
| Hidden | Ct | | 1 | | | | 1 | 2 | 4 | 0.5 | 4.0 | 0.25 |
| Hideaway | EB | 19 | 15 | 8 | | | 42 | 12 | 58 | 3.5 | 1.2 | 0.72 |
| Jude | EB | 2 | 3 | 1 | | | 6 | 4 | 9 | 1.5 | 1.5 | 0.67 |
| Lower | EB | 1 | | | | | 1 | 5 | 5 | 0.2 | 5.0 | 0.20 |
| Mirror | EB | 3 | 6 | | | | 9 | 9 | 31 | 1.0 | 3.4 | 0.27 |
| North Fork Reservoir | Rb | 101 | 976 | 13 | | | 1,090 | | | | | |
| (Clackamas R.) | St | 301 | | | | | 301 | | | | | |
| | | | | | | | 1,391 | 1,787 | 6,363 | 0.8 | 4.6 | 0.22 |
| Pyramid | EB | 2 | | | 1 | 35 | 38 | 19 | 36 | 2.0 | 0.9 | 1.06 |

Appendix VI continued

| Lake | Species | 6-8" | 8-10" | 10-12" | 12-14" | 14" & over | Total Fish | Total Anglers | Hours Fished | Fish per Angler | Hours per Fish | Fish per Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rock, Middle | EB | 2 | 2 | 1 | | | 5 | 2 | 6 | 2.5 | 1.2 | 0.83 |
| Rock, Upper | Rb | | 4 | | | | 4 | | | | | |
| | EB | | 1 | | | | 1 | | | | | |
| | | | | | | | 5 | 2 | 5 | 2.5 | 1.0 | 1.00 |
| Roslyn | Rb | 10 | 25 | 34 | 9 | 5 | 83 | | | | | |
| | St | 57 | 4 | | | | 61 | | | | | |
| | | | | | | | 144 | 155 | 456 | 0.9 | 3.2 | 0.32 |
| Round | Rb | 1 | 12 | 6 | 2 | 1 | 22 | | | | | |
| | Br | | 5 | 6 | 10 | 2 | 23 | | | | | |
| | | | | | | | 45 | 15 | 79 | 3.0 | 1.8 | 0.57 |
| Salmonberry | Ct | 1 | 3 | 1 | 1 | | 6 | 2 | 2 | 3.0 | 0.3 | 3.00 |
| Sauvie Island | LB | | 4 | | | 1 | 5 | | | | | |
| | WC | | 49 | 15 | | | 64 | | | | | |
| | YP | 3 | | | | | 3 | | | | | |
| | FC | 3 | 2 | | | | 5 | | | | | |
| | B | 39 | 1 | 1 | | | 41 | | | | | |
| | | | | | | | 118 | 147 | 397 | 0.8 | 3.4 | 0.29 |
| Serene | EB | 4 | 8 | 4 | | | 16 | 4 | 16 | 4.0 | 1.0 | 0.86 |
| Shellrock | EB | 6 | 28 | 14 | | | 48 | 7 | 40 | 6.9 | 0.8 | 1.20 |
| Shining | EB | | | 1 | | | 1 | 9 | 14 | 0.1 | 14.0 | 0.07 |
| Squaw | EB | 18 | 8 | | 1 | | 27 | 14 | 22 | 1.9 | 0.8 | 1.23 |
| Surprise #3 | Ct | 8 | 7 | 4 | | | 19 | 4 | 24 | 4.8 | 1.3 | 0.79 |
| Timothy | Rb | 70 | 107 | 59 | 11 | 2 | 249 | | | | | |
| | Ct | 3 | | | | 2 | 5 | | | | | |
| | EB | 46 | 61 | 7 | 2 | | 116 | | | | | |
| | K | 3 | 1 | | | | 4 | | | | | |
| | S Ct | 1 | | 3 | | | 11 | | | | | |
| | | | | | | | 385 | 420 | 1,530 | 0.9 | 4.0 | 0.25 |

Appendix VI continued

| Lake | Species | 6-8" | 8-10" | 10-12" | 12-14" | 14" & over | Total Fish | Total Anglers | Hours Fished | Fish per Angler | Hours per Fish | Fish per Hour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trillium | Rb | 1 | 9 | 74 | 5 | 7 | 96 | 102 | 283 | 0.9 | 2.9 | 0.34 |
| Twin, Lower | EB | 33 | 16 | 6 | 3 | | 58 | 10 | 46 | 5.8 | 0.8 | 1.26 |
| Twin, Upper | EB | 27 | 7 | | | | 34 | 7 | 18 | 4.9 | 0.5 | 1.89 |
| Veda | EB | 28 | 3 | 2 | | | 33 | 7 | 41 | 4.7 | 1.2 | 0.80 |
| Welcome | Ct | 1 | | | | | 1 | | | | | |
| | EB | 93 | 32 | 4 | | | 129 | | | | | |
| | | | | | | | 130 | 21 | 110 | 6.2 | 0.8 | 1.18 |
| Welcome, West | EB | | 3 | 3 | | | 6 | 6 | 4 | 1.0 | 0.7 | 1.50 |

## APPENDIX VII

Results of Fish Distribution Studies Conducted in Lower Willamette Basin Streams, 1963

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method[1/] | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Clackamas R. | Willamette R. | 1 | 8-28-63 | 100+ | 52 | Sh | Bridge on Lowe Cr. road | 70.0 | Ct 8, St or Ct fry 1, Cot 30 |
| Clear Cr. | Clackamas R. | 1 | 7-29-63 | 15 | 57 | Sh | Hwy. 211 bridge, 5 mi. S. of Estacada | 19.7 | Ct 1, St 5, Sil 1, Cot 3 |
| Little Clear Cr. | Clear Cr. | 1 | 7-29-63 | 4 | 54 | Sh | First br. above mouth | 0.1 | Ct 72 |
| Collawash R. | Clackamas R. | 1 | 8-29-63 | 95 | 57 | Sh | 200 yds. below Fan Cr. campground | 3.6 | St 8, Sil 11 |
| " | " | 2 | " | 90 | 56 | Se | Just below Hot Sprgs. Fk., Collawash R. | 4.0 | St 17, Sil 1, Rb (planted) 13 |
| Hot Springs Fk. Collawash R. | Collawash R. | 1 | 8-29-63 | 25 | 56 | Sh | Mouth | 0.0 | St 19, Rb (planted) 1, D 2 Cot 14, Sil 1 |
| " | " | 2 | " | 25 | 56 | Sh | 1 mi. above log jam | 1.2 | Rb (planted) 5, St 3, Cot 50, D 5 |
| " | " | 3 | " | 25 | 58 | Sh | 3¼ mi. below new Bagby bridge | 3.3 | Rb 3, St 4, Cot 12, D 2 |
| Deep Cr. | Clackamas R. | 1 | 7-23-63 | 20 | 60 | Sh | First br. above mouth | 0.6 | St 1, St or Ct fry 1, Sil 3, Rb 1, L 4 |
| " | " | 2 | " | 9 | 63 | Sh | Hwy. 211 bridge | 6.4 | St 9, Sil 17, Cot 21, L 7 |
| " | " | 3 | " | 2.5 | 57 | Sh | 2 mi. south on Firwood rd. from Hwy 26. | 11.9 | Ct 2, Cot 20 |
| N. Fk. Deep Cr. | Deep Cr. | 1 | 6-14-63 | 2.7 | 71 | Se | Boring, near old mill | 3.1 | Sil 6, D 1 |
| " | " | 1 | 7-23-63 | 2 | 72 | Sh | " " " " | 3.1 | D 1, L 1 |
| " | " | 2 | " | 2 | 62 | Sh | 1 mi. east of Boring | 4.2 | Ct 2, Cot 23 |
| Tickle Cr. | Deep Cr. | 1 | 7-23-63 | 8 | 60 | Sh | First br. above mouth | 1.0 | Ct 6, St 6, Sil 3, D 5, Cot 11 |
| " | " | 2 | " | 2.5 | | Sh | Second br. above mouth | 4.6 | Ct 1, Sil 3, Cot 20 |

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| North Fork Eagle Cr. | Eagle Cr. | 1 | 7-24-63 | 30 | 62 | Sh | Mouth | 0.0 | Sil 2, Rb(planted) 1, St 2, Cot 6 |
| " | " | 2 | " | | 63 | Sh | 1 mi. above mouth | 1.0 | Rb or St 14, Sil 1 |
| " | " | 3 | " | 9 | | Sh | Near Brayn Trout Ranch | 8.0 | Rb or St 42, Ct 1, Sil 3, Cot 6 |
| Fish Cr. | Clackamas R. | 1 | 8-29-63 | 16 | 64 | Se | ¼ mi. above mouth | 0.25 | Sil 66, St 10 |
| " | " | 2 | " | 12 | 63 | Sh | 2 mi. below Wash Cr. | 4.2 | Sil 10, St 24, Cot 8 |
| " | " | 3 | " | 3 | 56 | Se | 1 mi. above Wash Cr. | 7.7 | St 3 |
| Wash Cr. | Fish Cr. | 1 | 8-29-63 | 4 | 58 | Sh | ½ mi. above mouth | 0.5 | Sil 8, St 14, Cot 15 |
| " | " | 2 | " | 2.5 | 54 | Sh | 2.5 mi. above mouth | 2.5 | St 18 |
| Lowe Cr. | Clackamas R. | 1 | 8-28-63 | 2.5 | 50 | Sh | First culvert above mouth | 0.2 | Ct 22, Cot 2 |
| Oak Grove Fk., Clackamas R. | Clackamas R. | 1 | 8-29-63 | 9 | 55 | Sh | First br. above mouth | 0.6 | Sil 10, St 12, Rb(planted) 2, Cot 18 |
| " | " | 2 | " | 200 | 46 | Sh | First br. above Harriet L. | 5.5 | Ct 1, Ct or St fry 1, Cot 12 |
| Pinhead Cr. | Clackamas R. | 1 | 8-28-63 | 100 | 47 | Sh | Mouth | 0.0 | Ct 21, Rb 2, Cot 35 |
| Last Cr. | Pinhead Cr. | 1 | 8-28-63 | 7 | 47 | Sh | Mouth | 0.0 | Ct 5, Cot 9 |
| " | " | 2 | " | 5 | 47 | Se | Mouth of Camp Cr. | 1.6 | None caught |
| " | " | 3 | " | 3 | 46 | Sh | Mouth of Poop Cr. | 1.9 | Ct 6 |
| **Sandy River** | | | | | | | | | |
| Beaver Cr. | Sandy R. | 1 | 8-1-63 | 2 | 56 | Sh | Second br. above mouth | 0.1 | Sil 3, Ct or St fry 5, Ch 2, D 25, L 2, Cot 30 |
| " | " | 2 | " | 0.4 | 60 | Sh | Troutdale road crossing | 3.2 | Sil 2, Ct 11, D 3, L 3, Cot 22 |
| Buck Cr. | Sandy R. | 1 | 8-1-63 | 4 | 55 | Sh | Mouth | 0.0 | Sil 6, Ct or St fry 3, D 1, Cot 7 |
| " | " | 2 | " | 2 | 52 | Sh | Culvert 3 mi. above mouth | 3.0 | Ct 9, Cot 4 |

Appendix VII continued

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Cedar Cr. | Sandy R. | 1 | 8-16-63 | 5 | 65 | Sh | Culvert just above OFC hatchery | 1.0 | Sil 8, St 1, L 2, Cot 8 |
| " | " | 2 | " | 4 | 67 | Sh | Third road crossing above hatchery | 1.9 | Sil 11, St 3, L 2, Cot 11 |
| Clear Cr. | Sandy R. | 1 | 7-29-63 | 10 | 57 | Sh | Clear Cr. camp | 0.2 | Sil 3, St 14, Cot 2 |
| " | " | 2 | " | 6.5 | 57 | Sh | Old Maid's Flat on Aschoff Road | 2.0 | Sil 10, St 18, Cot 10 |
| Clear Fork | Sandy R. | 1 | 7-29-63 | 15 | 53 | Sh | First br. above mouth | 0.1 | Rb(planted) 20, St 3, Sil 2, L 1, Cot 40 |
| Gordon Cr. | Sandy R. | 1 | 8-1-63 | 18 | 59 | Sh | Bridge near mouth | 0.1 | Sil 2, Rb or St 10, D 2, Cot 9 |
| Lost Cr. | Sandy R. | 1 | 7-29-63 | | 50 | Sh | First br. above mouth | 1.8 | St 14, Rb(planted) 21, Cot 4 |
| Salmon R. | Sandy R. | 1 | 8-27-63 | | 63 | Sh | Mouth | 0.0 | St 6, Sil 2, Ch 1, Cot 5 |
| " | " | 2 | " | 50 | 63 | Sh | 1.5 mi. above Boulder Cr. | 2.2 | St 9, Sil 2, Cot 19 |
| " | " | 3 | " | | 57 | Sh | Confluence of Cheeney Cr. | 7.1 | St 6, Cot 9 |
| " | " | 4 | 8-26-63 | 40 | 54 | Sh | 2.7 miles above Cheeney Cr. | 9.8 | St 19, Sil 2, L 2, Cot 15 |
| " | " | 4 | 8-27-63 | 40 | 53 | Sh | " " " | 9.8 | St 7, Sil 9, Cot 10 |
| " | " | 5 | 8-22-63 | | 54 | Se | Halfway between end of road & confl. of South Fork | 10.5 | No fish caught. A few observed. |
| " | " | 6 | " | | 54 | Se | Just above South Fk. | 11.1 | St 1, Sil 94 |
| " | " | 7 | " | | 46 | Sh | Hwy. 26 below Timber-line Lodge | 29.6 | Ct 2 |
| Boulder Cr. | Salmon R. | 1 | 8-27-63 | 3 | 59 | Sh | Second br. above mouth | 1.0 | St 16, Sil 8, Cot 3 |
| Cheeney Cr. | Salmon R. | 1 | " | 3 | 60 | Sh | Mouth | 0.0 | St 6, Sil 25, Cot 6 |

Appendix VII continued

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| S. Fk. Salmon R. | Salmon R. | 1 | 8-22-63 | 8 | 54 | Se | 150 yds. above mouth | 0.1 | Sil 3, St 1 |
| Trout Cr. | Sandy R. | 1 | 8-1-63 | 6 | 56 | Sh | Hwy. culvert | 0.7 | Ct 5 |
| Camp Cr. | Zigzag R. | 1 | 7-29-63 | 8 | 54 | Sh | Camp Cr. Road #28 | 0.7 | Sil 6, St 22, Cot 8 |
| " | " | 2 | " | 8 | 54 | Sh | Camp Cr. Camp | 2.6 | Sil 7, St 11, Cot 10 |
| Henry Cr. | Zigzag R. | 1 | 7-29-63 | 4 | 49 | Sh | First culvert above mouth | 0.2 | Sil 6, Ct 2, St 5, Ct or St fry 4, Cot 6 |
| Still Cr. | Zigzag R. | 1 | 7-29-63 | 25 | 54 | Sh | Mouth | 0.0 | Sil 15, St 9, Cot 13 |
| " | " | 2 | " | 18 | 52 | Sh | 3.5 mi. above mouth | 3.5 | Sil 13, St 10, Cot 7 |

Small streams tributary to Columbia River

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Bridal Veil Cr. | Columbia R. | 1 | 7-26-63 | 18 | 53 | Sh | Hwy. 30 culvert | 0.08 | Sil 1, Ct 1, St 1, Ct or St fry 10, L 4, Cot 8 (culvert may impede passage) |
| " | " | 2 | 7-3-63 | 18.3 | 55 | Se | 80 yds. below falls | 0.15 | St 4 (one an adult) |
| " | " | 3 | 7-26-63 | 18 | 52 | Sh | Just above falls | 0.2 | Ct 11 |
| Horsetail Cr. | " | 1 | 7-25-63 | 6 | 54 | Sh | Scenic hwy. br. | 0.45 | Rb or St 46, Ct 1, D 2, Cot 40 |
| " | " | 2 | 7-26-63 | | 54 | Se | Just above falls | 0.55 | No fish caught |
| Latourell Cr. | " | 1 | 7-3-63 | 7.9 | 55 | Se | Scenic hwy. bridge | 0.6 | Sil 3, Ct 8, Cot 3 |
| " | " | 1 | 7-26-63 | 5.5 | 53 | Sh | " " " | 0.6 | Ct or St fry 3 |
| " | " | 2 | 7-26-63 | | | Se | Just above falls | 0.7 | Ct 3 |
| McCord Cr. | " | 1 | 7-25-63 | 5 | 55 | Sh | Hwy. 30 bridge | 0.2 | Rb or St 25, Rb or St or Ct fry 60, Ct 1, Sil 2, Cot 2 |
| " | " | 1 | 7-3-63 | 5.3 | 57 | Se | " | 0.2 | Rb or St fry 2 |
| Moffet Cr. | " | 1 | 7-25-63 | 2.5 | 57 | Sh | Hwy. 30 bridge | 0.1 | Rb or St 20, Rb or St fry 20, Sil 2, Cot 3 |

Appendix VII continued

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Multnomah Cr. | Columbia R. | 1 | 7-3-63 | 9.5 | 58 | Se | Just above scenic hwy. bridge | 1.0 | St 1, Sil 6, Cot 2 |
| " | " | 1 | 7-26-63 | 7 | 61 | Sh | " " " | 1.0 | Rb or St 4, Sil 10, D 6, Cot 4 |
| " | " | 2 | 7-26-63 | 3 | 52 | Sh | 2.5 mi. above falls | 2.6 | Ct 12 |
| Oneonta Cr. | " | 1 | 7-3-63 | 9.3 | 57 | Se | Scenic hwy. bridge | 0.2 | Rb or St 1, L 1, Cot 1 |
| " | " | 1 | 7-25-63 | 7 | 55 | Sh | " " " | 0.2 | Rb or St 14, Rb or St fry 9, Cot 24 |
| " | " | 2 | 7-25-63 | 7 | 55 | Se | Just above falls | 0.9 | No fish caught |
| Tanner Cr. | " | 1 | 7-3-63 | 5.9 | 54 | Se | 0.1 mi. above Hwy. 30 bridge | 0.5 | St 1, Sil 1 |
| " | " | 1 | 7-25-63 | 4 | 50 | Sh | " " " " | 0.5 | Rb or St 3, Rb or St fry 90, Sil 6, Cot 23 |
| " | " | 2 | 7-25-63 | 20 | 49 | Sh | Just above hatchery diversion dam | 1.0 | Rb or St 6, Sil 5, Cot 15 |
| Wahkeena Cr. | " | 1 | 7-26-63 | 3 | 52 | Sh | Railroad br. at Benson Park | 0.3 | Rb or St 5, Sil 3, Cot 6 |
| " | " | 2 | 7-26-63 | 3 | 48 | Sh | 1 mi. above falls | 1.4 | No fish caught |
| Small streams tributary to Willamette River | | | | | | | | | |
| Johnson Cr. | Willamette R. | 1 | 7-24-63 | 22 | 60 | Sh | Hwy. 99E br., Milwaukie | 1.7 | Ct 3, St 1, Su 3, L 1, Cot 6 |
| " | " | 2 | " | 3 | 65 | Sh | 10 mi. east of Portland on Foster Rd. | 11.0 | Sil 1, D 75, RsS 100, Cot 100 |
| " | " | 3 | " | 2 | 65 | Sh | Bridge 1 mi. above Gresham | 14.9 | Sil 33, Ct 3, D 10, RsS 30, Cot 100, L 2 |
| Crystal Springs Cr. | Johnson Cr. | 1 | 7-24-63 | 15 | 61 | Sh | R.R. access road near golf course | 0.8 | Sil 2, St 2, D 2, RsS 8, Cp 2, Su 10, L 1, Cot 6 |
| Tualatin R. | Willamette R. | 1 | 7-30-63 | 7 | 61 | Sh | About 3/4 mi. below Lee Falls | 74.0 | Sil 7, Ct 14, D 1, Cot 14 |

Appendix VII continued

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Tualatin R. | Willamette R. | 2 | 7-30-63 | 7 | 63 | Sh | Just above Lee Falls | 74.8 | Ct 8, Cot 4 |
| " | " | 3 | 7-31-63 | 5 | 64 | Sh | 1 mi. above Lee Falls | 75.8 | Ct 7, Cot 10 |
| " | " | 4 | " | 5 | 64 | Sh | Just above Haines Falls | 76.9 | Ct 8, Cot 6 |
| East Fork Dairy Cr. | Dairy Cr. (Tualatin) | 1 | 7-2-63 | 30 | 62 | Sh | First bridge above mouth | 0.9 | Cot 12 |
| " | " | 2 | " | 25 | 57 | Sh | 0.5 mi. east of Mountaindale | 5.2 | Ct 1, Sil 3, Skb 1, Cot 13, BG 1 |
| " | " | 3 | " | | 58 | Sh | 3 road mi. below Meacham School | 7.8 | Cot 8 |
| " | " | 4 | " | 25 | 54 | Sh | Meacham School | 11.2 | Ct fry 2, Ct 7, Sil 4, Cot 16 |
| Denny Cr. | E. Fk. Dairy Cr. | 1 | 7-2-63 | | 51 | Sh | At U-Catchum Trout Farm | 0.1 | Ct 3, St 3, Sil 4, Cot 2 |
| Plentywater Cr. | E. Fk. Dairy Cr. | 1 | 7-2-63 | 3 | | Sh | Culvert above mouth | 0.1 | Ct 17, Sil 2, Cot 14 (No Sil found above culvert) |
| West Fork Dairy Cr. | Dairy Cr. | 1 | 7-4-63 | 25 | 59 | Sh | Bridge on Tillamook Hwy. (U.S. 6) | 5.7 | RsS 15, Cot 5 |
| Sadd Cr. | Cedar Canyon Cr. (W. Fk. Dairy Cr.) | 1 | 7-4-63 | 2.5 | 57 | Sh | At gravel quarry | 1.1 | Ct 5, Cot 4 |
| Gales Cr. | Tualatin R. | 1 | 6-25-63 | 55 | 57 | Sh | Hwy. 47 br. at Forest Grove | 1.8 | L 2, Cot 15 |
| " | " | 2 | " | | 57 | Sh | Gravel dump 4 mi. above Forest Grove | 6.8 | L 2, Su 1, Cot 14 |
| " | " | 3 | " | 30 | 55 | Sh | Tillamook Junction 2 mi. above town of Gales Cr. | 12.7 | Ct 2, Sil 1, St or Rb 3, D 1, Cot 14 |
| Beaver Cr. | Gales Cr. | 1 | 7-1-63 | 4 | 51 | Sh | 1 mi. above mouth | 1.0 | Ct 1, Sil 13, Cot 4 |
| Clear Cr. | Gales Cr. | 1 | 7-1-63 | 15 | 55 | Sh | ¼ mi. above mouth | 0.25 | St 7, Sil 15, Ct 5, Cot 3 |
| Iller Cr. | Gales Cr. | 1 | 7-1-63 | 5 | 53 | Sh | 3 mi. above mouth | 3.0 | Ct 6 |
| S. Fk. Gales Cr. | Gales Cr. | 1 | 6-25-63 | 4 | 52 | Sh | 100 yds. above mouth | 0.1 | Ct 6, Rb or St 5, Sil 5, Cot 3 |

Appendix VII continued

| Stream | Tributary To | Sta. No. | Date | Flow (cfs) | Temp. (°F.) | Method | Location | Stream Mile | Species and Numbers |
|---|---|---|---|---|---|---|---|---|---|
| Scoggin Cr. | Tualatin R. | 1 | 7-30-63 | 11 | 62 | Sh | Hwy. 47 bridge | 1.9 | Ct 5, RsS 10, D 7, Cot 7 |
| " | " | 2 | " | | 61 | Sh | At br. above Stimson log pond | 4.1 | Sil 18, Ct 2, Rb(planted) 1, L 10, RsS 3, D 3, Cot 10 |
| " | " | 3 | " | 10 | 58 | Sh | Lee Road bridge | 5.6 | Sil 21, Ct 2, L 12, Cot 13, RsS 14, D 15 |
| " | " | 4 | " | 4 | 57 | Sh | 4 mi. above Stimson log pond | 7.4 | Ct 22, D 25, Cot 10 |
| Seine Cr. | Scoggin Cr. | 1 | 7-30-63 | 3 | 57 | Sh | Second br. above mouth on Seine Cr. Road | 0.8 | Sil 25, Ct 2, St 3, Ct or St fry 1, Cot 16 |
| Tanner Cr. | Scoggin Cr. | 1 | 7-30-63 | 1.5 | 54 | Sh | 1 mi. above mouth on Tanner Cr. Road | 1.0 | Ct 7, Sil 21, Cot 13 D 10 |

1/ Sh - Electric shocker

Se - Seine

12/8/94

| | |
|---|---|
| | # of pages ▶ 4 |
| To M. MITTICK | From A. MIRATI |
| Co. WRD | Co. ODFW |
| Dept. | Phone # 229-6967 x 438 |
| Fax # 378-8130 | Fax # |

OREGON Fish & Wildlife
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97207

Oregon
DEPARTMENT OF
FISH AND
WILDLIFE

March 19, 1991

Mr. Bill Fujii
Resource Management Division
Water Resources Department
3850 Portland Road NE
Salem, OR 97310

Subject: Streamflow recommendations for fish in the lower Sandy River, OR

Dear Bill:

The Water Resources Department (WRD) has requested the Oregon Department of Fish and Wildlife (ODFW) to make recommendations for streamflows required in the lower Sandy River to support fish resources. The WRD will use ODFW's recommendations in establishing flow requirements for recreation, fish and wildlife in the Sandy River Scenic Waterway. ODFW staff has evaluated available information and developed the attached flow recommendations (Table 1).

A previous study on the Sandy River developed recommendations for a portion of the year using a No-Net-Loss criterion (Beak 1985). These recommendations were developed from habitat exceedence analysis derived from habitat simulations based on the Instream Flow Incremental Methodology. In that analysis, flows were selected that resulted in no or very little (less than 5 percent) reduction in available habitat during each month of interest over a 20 year period of synthesized daily flow record (1961 - 1980). A separate analysis was performed for each month of interest for each of the 20 years. Recommendations were developed for the months of December through May (shaded portions of Table 1.)

In response to the WRD request for flow recommendations for the missing months, ODFW has performed a habitat exceedence analysis for the months of June through November using methods similar to the 1985 analysis. The present analysis is based on habitat exceedence over all months in a 5 year period of gaged mean daily flow records (1985 - 1990). The principal difference in these analyses is that the ODFW analysis lumps all months (all Junes 1985-90, all Julys 1985-90, ... etc) together in a single analysis, rather than performing a separate analysis for each month in each year

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(June 1985, June 1986, ... etc.). The effect of this difference in approach is that the ODFW method is somewhat less sensitive to short term flow changes (less protective of the fish habitat) and annual variation in water abundance.

Results of present and previous analyses compared to median and 90 percent exceedence flows show that the required flows for fish are equal to or less than the median flow for all months except June and July (Table 1 and Figure 1). ODFW believes requiring flows that appear to be higher than the median June and July flows are justified for several reasons. First, the flows are necessary to protect incubating steelhead eggs deposited by spawning in prior months. Second, the habitat analysis is based on highly detailed and carefully conducted IFIM studies and true incremental analysis. Third, the flow records on which the analysis is based contain a number of biases and vagaries which widens the uncertainty of these statistical reflections of norms and extremes.

Biases and vagaries which I am aware of are: 1) the gaged flow records reflect an unknown amount of upstream withdrawals (both legal and illegal), and thus do not necessarily represent natural flows, 2) the median flow is likely less than the mean monthly flow, 3) flow records on which the Beak analysis is based are pre-1966 data, synthesized to reflect current operations of PGE's Bull Run hydro project and the City's water supply and hydro projects, and 4) the post-1984 gaged period of record is short (5 years) and is generally reflective of a dry hydrologic cycle that is probably not indicative of the full range of flows that occur in the Sandy River.

Please call me at 229-5410, ext. 437 if you have questions regarding this analysis or want to discuss the recommendations.

Sincerely,

Richard L. Kruger

Richard L. Kruger
Hydropower and Water Projects Coordinator
Habitat Conservation Division

Attachments

c: Amin Wahib, WRD, Salem
Audrey Simmons, WaterWatch

Figure 1. Flow exceedence ranges for Sandy River stream flows and recommended required flows for fish.

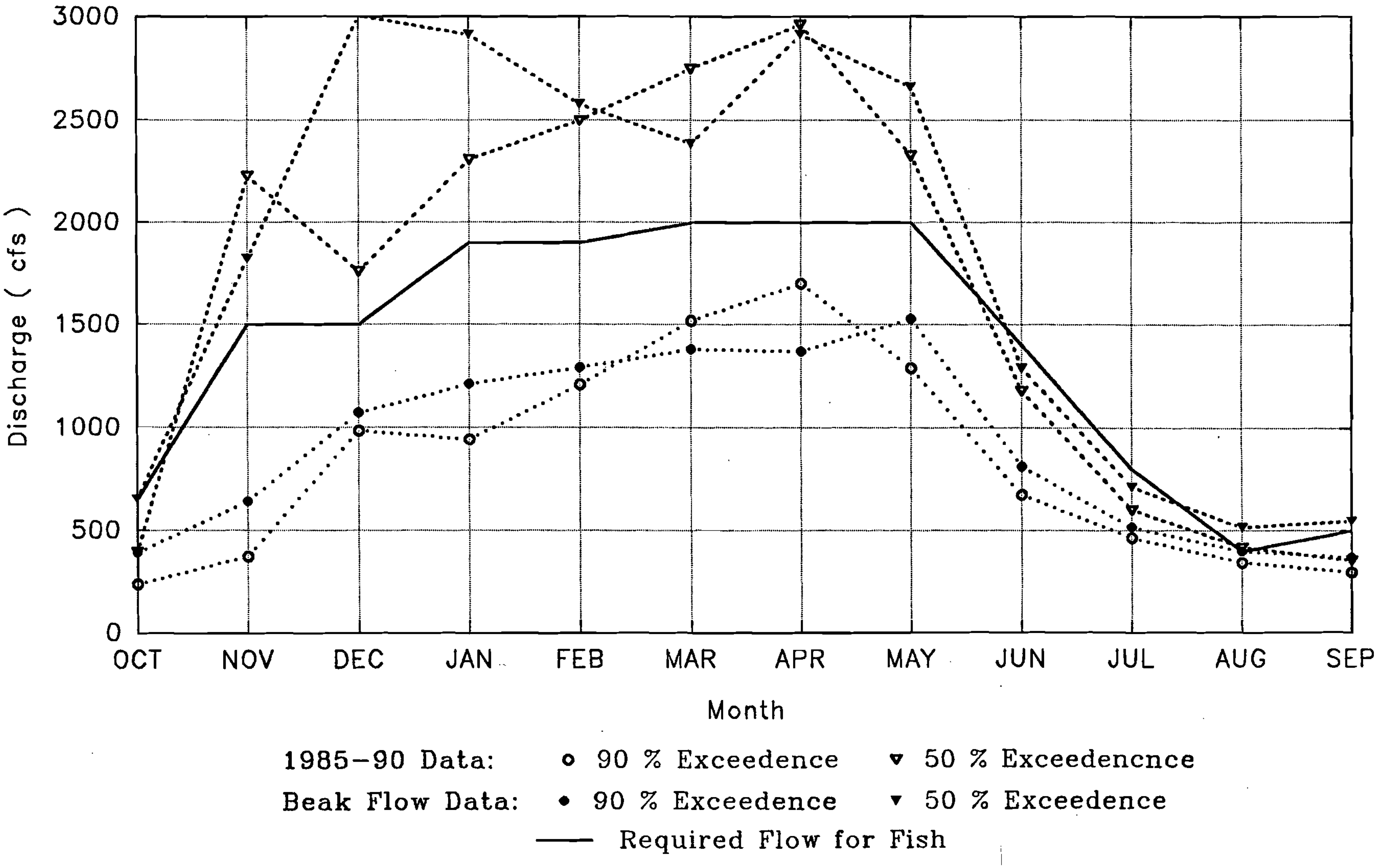

Table 1. Required flows by species and life stages for the Sandy River below Bull Run River.

| Species / Life Stage | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steelhead** | | | | | | | | | | | | |
| Spawning | | | | 1900 | 1900 | 2000 | 2000 | 2000 | 1400 | | | |
| Incubation | | | | 1900 | 1900 | 2000 | 2000 | 2000 | 1400 | 800 | | |
| Fry | | | | | | 600 | 600 | 600 | 600 | | | |
| Juveniles | 400 | 400 | 600 | 600 | 600 | 600 | 600 | 600 | 400 | 400 | 400 | 400 |
| **Chinook Salmon** | | | | | | | | | | | | |
| Spawning | 650 | 1500 | 1500 | 1500 | | | | | | | | 500 |
| Incubation | 650 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | | | | | 500 |
| Fry | | | | | 600 | 600 | 600 | 600 | 600 | | | |
| Juveniles | 200 | 200 | | | | | | 600 | 600 | 200 | 200 | 200 |
| **Highest Required Flow** | 650 | 1500 | 1500 | 1900 | 1900 | 2000 | 2000 | 2000 | 1400 | 800 | 400 | 500 |
| **Median River Flow** | 653 | 1823 | 3006 | 2914 | 2578 | 2388 | 2914 | 2661 | 1290 | 712 | 516 | 548 |
| **90 % Exceedance Flow** | 393 | 643 | 1075 | 1212 | 1292 | 1380 | 1370 | 1530 | 812 | 517 | 400 | 372 |
| **Recommended Flow** | 650 | 1500 | 1500 | 1900 | 1900 | 2000 | 2000 | 2000 | 1400 | 800 | 400 | 500 |

Data Source: Beak 1985 (shaded) | ODFW staff (unshaded)

## APPENDIX I

### RECOMMENDED MINIMUM FLOWS FOR FISH LIFE, LOWER WILLAMETTE BASIN

| Stream | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Clackamas R. | - | - | - | - | - | - | 400 | 400 | - | - | - | - | USGS gage 2095 (Three Lynx) |
| " 1/ | 240 | 240 | 240 | 240 | 240 | 200 | 150 | 150 | 150 240 | 240 | 240 | 240 | USGS gage 2080 (Big Bottom) |
| Clear Cr. | - | - | - | - | - | 40 - 35 | 30 25 | 20 | 20 | - | - | - | Mouth |
| " | - | - | - | - | - | 25 | 20 15 | 15 | 15 | - | - | - | Viola |
| Collawash R. | 250 | 250 | 250 | 250 | 250 | 200 | 150 100 | 75 60 | 60 250 | 250 | 250 | 250 | Mouth |
| E. Fk. Collawash R. | - | - | - | - | - | - | - | 15 10 | 7 | - | - | - | " |
| Elk Lake Cr. | - | - | - | - | - | - | - | 20 15 | 12 | - | - | - | " |
| Hot Springs Fk. | 75 | 75 | 75 | 75 | 75 | 75 | 50 30 | 20 | 20 75 | 75 | 75 | 75 | " |
| Deep Cr. | 35 | 35 | 35 | 35 | 35 | 20 15 | 15 10 | 8 | 8 | 8 12 | 35 | 35 | " |
| N. Fk. Deep Cr. | 20 | 20 | 20 | 20 | 20 | 3 | 3 2 | 1 | 1 | 1 3 | 20 | 20 | " |
| Tickle Cr. | 30 | 30 | 30 | 30 | 30 | 6 5 | 4 | 4 | 4 | 4 6 | 30 | 30 | " |
| Eagle Cr. | 125 | 125 | 125 | 125 | 125 | 100 | 75 50 | 40 35 | 30 | 30 40 | 125 | 125 | " |
| N. Fk. Eagle Cr. | 45 | 45 | 45 | 45 | 45 | 35 30 | 20 15 | 10 | 8 | 8 10 | 45 | 45 | " |
| Fish Cr. | 60 | 60 | 60 | 60 | 60 | 50 40 | 25 15 | 12 | 12 | 12 15 | 60 | 60 | " |
| " | - | - | - | - | - | - | - | 3 | 3 | - | - | - | Confl. of Wash Cr. |
| Wash Cr. | 25 | 25 | 25 | 25 | 25 | 20 15 | 10 5 | 3 | 3 | - | - | - | Mouth |
| Lowe Cr. | 8 | 8 | 8 | 8 | 8 | 8 6 | 3 2 | 2 | 2 | 2 | 8 | 8 | Mouth |
| Oak Grove Fk. | - | - | - | - | - | - | - | 10 | 10 | - | - | - | " |
| Pinhead Cr. | 75 | 75 | 75 | 75 | 75 | 50 | 50 | 50 | 50 | 50 | 75 | 75 | " |
| Roaring R. | 100 | 100 | 100 | 100 | 100 | 75 | 40 | 40 | 40 | 40 60 | 100 | 100 | " |
| S. Fk. Clackamas R. | 75 | 75 | 75 | 75 | 75 | 50 30 | 25 20 | 15 | 15 | 15 20 | 75 | 75 | " |
| Sandy R. 1/ | 510 | 510 | 510 | 510 | 510 | - | - | - | - 510 | 510 | 510 | 510 | " |
| " | - | - | - | - | - | - | 50 | 50 | 50 - | - | - | - | Release from Marmot Dam |
| " | - | - | - | - | - | - | - | 300 | 300 - | - | - | - | USGS gage 1370 (Marmot) |
| " | 250 | 250 | 250 | 250 | 250 | 200 | 150 100 | 100 | 100 250 | 250 | 250 | 250 | Conf. of Zigzag R. |
| Alder Cr. | 25 | 25 | 25 | 25 | 25 | 15 10 | 8 5 | 4 | 4 | 4 25 | 25 | 25 | Mouth |
| Beaver Cr. | 14 | 14 | 14 | 14 | 14 | 3 2 | 1 | 1 | 1 | 1 14 | 14 | 14 | Mouth |
| Bull Run R. | - | - | - | - | - | - | - | 12 | 12 - | - | - | - | USGS gage 1400 |
| Little Sandy R. | - | - | - | - | - | - | 25 20 | 15 | 15 | - | - | - | USGS gage 1415 |
| N. Fk. Bull Run R. | - | - | - | - | - | - | - | 10 | 10 | - | - | - | Mouth |
| S. Fk. Bull Run R. | - | - | - | - | - | - | - | 12 | 12 | - | - | - | " |
| Cedar Cr. | - | - | - | - | - | - | - | 10 | 10 - | - | - | - | " |
| Clear Cr. | 45 | 45 | 45 | 45 | 45 | 30 20 | 15 8 | 8 6 | 6 | 6 45 | 45 | 45 | " |
| Clear Fk. Sandy R. | 25 | 25 | 25 | 25 | 25 | 20 15 | 12 | 8 | 8 | 8 25 | 25 | 25 | " |
| Gordon Cr. | 50 | 50 | 50 | 50 | 50 | 30 20 | 15 | 15 | 15 | 20 50 | 50 | 50 | " |
| Lost Cr. | 20 | 20 | 20 | 20 | 20 | 15 | 15 12 | 12 | 12 | 12 20 | 20 | 20 | Confl. of Cast Cr. |
| Salmon R. | 250 | 250 | 250 | 250 | 250 | 250 | 150 125 | 100 80 | 80 250 | 250 | 250 | 250 | Mouth |
| " | - | - | - | - | - | - | - | 60 | 60 - | - | - | - | Confl. of South Fk. |
| Boulder Cr. | 30 | 30 | 30 | 30 | 30 | 20 10 | 8 | 5 4 | 3 | 3 30 | 30 | 30 | Mouth |
| Cheeney Cr. | 35 | 35 | 35 | 35 | 35 | 20 10 | 8 | 5 4 | 3 | 3 35 | 35 | 35 | " |
| S. Fk. Salmon R. | - | - | - | - | - | - | - | 5 | 5 - | - | - | - | " |

## Appendix I continued

| Stream | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trout Cr. | - | - | - | - | - | - | - | 3 | 3 | - | - | - | Mouth |
| Zigzag R. | 200 | 200 | 200 | 200 | 200 | 150 | 100 | 75 | 75 200 | 200 | 200 | 200 | " |
| Camp Cr. | 25 | 25 | 25 | 25 | 25 | 20 | 20 | 15 | 15 | 15 25 | 25 | 25 | " |
| Henry Cr. | 18 | 18 | 18 | 18 | 18 | 10 7 | 4 3 | 2 | 2 | 2 18 | 18 | 18 | " |
| Still Cr. | 60 | 60 | 60 | 60 | 60 | 50 40 | 30 25 | 25 | 25 60 | 60 | 60 | 60 | " |
| **Small streams tributary to Scappoose Bay** | | | | | | | | | | | | | |
| Milton Cr. | 25 | 25 | 25 | 25 | 25 | 10 8 | 5 4 | 3 | 3 | 3 5 | 25 | 25 | Confl. of Salmon Cr. |
| Cox Cr. | 6 | 6 | 6 | 6 | 6 | 3 2 | 1 0.5 | 0.5 | 0.5 | 0.5 1 | 6 | 6 | Mouth |
| Salmon Cr. | 5 | 5 | 5 | 5 | 5 | 1 0.5 | 0.3 | 0.3 | 0.3 | 0.3 0.5 | 5 | 5 | " |
| N. Fk. Scappoose Cr. | 40 | 40 | 40 | 40 | 40 | 25 18 | 15 8 | 5 | 5 | 5 7 | 40 | 40 | " |
| Alder Cr. | 8 | 8 | 8 | 8 | 8 | 3 2 | 1 | 1 0.5 | 0.5 | 0.5 1 | 8 | 8 | " |
| Cedar Cr. | 6 | 6 | 6 | 6 | 6 | 3 2 | 1 | 0.5 | 0.5 | 0.5 1 | 6 | 6 | " |
| Chapman Cr. (Lizzie Cr.) | 6 | 6 | 6 | 6 | 6 | 4 2 | 1.5 | 1 | 1 | 1 | 6 | 6 | " |
| N. Fk. of N. Fk. | 7 | 7 | 7 | 7 | 7 | 4 3 | 2 1 | 1 | 1 | 1 2 | 7 | 7 | " (Joins S. Fk. of N. Fk. 0.2 mi. above Mollenhoar Cr.) |
| Sierkes Cr. (Deep Cr.) | 7 | 7 | 7 | 7 | 7 | 1.5 0.5 | 0.5 | 0.4 | 0.3 | 0.3 0.4 | 7 | 7 | Mouth |
| S. Fk. of N. Fk. | 8 | 8 | 8 | 8 | 8 | 4 3 | 2 1 | 1 | 1 | 1 2 | 8 | 8 | " |
| S. Fk. Scappoose Cr. | 25 | 25 | 25 | 25 | 25 | 15 9 | 7 6 | 5 4 | 4 | 4 6 | 25 | 25 | Confl. of Raymond Cr. |
| Gourlay Cr. | 10 | 10 | 10 | 10 | 10 | 3 2 | 1 0.5 | 0.5 | 0.5 | 0.5 1 | 10 | 10 | Mouth |
| Raymond Cr. | 8 | 8 | 8 | 8 | 8 | 2 1 | 1 0.5 | 0.5 | 0.5 | 0.5 1 | 8 | 8 | " |
| **Small streams tributary to Columbia River** | | | | | | | | | | | | | |
| Bridal Veil Cr. | - | - | - | - | - | - | - | 5 | 4 | - | - | - | Mouth |
| Horsetail Cr. | - | - | - | - | - | - | - | 3 | 3 | - | - | - | " |
| Latourell Cr. | - | - | - | - | - | - | - | 3 | 3 | - | - | - | " |
| McCord Cr. | - | - | - | - | - | - | - | 1 | 1 | - | - | - | " |
| Moffet Cr. | - | - | - | - | - | - | - | 1 | 1 | - | - | - | " |
| Multnomah Cr. | - | - | - | - | - | - | - | 4 | 4 | - | - | - | " |
| Oneonta Cr. | - | - | - | - | - | - | - | 3 | 2.5 | - | - | - | " |
| Tanner Cr. | - | - | - | - | - | - | - | 15 | 15 | - | - | - | To arrive at hatchery dam |
| Wahkeena Cr. | - | - | - | - | - | - | - | 2 | 2 | - | - | - | Mouth |
| **Small streams tributary to Willamette River** | | | | | | | | | | | | | |
| Johnson Cr. | 25 | 25 | 25 | 25 | 25 | 5 4 | 4 | 4 | 4 | 4 5 | 25 | 25 | USGS gage 2115 |
| Crystal Springs | 15 | 15 | 15 | 15 | 15 | 10 | 10 | 10 | 10 | 10 | 15 | 15 | Mouth |
| Tualatin R. | 30 | 30 | 30 | 30 | 30 | 25 | 20 15 | 15 | 15 | 30 | 30 | 30 | USGS gage 2075 (West Linn) |
| " | - | - | - | - | - | - | - | 15 | 15 | - | - | - | USGS gage 2035 (Dilley) |
| " 2/ | 65 | 65 | 65 | 65 | 65 | 30 20 | 15 10 | 10 | 10 | 10 15 | 20 65 | 65 | River mile 70 |

Appendix I continued

| Stream | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dairy Cr. | | | | | | | | | | | | | |
| E. Fk. Dairy Cr. 2/ | 50 | 50 | 50 | 50 | 50 | 30 25 | 20 15 | 10 | 10 | 10 12 | 15 50 | 50 | River mile 13 |
| Denny Cr. 2/ | 15 | 15 | 15 | 15 | 15 | 4 3 | 2.5 | 2 | 2 | 2 | 4 15 | 15 | Mouth |
| Plentywater Cr. 2/ 3/ | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 1 | 1 | 1 | 2 5 | 5 | " |
| McKay Cr. 2/ 3/ | 36 | 36 | 36 | 36 | 36 | - | - | 4 | 4 | - | - 36 | 36 | River mile 15.5 |
| E. Fk. McKay Cr. | - | - | - | - | - | - | - | 2 | 2 | - | - | - | Mouth |
| Gales Cr. 1/ | 100 | 100 | 100 | 100 | 100 | 50 35 | 25 15 | 12 | 12 | 12 15 | - 100 | 100 | " |
| " 1/ | 70 | 70 | 70 | 70 | 70 | - | - | - | 8 | 8 - | - 70 | 70 | River mile 12 |
| Beaver Cr. 2/ | 17 | 17 | 17 | 17 | 17 | 3 2 | 2 1 | 1 | 1 | 1 | 2 17 | 17 | Mouth |
| Clear Cr. 2/ | 17 | 17 | 17 | 17 | 17 | 10 6 | 3 | 2.5 | 2.5 | 2.5 3 | 5 17 | 17 | " |
| Iller Cr. 2/ 3/ | 23 | 23 | 23 | 23 | 23 | 5 3 | 2 1 | 1 | 1 | 1 2 | 2 23 | 23 | " |
| Little Beaver Cr. | - | - | - | - | - | - | - | 1 | 1 | - | - | - | " |
| N. Fk. Gales Cr. | 25 | 25 | 25 | 25 | 25 | 4 3 | 2.5 2 | 2 1.5 | 1.5 | 1.5 2 | 3 25 | 25 | " |
| S. Fk. Gales Cr. | 20 | 20 | 20 | 20 | 20 | 3 2 | 1.5 1 | 1 | 1 | 1 | 2 20 | 20 | " |
| McFee Cr. | 12 | 12 | 12 | 12 | 12 | - | - | 2 | 2 | - | - 12 | 12 | Confl. of Gulf Canyon Cr. |
| Scoggin Cr. | | | | | | | | | | | | | |
| Seine Cr. | 25 | 25 | 25 | 25 | 25 | 10 6 | 3 2 | 1.5 | 1.5 | 1.5 2 | 3 25 | 25 | Mouth |
| Tanner Cr. | 9 | 9 | 9 | 9 | 9 | - | - | 1 | 1 | - | - 9 | 9 | " |

1/ The optimum or near optimum spawning flow listed is based on Oregon Game Commission studies utilizing transects.

2/ The optimum or near optimum spawning flow listed is based on Oregon Fish Commission studies.

3/ The lowest summer flow listed is the recommended minimum rearing flow based on Oregon Fish Commission studies.