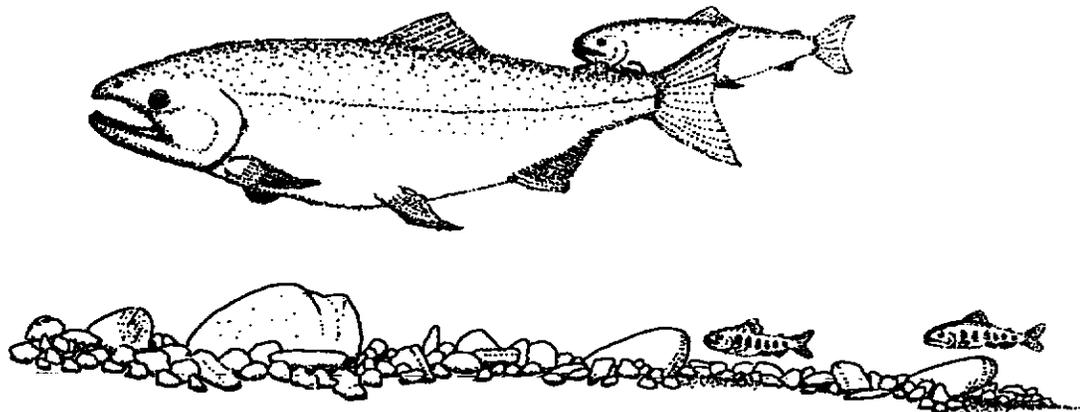


U.S. FISH AND WILDLIFE SERVICE

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HABITAT BY INCREASED WINTER
IMPOUNDMENT AT WYNOOCHEE RESERVOIR, WASHINGTON**



WESTERN WASHINGTON FISHERY RESOURCE OFFICE

OLYMPIA, WASHINGTON

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Evaluation of Inundating Salmonid
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Impoundment at Wynoochee Reservoir, Washington

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INTRODUCTION

A change in the storage operation of Wynoochee Reservoir has been proposed to provide greater hydropower potential. Under the proposal, there would be a permanent increase in wintertime elevation from 762.5 feet to 776.1 feet. Presently, the reservoir is held at elevation 762.5 from about November 1 to March 15 of each year. From mid-March until the beginning of June, the reservoir is filled to elevation 800, and then progressively drafted to 762.5 during the summer and early fall to augment downstream flows for municipal, irrigation, and fisheries purposes.

The proposed increase in wintertime reservoir elevation would permanently inundate tributaries to the Wynoochee Reservoir that are now only seasonally inundated during the period of refilling and gradual drafting from approximately mid-March until early fall, and briefly inundated during winter flood events. The principal tributaries impacted would be the Wynoochee River, and Beaver, Scatter, and Sixteen Creeks. Permanent inundation of the lower reaches of these tributaries would flood available spawning and rearing habitat for anadromous and resident fish. Chinook, coho, and steelhead bound for the upper Wynoochee are annually trapped below the project and hauled to a release point in the Wynoochee River above the reservoir to complete their life cycle. During very low flows in the upper Wynoochee in late summer, however, adult anadromous fish are instead released at the boat ramp in the reservoir's forebay.

The objectives of this study were to identify the extent and quality of salmonid habitat impacted by the proposed pool raise, and to document the extent of juvenile and adult salmonid use of the affected tributaries.

METHODS

Extent of Habitat

To identify the extent and quality of salmonid habitat impacted by the proposed pool raise, we surveyed, by elevation gain, each tributary from the present wintertime minimum pool elevation (762.5) to the proposed elevation (776.1), a gain of 13.6 feet. We used an automatic level and rod to determine the upstream boundary of the proposed inundation area. Total length, average width, and stream flow for each tributary were recorded along with a visual assessment of salmonid spawning and rearing habitat.

Salmonid Use of Habitat

To document the extent of juvenile and adult salmonid use of the inundation zone, we originally proposed surveys from November to April. However, due to delays in final project approval, transfer of funding, and a winter snow storm, the first survey occurred in late December. In addition, the final survey in April was not completed due to total inundation of the area.

Visual counts of live and dead adult salmonids, by species, were conducted monthly by foot surveys in all of the tributary inundation zones. Because Wynoochee river pools were deep, and visibility into the pools would have precluded accurate adult surveys by foot, we obtained live adult counts with snorkel surveys. These surveys were completed by two individuals starting at the upstream end of the inundation zone and snorkeling downstream along opposite banks to the wintertime minimum reservoir pool elevation (762.5).

Juvenile surveys were conducted in December and February with backpack electroshockers in the three creeks and the Wynoochee River. Due to the size of the Wynoochee River, we also used the adult snorkel surveys mentioned above as an opportunity to record juvenile salmonid presence.

RESULTS

Extent of Habitat

Approximately 613,500 square feet of stream habitat will be impacted by the proposed wintertime pool elevation increase (Table 1). Within the inundation zone of the Wynoochee River, excellent spawning substrate and a good pool/riffle ratio occurs with instream cover in the form of woody debris, large boulders, and undercut banks. Pools are sufficiently deep to hold adult spawners. Extensive side channels (area approximated in Table 1) near the river's delta could provide good rearing habitat for subyearling-sized fish, especially juvenile chinook. The Wynoochee River and side channels lack riparian vegetation due to seasonal inundation, and to some extent, channel shifting. The Wynoochee River upstream of the inundation zone appears to be similar in character. However, it is generally narrower and lacks the side channels present downstream.

Within the impact zones of the three creeks, seasonal inundation has eliminated all riparian vegetation. This effect is most pronounced when compared to the above-reservoir reaches of each stream where extensive streamside vegetation (trees, shrubs, and grasses) occur. Excellent spawning substrate does occur in all three streams. However, instream cover, such as deep pools, woody debris, and boulders, is extremely limited or non-existent. Sixteen Creek enters the reservoir from a steep-sided canyon and is wide enough for a substantial amount of channel meandering. The channel in the lower half of the inundation zone showed signs of frequent shifting. Scatter Creek enters the reservoir from a steep-sided canyon like Sixteen Creek. Its channel is considerably wider with up to six individual channels braiding off of the main channel. Its channel also shows signs of significant lateral movement in the lower half of the inundation zone. Beaver Creek is very similar to the other two creeks with a steep-sided canyon entry into the reservoir, and a broad channel with some braiding in the lower half of the inundation zone.

Salmonid Use of Habitat

No live adults or redds were observed during the study and the carcasses that were observed appeared to have been there for some time prior to the first survey in December (Table 2). No juveniles were observed in the Wynoochee River even though a good number of river sculpins were present (Table 3). A large number of aquatic insects were also observed during each of the surveys. Very few juveniles were collected in the three creeks (Table 3). All juveniles collected were obtained in the upstream half of the inundation zones.

DISCUSSION

Loss of tributary habitat due to the proposed pool elevation increase will reduce available spawning and holding habitat for adult salmonids, and stream rearing habitat for juveniles. Under present conditions, adult chinook could utilize the Wynoochee River for holding and spawning, while coho and steelhead could utilize both the Wynoochee River and tributaries for spawning within the inundation zones. This was evidenced by our carcass observations in December and January (Table 2). Further confirmation was obtained from September 1990 snorkel survey information (U.S. Forest Service, Hood Canal Ranger District, unpublished data). Forest Service personnel found adult steelhead within the inundation zones of the Wynoochee River (10 adults), Sixteen Creek (3 adults), and Scatter Creek (3 adults).

No juvenile salmonids were observed in the Wynoochee River during our winter surveys (Table 3), but Forest Service personnel saw 17 juvenile trout in the area in September. It appears that the inundation zone is used for short-term stream rearing. This same area may provide important short-term rearing for coho and chinook at different times of the year, when not inundated.

We found juvenile use in all tributaries (Table 3), except in Scatter Creek in February. In addition, Forest Service personnel found juvenile trout in all three tributaries on their September survey, although numbers were relatively low.

Review of trap records indicated that the numbers of adult salmon planted above the Wynoochee Dam were below habitat capacity in recent years, so the

likelihood of observing adult or juvenile steelhead or coho in survey areas was low. Adult steelhead planted for the last three years (July 1 to June 30, annually) were only about 107 (1988-1989), 148 (1989-1990), and 92 (1990-1991), compared to an escapement goal of 200 steelhead for the habitat area above Wynoochee Reservoir (Bill Freymond, Washington Department of Wildlife, personal communication). Likewise, adult coho planted above Wynoochee were 434 (1989-1990) and 976 (1990-1991). No coho escapement goal for the area upstream of the reservoir is available (Rick Brix, Washington Department of Fisheries, personal communication), but Findlay (1967) noted that 1,500 adult coho salmon historically utilized the habitat above the present reservoir site. Information on historic and potential chinook salmon usage upstream of Wynoochee Reservoir is lacking; no escapement goal has been set but the actual escapement has ranged between 47 and 148 over the past three seasons.

Because the inundation zones of the tributaries and Wynoochee River are now seasonally inundated through the spring and summer, and also inundated in the winter during flood events (Figure 1), their productive value as stream habitat is much reduced. The frequency of winter floods has varied over the last 19 years from 1 to 9 events a year (Figure 1). The average duration of these events in each year ranged from 2 to 8 days (Figure 2).

These winter flood events could have a very negative impact on any salmon or steelhead redds that were established within the inundation zone when the reservoir is at a lower level. Inundation would result in a velocity reduction of intragravel water flow, which in turn would lower dissolved oxygen levels needed by maturing embryos. This would occur because developing embryos need sufficient water velocity to transfer dissolved oxygen to the surface of the egg membrane (Cordone and Kelly 1961). Coble (1961) reported that higher water flow generally resulted in higher dissolved oxygen content in water. Studies have also demonstrated that low flow provides insufficient oxygen and waste removal, and adversely affects the size of chinook and steelhead embryos (Silver et al. 1963) and coho embryos (Shumway et al. 1964). It is widely recognized that salmonids are extremely sensitive to hypoxia (deficiency of oxygen reaching the body tissues) during early life stages (Doudoroff and Shumway 1970). Under conditions that are nearly lethal to embryos, delay of

hatching and reduction in size of emergent fry could result. This could precipitate high post-emergent mortality because of emergence from the gravel of many small and weak fry, with their subsequent success in the natural environment greatly reduced.

CONCLUSIONS

The extent of habitat available to both adult and juvenile salmonids in the proposed inundation zones is considerable, although salmonid use of that habitat is apparently relatively light at present. Even though good-quality stream habitat will be lost to the inundation, the proposed pool elevation increase could have a net positive effect by eliminating the possibility of salmon and steelhead spawning in an area that is now temporarily inundated during incubation, assuming that anadromous salmonids are not spawning-limited upstream of Wynoochee Dam. In addition, added lake rearing habitat would be available and could be of value to some species, especially coho.

REFERENCES

- Coble D. W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. *Trans. Am. Fish. Soc.* 90: 469-474.
- Cordone, Almo J., and Kelly, Don W. 1961. The influences of inorganic sediment on the aquatic life in streams. *Calif. Fish and Game.* 47(2): 189-228.
- Doudoroff, P., and Shumway, D. L. 1970. Dissolved oxygen requirements of freshwater fishes. *FAO Tech. Pap. No. 86.*
- Findlay, J. 1967. Letter from U.S. Fish and Wildlife Service Regional Director dated June 26, 1967 on the proposed Wynoochee Project. *Fish and Wildlife Coordination Act Report.* 19 pp.
- Shumway, D. L., Warren, C. E., and Doudoroff, P. 1964. Influence of oxygen concentration and water movement on the growth of steelhead trout and coho salmon embryos. *Trans. Am. Fish. Soc.* 92: 327-343.
- Silver, S. J., Warren, C. E., and Doudoroff, P. 1963. Dissolved oxygen requirements of developing steelhead trout and chinook salmon embryos at different water velocities. *Trans. Am. Fish. Soc.* 92: 327-343.

Table 1. Approximate habitat impacted by the proposed wintertime pool elevation increase of Wynoochee reservoir.

Tributary	Length (ft)	Width (ft)	Area (ft ²)	Discharge (cfs) ^C
Mainstem ^A	3,900	100 ^B	390,000	~350
Side sloughs ^A	-	-	>200,000 ^B	
Beaver Creek	616	15	9,240	18
Scatter Creek	613	15	9,195	20
Sixteen Creek	513	10	5,130	5
Totals:	5,642 ft		>613,565 ft ₂	

^A Wynoochee River.

^B Visual estimates at low winter flow.

^C Discharge at time of habitat survey (January 1991)

Table 2. Salmonid carcasses observed in the study reaches of each tributary.

Tributary	Survey Date			
	Dec 90	Jan 91	Feb 91	Mar 91 ^A
Wynoochee R.	1 Chinook 1 Coho	1 Unknown	0	0
Beaver Creek	1 Steelhead 1 Coho	0	0	0
Scatter Creek	1 Steelhead 2 Coho	1 Coho	0	0
Sixteen Creek	0	0	0	0

^A Tributaries were partially inundated by a flood event at the time of survey.

Table 3. Juvenile salmonids observed in the study reaches of each tributary.

Tributary	Survey Date			
	Dec 90	Jan 91	Feb 91	Mar 91 ^A
Wynoochee R.	0	0	0	0
Beaver Creek	2 trout fry		4 trout fry 1 coho fry	
Scatter Creek	6 coho fry		0	
Sixteen Creek	5 trout fry 1 cutthroat juv.		1 trout fry	

^A Tributaries were partially inundated by a flood event at the time of survey.

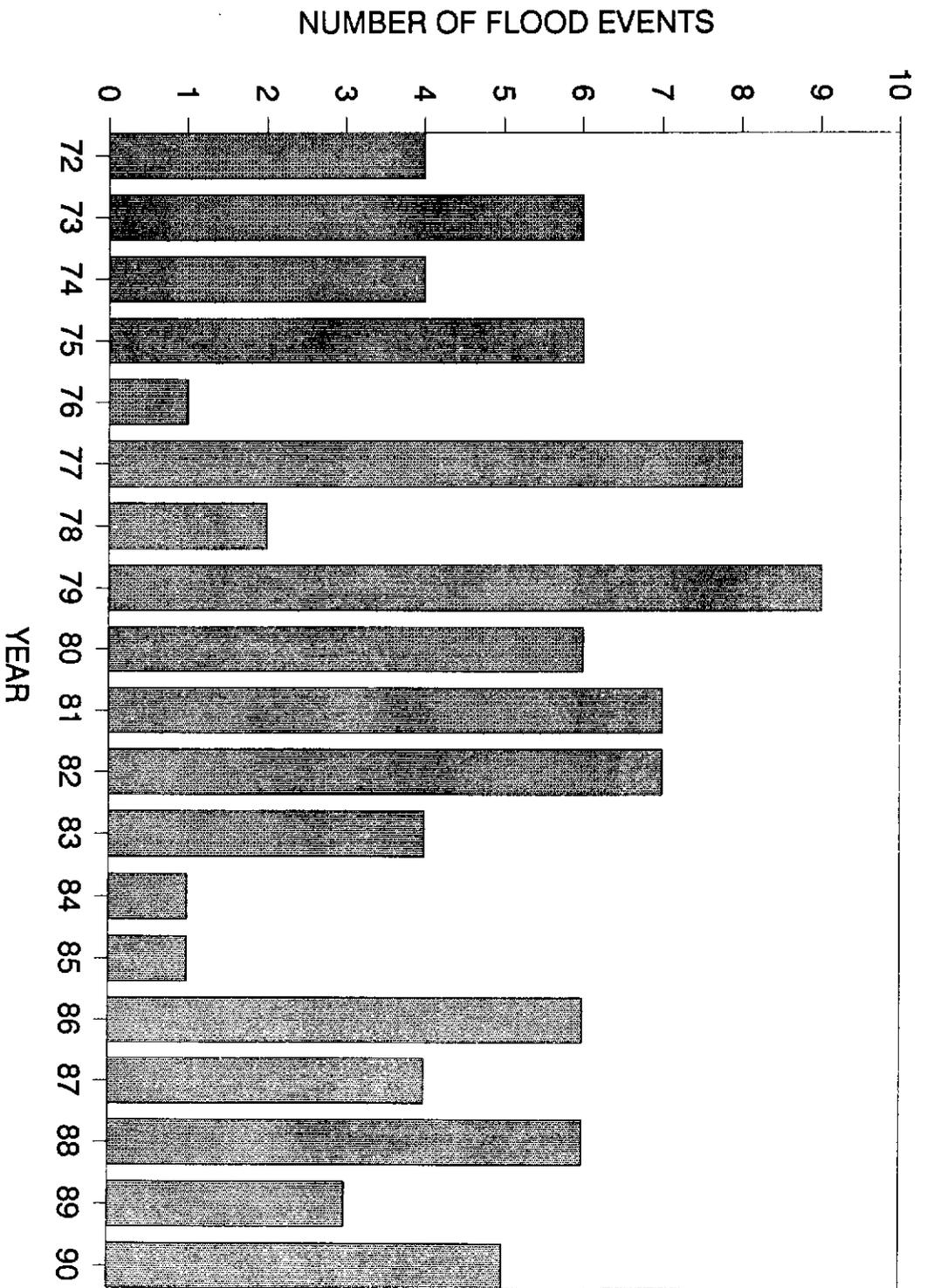


Figure 1. Number of flood events above normal full winter pool for Wynoochee Reservoir by year.

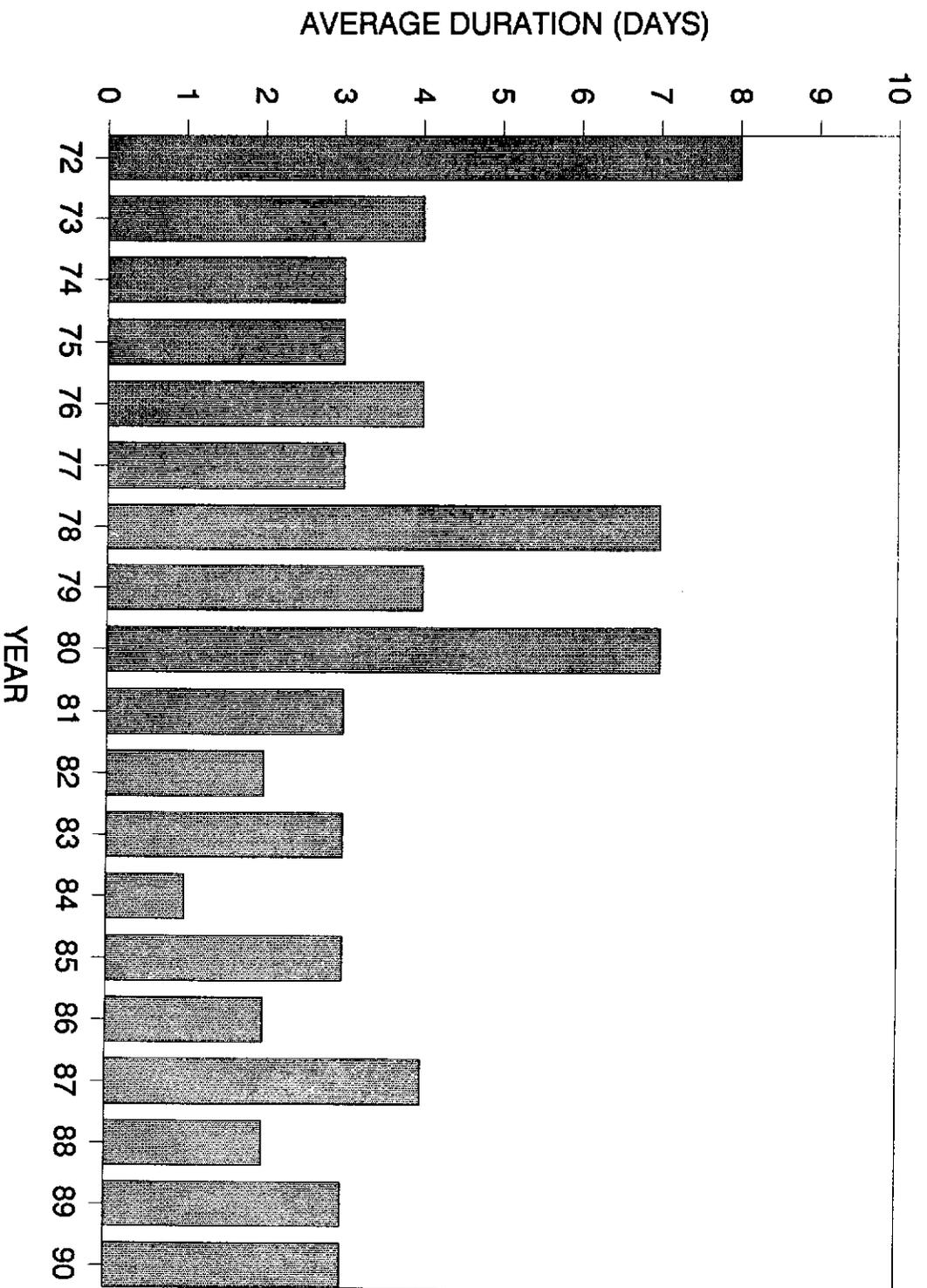


Figure 2. Average number of days per flood event by year that Wynoochee Reservoir remained above full winter pool.