APPENDIX P

FISH AND WILDLIFE IN COLUMBIA RIVER BASIN

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for

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

91276—52—vol. 7——8

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FOREWORD

1. Fish and wildlife are important resources of the Columbia River Basin and of the Pacific Northwest. The public interest in the conservation of these resources and necessity for effectual planning in connection with water-use development projects are recognized by Federal statutes. By provisions of the act of March 10, 1934 (48 Stat. 401), the Fish and Wildlife Service was designated the consultant of Federal reporting and constructing agencies.

2. Early in 1944 agreements were made by the Corps of Engineers with the Fish and Wildlife Service for investigations and studies of problems and projects and for preparation of a report on fish and wildlife, which would become a component part of the review report on Columbia River and tributaries, authorized by Congress for submission by the Corps of Engineers. The report in this appendix is the result of several years of intensive investigations and studies by the Service. It is, and will continue to be, of very great value in presenting regional fish and wildlife problems and coordinating water-resource planning with fish and wildlife conservation and rehabilitation. This evaluation of the fish and wildlife program, with relationship to project studies for development in the near future, forms one important aspect of the regional comprehensive plan of the review report.

3. Public Law 732 (60 Stat. 1080), approved August 14, 1946, provides that the reporting or constructing agency shall consult with both the Fish and Wildlife Service and the head of the agency exercising administration of the wildlife resources of the State and that the reports and recommendations of the Secretary of the Interior and the head of the State agency be made an integral part of any report submitted by any agency of the Federal Government responsible for engineering surveys and construction of projects. Reports under this act will be submitted by these interested agencies at a later date. After authorization of the plan as a whole, the cooperation of all agencies concerned will be required for effectual detailed planning of individual water-use development projects.

4. The assistance, consultation, and advice of the Fish and Wildlife Service on problems and data in the sub-basin appendixes and sections of the review report are appreciated. The Corps of Engineers recognizes and appreciates the very fine work the Service has accomplished in assembling and compiling data and in presenting the subject and supporting materials in the Fish and Wildlife report, and is pleased to make this appendix report a part of its larger review report.

APPENDIX P—FISH AND WILDLIFE

INTRODUCTION

1. This appendix reviews the history, development, and present status of the fish and wildlife resources in the Columbia Basin; the problems that may arise from authorized and proposed dams, and the measures that should be taken concurrently with the water-development program to minimize the deleterious effects and to promote the maximum benefits to the fish and wildlife resources of the basin.

2. The Columbia River Basin, owing to its exceptionally favorable environmental conditions, was—and still is—one of the Nation's most prolific producers of fish and wildlife. The development of the river in the interests of power, irrigation, navigation, and flood control, however, has had a profound influence on the fish and wildlife resources. These developments have been in progress for three-quarters of a century. In most instances the effects have been detrimental to the fish life of the watershed, particularly insofar as the anadromous [1] species are concerned. Many races have been greatly decimated due to the construction of dams and water diversions. The most notable example of this has been the effect on the populations of blueback salmon, which require a period of lake residence for their successful propagation. Access to most of the lakes in the watershed has been made impossible by the construction of dams. The other anadromous species have likewise suffered from having parts of their spawning areas blocked to free access or made unsuitable by the extensive diversion of water.

3. Many wildlife species have been gradually restricted by the appropriation of their habitats and breeding grounds for agricultural and industrial use. Waterfowl and fur animals have lost much valuable habitat through inundation of the valley lands. Reclamation of marshlands has resulted in the loss of extensive areas formerly used as resting and breeding grounds for waterfowl. The irrigation of semiarid lands has reduced the range of some native game birds but has benefited other upland-game species and waterfowl. Big-game animals have been gradually forced out of much of their native range lands until now they are largely restricted to mountainous areas beyond the reach of man's industrial development.

4. Over 300 dams have been built in the Columbia Basin up to the present time, these structures varying in size from small splash and irrigation dams to such huge structures as Bonneville and Grand Coulee (plate 1). Yet in only a few instances has any thought been paid to the effect that these developments might have on fish and wildlife. This disregard of our natural resources has been typical of the development of the entire country, and only of late have we

[1] Anadromous fish are those species which spend their adult life in the ocean and ascend fresh-water streams to spawn, such as Pacific salmon and steelhead trout.

begun to realize the magnitude of the losses suffered by our natural resources as a result of such neglect.

5. It is certain that a large number of additional dams will be constructed in the Columbia Basin in the immediate future (plate 1). With the knowledge that most of these will be dams that could have very serious effects on fish and wildlife, careful consideration should be given to the development program. Such consideration would point the way toward feasible plans which could prevent unnecessary losses and promote maximum benefits. It may be that some species would be reduced in abundance while others would increase, but certainly our natural resources will be in far better condition in the future if they are given a reasonable amount of intelligent consideration.

Fish

SALMON FISHERY

6. *Commercial fishery.*—Some commercial fishing in the Columbia River was carried on almost from the outset of the white man's occupation of the basin near the beginning of the nineteenth century; the first fish were commercially exported in 1830. Starting with the very limited operations of that time, there was a long period of transition, during which white men gradually displaced Indians as the chief consumer. This transition period culminated in the establishment of the Columbia River's first salmon cannery in 1866. The new and profitable outlet for fish thus made available caused commercial production to increase very rapidly, until in 1883 a peak catch of 43,000,000 pounds was attained.

7. At first the spring chinook salmon was practically the only variety caught; but as the demand for fish increased and the spring chinook became scarcer the commercial fishery was extended to include the runs of blueback, fall chinook, chum, and silver salmon, and the steelhead trout. The recorded catch of all these species begins around 1890, but small amounts were probably caught earlier and included in the reported chinook catch. Catches of all species for the period 1866–1947, including estimated recent high-seas troll catches of chinooks, are given in table 1 and shown in figure 1. The graph indicates the predominant importance of the chinook salmon to the fishery as well as the general downward trend in catch subsequent to 1883.

8. Although, as noted above, there has been a general downward trend in the catch of Columbia River salmon since 1883, the catches during the last decade reflect this, if at all, to a much lesser extent than during earlier years. If, for instance, the Chinook catches (either inside or total) for the period 1938–47 (fig. 1) were viewed without reference to the earlier catches, it would be very difficult to state that a downward trend existed. The average catches for this period, therefore, may be taken as a fair indication of the production of the fishery under present conditions and are summarized in table 2.

TABLE 1.—*Commercial catch of Columbia River salmon*

[Thousands of pounds]

Year	Chinook			Silver, including local troll	Blueback	Chum	Steelhead
	Inside [1]	Estimated troll	Estimated total				
1866	272		272				
1867	1,224		1,224				
1868	1,904		1,904				
1869	6,800		6,800				
1870	10,200		10,200				
1871	13,600		13,600				
1872	17,000		17,000				
1873	17,000		17,000				
1874	23,800		23,800				
1875	25,500		25,500				
1876	30,600		30,600				
1877	25,840		25,840				
1878	31,280		31,280				
1879	32,640		32,640				
1880	36,040		36,040				
1881	37,400		37,400				
1882	36,808		36,808				
1883	42,799		42,799				
1884	42,160		42,160				
1885	37,658		37,658				
1886	30,498		30,498				
1887	24,208		24,208				
1888	25,328		25,328				
1889	18,135		18,135		1,210		1,727
1890	22,821		22,821		3,899		2,912
1891	24,066		24,066		1,053		2,010
1892	23,410		23,410	284	4,525		4,920
1893	19,637		19,637	1,979	2,071	157	4,435
1894	23,875		23,875	2,908	2,979		3,565
1895	30,254		30,254	6,773	1,225	1,530	3,378
1896	25,224		25,224	2,999	1,155		3,377
1897	29,867		29,867	4,138	882		3,138
1898	23,180		23,180	4,449	4,534		1,787
1899	18,771		18,771	2,013	1,630	774	816
1900	19,245		19,245	3,055	895	1,203	1,401
1901							
1902	23,034		23,034	716	1,159	707	584
1903	27,917		27,917	828	570	680	493
1904	31,783		31,783	2,125	878	1,407	671
1905	33,029		33,029	1,824	528	1,751	668
1906	29,971		29,971	2,818	531	1,891	442
1907	24,250		24,250	2,159	374	1,534	403
1908	19,743		19,743	2,137	584	1,148	729
1909	17,119		17,119	2,868	1,704	1,669	1,175
1910	25,326	(2)		4,687	424	4,525	370
1911	36,602	(2)		5,400	407	3,636	584
1912	21,388	(2)		2,165	558	1,272	2,147
1913	19,384	(2)		2,786	758	905	2,168
1914	25,409	(2)		4,744	2,401	3,351	1,908
1915	32,127	(2)		2,267	371	5,884	2,690
1916	31,993	(2)		3,542	258	5,288	1,581
1917	29,522	(2)		4,372	542	3,649	2,233
1918	29,249	(2)		6,674	2,573	2,030	3,023
1919	30,325	(2)		6,170	494	5,134	1,900
1920	31,094	(2)		1,838	178	1,278	1,166
1921	21,552	(2)		2,338	411	328	1,021
1922	11,947	(2)		2,595	1,489	398	1,736
1923	17,617	(2)		3,671	2,737	1,140	3,242
1924	22,641	(2)		5,565	583	2,690	3,991
1925	26,737	(2)		7,692	542	2,203	3,356
1926	20,654	8,248	28,902	7,154	1,330	1,073	4,077
1927	21,810	10,613	32,423	4,041	452	3,950	3,745
1928	15,973	9,963	25,936	3,276	319	4,878	2,592
1929	14,444	8,107	22,551	4,499	674	1,989	2,838
1930	16,619	9,088	25,707	6,426	575	899	3,358
1931	20,127	8,323	28,450	2,917	253	1,218	2,976
1932	15,833	7,247	23,080	3,565	185	1,237	2,101
1933	18,360	7,227	25,587	2,506	432	1,174	2,295
1934	18,123	6,822	24,945	3,530	416	1,174	2,485
1935	15,141	7,832	22,973	5,302	68	810	1,748
1936	15,538	9,909	25,447	2,529	418	1,144	2,307
1937	18,450	8,649	27,099	2,924	335	1,910	1,933
1938	12,486	7,206	19,692	4,519	425	1,916	2,008
1939	13,588	6,754	20,342	3,336	266	1,175	1,583
1940	13,792	7,764	21,556	3,004	362	1,256	2,868
1941	19,405	8,316	27,721	1,930	505	4,147	2,606

See footnotes at end of table, p. 2866.

TABLE 1.—*Commercial catch of Columbia River salmon*—Continued

[Thousands of pounds]

Year	Chinook			Silver, including local troll	Blueback	Chum	Steelhead
	Inside [1]	Estimated troll	Estimated total				
1942	18,490	7,984	26,474	1,123	192	5,202	1,993
1943	11,268	4,953	16,221	1,084	144	970	1,426
1944	14,317	5,359	19,676	2,491	56	277	1,837
1945	12,384	6,336	18,720	2,112	9	456	1,800
1946	14,186	10,386	24,572	2,023	126	966	1,728
1947	[3] 17,470				[3] 697		

[1] May include small amounts of troll fish from 1910 to 1925.
[2] Trolling carried on, but no catch data available.
[3] Rough preliminary estimate.

TABLE 2.—*Average annual catches of Columbia River salmon landed in the Columbia River, 1938–47*

Species:	*Pounds*
Chinook salmon	14,738,563
Silver salmon	[1] 2,402,474
Blueback salmon	278,288
Chum salmon	[1] 1,818,217
Steelhead trout	[1] 1,983,320
Total	21,220,862

[1] Excludes 1947, for which data were not available.

9. Inspection of table 2 reveals that, despite the effects of an intensive fishery carried on for over 60 years and the reduction of spawning grounds by logging, mining, irrigation, power, navigation, and flood-control developments, there is still being landed in the Columbia River an average annual catch nearly equal to half the 43,000,000-pound peak production of the fishery in 1883. This is, of course, partly due to the increased utilization of the fall chinook runs as the more desirable spring runs became depleted, and to the increasing utilization of species other than the chinook (practically the only species caught in 1883).

10. The substantial commercial catch of Columbia River salmon provides the mainstay of the prosperity of many communities along the lower river, including the thriving city of Astoria, Oreg. This fishing port, located on the Oregon shore about 8 miles inside the mouth of the river, has a population of about 10,000 and is typical of small American industrial communities. Loss of the salmon catch, even if partly replaced by a gain in tuna and trawl-fish landings, would seriously affect the economy of the city.

11. In the above remarks no mention has been made of the high-seas troll catch of Columbia River chinook salmon indicated in table 1 and figure 1. It is known from tagging experiments that Columbia River fish are troll-caught from Oregon to Alaska, and on the basis of these experiments estimates have been made of the contribution of the Columbia chinooks to the troll catch. A summary of these estimates for the various regions along the coast for the period 1938–46 (1947 data not available) is given in table 3.

TABLE 3.—*Estimated annual troll catch of Columbia River chinook salmon, 1938–46*

Region:	Pounds
Oregon	827, 000
Washington	2, 917, 000
British Columbia	2, 060, 000
Alaska	1, 425, 000
Total	7, 229, 000

12. From table 3 it can be seen that Columbia River salmon contribute materially to the prosperity of fishing communities as widely separated as Sitka, Alaska, and Coos Bay, Oreg. Since in some coastal districts as high as 75 percent of the troll-caught chinooks originate in the Columbia River, their loss would be a severe blow to the fisheries of those districts.

13. The troll fishery did not attain any importance before 1910, and thus in the early peak year of 1883 the river catch might be taken to represent the total catch. In recent years, however, the troll catch has become an important part of the total and must be included to give a true picture of production. In Table 4 a summary is given of total commercial production for the decade 1938–47.

TABLE 4—*Average annual total commercial catch of Columbia River salmon and steelhead trout, 1938–47*

Location:	Pounds
In the river	21, 220, 862
On the high seas	7, 229, 000
Total	28, 449, 862

14. When the catch is thus viewed, it is found that the recent average commercial production is almost two-thirds that of the peak year 1883, despite the adverse factors mentioned above which have operated during the ensuing 60 years. Unquestionably, however, the catch in 1883 would have been far greater had the fishing effort been as intense as it is at the present time. Nonetheless, the present catch does reflect the marked persistence and resilience of natural populations, even under adverse conditions.

15. Since more Columbia River salmon are canned than are used for any other purpose, some measure of value related to the canned product seems appropriate. In table 5 an evaluation is presented which is based on current (1947) average primary wholesale prices actually paid per case for Columbia River canned salmon. This value is conservative, since fish sold fresh or frozen generally bring a higher price than canned fish, and most fish caught on the high seas are sold fresh or frozen.

TABLE 5.—*Evaluation of 1938–47 average annual commercial catch of Columbia River salmon and steelhead trout, basis of average 1947 primary wholesale price paid for canned fish*

Species	Average catch	Price per pound	Value
	Pounds		
Chinook salmon, including estimated troll catch	21, 967, 563	$0. 51	$11, 203, 457
Silver salmon	2, 402, 474	. 44	1, 057, 089
Blueback salmon	278, 288	. 65	180, 887
Chum salmon	1, 818, 217	. 22	400, 008
Steelhead trout	1, 983, 320	. 43	852, 828
Total	28, 449, 862		13, 694, 269

16. It should be noted that this catch of 28,000,000 pounds (table 5) valued at nearly $14,000,000 does not include the Indian subsistence catch nor the sport catch.

17. *Indian fishery.*—Indian fishing in the Columbia River no doubt antedated the coming of the white man by many centuries. When the Lewis and Clark expedition of 1805–06 reached the Columbia Basin, it found a well-established fishery furnishing the principal item of the Indians' diet. On the basis of the estimated Indian population of the basin before white settlement and the estimated per-capita consumption of fish by the Indians, it has been calculated that the average annual take may have been in the neighborhood of 18,000,000 pounds.

18. Originally Indians fished at a great many places along the Columbia and its tributaries; Clark indicated 100 such places along the lower Snake, Yakima, Wenatchee, and Spokane Rivers. With increasing white settlement and fishing and a decreasing number of Indians in the basin, most of these original fishing sites have been abandoned. Some of the most important early sites were Kettle Falls, the falls of the Spokane River, the San Poil, Celilo Falls, Cascade Rapids, and the falls of the Willamette.

19. In 1855 the United States Government negotiated treaties with several of the tribes in which the Indians reserved unto themselves, "the right of taking fish at all usual and accustomed places, in common with citizens of the Territory." These clauses in the treaties have resulted in considerable litigation between the Indians and the various agencies concerned with conservation of fish or with water-use projects affecting fishing places. The courts have usually sustained the rights of the Indians to fish in their accustomed places without interference, but have decreed that they are subject to regulation in the interest of fish conservation.

20. In concluding the historical sketch of the Indian fishery, it is pertinent to note that two important fishing sites have already been rendered useless by Federal water-use projects. These are Kettle Falls and Cascade Rapids, flooded out by the backwaters of Grand Coulee and Bonneville Dams, respectively.

21. In considering the present status of the Indian fisheries, it is necessary to recognize that the catch is composed of two parts: (1) fish caught by the Indians and sold commercially in the same manner as done by white men, and (2) fish caught by the Indians and used by themselves for food. Fish in the first category are reported along with the rest of the commercial catch and are included in the catch data presented above. Celilo Falls is the only Indian commercial fishing site of importance, and their catch at that point constitutes roughly 10 percent of the entire river-caught commercial catch.

22. Indian fishing for subsistence purposes is carried on at many places, but here again the site of chief importance is Celilo Falls. Since data on the extent of this subsistence catch were not available, a survey was made by the Bureau of Indian Affairs among 55 families of the Yakima, Columbia River, Warm Springs, and Umatilla Indians to determine the annual consumption in pounds per family. Based on the data obtained from this survey, the Bureau of Indian Affairs estimated that 795 Indian families in the area consumed an average of 1,611 pounds of fish per year each, making a total annual consumption of 1,281,000 pounds. Most of the fish consumed by Indians are chinook salmon, which brought an average price to Columbia River

fishermen in 1947 of approximately $0.19 a pound. If this subsistence catch is evaluated on the basis of its worth to commercial fishermen, the total annual value would be about $243,390. Preliminary estimates by the Oregon Fish Commission indicate that the consumption at present may be somewhat less than the previous figure.

23. *Sport fishery.*—In addition to the commercial and Indian fisheries, there are extensive sport fisheries for salmon and steelhead in the lower Columbia. The two most important sport-fishing grounds are the Willamette River near Portland and the Columbia River near Astoria. Surveys of the fishery in the former area have been made during four fishing seasons by the Corps of Engineers, the Fish and Wildlife Service, and the State of Oregon. Results are summarized in table 6.

TABLE 6.—*Estimates of the catch of chinook salmon by sport fishermen in the lower Willamette River*

	Number of fish
1941	30, 000
1942	12, 000
1946	12, 600
1947	12, 000
Total	66, 600
Average	16, 650

The average catch of 16,650 fish at the estimated average weight of 17 pounds per Willamette River chinook yields an average annual catch of 283,050 pounds.

24. Surveys of the sport fishery near Astoria have been made by the State of Washington Department of Fisheries during two separate fishing seasons, and results are given in table 7.

TABLE 7.—*Estimated catch of salmon in sport fishery near Astoria, Oreg., during the fall closed season, Aug. 25 to Sept. 10*

	Number of fish
1943	23, 500
1946	18, 000
Total	41, 500
Average	20, 750

The average catch of 20,750 fish per year when multiplied by the estimated average weight of 20 pounds yields an average annual catch of 415,000 pounds. It should be noted that this catch is made during a 2-week period of intense sport fishing. Some sport fishing is carried on in the vicinity of Astoria throughout the entire season lasting over 5 months; hence, the actual annual sport catch at Astoria is much greater than the above figure. In addition to the Willamette River sport fishery and the sport fishery at Astoria, there are sport fisheries for salmon at many other localities in the watershed, extending as far upstream as the headwaters of the Salmon River in Idaho. It has been estimated that the addition of the catch of all the other sport fisheries for salmon to that of the Willamette and Astoria fisheries would bring the total annual take to approximately 2,000,000 pounds.

25. It is difficult to evaluate sport fisheries in monetary terms, due to the intangible recreational and aesthetic values involved. Monetary evaluations which have been made are based on the amount of money spent by sportsmen on fishing gear, lodging, transportation,

etc. For the Willamette sport fishery, a value of $1.75 per pound of fish caught has been determined. By applying that figure to the above-mentioned annual production of about 2,000,000 pounds, a value of about 3½ million dollars is obtained.

26. *Value.*—In the preceding paragraphs separate evaluations have been made of the commercial, Indian, and sport fisheries for salmon. A recapitulation is presented in table 8.

TABLE 8.—*Average annual commercial, Indian subsistence, and sport catch of Columbia River salmon and steelhead trout*

Type of catch	Pounds	Value
Commercial	28,500,000	$13,700,000
Indian subsistence	1,281,000	240,000
Sport	2,000,000	3,500,000
Total	31,781,000	17,440,000

Thus, the value of the recent average catch of Columbia River salmon and steelhead amounts to $17,440,000, annually.

27. *Abundance trends.*—Each year since 1938 the Corps of Engineers has obtained complete counts of all fish passing through the fishways at Bonneville Dam. These counts are of great value in following changes in the escapement of the various runs of anadromous salmon and trout and become of greater value as each new year is added to the series.

28. In the case of the chinook salmon the counts do not give a complete evaluation of abundance since there is considerable spawning below the dam as well as a large commercial catch in the river and on the high seas (plate 2). In an attempt to obtain at least a rough picture of the changes in abundance of this species, the catches below the dam (converted from pounds to numbers) have been added to the Bonneville counts. If it is assumed that the escapement below Bonneville is directly proportional to the sum of the Bonneville count and the catch below Bonneville, then this sum for each year may be used as an index of abundance. The counts, catches, and sums are given in table 9 and figure 2 for the spring and fall runs (in separating these an arbitrary division has been made at July 31).

TABLE 9.—*Bonneville counts and estimated catches below Bonneville Dam of Columbia River chinook salmon*

[Thousands of fish]

Year	Spring run			Fall run		
	Count at dam	Estimated catch below the dam	Sum of count and catch	Count at dam	Estimated catch below the dam	Sum of count and catch
1938	43	295	338	235	574	809
1939	100	344	444	186	543	729
1940	88	244	332	303	757	1,060
1941	89	225	314	373	1,102	1,475
1942	65	178	243	337	1,001	1,338
1943	80	152	232	234	677	911
1944	43	145	188	197	739	936
1945	71	195	266	226	796	1,022
1946	119	181	300	327	1,064	1,391
1947	172	(1)	----------	308	(1)	----------
Mean	87	218	295	273	806	1,075

1 Data not available.

29. Although the assumption of parallelism between changes in magnitude of the escapement below Bonneville Dam and the Bonneville count plus the catch below Bonneville no doubt does not hold strictly true, the sums of counts and catches as presented should give at least a rough general picture of changes in relative abundance of the runs. It is seen that, when the catch is considered, the spring run has had a general downward trend, while the recent trend of the fall run has been one of alternating highs and lows with a current upward trend. In the Bonneville counts alone there is much less trend, perhaps reflecting the shift of fishing intensity from the spring to the fall run.

30. The decline of the spring run may be the result of the greater number of man-made hazards to which it is vulnerable (plates 1 and 2), since spring fish generally spawn farther upstream than fall fish and the young remain on the spawning grounds longer before returning to the sea. The upward trend of the fall run may reflect in part the protection afforded by the August 25 to September 10 closed season. Any effect of Bonneville Dam should have been felt by 1943, but there is little evidence of a change in the trend of the curves of that year.

31. The blueback is the one species of Columbia River salmon for which complete data on abundance are available since the construction of Bonneville Dam. This is because there is no significant spawning of the species below the dam, so that the catches below the dam plus the counts at the dam represent the total yearly runs. These counts and runs are presented in table 10 and figure 3.

TABLE 10.—*Bonneville counts, catches below Bonneville, and total runs of Columbia River blueback salmon*

[Thousands of fish]

Year	Bonneville count	Catch below Bonneville	Total run	Year	Bonneville count	Catch below Bonneville	Total run
1938	75	92	167	1944	15	8	23
1939	73	47	120	1945	10	1	11
1940	149	37	186	1946	74	28	102
1941	66	106	172	1947	171	167	338
1942	55	38	93				
1943	40	34	74	Mean	73	56	129

32. Inspection of figure 3 reveals that in both Bonneville count and total run there was a decline to 1945, followed by a recovery in 1946, and the peak of record in 1947. The total run in 1947 increased much more than did the Bonneville count; in other words, there was a considerable increase in fishing intensity. This increase is easily understood in the light of the conditions in the Columbia River gill-net fishery during recent years. Blueback salmon average so much smaller in size than the chinook salmon that special small-meshed nets must be used to fish intensively for bluebacks. In the early 1940's bluebacks had become so scarce that it was not profitable to fish for them, and blueback gear was seldom used. When it became apparent that the 1947 blueback run was to be heavy, there was a rush to fish for bluebacks, and practically all available blueback netting was pressed into service.

33. The recovery of the blueback run has not prevailed long enough for a determination as to whether or not it is permanent. It may be the result of special effort put forth in connection with the Grand Coulee fish-salvage project, or it may be a natural fluctuation such as those which occur as a result of unusually favorable environmental conditions.

34. The steelhead trout, like the chinook salmon, spawns extensively below Bonneville Dam, and the same reservations must be made with regard to using the counts and the catches below the dam as indications of fluctuations in abundance. The data are presented in table 11 and figure 4.

TABLE 11.—*Bonneville counts, and catches below the dam of Columbia River steelhead trout*

[Thousands of fish]

Year	Bonneville count	Catch below Bonneville	Count plus catch	Year	Bonneville count	Catch below Bonneville	Count plus catch
1938	121	186	307	1944	101	167	268
1939	122	182	304	1945	120	200	320
1940	185	300	485	1946	143	150	293
1941	118	262	380	1947	135	(1)	(1)
1942	151	176	327				
1943	92	142	234	Mean	129	196	324

[1] Data not available.

35. Neither the Bonneville counts nor the sums of the counts and catches below Bonneville show strong trends, although there is some indication of a downward trend in the sums. This is apparently due to a greater fishing intensity in 1940 and 1941 than in earlier or more recent years, such that the Bonneville counts of 1940–41 were kept down close to the average for the 10 years, 1938–47. Such meager evidence, however, does not offer a sufficient basis for any predictions as to the future of the steelhead runs, either with or without more dams.

36. The silver and chum salmon spawn so extensively below Bonneville Dam, and to such a small extent above it, that analyses such as those presented above would have little meaning. For the sake of completeness, however, the counts are presented in table 12 and figure 5.

TABLE 12.—*Bonneville counts of Columbia River silver and chum salmon*

Year	Silver	Chum	Year	Silver	Chum
1938	15,185	2,117	1944	4,207	954
1939	14,382	1,168	1945	791	727
1940	11,870	1,729	1946	3,897	1,176
1941	17,911	5,269	1947	11,174	199
1942	12,401	1,865			
1943	2,517	790	Mean	9,436	1,599

OTHER ANADROMOUS FISHERIES

37. *Commercial fishery.*—Although four species of Pacific salmon and the steelhead trout have always been of primary importance in Columbia River commercial fishing, there also are fisheries for stur-

geon, shad, and smelt. All of the latter are anadromous, but their migrations do not appear to be as extensive as those of the salmon and steelheads; and therefore they probably are less affected by water-use projects.

38. At one time there was a commercial sturgeon fishery in the Columbia, forming the basis of an industry of some importance during the period 1880 to 1900. Since then production has declined greatly; and, while these fish are still taken commercially, the catch is relatively small.

39. The shad is not a native of the Columbia River, having been transplanted to the Pacific coast from the Atlantic coast during the period 1871–86. There has been some commercial catch of shad since 1876, but the fish has never been favored as food on the Pacific coast markets, and production has always been minor as compared with that of salmon and steelhead.

40. The Columbia River smelt, or eulachon, forms the basis of a brief but intensive fishery during the spring months, when it ascends several of the lower Columbia tributaries (the Cowlitz, Lewis, and Sandy Rivers are the most important of these). Because of the small size of smelt, special gear is used in taking them, including small-mesh gill nets in the main river and dip nets in the tributaries.

41. In table 13 are given the annual catches from 1938 to 1946. The average catches are evaluated in terms of 1947 estimated primary wholesale prices, as shown in table 14.

TABLE 13.—*Annual commercial catch, minor fisheries of the Columbia River*

Year	Sturgeon	Shad	Smelt	Year	Sturgeon	Shad	Smelt
	Pounds	*Pounds*	*Pounds*		*Pounds*	*Pounds*	*Pounds*
1938	56,700	176,400	1,069,411	1944	258,203	584,735	[2] 2,158,000
1939	75,500	349,400	3,029,611	1945	255,406	909,886	[2] 4,324,000
1940	92,000	343,900	2,656,155	1946	[1] 199,435	[1] 657,759	[2] 3,028,000
1941	87,700	380,400	2,493,015				
1942	95,148	519,340	2,180,034	Mean	140,119	473,397	2,738,526
1943	140,980	338,750	3,708,506				

[1] Incomplete data.
[2] Estimated.

TABLE 14.—*Evaluation of average annual catch of minor fisheries of the Columbia River*

Species	Average catch	Price per pound [1]	Value
	Pounds		
Sturgeon	140,119	$0.25	$35,029
Shad	473,397	.17	80,477
Smelt	2,735,192	.07	191,463
Total	3,348,708		306,969

[1] Estimated 1947 primary wholesale price.

42. *Sport fishery.*—In addition to the commercial fisheries for these species, there is also a sport or subsistence fishery, particularly for smelt. During the smelt run literally thousands of people line the banks of the streams, utilizing all sorts of gear to make a catch of this delectable fish. Data are lacking to show the magnitude of this catch, but during the 1948 smelt run to the Sandy River, 32,422 non-

commercial licenses were issued to persons engaged in dipping this fish. At 50 cents each, these license fees amounted to a total of $16,210.

SPORT FISHERY FOR RESIDENT FISHES

43. The Columbia Basin is justly famous for its resident sport fishery resources. This area, with fifty to one hundred thousand miles of fishing streams and its five to ten thousand lakes, supports populations of rainbow, cutthroat, eastern brook, brown, Kamloops, lake, and Dolly Varden trout; kokanee; whitefish; grayling; sunfish; crappies; bass; catfish; and a number of other species. These fish furnish recreation for an ever-increasing number of sportsmen. In 1947 over twice as many fishing licenses were sold as in 1937, and there is every reason to believe that the number of sport fishermen will continue to increase as fast as, if not faster than, the population growth of the area.

44. While accurate data are not available on the number of fishing licenses sold in the Columbia Basin, it is estimated that over 700,000 fishing licenses were issued in 1947 and that over $2,000,000 were paid in license fees by resident and nonresident fishermen. It has also been estimated that from thirty to fifty million fish were caught and that upwards of $100,000,000 were spent in catching them. Whether or not the spending of money by sportsmen can be considered to create wealth, it is undeniable that sport fishing is big business and that the resident-fish resources are a valuable asset to the region, and to the health and well-being of the community as a whole.

45. In many instances water-use projects have resulted in a decrease of the resident-fish populations, while in others they have increased the abundance level. In virtually all projects the losses would have been less and the benefits would have been greater had reasonable consideration been given to resident fish, such as the screening of diversions and the maintaining of adequate stream flows. In order to permit better utilization of the fish habitat which may be created by the proposed dams to be constructed by the Corps of Engineers and as restitution for loss of trout streams, it is recommended that additional trout hatcheries be provided in appropriate locations throughout the basin. These should be considered a part of the cost of water development. At the present stage of planning the number of these hatcheries and their locations cannot be designated. It is suggested that a minimum of two complete units be provided for Washington, three for Idaho, two for Oregon, and three for Montana. Further developments will permit more precise recommendations on number and location of these units.

WILDLIFE

GENERAL

46. The abundance of big game, waterfowl, and upland game found throughout the mountains, plains, and valleys of the Columbia Basin assists in providing recreational opportunities unsurpassed in the Nation. The degree of utilization of these resources is expected to increase materially along with growing national demands for recreational development. The economic life of some areas depends largely

on the income from sportsmen and vacationists. Since trappers and settlers first penetrated this region, wildlife has been an important factor in the social and economic development of the basin. Game and fur animals have provided much food and clothing, and occasionally they have served as a medium of exchange.

47. The range of many forms of wildlife has been gradually restricted by the appropriation of their habitats and breeding grounds for agricultural and industrial uses. On the other hand, some species of upland game and waterfowl have benefited through irrigation developments. However, the improvement in roads and transportation methods has enormously increased the hunting pressure and made it possible for large numbers of sportsmen to utilize former wilderness areas. This exploitation of wildlife is augmented by the rapid increase of human populations in the Northwest.

48. License sales indicate that about 683,000 sportsmen participate in the hunting of big game and wildfowl in the Columbia Basin (table 15). This gives evidence of the importance of wildlife along with other resources of the basin.

TABLE 15.—*Hunting license sales*

State	State total	Estimated percentage of hunters using Columbia Basin	Estimated number of hunters using Columbia Basin
Washington	381,000	80	304,500
Oregon	200,000	85	170,000
Idaho	166,000	95	166,000
Montana	149,000	25	37,000
Wyoming	55,000	10	5,500
Total	951,000		683,000

In addition to the evident recreational value, wildlife is a significant source of food, especially for some 20,000 Indians living on reservations.

49. Construction of proposed impoundments (pl. 1) would have far-reaching effects on wildlife resources of the Columbia Basin. Certain reservoirs would destroy existing habitats of big game, upland game, and fur animals. They would also inundate some existing waterfowl habitat and substitute an expanse of water of relatively unknown value. Consequently, it is apparent that the wildlife effects should be carefully studied along with the problems of other resources.

50. Investigation of individual projects will be required as details are developed. Sufficient advance notice should be given for each project to allow a careful and comprehensive study of the resources involved. Feasible plans should be developed which would provide the highest possible utilization by wildlife without prohibiting the use of other resources.

51. In addition to project studies, a basin-wide survey of the wildlife resources of the Columbia Basin should be initiated to predict over-all results at the earliest possible date. Comprehensive programs for wildlife management are necessary in the areas being developed if the wildlife resources are to be improved and maintained.

52. Based on conservative estimates, the annual expenditure for hunting in the Columbia Basin is placed at $41,000,000. The distribution of this value among the various wildlife groups is shown in table 16.

TABLE 16.—*Estimated annual expenditures for hunting in the Columbia Basin within the United States*

Wildlife group:	Annual expenditures
Big game	$24,000,000
Upland game	11,000,000
Waterfowl	5,000,000
Fur animals [1]	1,000,000
Total	[2] 41,000,000

[1] Fur values based on pelt sales.
[2] Expenditure of $41,000,000 by 683,000 sportsmen indicates an average annual expense of approximately $60 per man for the sport of hunting.

BIG GAME

53. About 390,000 sportsmen participated in hunting of big game in the Columbia Basin in 1947. Mule, white-tailed, and black-tailed deer are reasonably plentiful, and they provide the major portion of this sport. Elk also are heavily hunted. Other big-game species include black and grizzly bears, mountain sheep, moose, antelope, and mountain goats.

54. With the exception of antelope, which are found on the sagebrush plains, the big-game species are largely confined to the mountainous and timbered sections. During winter storm periods the deer and elk migrate to lower elevations where climatic conditions are less severe. While their summer range is ample, the winter concentrations often find a scarcity of available forage. Consequently, the primary problem in the management of big game is the provision of adequate winter range. The construction of impoundments which flood out such areas will necessitate the acquisition of alternate areas where these animals can find food during the critical winter periods. If this is done, it may be possible to maintain the most desirable species at relatively high levels.

55. The estimated populations of each big-game species are given in table 17. The annual expenditure for hunting big-game animals in the Columbia Basin is believed to exceed $24,000,000.

TABLE 17.—*Big-game populations by States in 1946* [1]

Species	Washington	Oregon	Idaho	Montana	Wyoming	Total
Mule deer	79,700	172,600	147,000	104,200	149,000	652,500
Black-tailed deer	96,200	86,000				182,000
White-tailed deer	20,300	500	28,600	37,500	15,900	92,800
Elk	20,800	20,600	36,200	40,700	88,700	207,000
Antelope	50	9,600	10,500	37,800	80,600	138,550
Moose			2,200	3,900	7,100	13,200
Mountain bighorn sheep	20	10	2,100	1,500	5,500	9,130
Mountain goat	6,400		3,700	5,300		15,400
Black bear	21,100	9,900	8,000	8,400	5,300	52,700
Grizzly bear	3		60	772	487	1,322
Woodland caribou	15		10			25
American bison	25			1,300	1,000	2,325
Total	244,613	299,210	238,370	241,372	343,587	1,367,152

[1] The Columbia Basin includes the following estimated portions of the above States: Idaho, 95 percent; Washington, 68 percent; Oregon, 62 percent; Montana, 17 percent; and Wyoming, 5 percent.

It has been further estimated that the following percentages of each State's big-game kill are taken within the Columbia Basin: Idaho, 95; Washington, 70; Oregon, 75; Montana, 25; and Wyoming,10.

UPLAND GAME

56. The basin supports an abundant and varied population of upland-game birds. They are particularly plentiful in some of the mountainous areas and on the irrigated lands. The birds of this group, and the ring-necked pheasant in particular, afford the most popular hunting of the basin, in which an estimated one-half million sportsmen participate.

57. Upland-game birds are usually plentiful in the valley areas; consequently, most of the impoundments would destroy habitat of particular value to this wildlife group. However, where irrigation of new lands is involved, the benefits to game birds would usually exceed the losses. These benefits, in some instances, may be greatly increased by project planning which considers wildlife values along with that of other resources involved. The investigation of game-bird problems must be initiated at an early stage if maximum benefits are to be obtained.

58. The species native to the basin include blue, ruffed, Franklin, sharp-tailed, and sage grouse, band-tailed pigeons, mourning doves, and mountain quail. The number of native grouse has generally decreased over much of the basin, and particularly so in the lower sagebrush areas where much of their habitat has been destroyed. However, irrigation has resulted in the creation of much new habitat favorable to introduced game birds, among which the principal species are ring-necked pheasants, valley and bob-white quail, and Hungarian partridges. Of these species the pheasant is by far the most abundant, and it provides excellent hunting on the irrigated valleys and benchlands.

59. Estimates of the total game-bird population of the Columbia Basin are not available. However, statistics from the State of Oregon indicate the value of these birds over the entire Pacific Northwest.

60. In Oregon it has been estimated that there are 5,750,000 acres of available habitats for upland-game birds. These areas are believed to support populations of about 1,410,000 pheasants, quail, and partridges. In addition, there are various species of grouse in the mountainous areas. It is estimated that two and one-half million dollars are expended in the State for hunting upland-game birds. Furthermore, it is believed that about 85 percent of Oregon's upland-game hunting takes place in 62 percent of its area which lies within the Columbia Basin. The total annual expenditure by one-half million sportsmen for hunting of upland-game birds in the Columbia Basin is estimated at $11,000,000.

FUR ANIMALS

61. Fur animals constitute a valuable resource throughout the major portion of the Columbia River drainage. Martens are found in most of the higher mountainous regions. Other species common to the basin are muskrats, beavers, minks, otters, skunks, and raccoons. Fur animals are common along most of the streams of the Northwest, and they would be seriously affected by channelization, drainage, and

flood-control projects. The habitat of muskrats and beavers would be altered considerably by impoundment of these streams. Some utilization of the reservoirs by fur animals is to be expected; but the extent of such use is dependent on many factors, such as fluctuation, shore-line vegetation, and so forth. A thorough study of these factors must precede any estimate of future fur-animal populations, and, even then, the problem is often perplexing. Studies of existing impoundments should gradually increase the accuracy of these predictions. Detailed data on the number of each species taken in the basin are not available. However, the fur catch, exclusive of beavers, for the various States has been evaluated as follows: Washington, $280,138; Oregon, $208, 876; and Idaho, $273, 058. The value of the beaver take in Oregon for the winter of 1947–48 was $152, 000. The entire fur-animal catch of the Columbia Basin is worth in excess of $1,000,000 annually.

WATERFOWL

62. About one-third of the continent's waterfowl (estimated at 54,000,000 in 1947) is found in the Pacific Flyway, and nearly all of the birds of this flyway pass through the Columbia Basin each spring and fall (plate 2). The waterfowl resource is recognized as one of great importance which annually provides sport for about 150 thousand people in this area.

63. Ducks and geese nest extensively throughout the basin, while the wintering populations are concentrated in the lower and more protected regions. The nesting populations may approach 1,000,000 adult birds which, with the addition of young, would be expected to at least double in number during the summer. The January estimates of waterfowl numbers reveal a total of about one and one-half million in the Columbia Basin, some 80,000 of which are geese.

64. The reclamation of marshlands, especially along the lower Columbia and Willamette Rivers, has resulted in the loss of much habitat formerly used as resting and breeding grounds for ducks and geese. To perpetuate and develop this waterfowl resource, extensive areas must be acquired and developed for resting, feeding, and nesting birds, and for public shooting grounds. The provision of this essential habitat, without preventing the development of other resources, presents a most difficult problem. If feeding areas are available nearby, the substitution of large impoundments for the present valleys, with their meandering streams, may be beneficial to the migrating mallards, pintails, and baldpates. However, the resident birds, and especially the island-nesting geese, may not find suitable habitat.

65. The effects on waterfowl must be carefully investigated as each new impoundment is planned, since opportunities to benefit this resource should not be omitted. Where reservoirs are operated with very little fluctuation, their value to waterfowl is greatly increased. Additional benefits may be attained by growing grain for birds in the vicinity of impoundments. The increased benefits may be large on areas located in good migratory routes.

66. While it is difficult to evaluate the waterfowl of the Columbia Basin, it is apparent that a considerable portion of the ducks and geese of the Pacific Flyway depend on this area for a part of their support. A conservative estimate of $5,000,000 is given as the present annual value of the basin for maintaining the waterfowl resource.

SUB-BASINS

INTRODUCTION

67. In the appraisal of the anticipated changes in fish and wildlife habitat presented in the following pages, discussion is largely restricted to authorized and proposed projects that have the greatest effect on fish and wildlife. All of the many projects that are being considered for development of the Columbia Basin affect fish and wildlife in some respect, but because of the preliminary status of many plans, only the most important ones are reviewed. Nevertheless, it is realized that other projects will undoubtedly follow those that receive early authorization, and the total effects on fish and wildlife will have to be thoroughly studied.

68. For the sake of uniformity the same geographic sub-basins are discussed herein as are considered in other sections of the review report. In view of the anadromous-fish problems involved, the sub-basins are discussed in order from the mouth of the Columbia upstream to the Canadian border and then upstream from the mouth of the Snake.

COLUMBIA RIVER BELOW MOUTH OF YAKIMA

(Including tributaries below mouth of Cowlitz)

Fish

69. This area of the watershed is of importance to fish life primarily as a migration route to the upper river and tributaries. However, the main stem of the river between Celilo Falls and the confluence of the Yakima is utilized to some degree by spawning salmon; and the area does include a number of small tributaries near the mouth that are of great value to anadromous fish, chiefly for the production of fall-run chinook, silver, and chum salmon, as well as steelhead and sea-run cutthroat trout. On the Washington side of the Columbia in this section the most important salmon streams are the Grays, Skamokawa, and the Elokomin Rivers. On the Oregon side the principal salmon streams are the Klaskanine and Clatskanie Rivers and Big Creek. These and numerous smaller streams also have a considerable sport-fishery value for rainbow and cutthroat trout.

70. In addition to the above-mentioned species, the area supports populations of bass, crappie, perch, and other resident fishes, as well as sturgeon.

71. The area is of vital importance to the commercial, Indian subsistence, and sport fisheries for anadromous fish. All of the river commercial catches are made in this area, primarily below Bonneville Dam, although an important fishery is prosecuted at Celilo Falls. The major part of the Indian subsistence fishery is carried on at Celilo Falls, while the major part of the sport fishery is in the lower sections of the river. A discussion of the importance and value of these fisheries has been presented earlier in this report.

Effects of authorized projects on fish

72. *McNary Dam*, authorized for construction by the passage of the River and Harbor Act of March 2, 1945, will be located across the main stem of the Columbia River approximately 150 miles upstream from Bonneville Dam. It will be a concrete, gravity-type structure

similar to Bonneville but with approximately 50 percent greater head and with a tailwater-forebay height of approximately 90 feet.

73. McNary Dam is under construction at the present time and should be completed and generating power by 1953. Extensive plans are being made for facilities to provide upstream passage for anadromous fish. Since no methods of recognized efficacy are known for diverting fingerlings at such a structure, virtually all of the young fish migrating downstream would pass through the turbines and under the spillway gates unless studies now in progress by the Service disclose satisfactory methods for safe downstream migration (see par. 261).

74. In addition to presenting a problem for the upstream passage of migratory fish and a threat to the safe passage of downstream migrants, the backwater of this dam will inundate a considerable area of spawning grounds in the main channel of the Columbia River. The total effect on the anadromous-fish runs is difficult, if not impossible, to estimate, but unquestionably McNary Dam will result in a lowering of the productive capacity of the Columbia River salmon resources.

Effects of proposed projects on fish

75. Of the dams proposed for authorization at the present time, *The Dalles* (88 feet high [1]) and *John Day* (135 feet high), to be located across the main stem of the Columbia River between Bonneville and McNary, would present fishery problems comparable to those associated with McNary Dam. These dams would be similar in construction to McNary, except that the John Day Dam would be provided with additional storage capacity for flood control that would raise the forebay level 37 feet during excessive floods. Normally the maximum tailwater-forebay height would be 98 feet, and additional height would be encountered for a few weeks only during extreme flood seasons. If a fish ladder extended only to the 98-foot height, fish passage would be delayed during a period of flood-control storage. The effects on the fish runs would depend on the length of delay, and it is conceivable that during some years there might be a serious loss to the fishery. In addition to their direct effects on the anadromous-fish populations, these two dams would be a part of the series of obstacles in the main migration route of the majority of the upstream and downstream migrating salmonoid fishes. When they, together with already authorized dams, are constructed, salmon spawning in the upper reaches of the Snake River would have to pass eight huge dams, both on their upstream and downstream migrations and the cumulative effect of the series of dams might be much greater than eight times the effect of a single dam.

76. Besides facilities for passage of migrating fish, it is foreseen that provision would be needed for a hatchery to accommodate approximately 25,000 adult salmon and 50,000,000 eggs. The purpose of this hatchery would be as partial compensation for expected loss to anadromous-fish runs through construction of The Dalles and John Day Dams. Inasmuch as the Deschutes River is located near The Dalles Dam, where reasonably good water conditions could be obtained and transportation held to a minimum, it is recommended that the hatchery be constructed on the lower Deschutes. Separate hatchery facilities should not be needed at the John Day Dam site.

[1] Unless otherwise indicated heights of dams are given in this report as maximum tailwater to forebay distance.

77. The Dalles Dam has a unique fisheries problem in that it would inundate Celilo Falls, where an intensive commercial and subsistence fishery is carried on, primarily by the Indians. Celilo Falls is one of the "usual and accustomed" fishing sites reserved by certain Indian tribes in their treaty of 1855 with the United States Government. The inundation of these falls might be a violation of this treaty; however, that is a matter for negotiation between the Indians and the United States Government.

Wildlife

78. This sub-basin comprises only the lower Columbia River without reference to tributaries (except a few below the Cowlitz). Only land adjacent to the main river is involved; however, a wide variety of wildlife is produced because of the broad scope of climatic conditions included. Game species vary from those native to the semiarid lands of the interior to those inhabiting the humid transition zones of the lower Columbia. The principal wildlife concern in this sub-basin is the effect of the impoundments on habitats.

79. Big game and fur-animal resources are most abundant in the lower Columbia section. Deer are reasonably plentiful in this drainage, but they are seldom found along the river where the impoundments would be located. There have also been occasional sight records of elk in the vicinity of the proposed structures; however, the utilization of impoundment sites by all big-game species is negligible.

80. Ring-necked pheasants, valley quail, and Hungarian partridges are present in varying degrees of abundance on the impoundment sites. Fur animals, primarily beavers, muskrats, minks, raccoons, and skunks, are common along the streams. Waterfowl are abundant in migration, and Canada geese are common nesters on islands in the river. Mallard ducks nest along the stream where suitable habitat is present. Migrant waterfowl use the watercourse as a base from which to feed in adjacent grain fields. The river from The Dalles, Oreg., upstream to within 6 miles of the mouth of the Walla Walla River is in refuge status.

81. Wildlife habitat of considerable value to upland game and fur animals would be lost. Some good goose-nesting islands would be destroyed by inundation. The reservoirs should have considerable value as resting areas for waterfowl; moreover, the adjacent grain belt provides accessible food supplies to migrants. Ducks in particular will be benefited, but present utilization by migrant flocks of geese may show little, if any, increase. The projects' effect on big-game resources would be negligible.

82. Since waterfowl would be greatly influenced by the impoundments, investigations should be made to determine what means might be feasible in mitigating expected habitat losses. Particular attention should be directed to the possible utility of shoal areas and sand flats that would result from the impoundments. In addition, marginal shore zones of all reservoirs constructed in this sub-basin should be managed to permit maximum utilization by wildlife. Waterfowl, upland game, and the principal fur animals might all conceivably benefit from shore-line management where investigations indicate that it would be economically expedient to do so.

Effects of authorized projects on wildlife.

83. *McNary Dam.*—Some valuable upland-game habitat will be lost on inundated lands that are now well populated with pheasants and quail. Cultivated and grazed areas in the vicinity of Cold Springs, Techumtas Island, and near the mouth of Juniper Canyon will be among those affected.

84. Waterfowl will lose several essential nesting and resting islands in the impoundment site. Canada geese in particular will suffer heavily since their use of these islands and adjacent sand and gravel bars is especially marked. Under present plans, no comparable habitat of equal value will be provided. The Columbia National Wildlife Refuge, Techumtas Island, and several smaller islands near Cold Springs will be inundated. The impoundment would provide a resting area for migrant ducks and geese, but its utility may be less than that of the islands, sand bars, sloughs, and marginal shoal areas which will be lost.

85. The feasibility of providing waterfowl-nesting environment equal in value to that lost by inundation should be investigated with particular emphasis devoted to the utility of the possible shoal-water areas that will be created by the impoundment. After the loss of island-nesting sites, the geese may nest along the margins of the impoundment. However, nesting success might be considerably reduced because of accessibility to the area by ground as well as avian predators; also, marginal areas supporting the most suitable nesting cover might be subjected to intense grazing by livestock unless forage utilization policies were amended to allow for the probable benefits accruing to waterfowl by permitting only moderate stock use of the shore zone. This provision would be especially valuable in those sections of the impoundment characterized by shallow water or sand-flat areas where geese may be expected to congregate.

86. Since the construction of McNary Dam will destroy a number of the best goose-nesting islands in the sub-basin, investigation should be undertaken immediately to determine the feasibility of improving and maintaining the nesting habitat on Blalock Island, located about 12 miles downstream from the McNary site. Management might consist of controlling excessive grazing and expanding existing nesting facilities by planting suitable cover crops. This proposal is based on the assumption that sufficient time would elapse between the construction of McNary and John Day Dams to justify the expenditure involved. An increase in nesting density on Blalock Island might be expected to occur with the possible addition of the waterfowl whose nesting habitat will be destroyed by the McNary impoundment.

87. Fur-animal habitat in the impoundment area will be eliminated; moreover, much of the rocky shore line resulting from the impoundment might not be conducive to the satisfactory re-establishment of some species. Big-game resources will not be measurably affected by the proposed reservoir.

Effects of proposed projects on wildlife

88. *John Day Dam.*—Fur-animal habitat of considerable value would be eliminated in the impoundment area. Some of the best natural environment for fur animals along the Columbia River from The Dalles upstream to the McNary Dam would be destroyed. Slough areas that would be inundated are especially productive of

beavers, muskrats, and minks. Initial losses might be mitigated by re-establishment of suitable native cover types along the new shore line created by the impoundment.

89. Upland-game habitat affected would primarily be that used as nesting and escape cover along the main river channel and adjoining sloughs. Areas particularly affected are situated between the mouth of Willow Creek above Arlington and the McNary impoundment. The combination of available cover and refuge status of this stretch of the Columbia River has made it valuable in providing escape for pheasants and quail from heavily hunted adjacent areas. This fortunate circumstance for upland game would be unfavorably altered by inundation.

90. Waterfowl would lose several good nesting and resting islands in the impoundment site. These islands are especially important to Canada geese in providing suitable nesting environment isolated from the mainland and, consequently, from ground predators. Probably the most essential areas that would be affected are Blalock Island and several subsidiary islands and sand bars. These sites, in addition to some important slough areas, are situated from the town of Boardman upriver to the McNary impoundment. Elimination of these areas by inundation would be detrimental particularly to geese, since no comparable nesting habitat might be provided. The possibility of establishing new waterfowl nesting habitat to replace that lost by flooding should be investigated. The utility of shoal-water areas that would be created by the impoundment should receive particular attention. After the loss of island-nesting areas, the geese might nest along the shore line created by the impoundment. Success of shore nesting might be much less than that attained on the islands. Ready accessibility of ground predators and livestock to the shore zone could conceivably reduce nesting success through increased predation and overgrazing of existing ground cover. Field investigations should be made prior to actual construction to determine means of ameliorating the possible unfavorable effects of the impoundments on waterfowl habitat.

91. The effect of the project on big-game resources would be negligible.

92. It is probable that the possible management of shore zone and shoal-water areas would be most feasible to benefit all wildlife species resident or migrant in the impoundment site. This would be in addition to the resting value that the site would provide for waterfowl in flyway migration.

93. *The Dalles Dam.*—Waterfowl would lose some low, sandy islands and gravel bars of particular value to geese and, to a lesser extent, ducks during migration. Present bank-nesting habitat would be destroyed. However, existing islands that would be inundated by the impoundment would not equal the loss incurred by the possible construction of John Day Dam primarily because they do not support adequate vegetative cover to induce nesting use by Canada geese. The utility of the impoundment as a resting area might more nearly equalize the loss of nesting habitat occasioned by construction. Preproject study as to the possibility of utilizing suitable shoal-water and bank areas that would possibly benefit both migrant and nesting ducks and geese is recommended.

94. Upland-game habitat losses would be confined primarily to restricted and intermittent sections of the present shore area that would be flooded.

95. Some fur-animal environment would be lost by inundation, but it is considerably less productive than the habitat that would be lost in the John Day impoundment.

WILLAMETTE RIVER AND TRIBUTARIES

Fish

97. The Willamette River enters the Columbia River at Portland, Oreg. This river system formerly supported large runs of spring chinook and silver salmon, steelhead trout, and some fall chinook salmon. At the present time the Willamette is one of the chief producers of spring chinook salmon in the Columbia Basin, and it also continues to support a good run of steelhead trout. The main Willamette River is of value to spring chinook salmon chiefly as a migration route to the major tributaries; although, there is evidence that some of these fish spawn in the upper section of the main stream in the vicinity of Eugene, Oreg. The principal tributaries of value to salmon, beginning with the most important, are the McKenzie, the North Santiam, the Middle Fork of the Willamette, and the South Santiam. Other streams, with much smaller runs of spring chinook salmon, include the Clackamas, Molalla, Pudding, and Calapooya Rivers.

98. It will be noted that all of these stream systems drain the east side of the Willamette Valley watershed, those entering from the west being of relatively little value to salmon. The Tualatin is the most important of the west-side streams, supporting fair runs of silver salmon, steelhead and cutthroat trout. A good run of steelhead trout enters the Willamette River and ascends to the upper tributaries of many of the east-side streams, particularly into the several forks of the Santiam River.

99. The Oregon Fish Commission operates hatcheries on the Middle Fork Willamette, North Santiam, South Santiam, and McKenzie Rivers, with a combined capacity of approximately 32,000,000 eggs per year. The average egg take for the period 1918–46 was 24,600,000; however, the egg take for the past 5 years has averaged only 8,000,000 per year. A hatchery with an annual capacity of 250,000 spring chinook salmon fingerlings is being operated on a tributary of the Clackamas River by the Fish and Wildlife Service.

100. The Willamette River salmon support an intensive salmon sport fishery primarily in the section of the river below Willamette Falls. Estimates made by personnel of the Fish and Wildlife Service, the Corps of Engineers, and the Oregon Fish Commission during 1941, 1942, 1946, and 1947 give the sport catches as 30,000, 12,000, 12,600, and 12,000 respectively. Estimates, based on partial counts, by the Oregon Fish Commission place the passage of fish over Willamette Falls at 50,000 in 1946 and 45,000 in 1947.

101. The Willamette River system also supports a resident sport fishery of great recreational value. Fish-cultural operations by the Oregon Game Commission maintain a high level of trout production in many heavily fished areas. Rainbow trout from the east-side tributaries and cutthroat trout from the west-side streams are known to migrate down to the main river, returning to the smaller streams to spawn. The sluggish portions of the main stream and sloughs,

ponds, and small streams in the floor of the Willamette Valley support an increasingly popular sport fishery for largemouth black bass, crappie, perch, sunfish, and bullhead catfish. The McKenzie River long has been famous for its excellent rainbow trout sport fishery. All of the major streams and most of the lakes and upper tributaries maintain good populations of trout. Whitefish and charrs also contribute to the sport fishery. The east-side streams are the larger tributaries and are of most value to the sport fishery, the rainbow trout fishery being confined mainly to that portion of the watershed. However, many of the west-side streams, little utilized by salmon, are of considerable sport-fishery value, particularly in the upper sections for cutthroat trout.

Effects of Willamette River project on fish

102. The various multipurpose water-development projects for the Willamette River Basin have been presented in a previous Corps of Engineers report, and a report on the fish and wildlife problems has been submitted along with that report. Briefly, the plan of development calls for the completion of the authorized Meridian, Detroit, and Dorena Dams, the authorization of 14 additional dams, and certain channel-improvement work. These projects, frequently referred to as the Willamette Valley project, present difficult fishery problems, involving both anadromous and resident fishes. The general plan of solution includes large-scale fish-cultural operations, and the improvement of the fishways at Willamette Falls. Considerable study will be required prior to the completion of the project in order to obtain adequate solutions to all the fishery problems that are bound to arise.

Wildlife

103. Wildlife resources are particularly valuable in this basin, which supports two-thirds of Oregon's population. The principal mammals involved are deer, beavers, minks, muskrats, and martens. Game birds include ring-necked pheasants, band-tailed pigeons, and various species of quail, grouse, ducks, and geese.

Effects of Willamette River project on wildlife

104. The development of the Willamette River proposes flood control and drainage of vast areas by the use of storage dams, channel improvement, and bank protection. The total effects of the Willamette River project on wildlife of the reservoir areas above the valley floor appear to represent a very definite loss. While the losses to big game and fur animals may be sizable, they would not be as extensive nor as serious as the anticipated destruction of waterfowl habitat.

105. Seventeen of the reservoirs are to be located above the main valley floor in more or less wooded country where there is relatively little or no agricultural development. These reservoirs would inundate a portion of the better wildlife habitat of the Willamette Basin. Fur animals concentrate in these valley areas, which are also much used as fawning and wintering grounds for deer. Upland-game birds, largely grouse and quail, are common on most of the impoundment sites. Waterfowl use in these mountainous areas is negligible, and any prediction of such use is problematical.

106. The total wildlife value of the mountainous areas to be inundated is quite evenly divided among big game, upland game, and fur animals, and there is little chance for any means of improving such

impoundments to mitigate the expected losses. The exceptions are Dorena and Cottage Grove Reservoirs, which might be made more attractive to waterfowl.

107. The present Fern Ridge Reservoir and the proposed Lewisville impoundment, which would also be located in the valley plain, could be made very attractive to migratory waterfowl. A subimpoundment of Coyote Creek on the Fern Ridge Reservoir above the Southern Pacific Railroad should be constructed as a means of increasing wildlife values.

108. Waterfowl use of the present and proposed lower reservoirs, particularly Fern Ridge, Dorena, and Lewisville, could be increased by the cultivation of food crops for the birds in the immediate vicinity.

109. Since the proposed flood control and drainage of the Willamette Basin would remove a significant portion of the remaining habitat, it is essential that alternate habitat in the form of management areas be provided.

110. The proposed development of both reservoirs and drainage systems throughout the valley may destroy much of the habitat of muskrats and beavers. This effect on fur animals should be thoroughly investigated with a view to recommending feasible means for increasing wildlife use of the project areas.

TRIBUTARIES BELOW MOUTH OF YAKIMA RIVER[1]

Fish

111. These tributaries are not only of value as important producers of fish life, but also they have great potential value in view of the proposal for the development of the lower Columbia River tributaries in the interest of fish life, a subject which is discussed elsewhere in this appendix.

112. The *Cowlitz River* is the lowermost of the major stream systems and the most valuable in the area from the standpoint of present and potential fishery resources. It is the only major river in the lower Columbia Basin that has retained most of its stream system unobstructed by agricultural, industrial, or other water-use developments. The Cowlitz River system supports runs of fall and spring chinook salmon, silver salmon, a few chum salmon, steelhead, and sea-run cutthroat trout. Spring chinook salmon utilize extensive spawning areas in the upper main stream and also ascend to the point of origin of the main stream at the confluence of the Ohanapecosh River and the Clear Fork, where they are intercepted and taken for artificial propagation by the Washington State Department of Fisheries. Chinook salmon also ascend all of the major tributaries, such as the Coweman, Toutle, Tilton, and Cispus Rivers, as well as some of the smaller tributaries. Fall run chinook salmon and a few chum salmon and sea-run cutthroat trout utilize the lower section of the main stream and most of the lower tributaries. Silver salmon ascend all of the larger streams and, in addition, enter numerous smaller streams that are not utilized by other species of salmon. Steelhead trout ascend to the upper part of the main stream and into most of the tributaries. The lower main Cowlitz River also maintains a large and valuable run of smelt, for which there is an intense commercial and sport fishery. The Cowlitz is the chief smelt producer in the Columbia Basin and one of the few rivers that support this fishery.

[1] Excluding Willamette and Snake Rivers and streams below the Cowlitz.

113. A wide variety of resident fish in the Cowlitz system supports sport fisheries of great recreational value. Silver Lake, tributary to the lower Toutle River, produces large numbers of spiny-rayed fish. It is probably the most famous bass-fishing lake in the State of Washington. Spirit Lake, at the head of the Toutle River, contains large rainbow trout and is the center of a popular recreational fishing area. Rainbow and cutthroat trout and charrs are taken from most of the lakes and streams. Some of the tributaries, such as the South Fork of the Toutle River and the Green River, are not easily traversed and, though not fished intensively at present, support large trout populations.

114. The *Kalama River* maintains large runs of fall chinook and silver salmon and steelhead trout. A salmon hatchery is operated by the Washington State Department of Fisheries a few miles above the mouth. A power dam that formerly interfered with the passage of anadromous fish was improved in 1944 by the construction of a new fish ladder. However, there is a large amount of suitable spawning area above the power dam that is not fully utilized, even though the hatchery passes a portion of the runs upstream for natural spawning. The upper portion of the river and its tributaries are of considerable value for their production of resident rainbow and cutthroat trout.

115. The *Lewis River* system supports a large run of silver salmon, fair runs of spring and fall chinook salmon and steelhead trout, and a few chum salmon and sea-run cutthroat trout. The greater part of the main river and all the upper tributaries are rendered inaccessible to anadromous fish by the Merwin power dam 20 miles above the mouth. The runs are maintained in part by hatchery operations of the Washington State Department of Fisheries. Portions of the runs are lifted over the dam and allowed to proceed upstream to natural spawning grounds. The major tributaries below the dam are the East Fork and Cedar Creek. Both of these streams support runs of silver salmon, chinook salmon, steelhead, and sea-run cutthroat trout. The Washington State Department of Fisheries has greatly increased the value of Cedar Creek to anadromous fish in recent years by stream-improvement work. The main river and practically all of the tributaries support good populations of resident rainbow and cutthroat trout. Lake Merwin is of little value for the production of trout.

116. *Scappoose Creek* enters the Columbia River on the Oregon side. It is a small stream but is of some value to fall-run chinook and silver salmon, as well as steelhead and cutthroat trout.

117. *Salmon Creek*, a minor stream entering the Columbia River below Vancouver, Wash., supports small runs of fall chinook and silver salmon, steelhead, and sea-run cutthroat trout. A few chum salmon are also reported. Several beaver dams and log jams offer obstruction to the passage of anadromous fish. The resident-trout fishery is attractive to local sportsmen.

118. The *Washougal River* enters the Columbia on the Washington side about 15 miles above Vancouver. It supports a good run of steelhead trout, and small runs of chinook and silver salmon. The upper section of the stream and its tributaries are of some value to resident trout. Bass and other fishes are taken from the reservoir on Lacamas Creek, a tributary. Shad spawn at the mouth of the river, mainly at the head of Camas slough. Three low power dams formerly obstructed the passage of salmon in the Washougal River.

One of these washed out many years ago, and the others were removed in recent years through actions of the Washington State Departments of Fisheries and Game. The river is badly polluted at the mouth by the discharge of waste effluent from the Camas paper mills into the Camas slough. This condition is most dangerous to summer and fall-run fish, which attempt to enter during low-water stages.

119. The *Sandy River* enters the Columbia River approximately 20 miles upstream from Portland, Oreg. The stream supports runs of spring and fall chinook salmon and steelhead trout. These runs have been maintained in part by the Oregon State Fish Commission hatchery located at Marmot Dam. The Sandy River also supports a large and valuable run of smelt. The upper section of the stream and most of the tributaries are of some value for resident trout. The upper half of the main stream and one of the best major tributaries, Salmon River, containing a large amount of good spawning area, are not accessible to anadromous fish during the summer and fall low-water periods because of the water diversion at the Marmot power dam. Bull Run River, a major tributary below the Marmot Dam, is inaccessible to anadromous fish a few miles above the mouth because of a Portland domestic water-supply dam.

120. *Tanner Creek*, entering the Columbia River just below Bonneville Dam, and Herman Creek, entering above the town of Cascade Locks, Oreg., both serve as passageways for fall chinook and silver salmon to hatcheries of the Oregon Fish Commission located a short distance upstream. *Eagle Creek*, just above Bonneville Dam, has an important egg-collection station.

121. *Wind River*, entering the Columbia on the Washington side, has good runs of steelhead trout and fall chinook salmon. A falls about a mile above the mouth is a barrier to anadromous fish except at high-water stages, when steelhead are able to ascend. There is not sufficient natural spawning area below the falls to accommodate the fall chinook run. During some years these fish are trapped and the eggs hatched at the Carson Hatchery of the United States Fish and Wildlife Service in the upper section of the stream. Wind River and its tributaries support a considerable sport fishery for resident rainbow and cutthroat trout.

122. *Little White Salmon River* enters the Columbia at Cook, Wash. The river has a good fall run of chinook salmon, which is maintained by a hatchery operated by the United States Fish and Wildlife Service. Practically the entire run is trapped and taken for artificial propagation. Only a short section of this stream is available to salmon because of an impassable falls. Drano Lake, a small lake at the mouth of the river, is of some sport-fishery value for steelhead trout; however, these fish apparently are not able to ascend the falls in the Little White Salmon River. The upper section of the river and the tributaries also have some sport-fishery value for resident rainbow and cutthroat trout.

123. *Spring Creek*, a mere trickle of water located about a mile west of Underwood, Wash., is noteworthy because it has by far the largest run of any stream of its size in the Columbia Basin. Its entire flow of approximately 2.5 second-feet is utilized by a Fish and Wildlife Service hatchery at that location. The creek flows from hatchery ponds down a small fish ladder a distance of about 100 feet to the

Columbia. From three to ten thousand adult chinook salmon ascend the creek each year and are spawned artificially.

124. *Big White Salmon River* enters the Columbia River at Underwood, Wash. It is inaccessible to anadromous fish a short distance above the mouth because of a high, impassable power dam. A run of fall chinook salmon which enters the river is trapped for artificial propagation by the Fish and Wildlife Service and the eggs taken to the Spring Creek Hatchery for incubation. This hatchery operation has increased the run of chinook salmon into the Big White Salmon River, and since there is practically no accessible spawning area, the run can be maintained only by artificial propagation. The reservoir above the power dam is of sport-fishery value for trout, bass, and other resident fish. The upper main stream, most of the tributaries, and several small lakes also have good recreational fishery values for their production of rainbow, cutthroat, and eastern brook trout.

125. *Hood River* enters the Columbia River at Hood River, Oreg. It formerly supported good runs of fall chinook salmon and steelhead trout, and it continues to maintain a fair run of steelhead trout, but the chinook run is very small, due in large measure to the extensive diversion of water for power and irrigation. A power dam located 4 miles above the mouth frequently diverts practically the entire flow at low-water stages, the return flow entering at the power plant one-half mile above the mouth. Numerous irrigation dams and diversions in the upper section of the main river and in all the principal tributaries also contribute to low summer flow conditions and obstruct the passage of fall-run anadromous fish. The West Fork is impassable to salmon because of Punchbowl Falls, located one-half mile above the mouth. Steelhead trout are able to pass over this falls at high-water stages and ascend to the upper section of the stream. The three upper forks, which together form the main river, are of some sport-fishery value for resident trout.

126. The *Klickitat River* enters the Columbia River at Lyle, Wash. It formerly supported a good run of spring chinook salmon, which has been greatly depleted; however, recent observations indicate that the run is still of significance. It continues to support a good run of steelhead trout, although it does not approach its former magnitude. No fall-run salmon are able to ascend the Klickitat River because the several falls near the mouth are impassable at low-water stages. This series of falls, located in a narrow canyon, was formerly a favorite Indian fishing place. In recent years, the river has been closed to all commercial fishing by order of the Washington State Department of Fisheries. The Klickitat and most of its tributaries are of great sport-fishery value for steelhead trout, as well as resident rainbow and cutthroat trout. The Washington State Department of Game maintains a trout hatchery on the Little Klickitat River.

127. The *Deschutes River* enters the Columbia upstream from The Dalles, Oreg. This large river system is known to have formerly supported good runs of spring chinook salmon, blueback salmon, and steelhead trout. The chinook run retains only a small remnant of its former size, and the natural run of bluebacks has been exterminated; but the steelhead runs continue to be of significant importance. Sherar Falls, located in the lower section of the main river and formerly

an obstruction to salmon at low-water stages, has been improved in recent years for the passage of fish by the Oregon Fish Commission. The extensive withdrawal of water for expanding irrigation requirements has greatly reduced the potential value of the watershed for anadromous fish, and particularly for the summer and fall runs. The major tributaries formerly of great value to salmon are the Warm Springs, Metolius, and Crooked Rivers. The Warm Springs River maintains a small run of spring chinook salmon and a fair run of steelhead trout. Two low dams obstruct the passage of salmon during low-water stages, but the stream is of great potential salmon-fishery value. The Metolius River continues to be the most important producer of anadromous fish in the Deschutes River sytem. The Oregon Fish Commission is presently building a hatchery on this stream (pl. 3). Although greatly depleted, a small run of spring chinook salmon spawns in the upper section of the main stream below Suttle Lake, and steelhead trout utilize the suitable spawning areas throughout the main stream and many of the tributaries. The run of blueback salmon that formerly ascended to Suttle Lake has been exterminated due to the construction of a power dam at the outlet. The extensive diversion of water for irrigation and resultant low summer flows have rendered the Crooked River system of practically no present value to anadromous fish. The main Deschutes is famous for its sport fisheries of rainbow and German brown trout. The upper portions of the tributaries above the irrigation developments and most of the lakes within the watershed also have considerable sport-fishery values for resident rainbow and cutthroat trout and charrs.

128. Irrigation developments in the Deschutes Valley are presenting some serious and difficult problems to the maintenance of the sport fishery. Numerous diversions have destroyed many miles of choice habitat in the vicinity of Bend. The recently completed Wickiup Reservoir has added to these problems by drastically reducing needed flows in an important stretch below the dam.

129. The *John Day River* system is known to have formerly supported large runs of spring and summer chinook salmon and steelhead trout. There has been no run of salmon into the river for many years, but a small run of steelhead trout continues to enter, most of these fish now ascending the North and Middle Forks. The best spring salmon spawning areas formerly existed in the upper section of the main stream, above Dayville, Oreg. A large part of the stream bed in this section has been rendered unsuitable for fish by large-scale gold-dredging operations. There are also numerous unscreened irrigation diversions that, in addition to being hazardous to all fish life, result in such low flows that anadromous fish cannot enter the river during the summer and fall. Despite these conditions some of the tributaries, particularly the North and Middle Forks, have fair sport-fishery values for steelhead trout, as well as for resident rainbows. The steelhead run into the North Fork and Camas Creek, a tributary, has been built up in recent years by annual plantings made by the Oregon Game Commission.

130. *Umatilla River* enters the Columbia River about 4 miles downstream from the McNary Dam site. It formerly supported good runs of spring chinook salmon and steelhead trout. The chinook run has been depleted to the point of extermination, and the steelhead run has been reduced to a small number of early-arriving fish because

of the extensive diversion of water for irrigation. The entire Umatilla River watershed is of practically no present value to anadromous fish, although it might be restored as a fish producer if certain improvements were put into effect, such as the screening of all diversions and the maintenance of minimum flows. The upper section of the main stream and the headwater tributaries are of some value for resident trout.

131. The *Walla Walla River* enters the Columbia about 23 miles upstream from the McNary Dam site. It formerly supported large runs of spring chinook salmon and steelhead trout. A fair run of steelhead trout continues to ascend as far as the Tumalum Branch below the town of Freewater despite the extensive diversion of water for irrigation purposes, which has reduced their numbers and has almost exterminated the chinook runs. Few, if any, anadromous fish are able to ascend above the Tumalum Branch because of the extensive withdrawal of water for irrigation, and also because of a natural "sink" in this section that causes the stream channel to become dry during the summer. All of the water diversions in the lower, accessible portion of the stream have been screened by the Washington State Department of Fisheries. The principal tributary is the Touchet River, which formerly supported good runs of spring chinook salmon and steelhead trout. Irrigation demands on the Touchet River have greatly reduced the value of the stream to salmon. A fair run of steelhead trout continues to ascend to the upper section and enter some of the upper tributaries. The Walla Walla River system is of practically no value to salmon under existing conditions. It retains some sport fishery for steelhead trout, and the upper tributaries are of some value for resident trout.

Effects of proposed projects on fish

132. Two dams have been previously recommended for construction in this area, one by the Corps of Engineers at Heppner on Willow Creek and one by the Bureau of Reclamation near Prineville on the Crooked River. Neither would have serious effects on the fishery resources.

133. Three other projects have been considered for future development. They are Mayfield (180 feet) and Mossyrock (350 feet) on the Cowlitz and Yale (270 feet) on the Lewis River. The dams on the Cowlitz would cause serious damage to the salmon and steelhead runs as they would obstruct any movement of fish to spawning areas of the upper reaches. Fish ladders would not be feasible; consequently, if these dams should be authorized, a large salvage program would be required, involving study, restoration of habitat, and artificial propagation of the salmon and steelhead affected by the Mayfield and Mossyrock projects. A dam on the Lewis River at Yale would not be so serious to anadromous fish because the run is stopped at Merwin Dam; however, many are transported around the dam from the hatchery below.

Wildlife

134. This sub-basin includes tributary streams originating both east and west of the Cascade Range, and therefore it supports a wide variety of wildlife in the extensive and diversified habitats ranging throughout several life and climatic zones. The elevation ranges from near sea level to more than 10,000 feet. The timbered and mountainous areas, which are largely in national forests, comprise the principal

habitats for mule deer, black-tailed deer, white-tailed deer, Rocky Mountain and Roosevelt elk, bears, mountain goats, martens, beavers, and various species of grouse and quail.

135. Public and private grazing and uncultivated lands adjoin the national forests. This environment, which includes much open-range land, is occupied principally by antelope, badgers, mourning doves, sage hens, and some Hungarian and chukar partridges. It is of primary importance as winter range for mule deer and elk that inhabit the higher forested areas at other seasons. Also, where the lower reaches of this section border cultivated and irrigated valley lands, excellent escape cover is provided for upland-game species. This cover is of particular value during the hunting period.

136. The cultivated bench lands and irrigated stream valleys in the sub-basin support good populations of ring-necked pheasants, valley quail, Hungarian partridges, mourning doves, and band-tailed pigeons. In addition, big-game animals often tend to concentrate here locally during winter storms. Many of the watered areas and adjacent farm lands are utilized as resting and feeding grounds for ducks and geese during migration periods. These same areas may also furnish nesting habitat in summer. Principal waterfowl are geese, mallards, baldpates, pintails, teals, gadwalls, shovellers, redheads, and scaups. Fur animals constitute a valuable resource in several streams of the unit. They include muskrats, beavers, minks, raccoons, skunks, and otters.

Effects of proposed projects on wildlife

137. Dams proposed for consideration in this unit include Mayfield and Mossyrock on the Cowlitz River and Yale on the Lewis River. It is recommended that the Fish and Wildlife Service be given sufficient notice well in advance and provided with funds necessary to thoroughly investigate these projects while they are in the planning stage. This procedure would permit a careful field study of any special problems involving wildlife resources that may be endangered. Impoundments constructed might create additional resting areas for waterfowl, but they would destroy existing habitat within the reservoir sites currently used by big game, upland game, and fur animals.

YAKIMA RIVER BASIN

Fish

138. The Yakima River system was formerly one of the major salmon-producing areas in the Columbia River system. However, most of the stream system drains a valuable agricultural area, where irrigation developments began at an early date and have increased steadily to the present day. As a result, the anadromous-fishery resources were greatly depleted as early as the year 1885. These early runs consisted of blueback salmon, spring and fall chinook salmon, silver salmon, and spring and fall steelhead trout. The blueback salmon have been exterminated by the construction of dams at the outlets of lakes which they formerly inhabited. The other runs have been greatly depleted, especially the fall-run fish, which must enter the river at low-water stages. The silver salmon run is sporadic in character, a significant number entering the lower section of the river in some years, and few if any appearing in other years. Fair numbers of spring chinook salmon and steelhead trout still ascend to

the upper part of the river system, althought these runs do not approach their former magnitude.

139. The development of irrigation began long before local conservation agencies were able to require the installation of fish-protective devices. During recent years some of the many conditions unfavorable to fish have been remedied. The Washington State Department of Fisheries has required the construction of fish ladders over many dams and has screened most of the irrigation diversions. Likewise, the United States Fish and Wildlife Service has supervised the installation and maintenance of fish-protective devices wherever practicable at Federal water-use projects.

140. With adequate flows, the abundance level of the anadromous-fish runs could be raised considerably above their present level, and in addition, the populations of resident fish would be benefited. Storage for the sole purpose of maintaining adequate flows for fish life has been studied by the Washington State Department of Fisheries, Bureau of Reclamation, and Corps of Engineers, and it appears that water for this purpose will not be available after irrigation needs are filled.

141. The resident-fish population in the Yakima River system is of great recreational value. In the sections of the lower main stream having a slight gradient and in the sluggish side channels, there are large numbers of bass, crappie, and rough fish, as well as some trout and whitefish. The upper portion of the river system supports an intensive sport fishery for rainbow and cutthroat trout. Several of the reservoirs and lakes in the upper section also produce large numbers of landlocked blueback salmon or kokanee, as well as trout, charrs, and other resident fishes.

Effects of proposed projects on fish

142. In this area, no projects are proposed for authorization in the review report, although a number of possibilities are discussed in relation to flood control, irrigation, and fish requirements. Among the latter is the proposal by the Washington State Department of Fisheries, endorsed by the Bureau of Reclamation and the Corps of Engineers, to transport fish around channel reaches where flows are inadequate. This appears to be the only alternative for sustaining any appreciable portion of Yakima River runs if adequate flows cannot be maintained at all times. If certain improvements were made to the fishways at Prosser, Sunnyside, and Wapato Dams, as well as other improvements in the interest of fish life, and provided that successful passage could be maintained where flows were inadequate, it is conceivable that the fish population could be increased. However, these possibilities are tentative, and they are subject to further study by State and Federal agencies.

Wildlife

143. This sub-basin supports an abundant wildlife population. Big game is plentiful throughout most of the mountainous and timbered sectors. Upland game, fur animals, and waterfowl abound in the foothills and in the cultivated and irrigated valley lands.

144. Primary big-game species ranging the national-forest lands include mule deer and Rocky Mountain elk. There are some black-

tailed deer and bears present. The public and private grazing lands extend below the forest belt to the irrigated crop and orchard areas in the valleys. This environment supports many deer and elk that are forced to lower elevations by winter storms. Some of the most valuable big-game winter range in the State of Washington is located here. It is especially important since a critical lack of winter forage is the chief limiting factor in the survival of big-game herds in this area. No practicable means have yet been found to mitigate this condition. The sub-basin supports one of the most concentrated elk populations in the State. According to the Washington State Department of Game in a game bulletin of May 1948, 837 elk and 1,740 deer were harvested here by hunters during the 1947 season. This reported kill represented approximately 35 percent of the total elk and 8 percent of the total deer taken in Washington. Moreover, the open sagebrush country supports the State's only antelope herd.

145. The irrigated benchlands and stream valleys support large numbers of ring-necked pheasants and valley quail. Also, fair populations of Hungarian partridges, chukar partridges, and mourning doves are present. A few mountain quail, scaled quail, ruffed grouse, blue grouse, sage hens, and sharp-tailed grouse are found in restricted localities. However, in most instances they are disappearing through alterations of their former habitats. Yakima and Kittitas Valleys maintain one of the best upland-game populations in the entire State. Approximately 48 percent of the reported State-wide pheasant kill came from this sub-basin.

146. Fur animals constitute a valuable resource in several streams of the unit. They include muskrats, beavers, minks, and raccoons. The timbered forests of the drainage support an excellent marten population.

147. Principal waterfowl are geese, mallards, pintails, baldpates, teals, shovellers, redheads, and scaups. Islands in the Yakima furnish nesting habitat for waterfowl. In addition, bank areas of streams and irrigation canals are utilized by local nesting ducks. Cultivated lands adjoining the watercourses provide considerable food for migrant waterfowl.

Effects of proposed projects on wildlife

148. Although no impoundments are presently proposed, any development plans for this sub-basin should be carefully studied since they might destroy existing habitat of big game, upland game, and fur animals. Opportunity should be afforded while the projects are in the preliminary planning stage to determine what habitat effects might result from reservoir construction. This procedure would permit a thorough field study of any special problems involving wildlife resources. Impoundments constructed may create additional resting areas for waterfowl, and where fluctuations are not extreme, they might result in benefits to other forms of wildlife.

COLUMBIA RIVER AND MINOR TRIBUTARIES FROM CANADIAN BORDER TO MOUTH OF YAKIMA RIVER

Fish

149. The main stem of the Columbia River in this area is of importance to anadromous fish primarily as a migration route, although chinook salmon spawn on suitable gravel bars available in the main river.

150. The potential productivity of the area for anadromous fish was greatly reduced by the construction of Grand Coulee Dam. The runs that formerly ascended above the dam were transferred by the Fish and Wildlife Service to the Wenatchee, Entiat, Methow, and Okanogan Rivers during the period 1939–43. At the same time, hatcheries were constructed by the Bureau of Reclamation on each of the above streams, except the Okanogan, as a part of the relocation program. These hatcheries are still being operated by the Fish and Wildlife Service.

151. An indication of the importance of this area for anadromous fish is given by the fish counts at Rock Island Dam, located across the main stem of the Columbia about 12 miles below the confluence of the Wenatchee River. These counts are presented in table 18.

TABLE 18.—*Annual fish counts at Rock Island Dam, 1933–47*

Year	Chinook	Steelhead	Blueback	Year	Chinook	Steelhead	Blueback
1933	5,668	1,055	40,737	1941	2,571	3,561	949
1934	7,101	583	2,227	1942	6,814	3,586	16,282
1935	16,310	5,412	14,013	1943	11,145	2,351	17,665
1936	7,396	2,369	16,501	1944	3,375	1,329	4,932
1937	5,133	2,214	15,087	1945	5,696	1,095	7,142
1938	5,803	2,400	17,123	1946	9,982	1,768	45,029
1939	11,206	5,427	19,591	1947	11,727	1,941	79,480
1940	9,492	5,550	26,894				

152. The main Columbia River is also of importance in the maintenance of a resident-trout sport fishery of considerable recreational value. Trout are known to migrate between the tributaries and the main stem, the latter providing a refuge when conditions in the minor streams are unfavorable for fish, and also providing a source of stock for the minor streams. The headwater streams and lakes within the basin of the Columbia above Yakima River are practically all highly productive of rainbow and cutthroat trout and charrs. Several large lakes, as Lake Wenatchee, Lake Chelan, Lake Osoyoos, and Roosevelt Lake, also support a popular sport fishery for landlocked blueback salmon (kokanee or silver trout). Numerous other lakes in the area are important producers of trout, bass, and other resident fishes.

153. Roosevelt Lake, the Grand Coulee Dam impoundment, extending 150 miles to the Canadian border, provides fishing for many other species in addition to the kokanee. While not heavily fished at present, it affords an opportunity for the expansion of the sport fishery of the area.

154. The Coulee Reservoir, under construction, together with all the other watercourses of the Columbia Basin project will, when completed, provide exceptionally good sport fishing if proper plans and management practices are put into effect.

155. The *Wenatchee River* system supports runs of spring and summer chinook salmon, blueback salmon, and spring steelhead trout. The main river bed provides excellent spawning and rearing area for chinook salmon and also serves as a migration route for the other species. Dry stretches in the river at the Dryden and Tumwater power diversions are serious hazards to upstream-migrating fish during periods of low flows. The chinook and steelhead runs that enter Icicle Creek, a major tributary, are taken at the Fish and Wildlife Service Leavenworth Hatchery racks for artificial propagation. A

small run of silver salmon has recently been established by artificial propagation. Nason Creek and the Chiwawa River, entering the Wenatchee River just below Lake Wenatchee, are valuable for the production of the spring varieties of chinook salmon and steelhead trout. Lake Wenatchee is important as a rearing area for the blueback salmon which spawn in the Little Wenatchee and White Rivers, tributaries to Lake Wenatchee. A game-fish hatchery is operated on Chewaukum Creek by the State.

156. The *Entiat River* system supports small runs of spring and summer chinook salmon and steelhead trout. A lumber mill dam that formerly interfered with the passage of fish was washed out by the 1948 flood and will not be reconstructed. Other low-water barriers have been removed, and the irrigation diversions have been screened by the Washington State Department of Fisheries. The stream is now capable of supporting much larger populations of anadromous fish. Mad River, the principal tributary, is of value chiefly to steelhead and resident trout. The Fish and Wildlife Service operates a salmon hatchery about 7 miles upstream from the mouth.

157. The *Methow River* system supports runs of spring and summer chinook salmon and steelhead trout. Practically the entire main stem of the Methow River is of value as spawning area for chinook salmon and steelhead trout and as a migration route to the tributaries. The two major tributaries of most importance to anadromous fish are the Twisp and Chewack Rivers. Both of these rivers support runs of spring chinook salmon and steelhead trout. Portions of the runs into the Chewack River are taken for artificial propagation by personnel of the Fish and Wildlife Service Winthrop Hatchery. Most of the headwater tributaries have relatively steep gradients and are of value chiefly to steelhead and resident trout. Lost River, however, was formerly an important chinook-salmon producer, and it has good potential value. Other principal tributaries to the upper Methow River include Early Winters Creek, Robinson Creek, and the West Fork of the Methow.

158. The *Okanogan River* extends from its confluence with the Columbia River for a distance of about 80 miles northward to Lake Osoyoos, on the international boundary. Above Lake Osoyoos the river extends through Lake Vaseaux and Lake Skaha to its source in Lake Okanogan. A diversion dam below Lake Vaseaux is the present upper migration limit for anadromous fish. A large portion of the blueback-salmon populations that formerly spawned above Grand Coulee Dam has been relocated in the Okanogan system, and there is now ample evidence that the run has been successfully established. At the present time, the chief chinook-spawning areas are in the lower 16 miles of the river. A mill dam that partially obstructed the passage of fish into Lake Osoyoos has been recently improved by the construction of two new fish ladders. There are no minor tributaries to the Okanogan River that are of present or potential value to anadromous fish. Several of these, such as Salmon Creek and Omak Creek, formerly supported good runs of chinook salmon and steelhead trout but are now used so extensively for irrigation that they are no longer of any possible value to migratory fish. The Similkameen River is the only major tributary to the Okanogan. Very small runs of blueback and chinook salmon and steelhead trout enter the river and are blocked 6 miles above the mouth by a waterfall and power dam.

Effects of authorized projects on fish

159. The authorized *Foster Creek Dam* will be located some 51 miles below Grand Coulee Dam and a few miles above the mouth of the Okanogan River and will have no effect on anadromous-fish populations, since there are few spawning areas and no important tributaries in the river section between the Foster Creek Dam site and Grand Coulee Dam. The backwater of the dam should result in a small increase in the resident-fish populations of the area.

Effects of proposed projects on fish

160. The proposed Priest Rapids Dam, to be located across the main stem of the Columbia River approximately 50 miles above Pasco, Wash., would be approximately 146 feet high at normal maximum pool. Provision would be made, however, for storage of flood waters, which would raise the height of the dam an additional 32 feet. The added storage capacity would be utilized only during extreme floods and then for as short a period as possible. This dam would be an obstacle to the upstream and downstream migration of all of the anadromous-fish populations in the Grand Coulee area. While there is no assurance that fish could be safely passed over a dam of either 146-foot or 178-foot height, tentative plans should be made for the inclusion of fishways at this structure. If fish ladders are provided only to the normal maximum pool, a delay in fish passage would certainly result during flood periods. The effects on the fishery would depend on the frequency and length of delay. It should be recognized that, in spite of the best-laid plans, the construction of Priest Rapids Dam may result in the virtual extermination of the upper Columbia River salmon runs.

161. In addition to Priest Rapids Dam, two other projects (*Rocky Reach* and *Wells*) are proposed for future consideration on the main stem of the river and one (*Similkameen*) on the Similkameen, a tributary of the Okanogan. Rocky Reach Dam would have material effect on the transplanted salmon runs that now inhabit the Entiat, Methow, and Okanogan Rivers. If fish successfully get over Priest Rapids Dam (provided that it is built first), fish-passage facilities would have to be provided at Rocky Reach Dam (92 feet high). Wells Dam (65 feet) would block the blueback runs of the Methow and Okanogan Rivers, for which fish ladders would be needed. The Similkameen Dam would be of lesser significance, as far as salmon are concerned. Its height (245 feet) would prevent any chance of passing fish over it, but the number involved would not be great at present. The stream has a small falls and power plant which obstruct fish passage in the lower end. Since the stream has good spawning area, there has been serious thought toward the construction of a fish ladder at the falls, which would permit better utilization of the entire stream system. The Similkameen Dam would eliminate this possibility.

Wildlife

162. This sub-basin provides much excellent habitat for wildlife. It contains extensive areas which are well adapted to wildlife propagation and protection but poorly suited for human purposes.

163. Immense flights of waterfowl pass over the region, and available marshlands are heavily used. The area supports many nesting ducks and geese as well as the migrants. Refuge areas, which would

provide additional food and shelter for the birds, would assist greatly in maintaining this resource.

164. Big game, especially deer and elk, is abundant in the mountainous areas and higher valleys. The sport of hunting big game is rapidly becoming more popular, and demands for this form of recreation will continue to increase. Since man's development of the land has driven the animals from much of their former ranges, it is necessary to protect them from additional harmful restrictions. Where impoundments encroach on good winter range, it is essential that alternate range of comparable wildlife value be provided for the animals.

165. Upland game and fur animals, which are plentiful in the area, would lose some of their present habitat as each new impoundment is created. However, if relatively stable water levels can be maintained, the reservoirs may provide new habitat of considerable value to wildlife.

Effects of authorized projects on wildlife

166. The *Foster Creek* impoundment, inundating 51 miles of the Columbia River immediately below Grand Coulee Dam, will have very little effect on wildlife resources. The region to be flooded consists largely of loose, rocky slopes with very little vegetative cover. Deer and upland-game birds are common in the brushy patches along the rimrocks, which are well above the proposed high-water levels. The fur resources of the reservoir site are negligible. Waterfowl now make some use of the impoundment area as a resting place during migration. The completed reservoir is not expected to benefit geese, since it would permanently flood sandy beaches now used by these birds and no substitute area would be provided. However, the reservoir may result in an increase in the number of ducks using this part of the Columbia River.

167. The irrigation features of this project are being studied by the Bureau of Reclamation, and a report on their relation to wildlife will be prepared at a later date.

Effects of proposed projects on wildlife

168. The *Priest Rapids project* proposes an impoundment of 36,400 acres at elevation 550 in a semiarid region where present wildlife values are relatively low. As tentatively planned, fluctuation of the water surface would be held to 1 foot; however, modifications for flood control may considerably increase the height of the dam and the fluctuation during flood season.

169. Some upland-game birds inhabit the valley floor and the adjacent slopes within the impoundment site. The principal species are valley quail and ring-necked pheasants, with a few chukar partridges. The latter species is new in the area but appears to be establishing itself and increasing in numbers. The habitat of upland-game birds within the reservoir area would be lost, but if the operational plans limit fluctuation to 1 foot, except during spring flood periods, a strip of good vegetation should develop along the margins of the impoundment. This might provide much-needed escape and nesting cover for the birds, and its utilization would be expected to increase as the adjacent areas are developed by irrigation.

170. A few muskrats and beavers are resident in the impoundment site. They are fairly common in some sloughs and small tributaries

near Beverly. The presently used habitat would be lost by inundation, but if the reservoir pool is held within a fluctuation of 1 foot, and if food plantings and other good management practices are followed, it is probable that some fur animals might become established. Big-game animals do not use this area and are not expected to do so after development.

171. Waterfowl is the major wildlife value, and there is a splendid opportunity for benefiting this resource if fluctuation is held to 1 foot. The present use is small compared with that which would result from development. The Fish and Wildlife Service has proposed the purchase and development of the Crab Creek Valley for a wildlife refuge. Some land purchases have been made with this end in view. The Service's plans for this development call for the construction of numerous check dams creating small impoundments, with adjacent tillable land for the raising of crops to attract migratory waterfowl from surrounding agricultural lands. The fulfillment of these plans would create a well-balanced waterfowl area.

172. If plans for construction and operation of the proposed Priest Rapids Dam provide for a 1-foot fluctuation, the flooding of the lower part of Crab Creek Valley by this structure would create a large water area suitable for waterfowl but would eliminate most of the tillable land available for raising feed crops along the lower portion of Crab Creek. To offset this loss it is proposed that approximately 2,000 acres of tillable land east of the pool be acquired for cropping grain for duck food. Irrigation facilities would be necessary for part of this cropland. In addition, land in and adjoining the pool area in Crab Creek Valley should be acquired and set aside as a refuge to be administered by the Fish and Wildlife Service.

173. It is further recommended that one check dam be built above the pool area approximately on the line common to secs. 31 and 32, T. 16 N., R. 27 E., W. M., at a cost of approximately $52,000. On a monetary basis, the anticipated wildlife use of this proposed impoundment would more than justify its cost.

174. As other impoundments, such as *Similkameen*, *Wells*, and *Rocky Reach*, approach a more definite stage, their effects on the wildlife resources should be carefully studied. Sufficient time and funds should be allowed to permit thorough investigations.

SPOKANE RIVER BASIN

Fish

175. The Spokane River Basin, including Coeur d'Alene Lake and the principal tributaries, Coeur d'Alene and St. Joe Rivers, originally had all the qualities of good trout water. Except where the encroachment of man has destroyed good habitat by water utilization and pollution, most of the area is still very attractive to anglers. Mining wastes have perhaps caused the most serious depletion. They have literally destroyed the fishery of the lower Coeur d'Alene River and its South Fork, as well as several other tributaries in the same area.

176. Upper tributaries and lakes that are beyond these deleterious effects still comprise a very large and significant area that provides good sport fishing and draws considerable income to local business. Most of the mountain streams are stocked with cutthroat and rainbow trout. The Spokane River supports an unusual fishery for whitefish, as well as trout; many of the lakes throughout the basin have abundant

populations of kokanee. Anadromous species do not migrate into Spokane Basin. Grand Coulee Dam interrupted the remnants of the run, and no means of access are now available.

Effects of proposed projects on fish

177. *Springston Dam* (125 feet), near the mouth of the Coeur d'Alene River, has been studied by the Corps of Engineers and is suggested for construction. Due to mining pollution, there is no fish life at present in the river. However, several small lakes in the impoundment area, such as Rose, Porter, and Hidden Lakes, are valuable producers of bass, crappie, perch, and catfish. These populations would probably be destroyed since it is improbable that fish life would be able to exist in the reservoir if the pollution load of the Coeur d'Alene River remained unchanged. A determination of the full effects of this project on the fishery resources cannot be made without further study.

Wildlife

Effects of proposed projects on wildlife

178. Developments proposed for this basin would greatly affect wildlife habitats which support a very important and valuable game and fur-animal population. The *Springston project* would inundate many lake and marsh areas where the present waterfowl and fur-animal values are high. Big game, particularly deer, would be forced out of some of their present habitat. Extensive field studies and analysis of operation plans will be necessary to appraise the postproject wildlife values of this impoundment.

179. Directly affected by this project are the wildlife values of lands to be irrigated from the reservoir and of lowlands where agricultural development would become feasible. The stabilization of lake levels would permit the reclamation of large areas adjacent to Coeur d'Alene Lake, where present flood hazards preclude development. This would greatly alter the present wildlife habitat, and future studies will be needed to determine the relative values of present and anticipated returns from this resource.

CLARK FORK-PEND OREILLE RIVERS AND TRIBUTARIES

Fish

180. The Clark Fork-Pend Oreille Basin, with its countless miles of excellent trout streams and numerous natural lakes, has fishery resources of great value. In most waters of the basin, large populations of cutthroat trout offer excellent angling to both resident and vacation anglers. The cutthroat is the principal game fish of most streams in the region. Dolly Varden trout, some of very large size, and eastern brook trout are also taken in both lakes and streams. In recent years, catches of unusually large Kamloops rainbow trout have made Pend Oreille Lake famous. Grand Coulee Dam blocks anadromous fishes from the basin. However, landlocked blueback salmon or kokanee provide good fishing in some of the larger lakes, such as Flathead and Pend Oreille, and from these lakes ascend many tributaries during their fall spawning migrations. Bass and other warm-water fishes have become numerous in many lakes and are eagerly sought by many anglers. In Idaho, a small commercial hook-and-line fishery for kokanee and whitefish is prosecuted, principally during the winter

season, in Pend Oreille and Priest Lakes and Pend Oreille and Clark Fork Rivers.

181. Fishery resources contribute very largely to the present recreational value of the basin. Development of facilities for vacationists has barely begun, and it is anticipated that recreational facilities, including those for angling, will be increased substantially as the basin is developed. It is, therefore, essential that careful consideration be given to the conservation of the basin's fishery resources in planning the over-all development of the water resources. At present, vacationists support a significant local business in angling services and supplies. It is anticipated that, with wise planning, this business will increase progressively as the basin is developed and thereby add to the economic status of the basin's population.

182. The proposed water-development program for the Clark Fork-Pend Oreille Basin will result in major changes to the aquatic environment. These may have a profound effect on the fishery resources; however, it is not believed that the program will result in an over-all fishery loss if this resource is carefully considered in the individual project plans and if certain recommendations in the interest of fish are followed. It is possible that, for some projects, existing fishery resources may be increased.

Effects of authorized projects on fish

183. The *Hungry Horse Dam*, now under construction by the Bureau of Reclamation, is located on the South Fork of the Flathead River. This dam will inundate a number of miles of excellent trout stream and will make inaccessible a part of the kokanee-spawning area. The impoundment, though having a large fluctuation in level, may be of some value to kokanee and other fish populations if the pool is not drawn down excessively. Minimum flows for fish life should be provided at all times in the river below the dam, and all diversions should be screened.

Effects of proposed projects on fish

184. Three important projects are under consideration in this area. Of these, Albeni Falls and Glacier View are being proposed for early authorization. Paradise Dam is being considered but will require further detailed study. The *Albeni Falls Dam*, with a maximum tailwater-forebay height of 29.5 feet, would be located on the Pend Oreille River about 2 miles east of the Washington-Idaho boundary. The project would partially control the level of Pend Oreille Lake.

185. Pend Oreille Lake has an unusually high fishery value for large western lakes and furnishes excellent angling for ever-increasing numbers of vacationists. The lake has a very large population of kokanee, an abundance of cutthroat trout and whitefish, some very large Dolly Varden trout, huge Kamloops trout, and an abundance of crappies, sunfish, and bass. Recreational use of the area is expected to increase annually for many years.

186. It is believed that the Albeni Falls project would be beneficial to the fishery resources if present operational plans for the reservoir are carried out. Conditions for angling should be improved in the area between the dam and the present lower margin of the lake during the summer time, and the stabilization of the lake level should have beneficial effects to the fish life of the entire lake. Furthermore, the control of flows downstream from the dam should be beneficial to the

fish life of the river if minimum flows are maintained and violent fluctuations are avoided. However, the dam would block the migration of resident trout from the river to the lake; and, while the subject needs further study, tentative plans should be made for the inclusion of fishways at the dam.

187. The *Glacier View Dam*, 400 feet in height, would be constructed at a site 72 miles upstream from Flathead Lake. It is believed, but not definitely known at this time, that kokanee presently ascend the river beyond the dam site on their migrations to spawning beds in the headwaters. The dam would make these areas inaccessible to migrations of resident fish.

188. The reservoir would inundate approximately 30 miles of the main river and the lower reaches of many small tributaries, all of which are excellent trout waters. These trout streams are of importance to the recreational value of Glacier National Park, which borders the Flathead River on the east.

189. While the reservoir would have some fishery values, these would probably be insignificant compared to the fishery values that would be destroyed. The problem needs further biological study. Plans for the project should include provisions for such studies and tentative provision for the construction of a game-fish hatchery to stock the reservoir.

190. The Paradise Dam, 241 feet in height, would be located on the Clark Fork 74 miles west of Missoula and 2 miles downstream from Paradise, Mont. The main arm of the impoundment would extend upstream on the Clark Fork for about 49 miles and upstream on the Flathead River for about 72 miles. Small arms of the reservoir would cover the lower portions of the Little Bitterroot, Jocko, and St. Regis River Valleys. This impoundment would destroy a great many miles of excellent angling streams containing large populations of cutthroat trout, as well as Dolly Varden trout and whitefish. However, a preliminary study of the project plans indicates that the reservoir should provide very good angling, perhaps of equal or greater value than the fishery values destroyed. It appears that this reservoir might be a good habitat for trout and for the successful introduction of kokanee. By impounding much of the spring run-off and reducing the volume of flow below the dam during this season, it is believed that the present fishery value of the Clark Fork River below the dam would be increased.

191. As in the case of all impoundments, the ultimate success of creating good angling conditions depends in large part on the operation schedule of the impoundment, the species of fish involved, and a number of other factors. Further biological studies are necessary in this area if the deleterious effects of the project are to be kept to a minimum and the maximum benefits are to be obtained.

192. In addition to the above projects, nine others are proposed for future consideration in this sub-basin. They are *Boundary Dam* (314 feet high) on Pend Oreille River; *Priest Lake* on Priest River; *Cabinet Gorge* (89 feet high), *Noxon Rapids* (71 feet high), *Trout Creek* (92 feet high), and *Quartz Creek* (130 feet high) on Clark Fork; *Nine Mile* (307 feet high) on Blackfoot; and *Coram* (110 feet high) and *Canyon Creek* (153 feet high) on the Flathead. Less is known of the effects of these projects on the fish, but evidently all would have significant effects on the resource. In some instances, definite benefits would

ensue; in others, losses would occur. Further biological studies are necessary to permit proper evaluation of the results. Notwithstanding, it is evident that additional trout hatcheries will be needed to permit proper utilization of the water conditions presented by the new structures and to compensate for any damage that may have ensued. The number and location of the hatcheries will have to be determined later, but preliminary estimates indicate that three will be needed in Montana and three in Idaho. The latter will be placed so as to be able to supply other projects in nearby sub-basins of the State. Anadromous fish are not directly affected by these projects.

193. In addition to the dam sites discussed, several projects involving stream-channel improvement for flood control are being recommended or considered by the Corps of Engineers. In general, these would have little effect on fishery resources provided the work is carried on when trout are not spawning or when their eggs are not deposited in gravel beds, and if blasting is kept at a minimum and not undertaken in places where large numbers of trout or other game fish are present.

Wildlife

194. This sub-basin may be characterized largely as a mountainous and timbered area. There is some agricultural use, chiefly livestock raising. The principal wildlife asset is big game, and the leading species are mule and white-tailed deer and Rocky Mountain elk, with some mountain goats and sheep, black and grizzly bears, and moose. In the summer, deer and elk inhabit the higher elevations, but in the winter deep snows usually force these animals to migrate to lower elevations where climatic conditions are less severe. These winter ranges are located principally in the river valleys and tributaries of the Flathead, Swan, Clark Fork, Pend Oreille, and Bitterroot Rivers and are the limiting factors in the survival of the present big-game herds.

195. The sub-basin also supports fur animals, upland game, and waterfowl. The main fur animals are muskrats, beavers, minks, otters, and martens. These species, with the exception of martens, which are found in the higher timbered regions, inhabit the watered areas. The major portion of the sub-basin has a fair population of mourning doves and blue, ruffed, and Franklin grouse. In the agricultural areas, the principal species are ring-necked pheasants, valley quail, Hungarian partridges, and mourning doves. A few sage hens and sharp-tailed grouse are in the area, but these species are rapidly disappearing through the destruction of their former habitats. The watered areas, and especially the islands in the rivers, are valuable goose- and duck-nesting sites. In addition, the agricultural lands offer feeding grounds for migratory waterfowl.

Effects of proposed projects on wildlife

196. The *Albeni Falls*, *Glacier View*, and *Paradise Dams* are proposed for construction by the Corps of Engineers; however, Paradise Dam is not proposed for early construction. It appears now that Albeni Falls Dam would have an adverse effect on the present beaver and muskrat populations in Denton Slough and the Pend Oreille River. The construction of Glacier View Dam would result in the loss of habitat and critical winter range for elk, deer, and moose, as well as the present environment for beavers and muskrats. The Paradise

Dam would inundate about 71,200 acres of bottom lands along the Clark Fork, Flathead, Jocko, St. Regis, and Little Bitterroot Rivers; Siegal, Seepay, Camas, McDonald, Levais, Crow, Post, and Mission Creeks. The major portion of these lands now provides excellent habitats for many species of big game, upland game, fur animals, and waterfowl. Among important lands that would be lost for wildlife are approximately 2,000 acres of the 18,541-acre National Bison Range. This refuge was established by act of Congress, May 23, 1908, primarily for the perpetuation of bison. Incidentally, it serves a valuable purpose by providing deer and elk for restocking of big-game areas. These critical 2,000 acres are an integral part of the refuge, as they include the headquarter site, all of the meadow, and important winter-range lands. The remainder of the refuge is important upland range and constitutes spring, summer, and fall use areas, which would be of little wildlife value without adjacent bottom lands. A wildlife census of this range, taken in October 1947, revealed the following populations: buffalo, 609; elk, 115; mule deer, 463; white-tailed deer, 65; mountain sheep, 14; ring-necked pheasants, 1,850; Hungarian partridges, 500; sharp-tailed grouse, 7; ruffed grouse, 15; blue grouse, 35; and Franklin grouse, 85. It is recommended that project planning include provisions for substituting an alternate area of comparable wildlife value for the lands that would be lost by inundation. In addition, relocation of refuge headquarters buildings should be planned sufficiently in advance to permit uninterrupted administration of the area.

197. For further development, the Corps of Engineers has proposed the following nine dams: *Boundary, Priest Lake, Cabinet Gorge, Noxon Rapids, Trout Creek, Quartz Creek, Nine Mile, Coram* and *Canyon Creek.* These contemplated dams are located in the valleys of the Pend Oreille, Clark Fork, Flathead, Blackfoot, and North Fork of Flathead Rivers in the general vicinity of forested areas, and consequently their habitats seem to be somewhat similar. Big game appears to be the principal wildlife resource, and some of the reservoir areas constitute important winter ranges for deer and elk. Fur animals, upland game, and waterfowl would also be affected by the elimination of their present habitat and creation of new water areas. There will be much need for detailed wildlife surveys and careful long-range planning in this excellent wildlife region as each new project is studied.

KOOTENAY RIVER AND TRIBUTARIES IN THE UNITED STATES

Fish

198. In the Kootenay area of the United States, the streams and terrain are conducive to good trout production. The mountains are relatively low, glaciated, and covered with dense forests. Numerous small lakes are scattered throughout the basin. Most stream gradients are not precipitous. The main Kootenay has a moderate fall of about 6 feet per mile as it passes through a canyon from Canada across Montana to the Idaho border. Near Bonners Ferry it slows down and reaches a near base level as it flows across the border again into Canada.

199. Fishing is fairly good, and many trout are taken from both the main river and its tributaries. Many trails and forest roads lead to

favorite fishing sites of the interior. Spring run-off interferes with early-season angling, and the best fishing is usually enjoyed late in the summer. A majority of the sport fishermen are from the local populace, but the attraction to outsiders is also high. In Lincoln County, Mont., which comprises most of the area of the basin, the sale of out-of-State licenses ranks among the highest of the State.

200. State hatcheries stock these lakes and streams well with several species of trout and grayling. One fish hatchery is located in this sub-basin, at Libby, Mont., and several others are nearby. Salmon are not able to migrate to the Kootenay Basin.

Effects of proposed projects on fish

201. Two projects on Kootenay River (*Katka*, 270 feet, and *Libby*, 339 feet) are proposed for authorization in this area. The extent that these dams would affect the natural flow of the Kootenay would determine their benefit or harm to fish. It is very possible that they may improve the present condition by lowering the flood stages. The value and type of reservoir fishery would be largely dependent on the schedule of operation of the dams. The loss of stream fishing might be compensated by the gain in reservoir angling. In any event, further biological studies will be necessary before specific conclusions and recommendations can be made.

Wildlife

202. The Kootenay Basin is one of the most popular areas in North America for big-game hunting. Various species of wildlife abound throughout the region, with the heaviest concentrations of big game in remote, mountainous districts. The common species, particularly in the East Kootenay, are mule and white-tailed deer, elk, moose, mountain goats, and black bears. Grizzly bears, mountain sheep, and caribou are to be found in some of the more isolated areas.

203. Deer have always been plentiful in this basin where they, along with other wildlife forms, have played an important part in the development of the area. The early explorers and trappers, as well as the miners and railroad builders which followed, all depended on wildlife for the stocking of their larders.

204. Fur animals, principally martens, beavers, minks, and Canadian lynx, are taken in considerable numbers. Various forms of upland-game birds are found throughout the basin, and waterfowl are plentiful in the valleys.

Effects of proposed projects on wildlife

205. The *Katka* and *Libby Dams* are proposed for development in this sub-basin. They would flood important deer range, as well as some valuable waterfowl and fur-animal habitat. In order to appraise the ultimate results of these impoundments and to obtain the optimum wildlife populations, careful investigation of their effects on this resource should be planned well in advance of authorization and subsequent construction. The elimination of much good deer habitat would necessitate provision for alternate range to maintain the present herds.

COLUMBIA RIVER IN CANADA

Fish

206. The maintenance of the fishery resources in the Columbia watershed in Canada is the concern and responsibility of the Canadian

governmental agencies. However, it should be noted that the regulation of water flows in Canada could very materially affect the fisheries of the upper Columbia River in the United States. This is particularly true in the Okanogan River system. Not only is a major part of the blueback-spawning area and over one-half of Osoyoos Lake in Canada, but the flow of the lower Okanogan River is to a large degree dependent upon the flow of the river and its tributaries as they leave Canada.

207. Any control of Okanogan River water (or its tributaries) that would reduce the flows of the river during the salmon migrating or incubating periods could have profound adverse effect on the abundance level of the blueback-salmon population. The International Joint Commission has given assurance to the Fish and Wildlife Service that fish life shall be given adequate consideration in planning any water-use projects and that the Service shall be kept fully informed in regard to such plans.

Wildlife

208. The Columbia River Basin in Canada is a vast region of abundant wildlife resources. Much of the area is not yet fully occupied by man, and the hunting pressure is far less than that which occurs along the lower reaches of the basin in the United States.

209. Big game and fur animals are plentiful throughout most of the mountainous and timbered country. Waterfowl are plentiful in the valleys, and various species of upland-game birds may be found throughout the region.

210. Development projects should be carefully scrutinized by wildlife biologists for their effects on waterfowl, since this resource is international in aspect.

SNAKE RIVER AND TRIBUTARIES, MOUTH TO WEISER

Fish

211. This sub-basin is of major importance to fish life. The anadromous salmon and steelhead trout which spawn there maintain important components of the commercial runs, and the resident populations of trout and other game fish are of great recreational value.

212. The main *Snake River* below Weiser serves anadromous fishes as a migration route to its tributaries. It is considered probable that the main river contains spawning areas that may be suitable for fall chinook salmon; however, additional studies are needed to determine the utilization and probable value of them. Although this part of the river is not especially renowned for its trout fishing (possibly because of its turbidity), it is known that resident trout migrate between it and the tributaries. The main river thus aids in maintaining the stock in the tributaries and furnishes a refuge when tributary stream conditions become unsuitable. Another valuable main-river population is that of the sturgeon, which supports a small commercial fishery.

213. The tributaries of the Snake River in this area are also of great importance to both resident and anadromous fishes, although their productivity has been considerably reduced because of the construction of dams and the extensive diversion of water for irrigation purposes. These dams and diversions, many without fish-

protective devices, together with mining operations have rendered vast portions of former spawning and rearing areas in the tributaries inaccessible or unsuited to anadromous fish. The major tributaries are here considered in upstream order.

214. The *Palouse River* is obstructed by a high natural waterfall a few miles above the mouth and therefore is inaccessible to anadromous fish.

215. The *Tucannon River* formerly supported good runs of both spring and fall chinook salmon, silver salmon, and steelhead trout. The fall-run chinook salmon and the silver salmon, which also entered the stream during the fall, have been practically exterminated. The spring chinook run also has been greatly depleted. A good run of steelhead trout still enters the stream during the spring high-water period, although their numbers have been greatly reduced. This condition occurred mainly because of a dam in the lower section of the river that was impassable to fish except at high-water stages. Other destructive factors were the many unscreened irrigation diversions that took a heavy toll of downstream migrants and also reduced the discharge of the main stream in the late summer and fall months to the point where it was impossible for fish to ascend. These unfavorable conditions for fish are being corrected so far as possible by the Washington State Department of Fisheries, but a large part of the stock has been destroyed.

216. The *Clearwater River* was formerly one of the most important salmon producers in the Snake River system. It supported large runs of chinook and silver salmon and steelhead trout. A large part of its watershed remains in a primitive condition and is well adapted to salmon production. However, a large private power dam was constructed a few miles above the mouth of the river and operated for many years without adequate provision for the passage of fish. The result has been that all salmon except a very small remnant of the spring chinook run have been exterminated. The situation was considerably improved for anadromous fish in the year 1940 by the construction of additional fish facilities at the dam and power plant, but conditions for fish passage are still far from satisfactory. Major faults in the present facilities are air boils in the auxiliary water system, leaks in the collecting system such that the latter cannot be used, and shallow pools in the fish ladders. The entire problem of fish passage at this dam should be reviewed in the light of present-day knowledge and the fish-passage facilities either improved or completely rebuilt. While such a project would have merit solely for the purpose of maintaining and increasing the salmon and steelhead runs in the Clearwater, the possibility of having to relocate a part or all of the fish spawning above the Hells Canyon Dam site makes the project almost imperative. In addition to its salmon and steelhead trout, the Clearwater has resident populations which provide excellent rainbow and cutthroat trout fishing.

217. *Asotin Creek* is not one of the larger tributaries of the Snake River, but it is mentioned because it formerly supported a good run of spring chinook salmon, it continues to support a good spring run of steelhead trout, and it has potential value if additional fish-protective measures were put into effect. The present chinook run has been depleted to a small remnant of its former size. This has been due in large measure to the extensive diversion of water for irrigation and

domestic use. During low-water stages these diversions have been known to take the entire flow in the lower section of the stream channel. This has required the Washington State Departments of Fisheries and Game to undertake fish-salvage work in order to save large numbers of steelhead fingerlings and the few remaining chinook spawners in the stream from destruction.

218. The *Grande Ronde River* system was recognized near the turn of the century as being one of the best salmon producers in the Columbia Basin. Records of early fish-cultural work in this area give evidence of the large runs of chinook, blueback, silver salmon, and steelhead trout that formerly entered the river. It was especially important because one of its major tributaries, the Wallowa River, supported a good run of blueback salmon. In recent years, spawning areas in the upper section of the main stream have been rendered inaccessible and unsuitable for salmon and trout by extensive mining-dredge operations. The construction of an impassable power dam made Wallowa Lake unavailable to blueback salmon and resulted in the complete extermination of that run of fish. However, Wallowa Lake at present has a considerable population of landlocked bluebacks, or kokanee, which provide excellent sport fishing.

219. The *Salmon River* system continues to be one of the most important, and probably the most important producer of spring chinook salmon in the Columbia Basin. This is due to the fact that a large part of its watershed remains in the primitive state. The conservation of the Salmon River runs alone is sufficient justification for safeguarding the passage of anadromous fish throughout the lower Snake and Columbia Rivers.

220. In the easily accessible portions of the system, considerable depletion has occurred. Several dams have been constructed that have proved to be barriers to fish at most water stages. For example, the large runs of spring chinook and steelhead in the Lemhi River have been greatly depleted due to the construction of a power diversion dam near the mouth. Extensive diversion of water for irrigation has greatly interfered with salmon production in some streams, and mining operations have eliminated others. The former excellent blueback runs into the headwater lakes have been practically exterminated. The practice by sportsmen of spearing salmon on the spawning beds, no longer allowed, also contributed greatly to this depletion. The vast unmolested stream areas on the South Fork and Middle Fork of the Salmon River have maintained good spawning stocks, and the chinook run into the upper main Salmon River in 1947 was the largest that it has been for many years. In addition to the salmon-spawning grounds it provides, the Salmon River affords good sport fishing. There are excellent populations of rainbow and cutthroat trout, as well as landlocked blueback or kokanee in the Redfish Lakes and Warm Lakes.

221. The *Imnaha River* supports good runs of chinook salmon and steelhead trout. The stream flows through an extremely rugged, mountainous, almost inaccessible area and for this reason has not been subjected to demands for water-use development.

222. *Pine Creek* is one of the smaller tributaries to the Snake River, the main stream being approximately 30 miles long. It is included because it formerly supported a relatively good run of spring chinook salmon as well as steelhead trout. At present, it supports a small run

of chinook and a moderate run of steelheads, despite the extensive diversion of water for irrigation purposes.

223. The *Powder River* was an excellent salmon stream in the early settlement days. The extension of agriculture by means of irrigation in recent years has resulted in the extermination of anadromous fish in the greater part of the stream system. The Thief Valley Dam, in particular, blocked salmon and steelhead from the best spawning areas in the upper half of the river. Eagle Creek, a large tributary entering the lower section of the river, continues to maintain a fair run of chinook salmon and a good run of steelhead trout. This tributary drains a primitive area, and only a comparatively small portion of its flow is diverted for irrigation.

224. *Burnt River* originally supported good runs of chinook salmon and steelhead trout. These runs have been greatly depleted for many years, and at present only a small run of steelhead remains. Most of the Burnt River watershed is semiarid in character, making irrigation essential to crop production. This resulted in such extensive withdrawals of water during the irrigation season that it was impossible for fish to ascend. Moreover, none of the numerous diversions are provided with screens for the protection of downstream migrants. The Unity Dam in the upper section of the river now provides an ample stream discharge throughout the year, although it is impassable to migratory fish.

Effects of authorized projects on fish

225. The River and Harbor Act of March 2, 1945, authorized the "construction of such dams as are necessary and open channel improvement for purposes of providing slack water navigation" from the mouth of the Snake River to Lewiston, Idaho. After a study of various plans involving the construction of different numbers of dams the Corps of Engineers has decided upon the construction of four dams. These dams and their approximate heights are, in upstream order: *Ice Harbor*, 100 feet; *Lower Monumental*, 93 feet; *Little Goose*, 100 feet; *Lower Granite*, 82 feet.

226. Each of these dams, like McNary, will present problems related to both the upstream and downstream passage of anadromous fish and also will result in the inundation of a part of the spawning area for salmonoid fishes. It is believed that reasonably adequate facilities can be provided for the upstream passage of fish at these dams. The potential loss of downstream-migrating fingerlings presents a more serious problem, since each dam will take some toll of the migrating fingerlings, and the cumulative effect resulting from the passage of seveal dams may seriously diminish the productive capacity of the upper Snake River insofar as anadromous fish runs are concerned. In addition, these dams will inundate all of the spawning area between the mouth of the Snake River and Lewiston, Idaho. Quantitative data as to the exact number of fish utilizing this reach of the river are not available, but it is known that a large fraction of the spawning population above Bonneville Dam will be affected by dam construction.

227. The lower Snake River dams collectively present the greatest threat to the maintenance of the Columbia River salmon population of any project heretofore constructed or authorized in the basin. Because of this, serious doubts have been raised as to the possibility of

maintaining anadromous-fish populations in the Snake River watershed. Pending further study of the many fishery problems involved, plans should be made for providing fish-passage facilities at all of these dams. However, it is of the utmost importance that, in addition, the plan for the development of the lower Columbia River in the interest of anadromous fish life be rushed to completion as rapidly as possible. Appropriations for the initial steps of the plan, which is discussed in a later section, were made by the Eightieth Congress.

Effects of proposed projects on fish

228. *Hells Canyon Dam*, as proposed for authorization, would be located across the main stem of the Snake River approximately 250 miles upstream from the junction of the Snake and Columbia Rivers or roughly halfway between the Imnaha and the Powder Rivers. Since it would be 582 feet high from tailwater to forebay, it would not be feasible to provide fish-passage facilities at the dam. Consequently, all anadromous fish utilizing the spawning areas above the proposed dam site would be completely blocked at that point. Whether or not the loss of the now valuable spawning and rearing areas above the dam site would be compensated for below the dam would be contingent upon the satisfactory control of releases of water, suitable water temperatures, and the availability and extent of adequate spawning and rearing areas in that section of the river. There is every reason to believe that water conditions could be greatly improved, but considerable study is needed before definite conclusions can be made. In view of the possibility of having to relocate a part or all of the fish now spawning above the Hells Canyon site, plans should be made for providing satisfactory fish-passage facilities at the power dam in the lower reach of the Clearwater River as mentioned in paragraph 216.

229. In addition to Hells Canyon Dam, nine other dams are proposed and nearly 50 other sites have been given some preliminary thought. The following are being considered for future authorization: *Bruces Eddy* (367 feet) and *Elkberry* (543 feet) on the North Fork of Clearwater River; *Kooskia* (516 feet) on Clearwater River; *Moose Creek* (592 feet) on Selway; *Clarkston* (46 feet), *Asotin* (145 feet), and *Nez Perce* (634 feet) on Snake River; and *Crevice* (515 feet) and *Freedom* (230 feet) on Salmon River. Dams at many of these sites, if built to the height suggested, would do serious and irreparable damage to the anadromous-fish populations. For example, a 634-foot dam at the Nez Perce site would block all anadromous-fish populations not only from the upper Snake River but also from the valuable Salmon River spawning areas. Fish-passage facilities would be useless, and salvage or maintenance programs would be of tremendous proportions, even if feasible. Since additional study is needed, a detailed discussion of the probable effects is not possible. However, the fact that these dams are proposed points to the need of earnest consideration of the entire anadromous-fish problem in the Snake River watershed and to the need for earliest possible development of the lower river in the interest of fish life.

Wildlife

230. This sub-basin may be characterized as a forested area containing ponderosa, western white, and lodgepole pines, Douglas and white firs, western larch, and hemlock. There is some agricultural use, chiefly livestock raising. The principal wildlife asset is big game, and

the leading species are mule and white-tailed deer and Rocky Mountain elk, with some mountain goats and sheep, moose, and black and grizzly bears. In the summer, deer and elk inhabit the high-timbered and mountainous sections; however, in the winter deep snows usually force these animals to migrate to lower elevations where climatic conditions are less severe. These winter ranges are located principally in the river valleys and tributaries of the Snake, Salmon, Selway, Clearwater, Burnt, Powder, and Wallowa Rivers and are the limiting factors in the survival of the present big-game herds.

231. The sub-basin also supports fur animals, upland game, and waterfowl. The main fur animals are muskrats, beavers, otters, raccoons, and martens. These species, with the exception of martens, which are found in the higher-timbered regions, inhabit the watered areas. The major portion of the sub-basin also has a fair population of mountain and valley quail; blue, ruffed, and Franklin grouse; and mourning doves. In the agricultural areas the main species are ring-necked pheasants, valley quail, and mourning doves. The watered areas, and especially the islands in the rivers, are important goose- and duck-nesting sites. In addition, the wheat and other agricultural lands offer good feeding grounds adjacent to resting places for migratory waterfowl.

Effects of authorized projects on wildlife

232. The four authorized *Snake River dams* will be located in a stretch of the river with uniform habitat. These projects are *Ice Harbor*, *Lower Monumental*, *Little Goose*, and *Lower Granite*. Although they will alter the habitat for some native species, the chief wildlife resource before and after construction in these impoundment areas is waterfowl. It appears that the reservoirs will undoubtedly inundate valuable nesting islands, yet some of them may be expected to create good resting areas.

Effects of proposed projects on wildlife

233. *Hells Canyon.*—The habitat in the area of this proposed project is poor to fair and consists generally of sagebrush and bitterbrush with an understory of miscellaneous grasses and weeds. Mule deer are common in the lower portions of the area. The principal species of upland game are mountain quail, Hungarian partridges, and ring-necked pheasants. Beavers and muskrats are the only fur animals of importance. The area also has some nesting and resting values for ducks and geese. It appears that after construction the chief wildlife value of the reservoir would be resting use by migratory waterfowl, since it is an area where these birds are abundant and the acreage of small grains is extensive.

234. The Corps of Engineers has studied the following dams for possible future authorization: *Clarkston*, *Asotin*, *Nez Perce*, *Freedom*, *Crevice*, *Bruces Eddy*, *Elkberry*, *Kooskia*, and *Moose Creek*. These contemplated dams are located in the valleys of the Snake, Clearwater, and Salmon Rivers in the general vicinity of forested areas, and consequently their habitats appear to be somewhat similar. Big game appears to be the principal wildlife resource, and some of the impoundment sites constitute important winter ranges. Fur animals, upland game, and waterfowl would also be affected by the elimination of their habitats.

SNAKE RIVER AND TRIBUTARIES, WEISER TO KING HILL

Fish

235. This section of the Snake River system still supports runs of anadromous fish, consisting principally of spring and fall chinook salmon and steelhead trout, despite the serious depletion that has taken place within the last 60 years. Although a reduction of the stocks of anadromous fish has been universal throughout the Columbia River Basin, this condition has been most pronounced in those areas, such as the central Snake River sub-basin, where dams have been erected in the lower sections of tributary streams without any consideration for the passage of fish. There also has been an ever-increasing diversion of water, chiefly for irrigation, without the installation of screens to prevent the loss of small fish, and with no provision for maintaining sufficient flows in the stream channels to allow the passage of adult fish.

236. The valuable blueback salmon run which formerly ascended the Payette River and spawned in the Payette Lakes area was completely exterminated by impassable dams in the Payette River.

237. The runs of spring chinook salmon have suffered the next greatest reduction in numbers. Large runs of these most valuable salmon formerly ascended all the large rivers in the sub-basin, including the Weiser, Payette, Boise, Malheur, Owyhee, and Bruneau Rivers. It is believed that they have been almost exterminated above the Swan Falls Dam on the main Snake River, and blocked from most of their former spawning grounds below Swan Falls by dams and water diversions on all of the major tributaries, with consequent great depletion amounting to virtual extermination in most of these rivers.

238. Very large numbers of fall chinook salmon formerly spawned in the main Snake River up to Swan Falls. This run also has been greatly depleted, although the area still supports an important run which spawns from a point near Marsing, Idaho, up to Swan Falls, and particularly in the section from 12 to 7 miles below Swan Falls.

239. The runs of steelhead trout have survived somewhat better than salmon, although they also are greatly reduced in size. The steelhead ascend the tributary streams on their spawning migration during the winter and spring high-water stages and are thus able to surmount many obstructions that are barriers to salmon.

240. Despite the serious reduction in the abundance levels of the various anadromous-fish populations, they are still of sufficient importance to warrant thorough consideration and protection.

241. The resident-fish population within the sub-basin has assumed considerable importance in recent years. The landlocked blueback salmon, generally known as kokanee, is found in the Payette Lakes area, where it supports a popular sport fishery. A few sturgeon are caught in the main Snake River from Weiser to Swan Falls. Sport fishing for large rainbow trout prevails throughout the reach from Weiser to King Hill. The upper portions of most of the tributaries also support a good sport fishery for both rainbow and cutthroat trout. An important sport-fishery development in Owyhee and other reservoirs has occurred in recent years for warm-water species such as bass, crappie, and perch. With the increase in population, the resident fish are certain to become even more important to recreation and the economy of the area. Continual effort is required to maintain the fishery where it will withstand the increased pressure and yet

permit full recreational utilization. If water-development projects can be so modified as to result in greater fishery values without decreasing the effectiveness of the projects, it is desirable. Diversions should be screened and adequate stream flows provided.

Effects of authorized projects on fish

242. *Lucky Peak Dam*, authorized for construction by the Flood Control Act approved July 24, 1946, will be located on the Boise River a short distance upstream from the city of Boise, Idaho. This dam will be 251 feet high and will inundate a 12-mile stretch of the Boise River and about 5 miles of Mores Creek. An important trout fishery will be seriously affected. Some fishing would be available in the reservoir, but because of a water fluctuation of as much as 155 feet, this is not expected to be comparable to the existing fishery values.

Effects of proposed projects on fish

243. The Bureau of Reclamation has already recommended five new dams on the following tributaries: South Fork Payette River, Bully Creek, Hornet Creek, Camp Creek, and Mann Creek, and the enlargement of the Lost Valley Reservoir on the Weiser River. Reports on the probable effects of these dams are being prepared for submission to the Secretary of the Interior. In this area of the Snake River, no dams are proposed for authorization in the review report of the Corps of Engineers; however, some 30 sites have been studied in a preliminary manner. These projects will require further investigations to determine the probable effect on the fishery resources.

Wildlife

244. This sub-basin provides much excellent habitat for big game, fur animals, waterfowl, and upland game. The timbered and mountainous areas are largely in national forests and contain the principal habitats for mule deer, white-tailed deer, Rocky Mountain elk, bears, moose, martens, and various species of grouse and quail. On the Federal range and other uncultivated lands, the habitat consists largely of sagebrush-downy chess type with some western juniper. These lands are chiefly inhabited by mule deer, antelope, badgers, sage hens, and mourning doves. They are important as winter ranges for big game, which uses the forested areas in the summer. In addition, these lands also afford cover adjacent to irrigated and cultivated sections occupied by ring-necked pheasants, quail, and Hungarian partridges. The valleys of Snake River and its tributaries are extensively used by waterfowl, fur animals, and as winter ranges for big-game animals. The numerous islands in Snake River provide valuable nesting sites for Canada geese and various species of ducks. The principal waterfowl are geese, mallards, baldpates, pintails, gadwalls, teals, redheads, and scaups. The main fur animals are muskrats, beavers, minks, raccoons, and otters.

Effects of authorized projects on wildlife

245. At the present time, *Lucky Peak* is the only project authorized in this sub-basin. The reservoir site is critically needed as winter range for mule deer. It also provides cover for mourning doves, Hungarian partridges, various species of quail and grouse, and a few mallards and Canada geese nest there. The leading fur animals are beavers, muskrats, minks, raccoons, skunks, and otters.

246. The construction of this reservoir will result in the destruction of part of the mule deer winter range. This range is important as it constitutes a part of the limiting factor in the survival of the present deer herd. Moreover, it is probable that the proposed reservoir will also obstruct the present migration route from the spring-fall area to some of the remaining winter range. It will also eliminate some present upland-game-bird, fur-animal, and waterfowl habitats. The project may result in the creation of some additional resting areas for waterfowl. However, the use will probably be light as evidenced by present waterfowl numbers on the Arrowrock Reservoir, a few miles east of the project. There will also be some flood-control benefits for nesting geese in the river below the proposed dam. Nevertheless, these gains will be more or less restricted by the fluctuating water levels during the summer growing season, the barren, steep-sided reservoir walls, and the scarcity of aquatic food plants. The project will likewise have little value for nesting purposes.

SNAKE RIVER AND TRIBUTARIES ABOVE KING HILL

Fish

247. Runs of spring chinook salmon and steelhead trout formerly ascended the main Snake River as far as Augur Falls, opposite Jerome, Idaho. No records are available to indicate that fall chinook ever spawned above Swan Falls. Recent field studies indicate that a small run of steelhead trout currently enters Bruneau River above Swan Falls, but recent information is lacking regarding any spring chinook going above this point.

248. This sub-basin is well adapted to a variety of resident fish and has a considerable recreational value resulting from game-fish production. The upper main Snake River is famous for its yield of large rainbow trout. Most of the upper tributaries and many of the lakes also are noted for their production of several species of trout, as well as whitefish and other species. In addition, there is a number of large reservoirs on both the main Snake River and some of its tributaries that are highly productive of such fish as bass, perch, and crappie, as well as trout.

249. The Thousand Springs flow into the Snake River in the lower part of the area and provide some of the finest water for artificial propagation to be found anywhere in the basin. Only two hatcheries, one operated by the State of Idaho and one operated by the Fish and Wildlife Service, utilize this water at present; however, it certainly will be utilized for fish-cultural purposes to a far greater extent in the future.

Effects of authorized projects on fish

250. The authorized *Palisades project*, to be constructed by the Bureau of Reclamation, will include a dam 360 feet in height located across the main stem of the Snake River in Idaho about 15 miles from the Idaho-Wyoming border. The project will result in the inundation of about 20 miles of the main Snake River and 18 miles of tributary streams. There will be substituted for this stream area a reservoir that may be expected to produce fair fishing, and an increase in the fishery value of the river below the dam resulting from the control of flood flows. Fishing at Jackson Lake may also be im-

proved through a more favorable schedule of operation permitted by Palisades Dam.

251. Some 36 projects with a total storage capacity of nearly 6,000,000 acre-feet have been given preliminary study. These projects will require study to determine the full effect on the fishery resources; however, in general it is believed that some would be beneficial to fish life if reasonable consideration is given to the fishery resources in the project planning.

Wildlife

252. Much good habitat for big game, fur animals, waterfowl, and upland game is to be found in this drainage. The timbered and mountainous areas are largely in national forests and contain the principal habitats for mule deer, white-tailed deer, Rocky Mountain elk, bears, mountain goats and sheep, moose, martens, and various species of grouse and quail. On the Federal range and other uncultivated lands, the cover is largely sagebrush-downy chess type. These lands are mainly inhabited by antelope, badgers, sage hens, and mourning doves. They are valuable as winter ranges for big game that use the higher elevations in the summer. In addition, they also afford cover adjacent to irrigated and cultivated sections occupied by ring-necked pheasants, valley quail, and Hungarian partridges. The Snake River and its tributaries are extensively used by waterfowl, fur animals, and also sometimes as winter ranges for big game. The numerous islands in Snake River provide valuable nesting sites for Canada geese and various species of ducks. The principal waterfowl are geese, mallards, baldpates, pintails, gadwalls, teals, redheads, and scaups. The leading fur animals are muskrats, beavers, minks, raccoons, and otters.

Effects of proposed projects on wildlife

253. Any contemplated impoundments would create additional resting areas for waterfowl; yet they might eliminate some big-game winter ranges, waterfowl nesting areas on islands, and fur-animal habitat in reservoir sites.

SPECIAL FISH PROBLEMS

Salmon

254. *General.*—While each new dam and development project will have an effect on the fish and wildlife resources of the area immediately adjacent thereto, certain species have migratory habits such that their abundance in one area may be seriously modified by the effects of a project located many miles away. This is particularly true in the case of anadromous fish, such as salmon and steelhead trout. Because of their great importance to the economy of the region and because the development program may have such profound effects on their spawning distribution and level of abundance, a brief résumé of their life history follows:

255. *Life History.*—Salmon (and anadromous trout) deposit their eggs in suitable gravel in the tributary streams and the main rivers. In the gravel, the eggs incubate and eventually hatch, and usually the young fish emerge from the spawning beds during the spring of the year following the deposition of the eggs, though in some instances they emerge during the same year the eggs are laid. Following their

emergence, the fish spend from a few weeks to a year in fresh water and then migrate to the ocean. At this time they are 1½ to 6 inches in length. They remain in the ocean for 1 to 3 years and then return to their native stream to spawn, at which time they range in weight from 2 to 50 pounds or over. The average weights of the different species are as follows: chinook, 20 pounds; blueback, 3.5 pounds; silver, 9 pounds; steelhead, 7 pounds; and chum, 8 pounds.

256. Blueback salmon are unique in that they must spend a part of their early life history in a lake. In view of this fact, blueback populations are only found in those tributaries in which an accessible lake is located.

257. *Problems.*—Since these fish utilize the main-river channels during their migration, as fingerlings, from the spawning areas to the ocean and during their migration, as adults, from the ocean to the spawning areas, any serious obstruction to their free passage upstream and downstream obviously will reduce the abundance level of the populations.

258. A dam across the migration route of a population of anadromous fish may result in a loss of fish in any one or all of the following ways: (1) by so stopping or interfering with the upstream migration of adult fish that all or some portion of the fish fail to reach their spawning grounds and thus die without successfully spawning; (2) by inundating a portion of the suitable spawning area available to the fish; and (3) by producing dangerous passages, which cannot be screened, through which the downstream-migrating fingerlings may travel on their journey to the ocean.

259. A vast amount of time, thought, and money has been expended studying the problem of the upstream passage of anadromous fishes at dams and at natural obstructions. All of the information on the subject was utilized in the design and construction of the fishways incorporated in the Bonneville Dam, and several new features were included as a result of studies relating to that particular structure. These fishways have been quite successful, though unquestionably there is a loss, of unknown though probably small magnitude, of adult fish as a result of their not being able to find safe passage around the dam. Although there would be a serious loss of fish if they were delayed for any length of time during their passage, extended observations at Bonneville indicate that the probable delay is small enough to be insignificant. Thus, it is considered that the construction of main-stem dams, if provided with adequate fish-passage facilities for upstream-migrating fish, would not result in a serious diminution of the runs of anadromous fish from the standpoint of interfering with their upstream migration.

260. With considerable justification it is believed that a sizable portion of the Columbia River salmon populations, particularly fall chinook, spawn in the upper reaches of the main stem of the river, roughly upstream from Celilo Falls (pl. 2). Unfortunately, reliable data on the magnitude of the portion of the run that spawns in this area are not available, nor is it known just how the fish returning to spawn in the area would react on finding the spawning gravels inundated. They might continue on upstream, ascending the fishways at each dam in turn and spawn in the first area available; or, having ascended the river as far as they were destined to go, they might stop and eventually die without successfully depositing their eggs because

of not reaching a suitable spawning area. This is a subject that will require considerable attention, particularly in regard to those dams whose reservoirs would inundate considerable amounts of spawning area.

261. The problem of providing safe passage for downstream-migrating fingerlings at Bonneville Dam and similar structures is one that has not as yet been solved. Extensive observations by the Fish and Wildlife Service in recent years have shown that the fingerlings are distributed in the river somewhat uniformly both horizontally and vertically and that in rough terms they go through various passages (draft tubes, spillways, bypasses) in proportion to the water going through those passages. The flow of the Columbia River is such that it is impossible to mechanically screen the intakes to the turbines or the water passing under the spillway gates. A series of marking experiments has been in progress for a number of years designed to provide information on the mortality of seaward-migrating chinook salmon. In these experiments, over a million salmon fingerlings have been distinctively marked, and over 3,000 marked fish have been recovered to date. The results of these experiments indicate that the mortality of hatchery-reared fingerlings, of the species (chinook), race (fall), and size (average, 3½ inches) used in the experiments, in passing through either the turbines or spillways is approximately 15 percent. Such a mortality at one dam would not have a drastic effect on the abundance level or the productivity of the salmon populations. The fact that Bonneville Dam has been in existence for 10 years and that the trend of the abundance level of the fish runs has not dropped noticeably is ample proof of this. However, the construction of a series of dams between the ocean and the major spawning areas might seriously reduce the level of abundance of those populations spawning in the upper part of the watershed. That most of the proposed main-stem dams will be over 50 percent higher than Bonneville Dam lends weight to this eventuality.

262. The problem would be virtually solved if some means could be provided for diverting the downstream-migrating fingerlings away from dangerous passages and into safe channels of migration. Mechanical screening is impossible because of the large quantities of water involved. Electric screening has proved to be of little or no use for migratory fish. Studies are in progress by the Fish and Wildlife Service, with the cooperation of the United States Navy and the Corps of Engineers, to determine the efficacy of ultrasonic waves and moving lights. While some success has been achieved in the experiments, little hope is held forth that either method would be successful at such structures and under such conditions as are proposed and will prevail in the main stems of the Columbia and Snake Rivers. However, the importance of the subject warrants further research.

263. The development of the Columbia as a whole will greatly increase the dependence that must be placed upon fish hatcheries (pl. 3). Despite the fact that artificial propagation has been carried on in this country for considerably over half a century, evidence is lacking that an anadromous-fish resource can be maintained solely by this means. Many problems of disease and nutrition must be solved before full reliance can be placed upon artificial propagation of salmonoid fishes. Yet the need of augmenting the runs and, in some instances, of finding a substitute for natural spawning is so urgent and

the time for study so short that obviously the construction of fish hatcheries cannot be delayed until all the problems are solved. Operations and studies will have to be carried on simultaneously, but on no account should the studies be neglected in the future as they were in the early days of fish culture. The dismal record of artificial propagation in the past is ample proof of the need for scientific approach in the future.

FLOOD DAMAGE

Flood of 1948

264. The historic and devastating flood of 1948, which raised such havoc with life and property in the Northwest, also dealt a severe blow to the fish and wildlife resources of the Columbia Basin. The Refuge Branch of the Fish and Wildlife Service estimates the cost of replacement or repair of damaged refuge facilities at approximately $289,000. State upland game-bird hatcheries suffered considerable loss, especially to small pheasants. Operations of State and Federal fish hatcheries were badly disrupted; refrigeration units were damaged, personnel quarters, racks, and headgates either completely destroyed or badly twisted out of plumb, and ponds and rearing areas flooded and heavily silted. It is roughly estimated that damage to Federal fish hatcheries alone will run as high as $300,000. State hatcheries suffered similarly.

265. In addition to the damage to property and facilities, the effects of the exceptionally high and heavily silt-laden waters upon spawning areas, fingerlings, and adults of anadromous fish will be felt for many years. Flooding of hatchery ponds and rearing pools permitted more than 10,000,000 young salmon to escape prematurely. In many cases, alert hatchery personnel released their fish in advance of the flood in order to minimize damage to the fish.

266. It is impossible to calculate the losses to the resident-trout populations of the tributary streams affected by the floods. Many years must elapse before the streams affected will return to a normal productivity of natural fish food and suitable trout habitat. The scouring of stream beds undoubtedly destroyed tremendous quantities of spawning gravel and aquatic fauna. The movement of vast quantities of silt in the water not only affected the fish that were present, but in many cases, the deposition of silt on spawning areas that survived the scouring action of the water undoubtedly smothered out large numbers of trout eggs and immature fish. Many of the flash floods in the tributary streams occurred when trout eggs were either incubating or just emerging from the gravel.

267. Estimates of damage to the commercial fishery of the Columbia River have not as yet been compiled. There is little doubt, however, that the curtailment of fishing, the destruction of gear and boats, and the damage to processing plants imposed considerable loss upon the entire industry. Some concern has recently been expressed by the commercial fishery over the probable damage to the shell fisheries of both Oregon and Washington shores resulting from the tremendous quantities of fresh water flowing out of the Columbia River.

268. The fish and game departments of Oregon and Washington are anxiously waiting for the floodwaters to recede sufficiently to permit full salvage operations in the innumerable back-water areas. It is heartening to learn that preliminary salvage work already initi-

ated by the Oregon Game Commission seems to indicate that in the few areas examined near Portland, Oreg., only about 5 percent of the young fish found in the pools left by the receding Columbia River were of sport or commercial species. The full damage to the downstream migrants of anadromous fish of 1948 will not be known until the adult fish return 3 or 4 years hence.

DEVELOPMENT OF LOWER RIVER

269. *General.*—When the individual dams and development projects are considered separately, it appears in many cases that the problems of fish protection could be solved with reasonable anticipation of not more than minor loss of fish. A succession of dams between the ocean and a greater part of the more important spawning grounds (pl. 2) presents a combination of problems that cannot be looked upon so optimistically. When the presently authorized dams and those proposed for authorization are constructed, fish spawning in the productive Salmon River area would have their passage obstructed by 11 high dams. Some of these, as Nez Perce, would be of such height that they would entirely block this area and many other important areas to anadromous fish. Even if none of the latter group were constructed, it appears that the losses incurred during the passage of fish upstream and downstream over the dams, plus the reduction of spawning and rearing areas and the general change in environmental conditions, might be so serious as to make continued propagation in the headwater tributaries impracticable. The only alternative in this case would be to depend entirely upon the tributaries of the lower river and upon artificial propagation for the maintenance of the runs of anadromous fish in the Columbia River.

270. A comprehensive program of restitution and rehabilitation of this natural resource long has been needed. Apprehension concerning the effects of proposed major dams has brought the situation to a timely focus and offers the opportunity to initiate such a program on an effective scale. It would be an essential program even if no more dams were built. It becomes an urgent program in contemplation of extensive dam construction and is a proper part of the coordinated development of all the water resources.

271. The plan of developing the fishery resources of the lower river is not proposed as a complete solution of the problem of fish maintenance in the Columbia River. It is in no sense a substitute for maintaining the fish populations which spawn in the upper river and which have the highest value of any of the runs in the Columbia system. Every effort must be made to maintain the runs in the upriver tributaries by installation at every project of the best fish-protective devices that can be provided. The plan for the development of the lower river is, however, in the nature of insurance to protect the fishery resources of the river if at some unpredictable time fish-protective devices fail in their purpose.

272. Certain phases of the plan should be put into immediate operation to provide this insurance before the upriver races of salmon are lost. Moreover, the restoration of the once-abundant runs in certain of the lower tributaries and the development of the latent possibilities of fish production in others is a public responsibility which should have been recognized many years ago. The threatened crisis now makes action imperative.

273. In essence, the plan proposes to develop the salmon runs in the lower tributaries of the Columbia River to the highest possible level of productivity by the removal of obstructions, the abatement of pollution, the screening of diversions and fishway construction, the transplantation of runs, the extension of artificial propagation, and the establishment of fish refuges (plate 4).

274. *Development program.*—The plan of development as tentatively considered is divided into two periods of about 6 years each. The over-all capital cost of this lower tributary development plan is tentatively estimated to be about $20,000,000. The first 6-year period would include extensive water-resource, engineering, and biological surveys, and work on streams which have some natural stock of salmon and steelhead. The estimated cost in the first 6-year development period is about $15,500,000, which includes $2,800,000 for operation, maintenance, and supervision. The annual costs after the first development period would be about $1,230,000. The plan of development in the second period would include work on the remaining tributaries below McNary Dam, which would involve transfer of fish from other streams with material increase in hatchery facilities and increased expense for annual supervision, operation, and maintenance.

275. *Stream improvement.*—In the lower Columbia River Basin, a considerable amount of stream-improvement work could be carried on that would have very beneficial effects on the anadromous-fish populations. This work includes the construction of fishways and the improvement of natural falls to facilitate the passage of migratory fish, the removal of log jams, old dams, or other obstacles to the free migration of fish and proper management of water resources. In the Washington tributaries of the lower Columbia River, it is estimated that more than 250 stream obstacles of a temporary nature exist, and large numbers of similar obstacles are existent on tributaries in Oregon.

276. The following list of 75 natural falls represents a part of the total number in lower Columbia River tributaries of Oregon and Washington. The feasibility of improving or laddering falls on other streams not listed will be dependent upon further survey and evaluation data.

Stream or location	Number of falls	Stream or location	Number of falls
WASHINGTON		WASHINGTON—continued	
Grays River	2	Cedar Creek	1
Mill Creek (tributary of Columbia River)	1	East Fork Lewis River	11
Abernathy Creek	2	Washougal River	10
Coweman River	3	West Fork Washougal River	1
Ostrander Creek	2	McCloskey Creek	1
Arkansas Creek	3	Stebbins Creek	1
Green River	2	Wind River	6
Coldwater Creek	2	Bear Creek	1
Olequa Creek	1	Klickitat River	5
Mill Creek (tributary of Cowlitz River)	1	OREGON	
North Fork Tilton River	2		
Nineteen Creek	1	Oregon City (3 ladders)	1
Cowlitz River	2	Scappoose Creek	1
Cispus River	1	Clatskanie River	1
Niggerhead Creek	1	Molalla River	1
North Fork Cispus	1	Little Fall Creek	2
Skate Creek	1	Little North Santiam River	1
Butter Creek	1	Hood River	1
Kalama River	1		

277. *Hatcheries.*—The minimum future hatchery requirements for obtaining the proper rehabilitation and the full utilization of tributary streams include the construction, relocation, or expansion of approximately 31 individual hatcheries, which are listed as follows:

Location	Ponds	Location	Ponds
WASHINGTON		OREGON	
Klickitat	20	Metolius River	14
Cowlitz	20	Sandy River	14
Toutle	20	Lindsey Creek	6
Washougal	20	Tanner Creek	10
Coweman	15	Herman Creek	6
Kalama	20	Klaskanine River	6
Grays River	15	Hood River	10
Elokomin	12	Warm Springs River	10
Yakima	12	John Day River	10
Tucannon	10	Molalla River	10
Skamokawa	10	Tillasqua River	21
Deep River	8	Eagle Creek	--------
Abernathy	6	Clackamas	--------
Husum (Big White Salmon River)	--------		
Spring Creek expansion	--------		
Little White Salmon expansion	--------		
Wind River (Tyee Springs) expansion	--------		
Upper Little White Salmon	--------		

278. *General outline of work program.*—A. Work to be accomplished with Federal funds by the States of Washington and Oregon in cooperation with the United States Fish and Wildlife Service under the 6-year program falls under the following five general classifications:

(1) *Water-resource surveys.*—To be carried on wherever necessary within the lower Columbia River watershed during the first 6 years of the development program.

(2) *Engineering and biological surveys.*—To encompass the field surveys necessary for the determination of need, the planning of hatcheries, fish ladders, fish screens, tide gates, culverts, and water-diversion structures, etc.

(3) *Stream improvement.*—To perform, or contract to perform the actual tasks of—

(*a*) Construction of fish ladders, screens, etc.

(*b*) Removal of log and debris jams and certain dams.

(*c*) Abatement of pollution.

(4) *Hatchery construction.*—To prepare, or contract to prepare, the hatchery sites, construct the hatcheries, rearing ponds, residences, water systems, fish racks, roads, and other facilities pertinent to the full development of hatcheries for migratory fish; also, to completely equip such hatcheries for operation.

(5) *Supervision, operation, and maintenance.*—To initiate the entire operating program: The supervision, operation, or maintenance of any project, work, or facility constructed or accomplished in the 6-year development period.

B. Work to be accomplished with Federal funds by the States of Washington and Oregon and the Fish and Wildlife Service after the 6-year development period includes the supervision, operation, and maintenance of any project, work, or facility started or completed under the 6-year development program and the extension of the work outlined under A.

279. *Estimate of costs—first 6-year period.*—The combined estimates of capital and annual costs for the first 6-year development period

and the estimated annual costs after the 6-year period for that portion of the work outlined are shown in the following tabulation:

Washington Department of Fisheries:	
Stream surveys and improvements	$952, 000
Preparation of plans, etc	305, 000
Hatchery construction	3, 516, 000
Supervision, operation, and maintenance	1, 275, 500
Total	6, 048, 500
Annually after 6-year development period for supervision and operation and maintenance	710, 000
Oregon Fish Commission:	
Stream surveys and improvements	1, 553, 320
Preparation of plans, etc	197, 000
Hatchery construction	2, 198, 443
Supervision, operation, and maintenance	841, 432
Total	4, 790, 195
Annually after 6-year development period for supervision and operation and maintenance	300, 778
Fish and Wildlife Service:	
Administration	370, 000
Fish-refuge studies	115, 890
Pollution studies	270, 330
Stream surveys	38, 315
Transplant upper river fish runs to lower tributaries	80, 000
Engineering plans, surveys, and inspection	356, 318
Hatchery construction	2, 339, 250
Fishway construction, River Mill and Cazadero Dams, Clackamas River	400, 000
Operation and maintenance (hatcheries)	690, 819
Total	4, 660, 922
Annually after 6-year development period for supervision and operation and maintenance of Federal hatcheries	220, 000
Total for 6-year period:	
Washington Department of Fisheries	6, 048, 500
Oregon Fish Commission	4, 790, 195
Fish and Wildlife Service	4, 660, 922
Total	15, 499, 617
Annually after 6-year period:	
Washington Department of Fisheries	710, 000
Oregon Fish Commission	300, 778
Fish and Wildlife Service	220, 000
Total	1, 230, 778

It is anticipated that, as a result of the pollution, stream-survey, and fish-refuge studies, additional recommendations for further stream improvements and hatcheries will be made. It is reasonable to expect that the additional features of the lower-river plan will probably entail a capital investment of approximately 4½ million dollars, making a grand total investment of $20,000,000 in the plan for the maintenance of the anadromous fisheries of the lower Columbia River.

280. *Fish refuges.*—In the planning for the comprehensive utilization of the water resources of the basin, the streams tributary to the

lower Columbia River which are ideally suited for salmon propagation should be so recognized, and no developments that would be inimical to the maintenance of the runs should be planned or sanctioned for early construction in those watersheds. It is realized that economic conditions may be so different at some time in the unforeseeable future that streams now reserved solely for fish life, under this proposal, might better be utilized for some other purpose or multipurpose. But certainly there are enough sites for the development of power, irrigation, and flood-control projects such that—for the foreseeable future, at least—certain fish streams could be left inviolate. This should in no way diminish the rights and consideration of fish life in other parts of the Columbia Basin where plans for multipurpose use of water are being made. The fish requirements in those areas must be maintained if at all possible. The proposal would, however, prevent the promiscuous and unnecessary construction of water-use projects in areas where the damage to fish life would—in the long run—far exceed the transitory benefits that might accrue from other water uses. It must be remembered that in the anadromous-fish resources of the Columbia River we are dealing with a renewable natural resource that has inherent values far in excess of those that can be ascribed in monetary terms.

281. The streams proposed for inclusion in the category of fish refuges, and in which no further proposals for water utilization inimical to fish life would be considered, are as follows:

WASHINGTON TRIBUTARIES

Chinook Creek	Elokomin River	Lewis River
Deep River	Mill Creek	Salmon Creek
Grays River	Abernathy Creek	Washougal River
Crooked Creek	Germany Creek	Wind River
Jim Crow Creek	Cowlitz River	Klickitat River
Skamokawa Creek	Kalama River	

OREGON TRIBUTARIES

Lewis and Clark River	Clatskanie River	Clackamas River
Youngs River	Green River	Molalla River
Bear Creek	Tide Creek	Sandy River
Big Creek	Scappoose Creek	Hood River
Gnat Creek	Milton Creek	Deschutes River
Plympton Creek	McNulty Creek	

SUMMARY

FISH

282. The Columbia River supports a large salmon-steelhead fishery that is of considerable commercial and sport significance. In 1883 the commercial pack of the choicest canned salmon amounted to approximately 43,000,000 pounds. At present, the average commercial production of all salmon and steelhead, canned, cured, and fresh, amounts to 28,000,000 pounds. Sport and Indian subsistence catches bring the total average yield to nearly 32,000,000 pounds a year, which is presently valued at 17.5 million dollars.

283. The sport fishery for trout and other resident fish is of tremendous proportions. Some 700,000 sport-fishing licenses were purchased in the basin in 1947 by sportsmen whose fishing expenditures amounted to more than $100,000,000.

284. The program of water utilization as proposed by the Corps of Engineers would have both beneficial and harmful effects on the fish resources. Dams on the main rivers, such as The Dalles, John Day, Priest Rapids, Rocky Reach, Wells, the lower Snake River dams, Clarkston, and Asotin, would offer serious obstructions to the salmon migration of the entire upper basin. The high dams of Nez Perce and Hells Canyon on the Snake River would be insurmountable barriers to all anadromous species now inhabiting the area above these dam sites. The effect of these dams will undoubtedly be a serious depletion of permanent nature. The greatest hope of survival of any of the salmon runs above the dams lies in careful management, with the aid of all known facilities for propagation and fish passage over dams. Fish ladders will be required over all dams below Foster Creek and Nez Perce, as well as supplementary hatcheries. Not only main-stream dams, but many on tributaries, such as the Cowlitz, the Clearwater, and the Salmon, will have similar harmful effects that will involve serious salvage problems and depletion.

285. Resident game fish will benefit from some impoundments; however, much good stream fishing will be lost. Additional hatcheries will be needed throughout the basin to supplement State and Federal facilities for stocking.

286. Special problems connected with dam construction require concentrated study, with the hope that the results may relieve the tension and improve the chance of survival of migratory fish. These include the safe downstream passage of migrating fingerlings at dams, additional fish-cultural refinements, etc. The fuller utilization of the lower-basin tributaries for salmon is being developed as restitution for losses that have been encountered at previously constructed dams and to mitigate future losses.

WILDLIFE

287. The abundance of wildlife found throughout the Columbia Basin provides recreational opportunities unsurpassed in the Nation. The degree of utilization of these resources is expected to increase materially along with the growing national demands for recreational development. Former wilderness areas are now increasingly accessible to large numbers of sportsmen. A present annual value of $41,000,000 is assigned to the wildlife resources. Good big-game hunting is provided by mule, white-tailed, and black-tailed deer, and elk. In addition, there are black and grizzly bears, mountain sheep, moose, antelope, and mountain goats. The basin supports an abundant and varied population of upland-game birds. The species native to the region include blue, ruffed, Franklin, sharp-tailed, and sage grouse; band-tailed pigeons; mourning doves; and mountain quail. Development of new lands has resulted in the creation of much new habitat favorable to introduced game birds, among which the principal species are ring-necked pheasants, valley and bobwhite quail, and Hungarian partridges. Fur animals constitute a valuable resource throughout the major portion of the Columbia River drainage. They are common along most of the streams of the Northwest. Species indigenous to the basin include martens, muskrats, beavers, minks, otters, skunks, and raccoons. About one-third of the continental waterfowl population is found in the Pacific Flyway, and nearly all of

the birds in this flyway pass through the Columbia Basin each spring and fall. It is apparent that a considerable portion of these ducks and geese depend on this area for a part of their support. Many species nest extensively throughout the basin, while the wintering populations concentrate in the lower and more protected regions.

288. The wildlife environment of the basin would be altered considerably by the proposed impoundments, which would eliminate some of the habitats of native species. Some utilization of the reservoirs is to be expected, yet the extent of this use is dependent on such factors as fluctuation and shore-line vegetation. Thorough studies should be made by the Fish and Wildlife Service of all anticipated changes in wildlife habitat caused by construction of proposed projects. These studies should be undertaken well in advance of actual development so that they will serve as a basis for specific recommendations to mitigate losses and derive maximum benefits.

Recommendations

289. In order to promote orderly planning, to minimize the deleterious effects of the water-development projects, and to obtain the maximum benefits to fish and wildlife from such developments, it is recommended that—

(1) The Fish and Wildlife Service and the State fish and game agencies concerned be kept fully and currently informed in regard to the proposals, plans, and designs of all water-use projects to be recommended for construction or to be constructed.

(2) Wherever possible those projects having the least harmful effects and the greatest benefits to fish and wildlife be scheduled ahead of those less favorable.

(3) Full consideration be given at each project to be constructed to the inclusion of such plans for the protection, utilization, and development of the fish and wildlife resources as may be recommended by the Fish and Wildlife Service.

(4) The development of the tributaries of the lower Columbia River in the interest of fish life be carried forth as speedily as possible.

(5) A coordinated program of research on fish and wildlife problems associated with the proposed development program be undertaken by the Fish and Wildlife Service with funds provided by the sponsor on a scale sufficiently adequate to obtain solutions to the numerous problems arising from the water-development program.

(6) Where areas of particular value to wildlife, such as refuges or critically needed winter ranges, are to be destroyed, an alternate habitat which will provide equivalent wildlife use be acquired, such as—

(*a*) The Crab Creek arm of the Priest Rapids impoundment and some adjacent farm land should be developed as a National Wildlife Refuge.

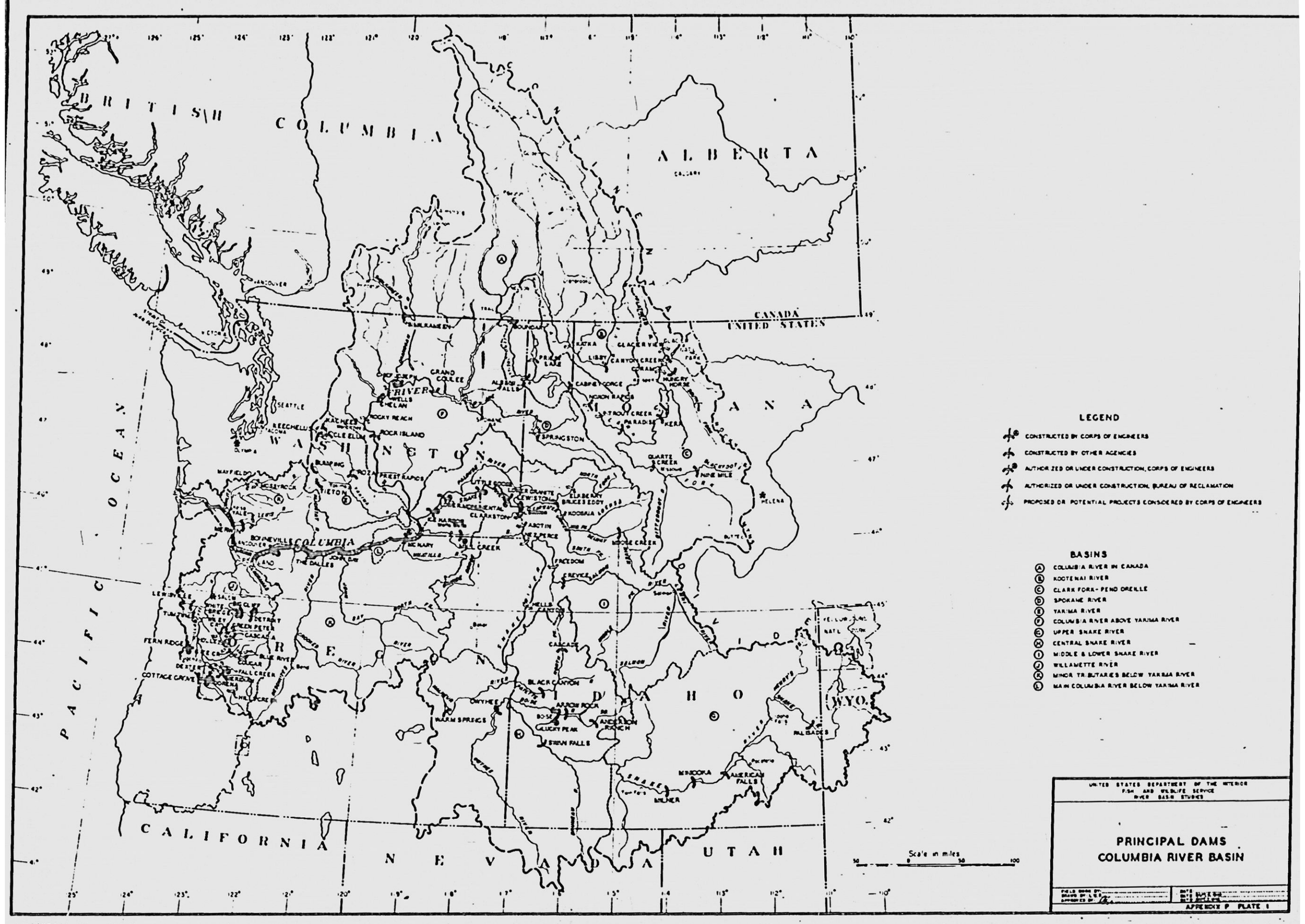
(*b*) The headquarters site and lands of the National Bison Range, which would be inundated by the Paradise Dam, should be replaced with areas of equivalent wildlife value.

(*c*) Farming areas for the cultivation of waterfowl food crops in the Willamette Valley should be provided as follows: Fern

Ridge Reservoir, 600 acres; Dorena Reservoir, 200 acres; an Lewisville Reservoir, 200 acres.

(*d*) A subimpoundment on the Coyote Creek arm of the Fe Ridge Reservoir should be constructed and developed for wildlif

(*e*) To provide the minimum requirements for waterfowl c the Pacific flyway, provision should be made for the developme of feeding areas adjacent to reservoirs to be constructed in th basin. It is anticipated that from 12 to 15 such areas will b required.



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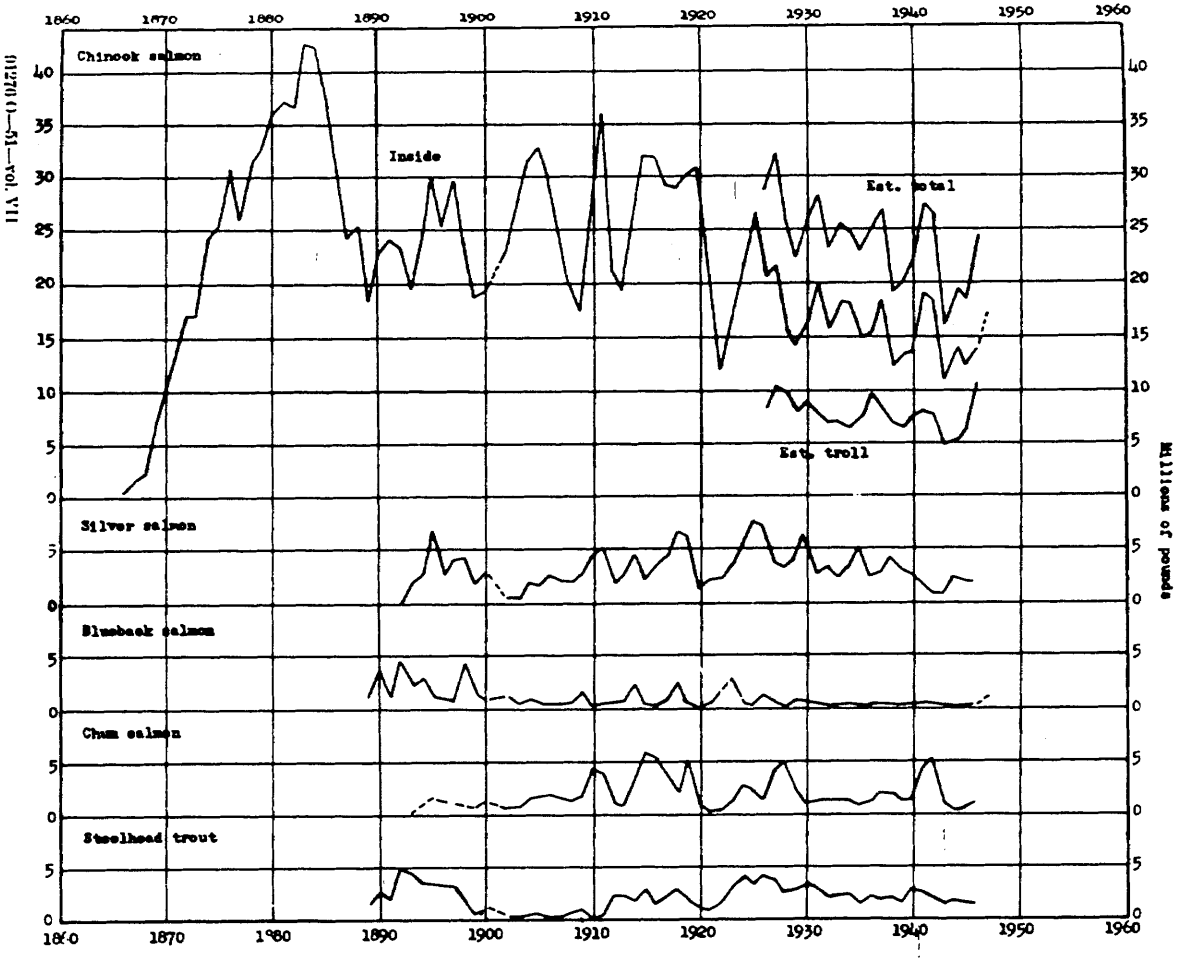


Figure 1. Commercial catch of Columbia River salmon and trout.

APPENDIX P FIG. 1

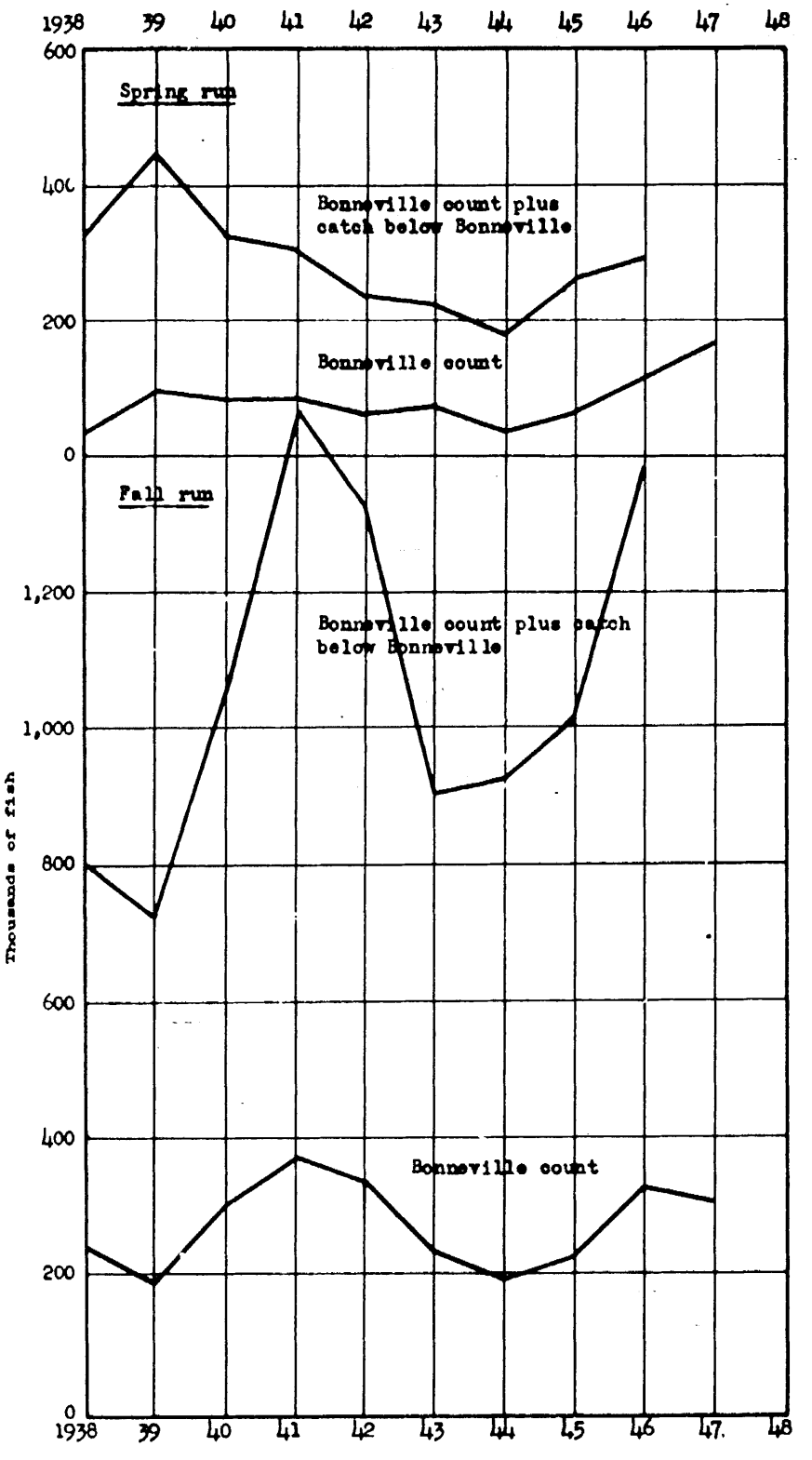


Figure 2. Bonneville counts, and catches below Bonneville Dam, of Columbia River chinook salmon.

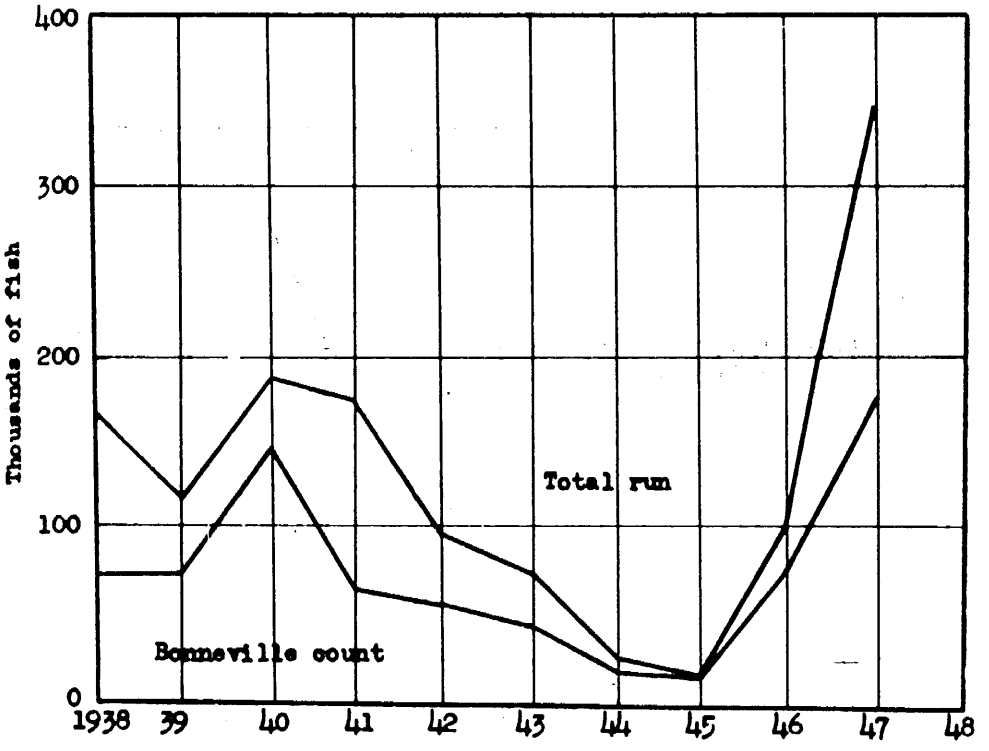


Figure 3. Bonneville count and total run of Columbia River Blueback salmon.

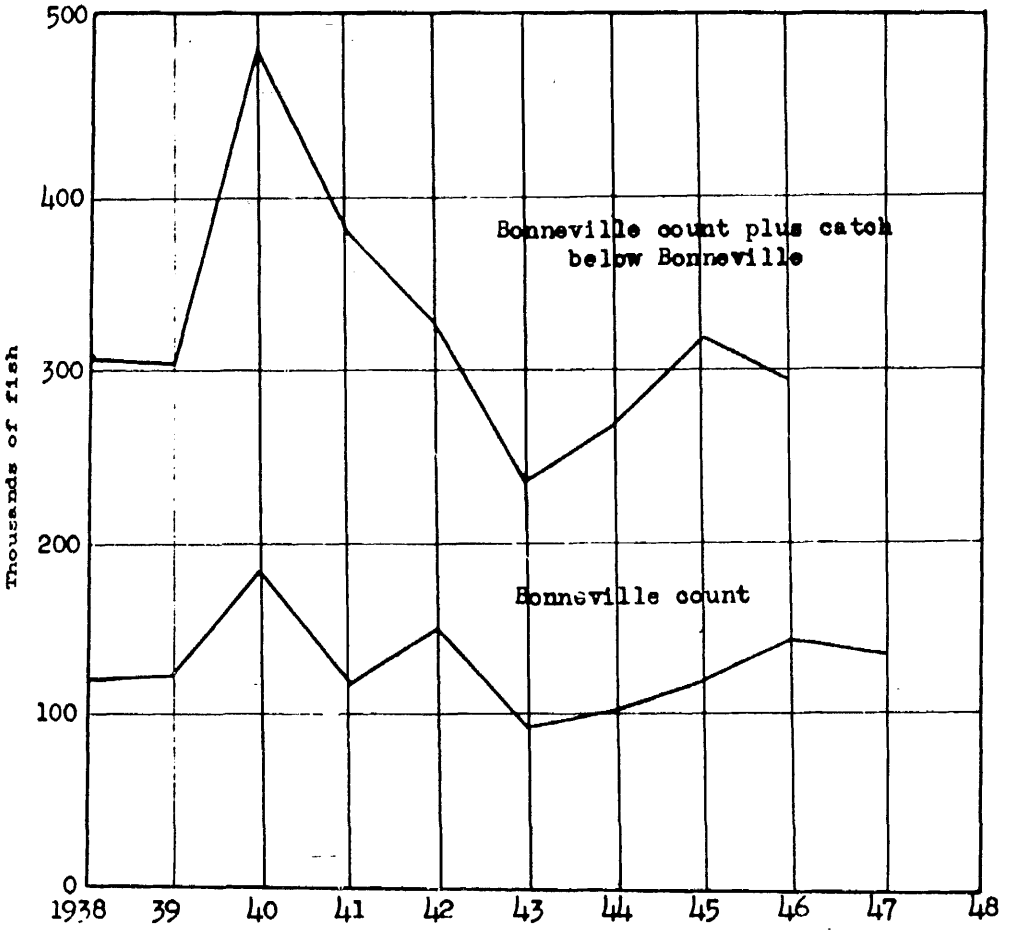


Figure 4. Bonneville count and catch below Bonneville of Columbia River steelhead trout.

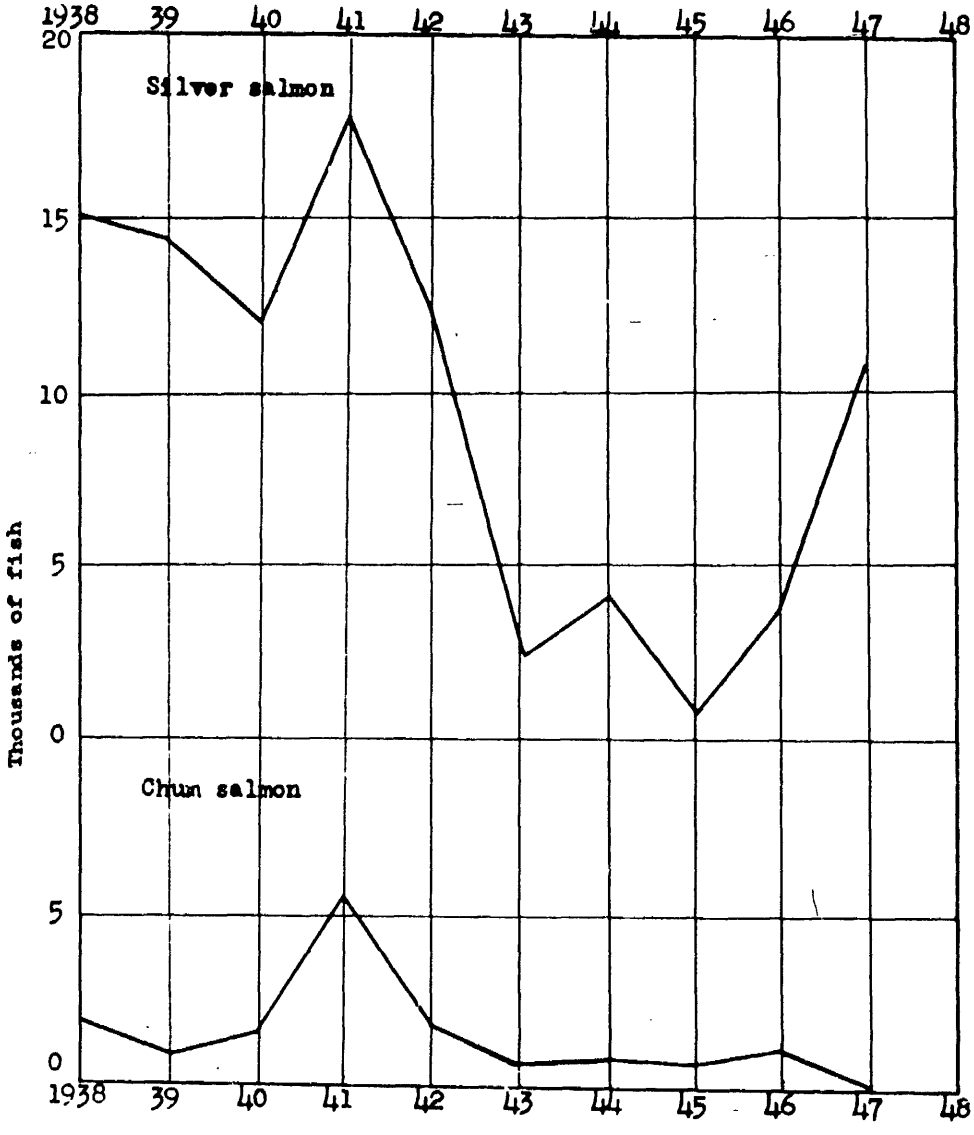
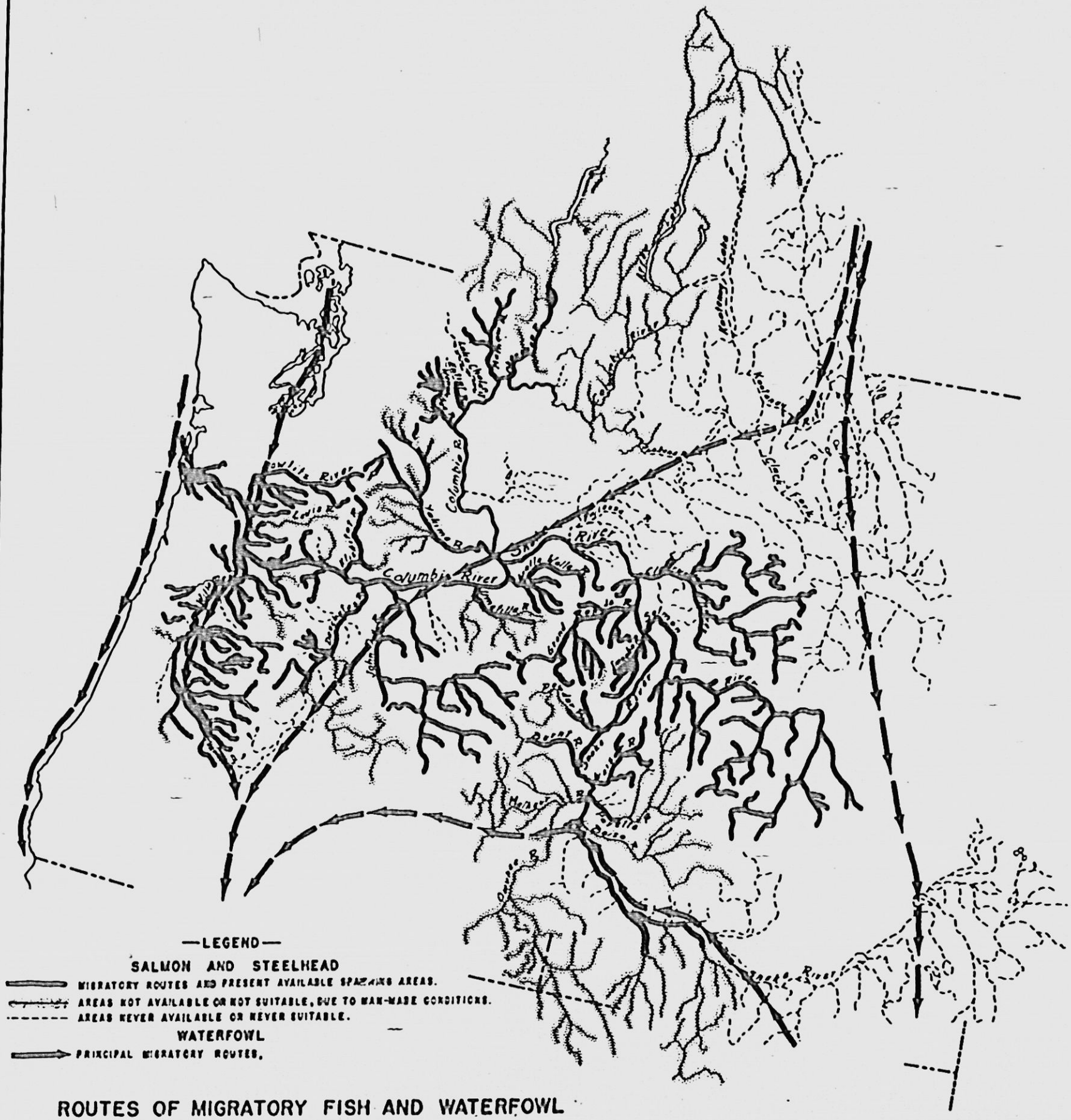
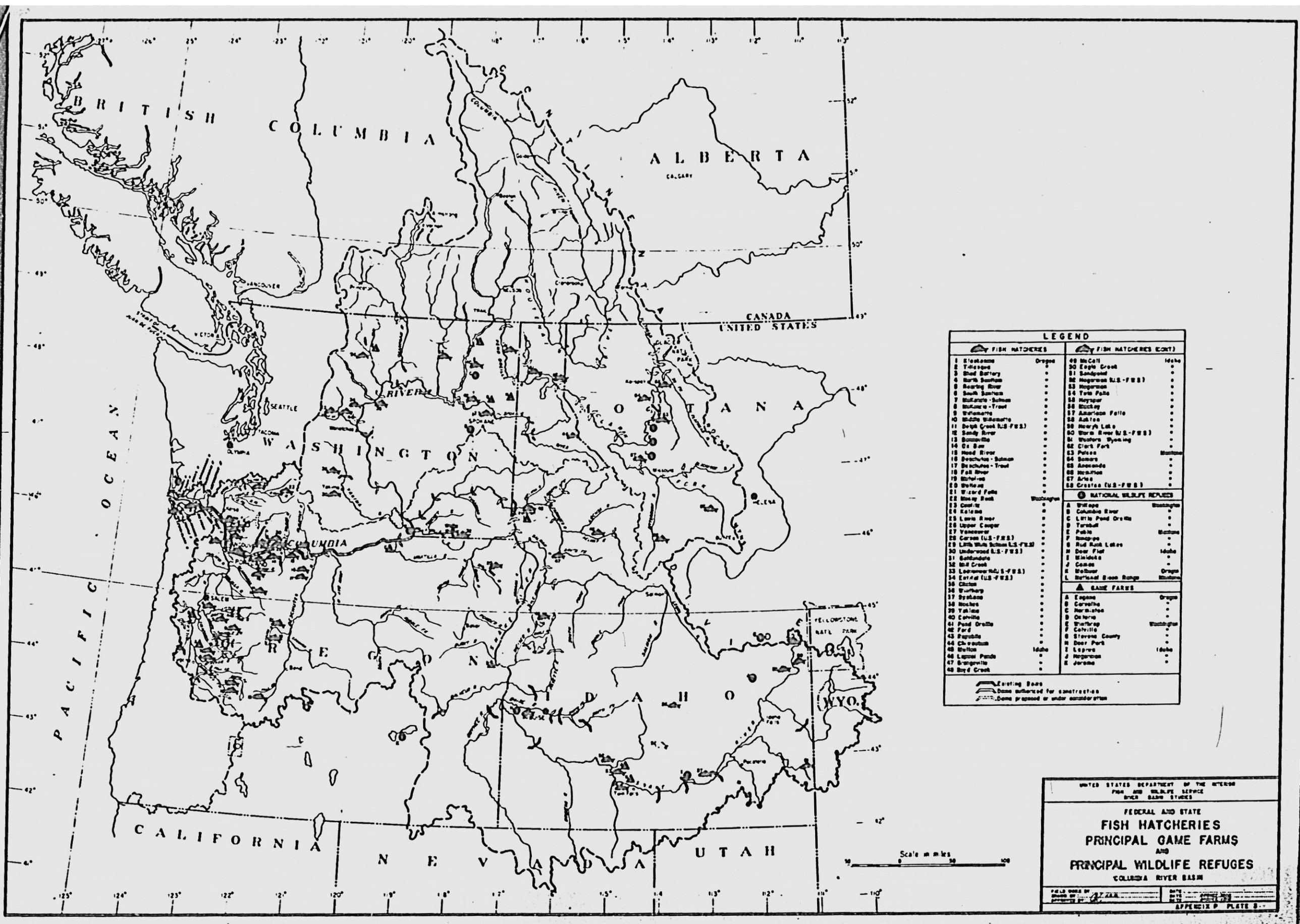


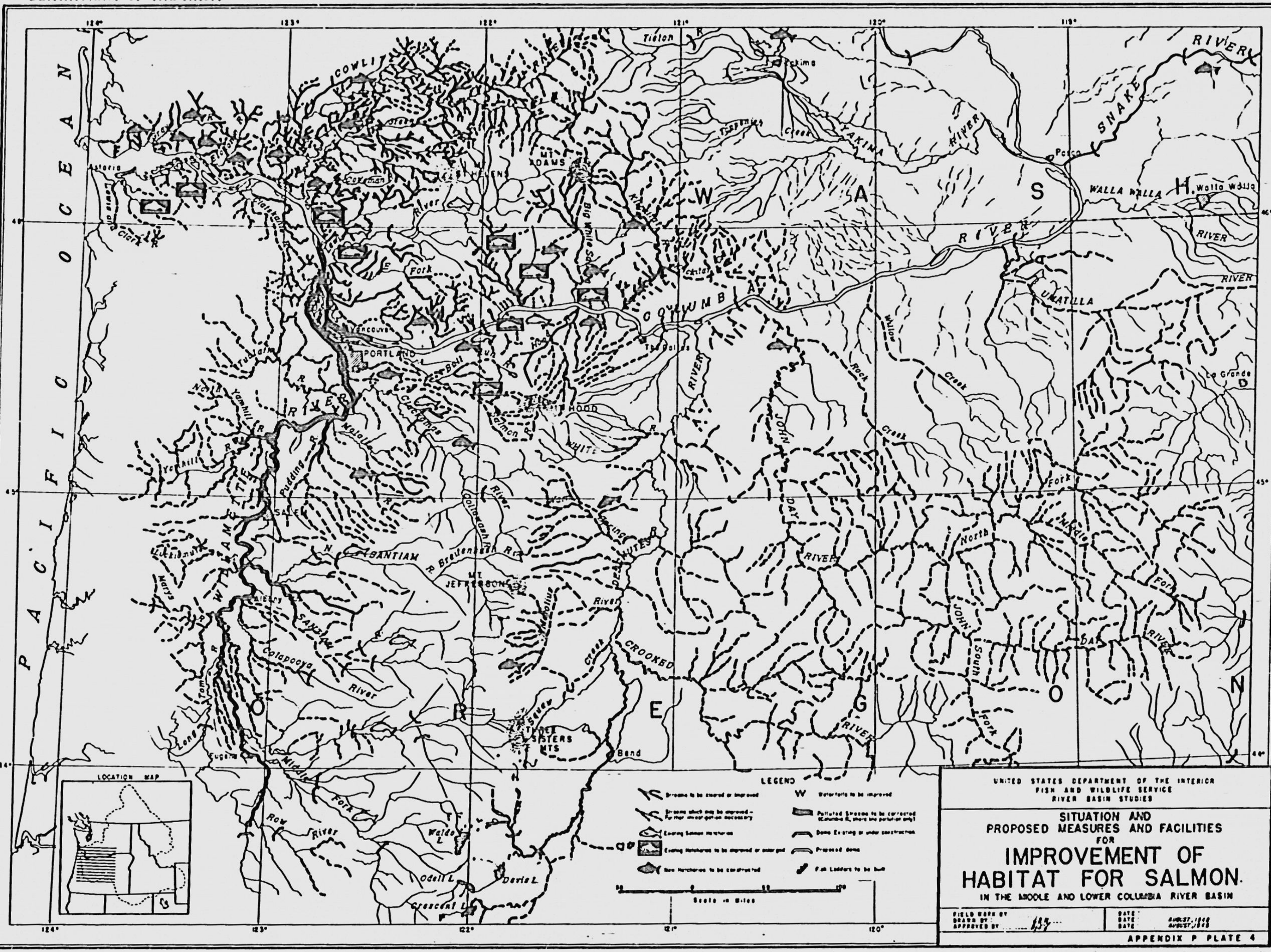
Figure 5. Bonneville counts of silver and chum salmon.



ROUTES OF MIGRATORY FISH AND WATERFOWL

APPENDIX P PLATE 2


BRITISH COLUMBIA
ALBERTA
CALGARY
CANADA
UNITED STATES
VANCOUVER
VICTORIA
SEATTLE
TACOMA
OLYMPIA
WASHINGTON
RIVER
SPOKANE
MONTANA
HELENA
COLUMBIA
SALEM
OREGON
IDAHO
WYO.
YELLOWSTONE NATL. PARK
PACIFIC OCEAN
CALIFORNIA
NEVADA
UTAH
Scale in miles
LEGEND
FISH HATCHERIES
1 Klamath Oregon
2 Trillicoom "
3 Shad Battery "
4 North Bonneville "
5 Roaring River "
6 South Santiam "
7 Multnomah - Salmon "
8 Multnomah - Trout "
9 Willamette "
10 Middle Willamette "
11 Delph Creek (U.S.-F.W.S.) "
12 Sandy River "
13 Bonneville "
14 Oak Spring "
15 Wood River "
16 Deschutes - Salmon "
17 Deschutes - Trout "
18 Fall River "
19 Wallowa "
20 Wallowa "
21 Wizard Falls "
22 Mossy Rock Washington
23 Cowlitz "
24 Kalama "
25 Lewis River "
26 Upper Cowlitz "
27 Vancouver "
28 Carson (U.S.-F.W.S.) "
29 Little White Salmon (U.S.-F.W.S.) "
30 Underwood (U.S.-F.W.S.) "
31 Goldendale "
32 Mill Creek "
33 Leavenworth (U.S.-F.W.S.) "
34 Entiat (U.S.-F.W.S.) "
35 Chelan "
36 Winthrop "
37 Spokane "
38 Naches "
39 Yakima "
40 Colville "
41 Pend Oreille "
42 Ford "
43 Republic "
44 Chewaucan "
45 Walton Idaho
46 Lapwai Ponds "
47 Grangeville "
48 Boyd Creek "
FISH HATCHERIES (CONT.)
49 McCall Idaho
50 Eagle Creek "
51 Sandpoint "
52 Hagerman (U.S.-F.W.S.) "
53 Hagerman "
54 Twin Falls "
55 Hayspur "
56 Stocking "
57 American Falls "
58 Ashton "
59 Henry's Lake "
60 Warm River (U.S.-F.W.S.) "
61 Western Wyoming "
62 Clark Fork "
63 Polson Montana
64 Somers "
65 Anaconda "
66 Jocko "
67 Arlee "
68 Creston (U.S.-F.W.S.) "
NATIONAL WILDLIFE REFUGES
A Willapa Washington
B Columbia River "
C Little Pend Oreille "
D Turnbull "
E Pablo Montana
F Bowdoin "
G Red Rock Lakes "
H Deer Flat Idaho
I Minidoka "
J Camas "
K Malheur Oregon
L Northern Bison Range Montana
GAME FARMS
A Eugene Oregon
B Corvallis "
C Hermiston "
D Oakridge "
E Winthrop Washington
F Colville "
G Stevens County "
H Deer Park "
I Lapwai Idaho
J Hagerman "
K Jerome "
Existing Dams
Dams authorized for construction
Dams proposed or under consideration
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
RIVER BASIN STUDIES
FEDERAL AND STATE
FISH HATCHERIES
PRINCIPAL GAME FARMS
AND
PRINCIPAL WILDLIFE REFUGES
COLUMBIA RIVER BASIN
APPENDIX D PLATE 8


UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
RIVER BASIN STUDIES
SITUATION AND
PROPOSED MEASURES AND FACILITIES
FOR
IMPROVEMENT OF
HABITAT FOR SALMON.
IN THE MIDDLE AND LOWER COLUMBIA RIVER BASIN
FIELD WORK BY
DRAWN BY
APPROVED BY
DATE
DATE
DATE
APPENDIX P PLATE 4
LEGEND
Streams to be cleared or improved
Streams which may be improved — Further investigation necessary
Existing Salmon Hatcheries
Existing Hatcheries to be improved or enlarged
New Hatcheries to be constructed
Waterfalls to be improved
Polluted Streams to be corrected (Columbia R. shore line pollution only)
Dams Existing or under construction
Proposed dams
Fish Ladders to be built
Scale in Miles
LOCATION MAP
PACIFIC OCEAN
WASH
OREGON
COLUMBIA RIVER
SNAKE RIVER
YAKIMA RIVER
WALLA WALLA RIVER
UMATILLA RIVER
JOHN DAY RIVER
DESCHUTES R
CROOKED RIVER
WILLAMETTE R
N. SANTIAM
COWLITZ
MT. ADAMS
MT. HOOD
MT. JEFFERSON
THREE SISTERS MTS
PORTLAND
Vancouver
Astoria
Salem
Albany
Eugene
Bend
The Dalles
Pasco
Walla Walla
La Grande
Odell L.
Crescent L.
Davis L.
Waldo L.
124°
123°
122°
121°
120°
119°
46°
45°
44°