IMNAHA RIVER SYSTEM

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INTRODUCTION

The Imnaha River System of northeastern Oregon drains the eastern escarpment of the Wallowa Mountains and that part of an adjacent plateau located between the Wallowa River Drainage to the west and Hells Canyon of the Snake River to the east. The Imnaha watershed attains an elevation of 10,000 feet and the main stem, prior to entering the Snake River, traverses approximately 80 miles of extensively and deeply dissected terrain. The basin encompasses about 950 square miles.

The major tributaries of the Imnaha Basin include the North and South Forks and Big Sheep, Horse, and Lightning Creeks, all of which were surveyed (Figure 94). Because of their apparent lack of value for the production of salmonids, observations were not conducted on many of the numerous smaller tributaries of the system.

Anadromous salmonids which are known to inhabit the Imnaha Basin are chinook salmon and steelhead trout. At the present time, evidence points to the existence of sizable populations of both of these species. The presence of only the spring type of chinook salmon has been verified.

The climate of the Imnaha Drainage varies considerably with altitude and consists of cool temperatures and moderate precipitation in the mountains to warm summers and semi-arid conditions in the lower elevations. Proceeding from the headwaters, the watershed undergoes a change from alpine mountains, to forested plateau, to semi-arid plateau as the Snake River is approached. The run-off cycle of the drainage consists generally of maximum flows in April, May, and June and minimum discharges from September through January.

Comparatively speaking, the Imnaha Basin is located in a semi-remote area. With exception of the small town of Imnaha, Oregon, which is situated about 25 miles above the mouth of the Imnaha River, the nearest centers of population are Joseph and Enterprise, Oregon, each 36 or more miles distant from the most adjacent point on the stream. At the present, industries operating in the drainage are livestock raising, truck gardening of a local nature, and logging, which has recently increased in intensity. Also, the basin is of considerable importance as a recreation area for anglers, hunters, and campers, and several well-equipped forest camps have been developed along the stream. With the exception of some of the lower tributaries, irrigation demands on the Imnaha River are not severe. Most of the diversion ditches are relatively small and irrigation does not appear at any time to reduce the flow of the main river to an undesirable level. It is believed that irrigation needs will remain relatively stable in the future.

For the purposes of this report, the Imnaha River main stem and the tributary streams, i.e., North Fork, South Fork, and Horse, and Lightning Creeks have been considered under an initial and separate section of the Imnaha River System, while, because of its relative importance and numerous problems, the major tributary, Big Sheep Creek, is discussed under a later section.

IMNAHA RIVER MAIN STEM

Introduction

The North and South Forks of the Imnaha River arise at elevations of up to 8,500 feet and flow east for distances of approximately 7 miles through deep, U-shaped canyons to join near the 5,500 foot level and form the main river. From this point, the stream continues an easterly course for 11 miles and then swings north to parallel the Snake River, which it enters some 70 miles further downstream near an altitude of 900 feet (Figure 94). At approximately river-miles 6, 12, and

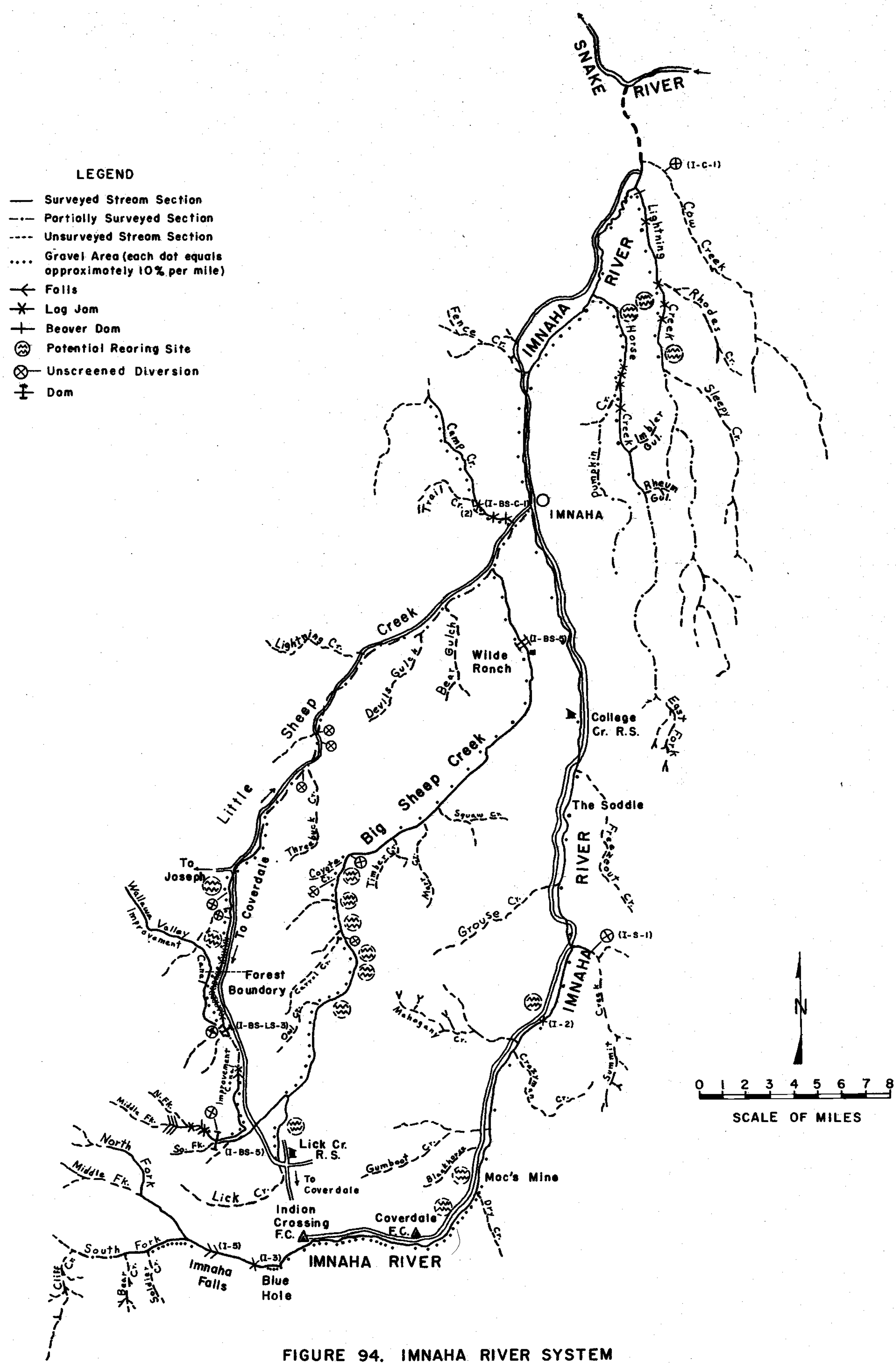

FIGURE 94. IMNAHA RIVER SYSTEM

25, Lightning, Horse, and Big Sheep Creeks enter the river, in that order. Throughout much of the lower 60 miles, ranches are found wherever the canyon widens sufficiently to form arable land. The small settlement of Imnaha, Oregon, is located just below the mouth of Big Sheep Creek.

Access to the Imnaha River is good, especially during mild weather. A dirt and gravel road parallels the stream for a distance of approximately 60 miles between Indian Crossing Forest Camp and the mouth of Cow Creek. This road is intercepted in two places by roads leading to Joseph, Oregon. The lowermost of these roads, which extends from Imnaha to Joseph, is open generally the year around. Above Indian Crossing Forest Camp and below Cow Creek, the river and its tributaries are accessible by trail.

Inventory Surveys - Dates and Areas

Inventory surveys, by foot and boat, were conducted on the Imnaha River on August 8, 1958, June 25, 1959, and July 16 and 17, 1959, over approximately 67 miles of the stream. In addition, an aerial survey was made between the confluence of the North and South Forks and College Creek Ranger Station on June 1, 1959.

Unsurveyed sections of the stream include the first 3 miles above the mouth and the 10-mile area from the Blue Hole to Mac's Mine. The latter segment is familiar to the surveyors from past spawning ground observations, and information regarding the lower area has been obtained from Fish Commission personnel engaged in duties apart from this program.

Survey Data

Terrain and Gradient: The main stem of the Imnaha River is formed near a level of topographic transition from high mountains to plateau. In its course over the plateau, the river has cut a deep, rugged canyon which narrows in several places to form gorges. The upper 5 miles of the canyon, as far down as the Blue Hole, has a history of glaciation and is typically steep-walled. Gradient here is steep to torrential. Below the Blue Hole and to the vicinity of Summit Creek, the canyon widens somewhat and the gradient varies generally between moderate and steep. This section extends for 23 miles and contains most of the spawning area utilized by chinook salmon on the river. From Summit Creek to the mouth, the river enters two gorges, one near Fence Creek (Figure 95), and the other near Cow Creek. Excluding a 10-mile section of moderate to steep gradient between Imnaha, Oregon, and Horse Creek, the gradient in this lower 40-mile area is predominately steep, interspersed with short areas which have either a moderate or nearly torrential gradient.

Slope and Bank Cover: The Imnaha watershed is in a generally good condition, especially in the upper half of the stream. Conifers, rock outcroppings, and grasses dominate the slope cover above Summit Creek while below here the timber recedes and grasses and rocks are predominant. Bank vegetation consists of conifers and brush on the upper one-third of the stream, and in the lower two-thirds, deciduous trees gradually replace the evergreens in a downstream progression.

Shade: Although many gradations of streambed exposure exist in the long course of the Imnaha River, shading, on the average, is considered to be partial.

Stream Cross Section: In general, the stream has a moderate cross section throughout its length. Good pools are frequent and in the spawning areas, the numbers of pools and shallows are well balanced.

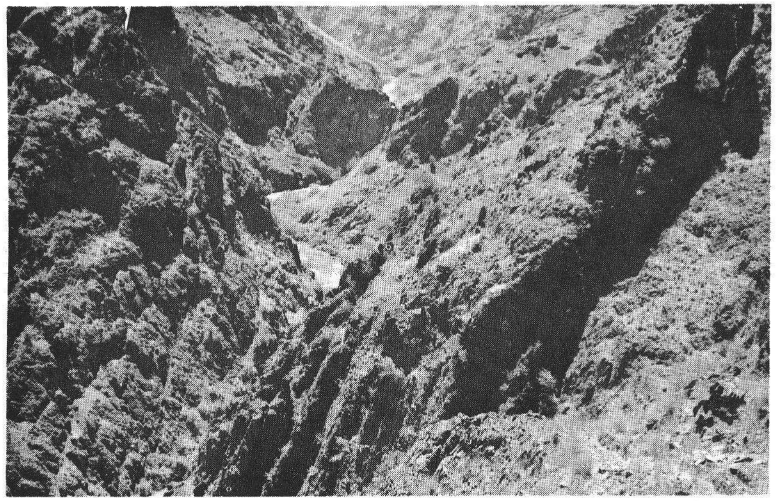

Figure 95. A Gorge Section on the Lower Imnaha River Between Fence and Horse Creeks.

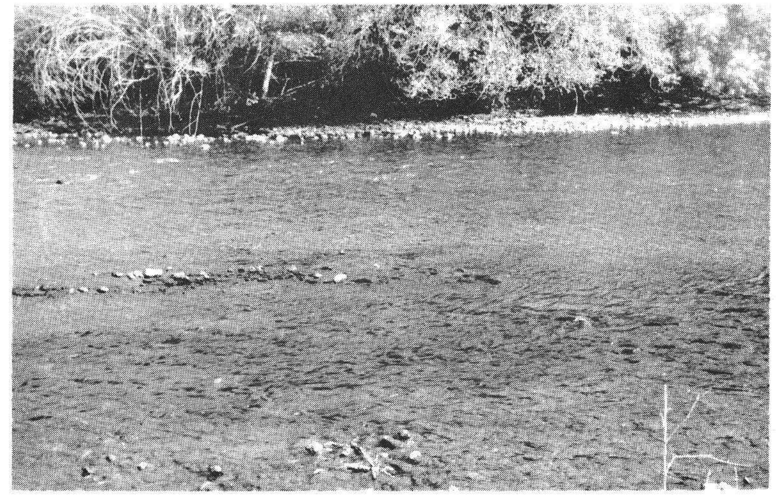

Figure 96. Gravel Deposit on Lower Imnaha R. about 16 Miles Below Imnaha, Ore. About 5 Per Cent of the Stream in this General Area is Suitable for Spawning.

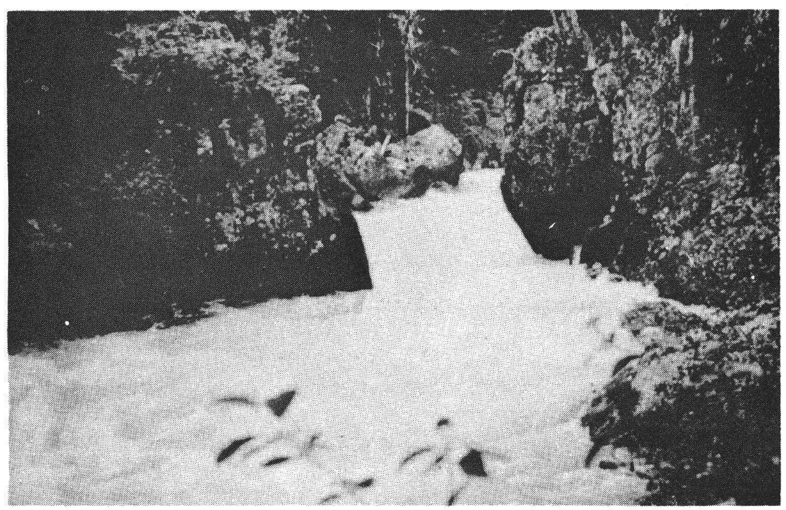

Figure 97. Cataract and Gorge Section on Upper Imnaha R. about 1 Mile Above the Blue Hole on 6-25-59.

Figure 98. Torrential Section of Upper Imnaha River Approximately 0.75 Mi. Above the Blue Hole on 6-25-59.

Bottom Materials: The principal gravel concentrations on the Imnaha River are in the 10-mile length of stream between the Blue Hole and Mac's Mine. This area is estimated to be 30 per cent suitable for spawning. The next greatest concentrations of gravel are found in the 10-mile stream section between the town of Imnaha and Horse Creek. In this area, 10 per cent of the bottom materials were estimated to be suitable for spawning. Excluding the aforementioned 2 sections, the approximately 50 miles of remaining stream is estimated to consist of 5 per cent spawning area (Figure 96). In all sections of the river, the dominant bottom material is rubble, and in many areas of steepened gradient, a large percentage of boulders exists. The location and relative abundance of gravel deposits are presented in Figure 94.

Obstructions and Diversions: Obstructions on the Imnaha River consist of numerous cataracts, several low falls, and one log jam, all located within the upper 5-mile, torrential section of the stream (Appendix B, Table VI). During a survey of the upper river on June 24, 1959, at which time high water prevailed, 10 serious cataracts (I-4), were observed in the first 2 miles above the Blue Hole. In constricted areas, cataracts were developing sufficient hydraulic head to be classified as low falls (Figures 97 and 98). At the time of this observation, the discharge was estimated to be between 500 and 1,000 c.f.s. and in many places water velocities appeared to approach the upper limit of those believed negotiable by salmonids. At the observed volume of flow, the section appeared impassable to upstream migrants. This type of gradient continues almost to the confluence of the North and South Forks. Near the upper end of the 5-mile long canyon (about 1 mile below the forks) upper (I-6) and lower Imnaha Falls (I-5), in particular, form barriers of questionable passage (Figures 99 and 100). Both of these falls are located in bedrock gorges where water velocities are likely to become excessive during periods of high flow.

Lower Imnaha Falls (I-5), as observed during the low water period in September of 1957 and 1958, is about 5 feet in height and width. It has a pool at the base from which fish could jump and may form only a partial barrier. It has not been observed during the high flow period. The upper falls (I-6), located about one-fourth mile above the lower falls, appears to form a more serious obstruction. This falls is approximately 7 feet in height as viewed during the low water stage in September.

A large log jam (I-3), which is wedged in a narrow gorge immediately above the Blue Hole, may form at least a partial barrier to upstream migration (Figure 101). This jam varies in width from 20 to 40 feet, ranges from 10 to 30 feet long, and extends above the water surface about 6 feet. The site of the jam may be inaccessible to heavy equipment. Another large jam (I-2) is forming in the river 2.3 miles below Mahogany Creek. This jam is presently passable, but will bear watching in the future.

A rock slide (I-1) which occurred during the construction of a road along the Imnaha River in the winter of 1952-53, at one time formed a serious barrier in the stream about 15 miles above the settlement of Imnaha, Oregon (Figure 102). This condition was later rectified, and at the present, no passage problem appears to exist.

No functioning unscreened diversion ditches were noted on the main river. Twelve screened ditches were checked and a number of abandoned ditches observed. On Summit Creek, which has a run of steelhead, there may be one unscreened ditch (I-S-1). This ditch was reported by a local rancher, but was not observed since no survey of Summit Creek was made. Another unscreened ditch (I-C-1) is present on Cow Creek approximately 1 mile above the mouth.

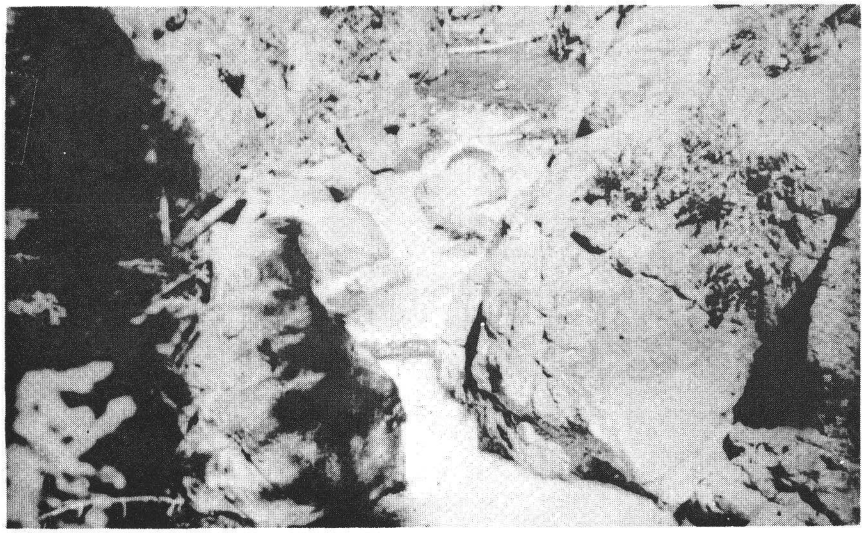

Figure 99. Lower Imnaha Falls Located 1 Mile Below the Forks of Imnaha R. At the Water Stage on 9/5/59, the Falls was About 5 Feet in Height and Width.

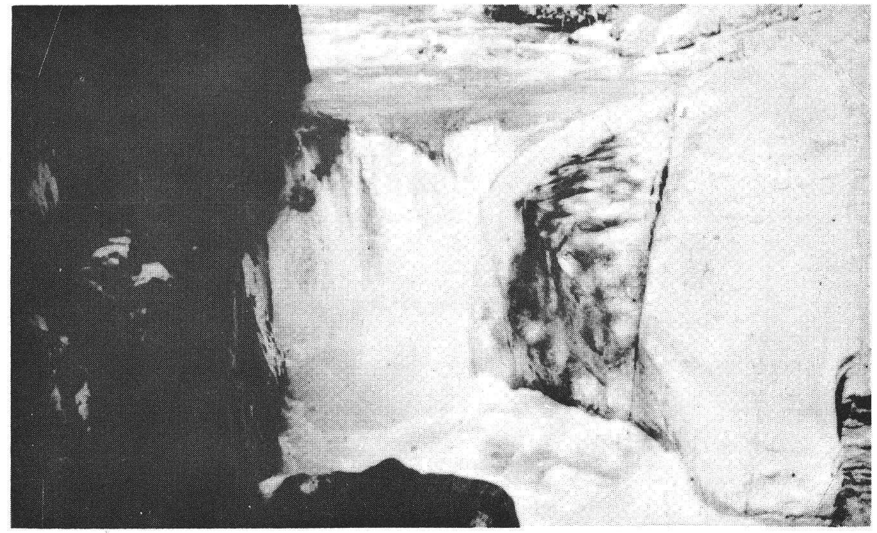

Figure 100. Upper Imnaha Falls Located on the Upper Imnaha R. About 0.25 Mile Above Lower Imnaha Falls. This Falls is About 6 or 7 Feet in Height.

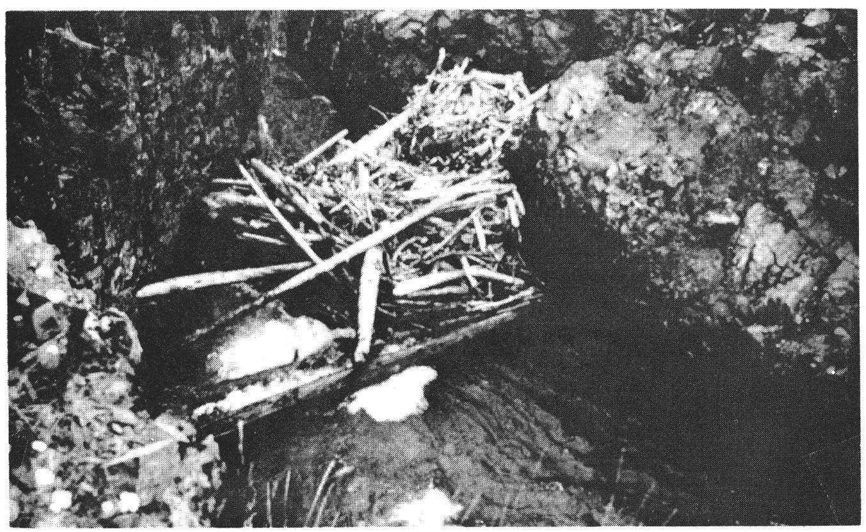

Figure 101. A Log Jam on the Upper Imnaha River Just Above the Blue Hole.

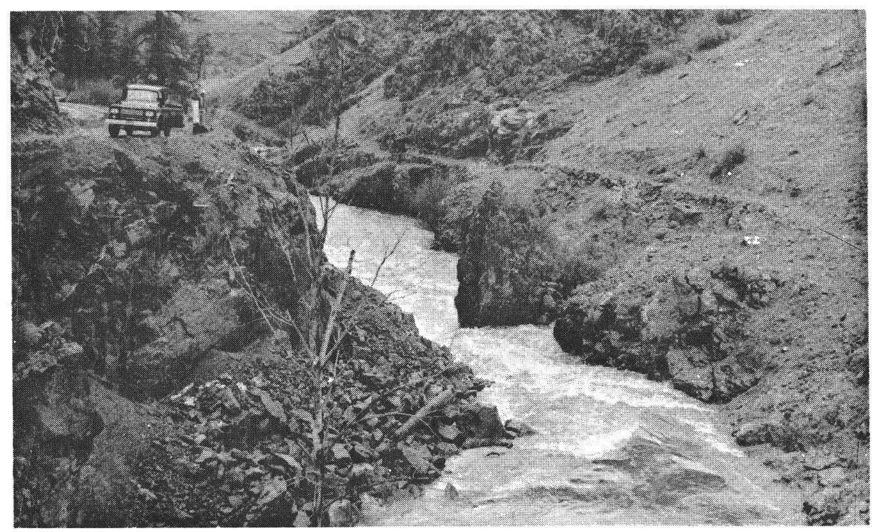

Figure 102. The Site of a Former Rock Slide Barrier Known Locally as "The Saddle" on the Central Imnaha R.

The locations of the obstructions on the Imnaha River and the unscreened ditch on Summit Creek are given in Figure 94.

Impoundment and Hatchery Sites: Sites believed adaptable for use as off-channel impoundments for the rearing of salmon are numerous along the Imnaha River. An estimated 100 or more acres of impoundment sites were noted along a 4.5-mile section of stream between Coverdale Forest Camp and Blackhorse Creek. Most of these sites are comprised of long, narrow tracts of bottom land bordering the stream. Some were estimated to be larger than 10 acres. All are located within U. S. National Forest boundaries, and portions of some of the larger sites are timbered. Other potential impoundment sites were noted on private land below Blackhorse Creek. One of these is a large open area located about 2.5 miles below Mahogany Creek. An abandoned diversion ditch existing at this site may be adaptable for use in conveying water to a pond. The locations of the observed impoundment sites are presented in Figure 94.

No sites which appeared suitable for hatchery use were noted.

Flow and Temperature Data: Flows and temperatures existent on the Imnaha River are considered to be generally favorable to the production of salmon. Flow records obtained on the river at Imnaha, Oregon, from 1929 through 1956, indicate that the average minimum monthly flow (September through January) ranges between 80 and 490 c.f.s. 1/ In this same period, the average maximum monthly flows (April through June) have ranged from 430 to 2,800 c.f.s. Minimum and maximum flows during the entire period are 16 2/ and 5,700 c.f.s.

During the inventory surveys, the water temperature ranged from 44°F. at 1:30 p.m., June 24, 1959, at a point 2 miles above the Blue Hole to 69°F. at 1:00 p.m., July 17, 1959, near Cow Creek. The discharge near Cow Creek on July 17 was estimated to be 500 c.f.s.

Table 77 presents detailed temperature and flow data for the Imnaha River obtained from records of annual spawning ground surveys and from USGS instantaneous temperature records. Further detailed temperature data are provided in Figures 103 and 104 which depict daily maximum and minimum stream temperatures at the town of Imnaha for portions of the years 1955, 1956, and 1957. Table 78 presents average monthly flow obtained at Imnaha, Oregon, from 1951 through 1957. 1/

Tributaries: The more important tributaries of the Imnaha River are dealt with later in the report. The smaller noteworthy tributaries which are not discussed at a later time are Gumboot, Crazyman, Summit, Grouse, Freezeout, and Cow Creeks. With the exception of Cow Creek, which is approximately 20 miles long, the other small streams range from about 5 to 12 miles in length. Because of their apparent lack of importance for the production of salmon, surveys were not conducted on these small tributaries. Nevertheless, their value to the production of steelhead should not be overlooked.

1/ Data obtained from U. S. Geological Survey Water Supply Papers, Part 13, Snake River Basin. Drainage area above flow station at Imnaha, Oregon, is 640 square miles.

2/ Flow of 16 c.f.s. in November 1931 was believed to have been caused by ice jams in river. Average discharge for week following 16 c.f.s. reading was 95 c.f.s.

Table 77. Spot Temperatures and Estimated Flows for Imnaha River, Arranged by Month.

Date and Year	Approximate Location	Time	Temp. in °F. Air	Temp. in °F. Water	Flow in c.f.s.	Source of Data
January						
1-31-57	Imnaha, Oregon	9:00 a.m.	27	32	163	USGS
1-14-58	"	8:30 a.m.	40	35	163	"
1-13-59	"	9:30 a.m.	32	35	947	"
February						
2-27-58	"	11:00 a.m.	36	38	901	"
March						
3-14-57	"	11:00 a.m.	34	37	406	"
April						
4-9-58	"	11:00 a.m.	60	46	501	"
May						
5-1-57	"	11:00 a.m.	71	48	1,610	"
June						
—	———	———	—	—	—	—
July						
7-30-57	Imnaha, Oregon	9:30 a.m.	82	64	260	USGS
7-16-59	Near Crazyman Cr.	3:20 p.m.	83	59	-	OFC
7-16-59	Mac's Mine	1:45 p.m.	82	54	400+	"
7-17-59	Imnaha, Oregon	8:55 a.m.	84	59	500+	"
7-17-59	Near Horse Cr.	(morning)	90	64	-	"
August						
8-18-49	Coverdale Forest Camp	8:20 a.m.	-	52	-	"
8-21-50	"	1:30 p.m.	-	53	-	"
8-17-52	Blue Hole	2:30 p.m.	70	54	75	"
8-17-52	2.5 mi. below Indian Crossing	1:15 p.m.	80	54	-	"
8-17-52	Coverdale F. Camp	5:30 p.m.	64	56	80	"
8-25-53	Blue Hole	11:45 a.m.	62	48	75	"
8-20-54	Near Blue Hole	9:50 a.m.	58	45	-	"
8-20-54	Near "The Saddle"	4:00 p.m.	57	54	-	"
8-21-54	2.5 mi. below Indian Crossing	8:00 a.m.	59	50	90	"
8-12-55	2.5 mi. below Indian Crossing	11:00 a.m.	66	52	-	"
8-12-55	Indian Crossing	11:00 a.m.	66	52	80	"
8-17-55	Blue Hole	11:30 a.m.	52	-	-	"
8-17-55	Coverdale F. Camp	7:00 a.m.	49	-	-	"
8-25-55	Indian Crossing	9:40 a.m.	65	48	65	"
8-25-55	Blue Hole	10:30 a.m.	62	58	-	"
8-25-55	2.5 mi. below Indian Crossing	5:45 p.m.	72	56	75	"
8-27-55	Coverdale F. Camp	8:30 a.m.	68	47	60	"
8-27-55	Blue Hole	8:00 a.m.	58	44	60	"
8-19-56	Blue Hole	11:30 a.m.	77	50	-	"
8-19-56	2.5 mi. below Indian Crossing	3:30 p.m.	86	56	-	"
8-20-56	Coverdale F. Camp	8:00 a.m.	61	48	-	"
8-20-56	Illahee Forest Camp	9:30 a.m.	78	50	-	"

Table 77. Spot Temperatures (continued)

Date and Year	Approximate Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.	Source of Data
August (continued)						
8-31-56	Indian Crossing	7:45 a.m.	50	42	--	OFC
8-31-56	Blue Hole	8:00 a.m.	60	42	50	"
8-26-57	Blue Hole	10:00 a.m.	73	46	55	"
8-26-57	2.5 mi. below Indian Crossing	9:55 a.m.	68	48	60	"
8-26-57	Coverdale F. Camp	(afternoon)	66	55	--	"
8-28-58	Imnaha, Oregon	9:00 a.m.	73	62	168	USGS
8-25-59	Blue Hole	11:00 a.m.	70	48	62	OFC
8-25-59	Indian Crossing	10:45 a.m.	73	58	108	"
8-25-59	Coverdale F. Camp	2:00 p.m.	76	55	108	"
8-25-59	Illahee F. Camp	4:45 p.m.	--	--	127	"
8-21-50	Coverdale	1:30 p.m.	--	53	--	USGS
8-24-55	2.5 mi. below Indian Crossing	5:45 p.m.	--	56	75	"
8-26-58	2.5 mi. below Indian Crossing	7:30 a.m.	55	50	--	"
8-21-50	Indian Crossing	1:00 p.m.	--	52	--	OFC
September						
9-12-54	Mac's Mine	9:00 a.m.	58	46	40-50	"
9-11-57	6 mi. below Coverdale	11:00 a.m.	74	50	60	"
9-11-57	9 mi. below Coverdale	11:30 a.m.	--	51	60	"
9-11-57	11 mi. below Coverdale	1:20 p.m.	78	55	60	"
9-12-57	1 mi. below College Cr.	10:25 a.m.	--	56	--	"
9-12-57	3.5 mi. below College Cr.	10:55 a.m.	--	57	--	"
9-12-57	6 mi. below College Cr.	11:25 a.m.	--	60	--	"
9-12-57	Imnaha, Oregon	11:55 a.m.	--	60	--	"
9-12-57	3 mi. below Imnaha	12:25 p.m.	--	61	--	"
9-12-57	16 mi. below Imnaha	2:00 p.m.	--	65	--	"
9-6-56	Blue Hole	7:50 a.m.	52	41	60	"
9-6-56	Illahee Forest Camp	2:00 p.m.	71	54	70	"
9-11-57	Near mouth of Gumboot Cr.	11:00 a.m.	--	50	--	"
9-11-57	12 mi. below Coverdale F. Camp	2:00 p.m.	--	55	--	"
9-11-57	Near mouth of Summit Cr.	3:15 p.m.	--	59	--	"
9-12-57	1 mi. below College Cr.	10:25 a.m.	--	56	--	"
9-12-57	3.5 mi. below College Cr.	11:00 a.m.	--	57	--	"
9-12-57	6 mi. below College Cr.	11:30 a.m.	--	60	--	"
9-12-57	Mouth Big Sheep Cr.	12:00 Noon	--	60	--	"
9-12-57	3 mi. below Imnaha	12:30 p.m.	--	61	--	"
9-12-57	16 mi. below Imnaha	2:00 p.m.	--	65	--	"
October						
10-15-57	Near Blackhorse Cr.	1:30 p.m.	--	46	--	"
10-16-57	Near mouth Cow Cr.	2:50 p.m.	--	53	--	"
10-22-57	Imnaha, Oregon	10:00 a.m.	50	48	163	USGS
10-28-58	"	8:30 a.m.	36	40	142	"
November						
11-18-58	Imnaha, Oregon	3:00 p.m.	--	50	55	"
December						
12-18-56	Imnaha, Oregon	1:00 p.m.	50	40	270	"
12-4-58	Imnaha, Oregon	8:00 a.m.	34	39	236	"

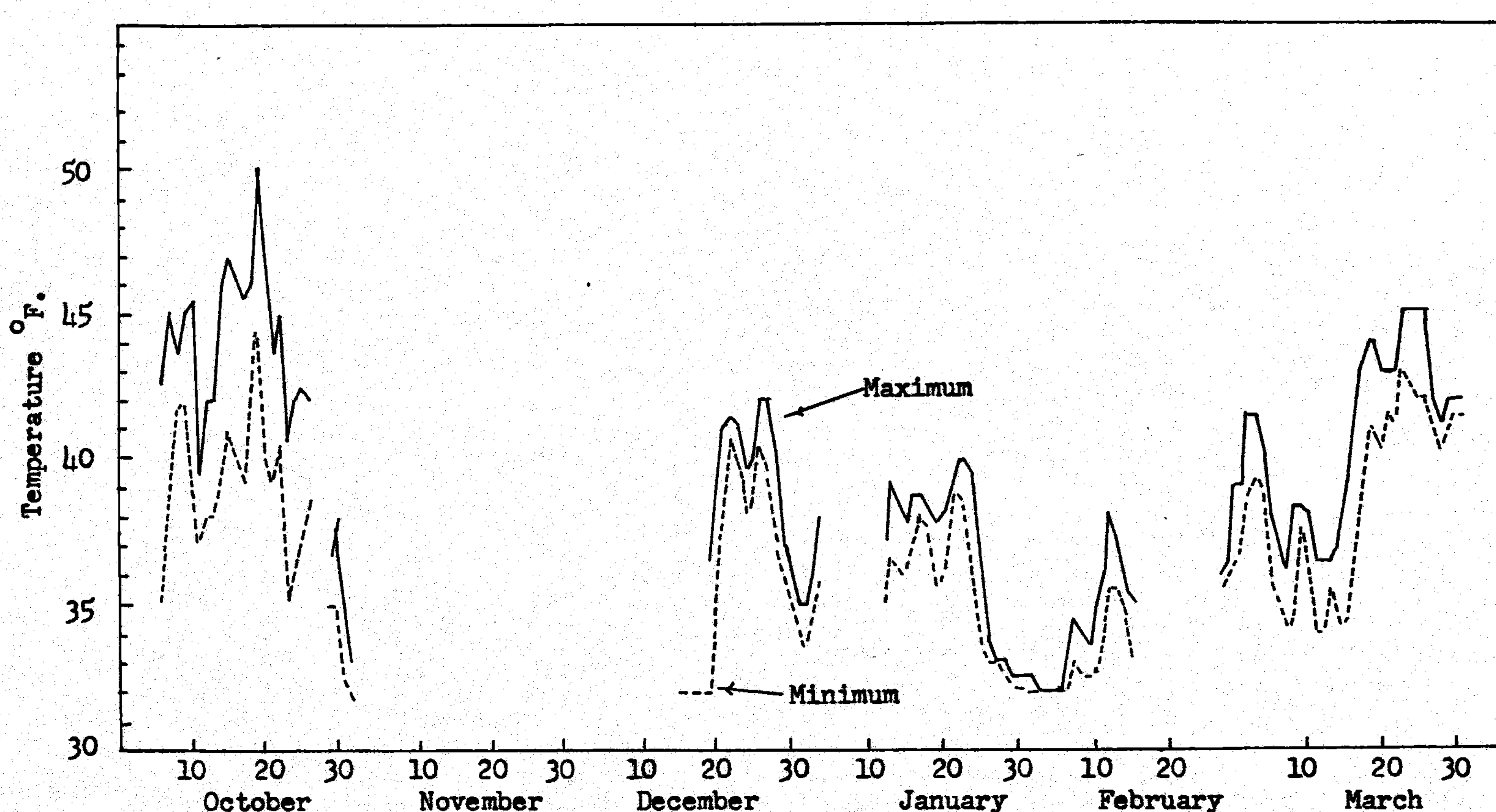

Figure 103. Daily Maximum and Minimum Temperatures in Degrees Fahrenheit for the Imnaha River 4.5 Miles Below Imnaha, Oregon, October 1955—September 1956 (Data obtained from U. S. Fish and Wildlife Service Report entitled, "A Progress Report on Air and Water Temperature Studies, Middle Snake Drainage, 1954-56," January 1958.)

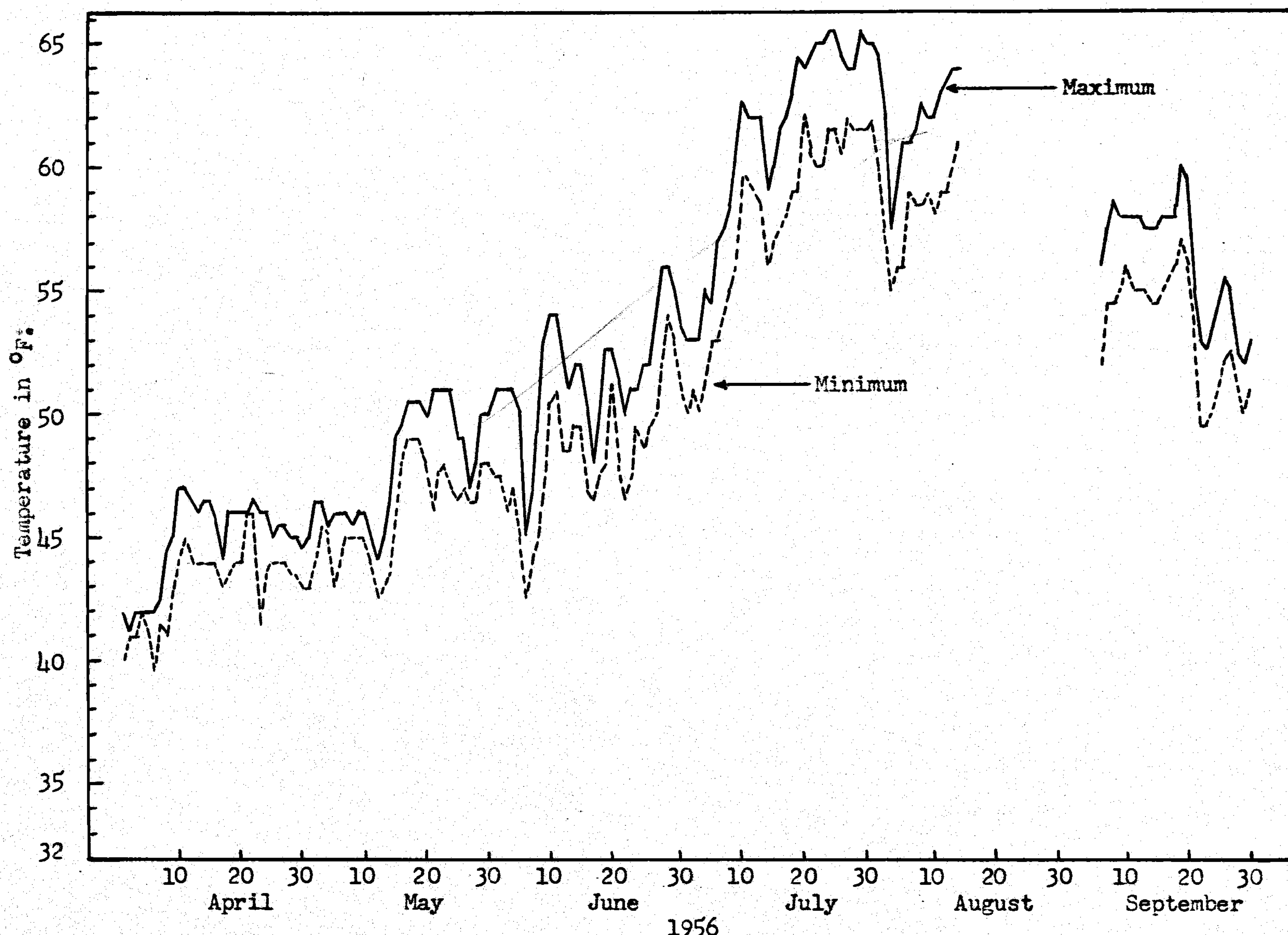

Figure 103. Daily Temperatures, Imnaha River, 1955-56 (continued).

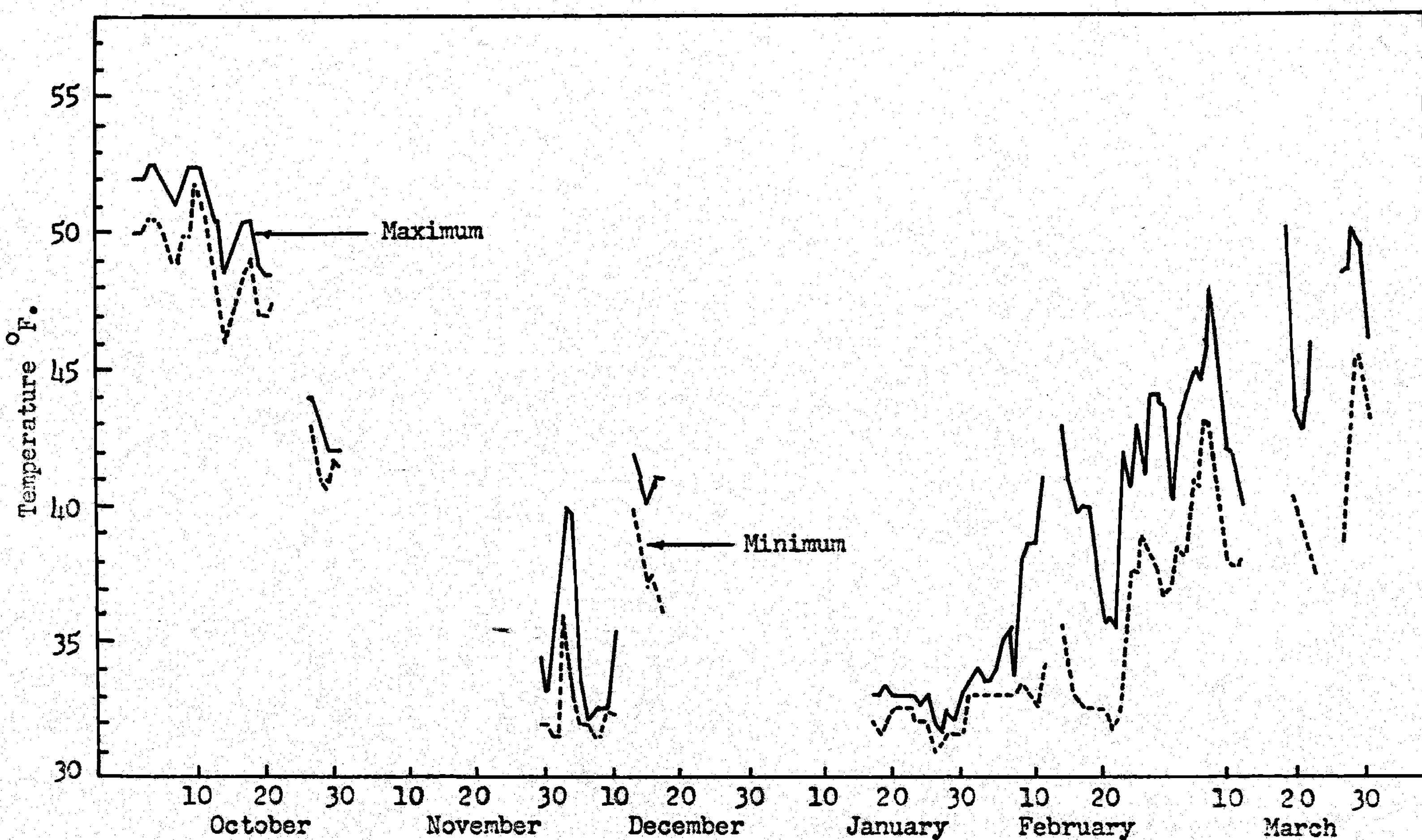

Figure 104. Daily Maximum and Minimum Temperatures in Degrees Farenheit for the Imnaha River 4.5 Miles Below Imnaha, Oregon, October 1956 - July 1957 (Data obtained from U. S. Fish and Wildlife Service Report Entitled, "Air and Water Temperature Studies for 1957, Middle Snake Drainage," April 1958.)

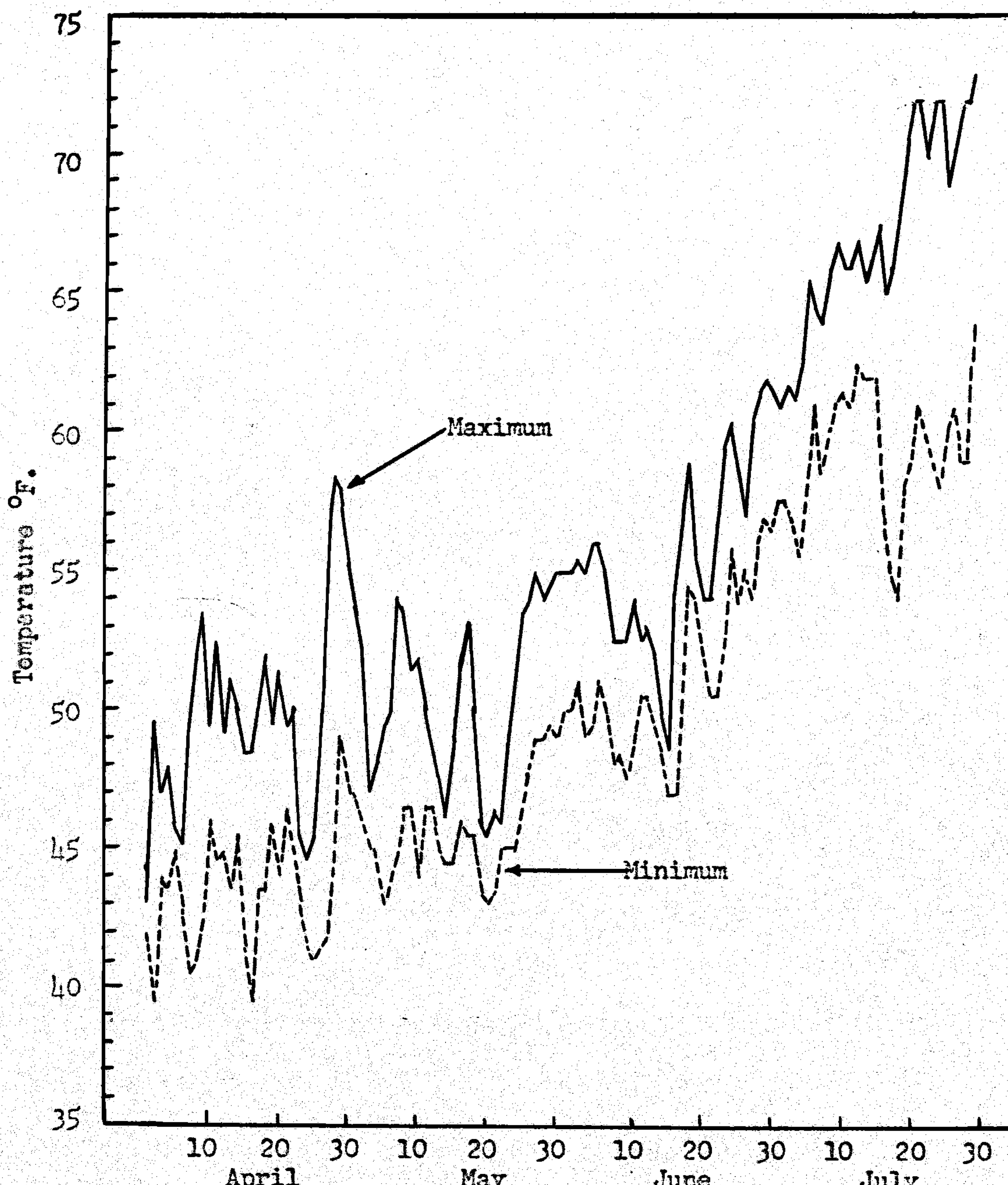

Figure 104. Daily Temperatures, Imnaha River, 1956-57 (continued).

Table 78. Mean Monthly Discharge in Cubic Feet Per Second for the Imnaha River at Imnaha, Oregon, 1951-57. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	226	296	303	193	318	303	1,147	1,515	972	493	173	122
1952	160	156	262	163	187	244	1,532	2,421	1,753	915	241	149
1953	123	113	148	237	229	330	943	1,544	1,881	1,120	306	155
1954	131	149	158	168	278	363	884	1,349	1,026	581	199	152
1955	142	146	114	117	111	141	512	1,505	1,386	522	169	132
1956	175	229	593	378	241	642	1,760	2,381	1,796	674	246	174
1957	190	203	218	155	351	475	815	2,661	1,394	435	183	134

1/ Data obtained from U. S. Geological Survey Water Supply Papers 1217, 1247, 1287, 1347, 1397, 1447, and 1517, Part 13, Snake River Basin.

Anadromous Fish Populations

The Imnaha River has a good run of spring chinook salmon. Less is known concerning the size of the steelhead population, but indications are that it is substantial. Limited field observations have failed to verify the presence of a fall-spawning type of salmon, such as summer or fall chinook or silver salmon on the stream.

Spring Chinook Salmon: With exception of the year 1951, Fish Commission personnel have conducted annual spawning ground surveys on the Imnaha River since 1948. The resulting 10 years of records indicate that this is probably the most consistently productive chinook salmon stream in Eastern Oregon (Table 79). Past observations have shown chinook to spawn from the Blue Hole to the vicinity of Freezeout Creek, some 30 miles in distance, with the largest concentrations of spawners found generally in the 10-mile section between the Blue Hole and Mac's Mine. Below Mac's Mine, gravel becomes less abundant and water temperatures during the summer become progressively warmer as the stream mouth is approached.

In respect to timing of spawning activity, multiple surveys conducted over the greater part of the spring chinook spawning season in 1955 indicated that the peak of spawning in that year occurred slightly prior to August 24. In other years, there has been evidence that peak spawning activity may sometimes occur later than was indicated in 1955. In this same year, the initial survey was conducted on August 12, at which time spawning was already well in progress. On the last survey made on September 5, spawning activity had diminished to what appeared to be the final stages.

Downstream migrant chinook salmon are commonly trapped on the Imnaha River at fish screen installations at diversion ditches. Table 80 lists the numbers of fingerlings captured at the screens, and the months of capture for the years 1953-1957. The catches made in August and September greatly outnumber those of other months.

Table 79. Annual Spawning Ground Counts of Spring Chinook Salmon Within an Index Unit on the Imnaha River. 1/

Date and Year	Location	Alive	Dead	Redds
8-18-49	Blue Hole to Mac's Mine.	143	17	256
8-21-50	Blue Hole to Mac's Mine.	99	8	122
8-17-52	Blue Hole to Mac's Mine.	563	48	426
8-25-53	Blue Hole to Mac's Mine.	265	67	348
8-20-54	Blue Hole to Mac's Mine.	367	112	364
8-24-55	Blue Hole to Mac's Mine.	697	231	698
8-25-56	Blue Hole to Coverdale.	269	53	206
8-26-57	Blue Hole to Mac's Mine.	805	350	747
8-26-58	Blue Hole to Mac's Mine.	267	129	129
8-25-59	Blue Hole to Illahee.	166	38	115

1/ Surveys conducted by the Oregon Fish Commission.

Table 80. Monthly Catch Records of Chinook Salmon Captured in By-Pass Traps at Certain Irrigation-Ditch Fish-Screen Installations on the Imnaha River, 1953-57. 1/

Year	Period of Capture	Month of Capture							Total
		Apr.	May	June	July	Aug.	Sept.	Oct.	
1953	6-24 - 10-15	0	0	34	179	15,344	22,575	3,126	41,258
1954	7-1 - 10-30	-	-	0	428	1,800	1,454	666	4,348
1955	6-8 - 10-15	-	0	28	1,357	42,493	33,709	5,611	83,198
1956	7-24 - 10-31	-	-	-	129	8,195	12,123	11,238	31,685
1957	5-1 - 10-15	0	1,410	111	356	16,873	20,672	3,942	43,364
	Total	0	1,410	173	2,449	84,705	90,533	24,583	203,853

1/ Information courtesy of the Oregon Game Commission. Screens and by-pass traps operated by the Game Commission.

Steelhead Trout: The distribution of steelhead in the Imnaha River has never been fully determined. With exception of the North and South Forks, this species is known to exist in all of the larger tributaries as well as in some of the smaller ones. Since steelhead are commonly observed in many of the small tributaries in Eastern Oregon, it seems reasonable to presume their presence in all accessible streams of suitable flow and gradient in the Imnaha system. Tributaries most likely to be in this category are Dry, Gumboot, Mahogany, Crazyman, Summit, Grouse, Freezeout, Sheep, Horse, Lightning, and Cow Creeks. This does not preclude the possibility of steelhead inhabiting some of the steep, smaller perennial tributaries or some of the smaller tributaries of intermittent nature.

As in the case of the tributaries, the distribution of steelhead reproduction on the main river is unknown. Information obtained from the Oregon Game Commission indicates that the stream may be utilized by steelhead for spawning above Freezeout Creek. 1/

Although the relationship of the numbers of sport-caught steelhead to population numbers is unknown, it is of interest to present the estimated sport catch on the Imnaha River for the years 1953-55 as compiled from punch cards by the Oregon Game Commission. These estimates are 868, 787, and 196 steelhead, in chronological order. 2/

Other information concerning this species is available from the capture of rainbow fingerlings at by-pass traps operated at irrigation ditch fish screen installations on the Imnaha River (Table 81). These data indicate that juvenile rainbow trout are available to the traps from May through October and that the peak months of capture are August and September.

Fall-Spawning Chinook Salmon: Chapman (1940) states "I was told that there is a considerable fall chinook run into the lower river in September but that they seldom get upstream as far as Imnaha". No other information on the presence of fall-spawning chinook has been obtained. Limited surveys made in the fall of 1957 disclosed no fall chinook on the lower Imnaha River.

Silver Salmon: Fish of this species apparently have never been observed on the river by personnel of the various fisheries agencies.

SOUTH FORK IMNAHA RIVER

Introduction

The South Fork arises at an altitude of approximately 8,500 feet and flows 7 miles through a deep, mountainous canyon to join the North Fork and form the Imnaha River (Figure 94). This tributary is located in a remote area accessible only by trail.

Limited investigation has revealed no utilization of the South Fork by anadromous fishes.

1/ Oral interview, Robert Sayre, Oregon Game Commission, Region 4.

2/ Oregon Game Commission punch card data as listed by R. B. Pirtle, 1957, Idaho Department of Fish and Game, Final Report to the Corps of Engineers.

Table 81. Monthly Catch Records of Rainbow Trout Captured in By-Pass Traps at Certain Irrigation-Ditch Fish-Screen Installations on the Imnaha River, 1953-57. 1/

Year	Period of Capture	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
1953	6-24 - 9-23	0	0	2	19	44	63	0	128
1954	7-1 - 10-30	-	-	0	21	87	95	61	264
1955	6-8 - 10-15	-	0	11	276	607	235	72	1,201
1956	8-16 - 10-23	-	-	-	0	0	7	80	87
1957	5-1 - 10-15	0	23	3	11	40	61	26	164
	Total	0	23	16	327	778	461	239	1,844

1/ Information courtesy of the Oregon Game Commission. Screens and by-pass traps operated by the Game Commission.

Inventory Surveys - Dates and Areas

Surveys on the South Fork extended over a 5 mile section of stream from the mouth to Cliff Creek. The lower 3 miles were observed on foot on June 12, 1958. On September 5, 1958, a survey was conducted on the lower 2 miles to determine if the stream is utilized by chinook salmon for spawning. On June 1, 1959, an aerial survey was made over the 2-mile stream section extending from 3 miles above the mouth to Cliff Creek.

Survey Data

Terrain and Gradient: The South Fork is in a canyon which is intermediate between narrow and wide. The gradient in the first 1.5 miles above the mouth is moderate and thereafter becomes steep.

Slope and Bank Cover: The condition of the South Fork watershed appears good. The dominant slope cover is composed of coniferous timber, grasses and rock. Due to former glaciation, considerable underlying rock is exposed along the canyon walls. Cover along the stream consists of conifers, brush, and grasses.

Shade: Stream shading is partial throughout the area of survey.

Stream Cross Section: The stream channel is shallow for approximately the lower half mile, and above this point becomes moderate in cross section.

Bottom Materials: The greatest concentration of gravel is in the lower 1.5 miles. This section was estimated to be 50 per cent suitable for spawning. Above this point, the gradient steepens and less than 10 per cent of the next 1.5 miles appeared of value for spawning.

Obstructions and Diversions: No obstructions were noted on the South Fork. Since the stream is well above the agricultural zone of the Imnaha Basin, no diversions are present. Access of the South Fork to anadromous fish may be prevented by obstructions located in the torrential section of the upper Imnaha River.

Impoundment and Hatchery Sites: A 10-acre meadow, which appeared suitable for the construction of an off-channel impoundment, was noted at the confluence of the North and South Forks. However, development of this site is questionable since excavation would be necessary, and the area is presently inaccessible to heavy equipment.

Flow and Temperature Data: These data are limited to the few observations made during the inventory survey program and on two earlier surveys (Table 82). Considering the elevation of the watershed, it is doubtful that critically low flows or excessive water temperatures characterize summer stream conditions on the South Fork.

Tributaries: The South Fork has about six noteworthy tributaries of which Soldier and Bear Creeks were observed during the foot survey. Both streams were flowing an estimated 15 c.f.s. Because of steep gradients, the tributaries of the South Fork appear to be of little importance to the production of anadromous fishes.

Anadromous Fish Populations

It is presently unknown if the South Fork is utilized by any anadromous species. A survey to investigate the status of chinook utilization was made on the lower 2 miles of the stream on September 5, 1958. No evidence of spawning was found. Since abundant gravel of a size suitable for spawning is present in the first 1.5 miles above the mouth, it is believed that the South Fork is generally inaccessible to chinook. A survey made to determine passage conditions in the torrential section of the upper main stem on June 24, 1959, further substantiates this opinion. Information regarding steelhead utilization of the South Fork is lacking.

Table 82. Spot Observations of Temperatures and Estimated Flows for the South Fork of the Imnaha River.

Date	Location	Time	Temp in °F.		Flow in c.f.s.
			Air	Water	
8-18-49	Mouth.	4:30 p.m.	--	56	--
8-21-50	Mouth.	10:30 a.m.	66	50	--
6-12-58	Mouth.	10:00 a.m.	--	40	350
6-12-58	3 miles above mouth.	3:00 p.m.	--	40	300
9-5-58	Mouth.	11:00 a.m.	--	--	55

NORTH FORK IMNAHA RIVER

Introduction

The North Fork originates near an elevation of 8,000 feet and descends approximately 3,000 feet within 7 miles to join the South Fork (Figure 94). The stream is accessible only by trail.

At this time there is no evidence that the North Fork is inhabited by any of the anadromous fishes.

Inventory Surveys - Dates and Areas

The lower 5 miles of the North Fork were surveyed on foot on June 12, 1958. No survey was conducted on the major tributary, the Middle Fork.

Survey Data

Terrain and Gradient: The North Fork canyon is typically U-shaped as a result of glaciation. The gradient in the surveyed area is generally steep to torrential. In the approximate uppermost mile of the area of survey, the stream flows through a meadow where the gradient decreases periodically to form riffles over gravel. A few very short riffles were also observed in intermediate parts of the surveyed section where momentary slackening of the gradient occurs. The steepest part of the observed stream section is the first mile above the mouth. In this area, the overall gradient is approximately 400 feet per mile (7.5 per cent). 1/

Slope and Bank Cover: Slope cover consists of various conifers, grasses and rock. At the higher elevations, the slopes are only sparsely timbered and rock and alpine vegetation is predominant. Cover in the canyon bottom includes conifers, brush, and grasses.

Shade: The stream is partially shaded within the surveyed area.

Stream Cross Section: The stream is moderate in cross section.

Bottom Materials: The only noteworthy gravel concentrations on the North Fork were in the upper mile of the surveyed area. This section was estimated to be 10 to 20 per cent suitable for spawning. Other than in the upper mile, boulders were the dominant bottom material.

Obstructions and Diversions: The North Fork below the Middle Fork (lowermost 2.5 miles) is considered to be impassable to upstream migrants due to the cumulative affect of multiple cataracts (I-NF-1) (Appendix B, Table VI). The channel may be totally obstructed by one particularly serious cataract located about 0.5 mile above the mouth. In addition, obstructions in the torrential section of the upper Imnaha River may prevent access to the mouth of the North Fork.

Impoundment and Hatchery Sites: No sites which appeared suitable for impoundment or hatchery use were noted.

Flow and Temperature Data: Table 83 presents available temperature and flow data for the North Fork.

1/ Gradient determined from U. S. Geological Survey topographic map, Cornucopia Quadrangle.

Table 83. Spot Observations of Temperatures and Estimated Flows for the North Fork of the Imnaha River.

Date	Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.
8-18-49	Mouth.	4:30 p.m.	—	52	—
8-21-50	Mouth.	10:10 a.m.	66	44	—
6-12-58	Mouth.	10:30 a.m.	—	40	350
6-12-58	Immediately above mouth Middle Fork.	2:00 p.m.	—	39	150
9-5-58	Mouth.	—	—	—	45

Tributaries: The major tributary of the North Fork is the Middle Fork which enters the main stream about 2.5 miles above the mouth. The Middle Fork is comparable to the North Fork in drainage area and on June 12 was flowing an estimated 150 c.f.s. at the mouth. Because of the large volume of flow which prevailed during the inventory of the upper Imnaha River tributaries, the Middle Fork was not accessible from the bank from which the North Fork was surveyed. Other data, however, provide some indication of the physical characteristics of this stream. Reference is made to the U. S. Geological Survey map of the Cornucopia Quadrangle which shows a gradient of approximately 5 per cent in the first mile of the Middle Fork above the mouth. Beyond the initial mile, the gradient increases.

Anadromous Fish Populations

Although information concerning the North Fork is generally lacking, it probably is not unreasonable to assume that this stream has little or no value for the production of salmon or steelhead. This opinion is based primarily on the presence of several barriers, both on the main Imnaha River and the North Fork, which appear to obstruct passage to the gravel deposits located on the upper reaches of the stream.

HORSE CREEK

Introduction

Horse Creek enters the Imnaha River approximately 12 miles above the mouth (Figure 94). From its source, at the altitude of about 6,500 feet, the stream flows northerly 20 miles through a rugged, deeply eroded canyon which parallels the Imnaha River. Elevation at the stream mouth is about 1,500 feet.

Horse Creek canyon contains only a small amount of arable land, hence the diversion of water for irrigation is restricted. Logging has occurred in some accessible portions of the canyon, especially along the slopes in the lower reaches and in the headwater area.

Knowledge concerning the fish populations of Horse Creek is very limited. At this time, there is no evidence that salmon are present; however, the stream is known to support a run of steelhead.

Horse Creek in the lower 7 miles is accessible by way of the lower Imnaha River road, and upper Horse Creek can be reached by trail via the Hot Point road from Imnaha, Oregon.

Inventory Surveys - Dates and Areas

Foot surveys covering approximately the lower half of Horse Creek, from Rheumatiz Gulch to the mouth, were made on May 7 and June 10, 1959. On June 1, 1959, an aerial survey, 10 miles in length, was made on the upper creek from the East Fork to Rheumatiz Gulch. In the fall of 1957 and the spring of 1958, 2 spot-check surveys were conducted in the lower 9 miles. Pumpkin Creek, the principal tributary of Horse Creek, was spot checked from source to mouth on May 7, 1959.

Survey Data

Terrain and Gradient: Horse Creek canyon is generally narrow above Imbler Gulch and of narrow to intermediate formation from this point to the mouth (Figure 105). The upper canyon becomes gorgelike in some sections. The stream gradient is generally steep, becoming moderate only on occasion (Figure 106).

Slope and Bank Cover: Near the East Fork, conifers are present on ridge tops and in the ravines. In a downstream direction, the timber gradually thins out, giving way to grasses and outcroppings of rock. Above Imbler Gulch, bank cover is predominantly conifers and brush. Below this point, conifers are largely replaced by deciduous trees intermixed with brush.

Shade: Shading of the stream is dense above the mouth of Pumpkin Creek and dense to partial below this point.

Stream Cross Section: No record of this characteristic was obtained in the section of aerial survey. In the area of ground survey, below Rheumatiz Gulch, the channel cross section was moderate to deep in the upper 2.5 miles and moderate the remaining distance to the mouth.

Bottom Materials: Since aerial surveys were found to be generally unsatisfactory for observation of bottom materials, no estimate of bottom composition is presented for the 10-mile section of aerial survey on Horse Creek (East Fork to Rheumatiz Gulch). In the area of foot survey, below Rheumatiz Gulch, the upper 2.5 miles was estimated to be 5 per cent gravel, the next 4 miles, 15 per cent gravel, and the lower 3 miles to the mouth, 30 per cent gravel. Rubble and boulders are the dominant bottom materials. Figure 94 depicts the location and relative abundance of the gravel deposits in the ground survey section of Horse Creek.

Obstructions and Diversions: Two log jams (I-H-2), the degree of obstruction undetermined, were noted near the center of the aerial survey section (Appendix B, Table VI). Due to poor visibility while making aerial observations, other jams may have gone undetected. In the area of ground observation, 12 log and debris jams were encountered in the 2.5-mile section immediately below Rheumatiz Gulch (Figures 107 and 108). Two of these (I-H-1) may form low-water blocks. Within the next 4 miles, 6 log and debris jams were noted, 5 (I-H-1) of which may form low-water barriers. One other debris jam (I-H-1), a possible low-flow barrier, was observed 1.5 miles above the mouth. The general locations of the jams are given in Figure 94.

No diversion ditches were observed on Horse Creek.

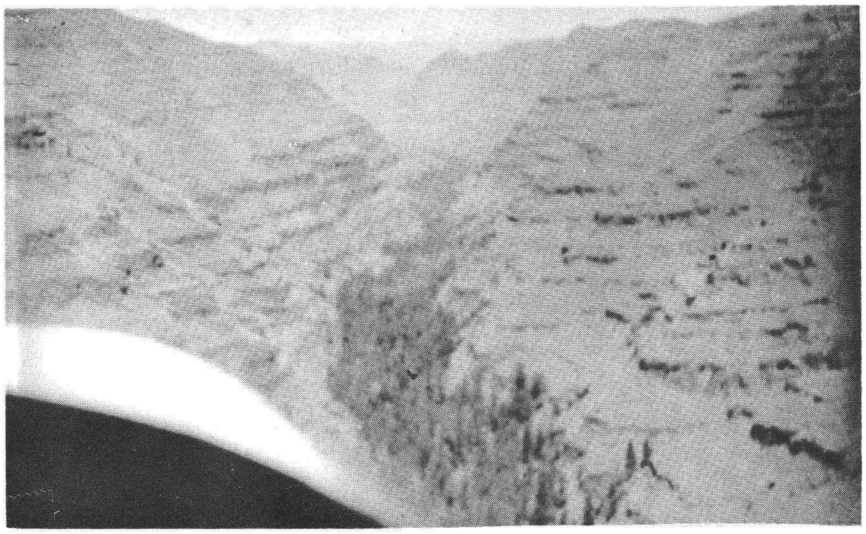

Figure 105. Aerial Photo of Lower Horse Cr. Canyon Depicting Slope Cover and Rugged Terrain of this Region.

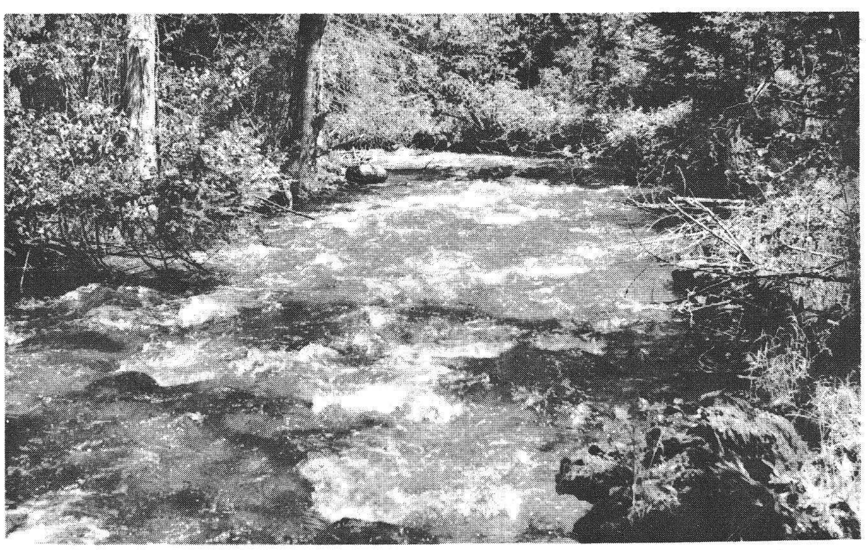

Figure 106. Rapid Flow and Degree of Stream Bank Shade Found on Horse Cr. About 7 Miles Above the Mouth.

Figure 107. This Small Debris Jam on Horse Creek Between Imbler Gulch and Rheumatiz Gulch is a Possible Low Flow Barrier to Upstream Migrants.

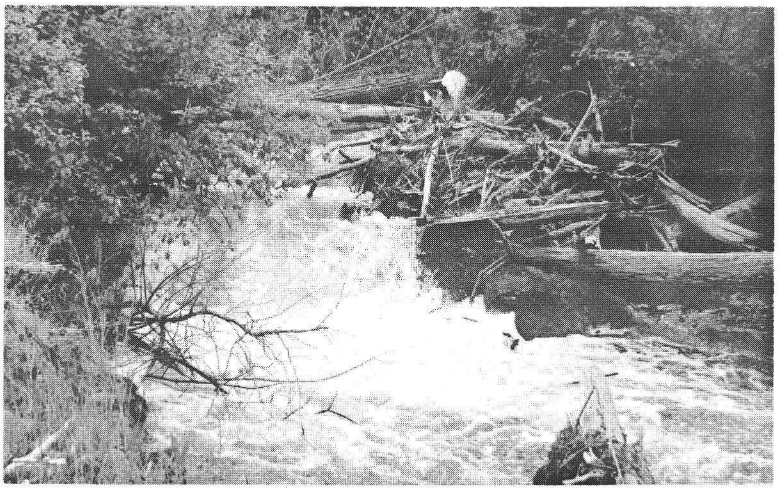

Figure 108. A Possible Low Flow Barrier on Horse Creek Below the Mouth of Pumpkin Creek. This Jam Had Poor Jumping Conditions at the Base in June 1959.

Impoundment and Hatchery Sites: A limited number of small sites suitable for the construction of off-channel impoundments are present on Horse Creek below the mouth of Pumpkin Creek. In-channel impoundment construction on this stream may be complicated due to the steep gradient and the high volume of spring run-off.

No sites which appeared suitable for hatchery construction were observed.

Flow and Temperature Data: Flow and temperature records are restricted to observations made since the initiation of the inventory survey program. Data for the warmer summer months are generally lacking. The highest recorded water temperature is 66°F. taken at the mouth on July 17, 1959, at 1:00 a.m. It is believed that water temperatures may sometimes exceed 70°F., particularly in the lower reaches of the stream. Flows approaching a magnitude of 100 c.f.s. were observed below Imbler Gulch on June 10, 1959. The lowest recorded flow was on September 12, 1957, when discharge at the mouth was estimated to be 6 c.f.s. Flow and temperature data in greater detail are presented in Table 84.

Tributaries: Pumpkin Creek is the only important tributary of Horse Creek. On May 7, 1959, this stream was discharging an estimated 15 c.f.s. near the mouth and on June 10, 1959, discharge at the mouth was about 8 c.f.s. The water temperature at the mouth on the latter date was 53°F. at 1:00 p.m.

A spot check survey was conducted on Pumpkin Creek on May 7, 1959. At a series of impassable falls located 4 miles below the source, the stream drops an estimated 40 feet within a 100 yard distance. The remaining 6 miles to the mouth has a steep gradient and only small occasional patches of gravel were observed. As indicated by spot checks, most of the gravel is situated above the falls in an area of probable critical summer flow.

Anadromous Fish Populations

Salmon: Utilization of Horse Creek by any of the species of salmon has not been indicated.

Steelhead: The size and distribution of the steelhead population are unknown at this time. On April 29, 1958, 4 steelhead were observed on a redd about 3 miles above the mouth. Another redd, presumably that of a steelhead, was observed on June 10, 1959, about 1 mile below Imbler Gulch.

Table 84. Spot Observations of Temperature and Estimated Flows on Horse Creek.

Date	Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.
9-12-57	Mouth.	6:00 p.m.	—	—	7
10-16-57	1 mile above mouth.	11:30 a.m.	—	48	8 - 10
10-16-57	6 miles above mouth.	12:45 p.m.	—	47	6
7-17-59	Mouth.	11:00 a.m.	—	66	8

LIGHTNING CREEK

Introduction

Lightning Creek arises near the headwaters of Horse Creek at an elevation of about 6,500 feet. It flows some 22 miles through a deep rimrock canyon and joins the Imnaha River about 6 miles above the mouth at the 1,200 foot elevation. Some sections of the basin have been logged in the past.

As a result of lack of investigation, little is known concerning the status of anadromous fishes in the stream. Superficially, the stream characteristics appear more compatible to the production of steelhead than to salmon.

Lightning Creek is accessible via the lower Imnaha River road, from which a private road ascends the canyon for more than 8 miles above the mouth.

Inventory Surveys - Dates and Areas

An aerial survey was made on Lightning Creek on June 1, 1959, from the mouth upstream 16 miles. Other observations include spot checks of flow and temperatures at the mouth, a spot-check survey by vehicle for the first 6 miles above the mouth to Rhodes Creek on April 29, 1958, a spot-check survey for 8 miles above the mouth to Sleepy Creek on July 17, 1959, and a more detailed check for obstructions over the lower 8 miles of the stream on October 19, 1959.

Survey Data

Terrain and Gradient: From the upper forks of Lightning Creek down to Sleepy Creek (8 miles), the canyon is generally narrow, becoming slightly wider only in the lower third. Below Sleepy Creek, the basin widens and is intermediate between narrow and wide. The gradient is steep from the upper survey boundary to Sleepy Creek, where the stream becomes moderate to steep the remaining 8 miles to the mouth.

Slope and Bank Cover: Slope cover in the upper half of the canyon consists of grasses and rocks with coniferous timber in the gullies. The conifers diminish in abundance below Sleepy Creek and grasses and rocks assume dominance. Above Sleepy Creek, bank cover is predominantly conifers and brush. From Sleepy Creek to the mouth, the conifers gradually thin out along the banks and are replaced with deciduous timber intermixed with grasses and brush.

Shade: Shading is partial down to the vicinity of Sleepy Creek where the stream becomes partially to openly exposed.

Stream Cross Section: As evaluated by ground observations, the stream cross-section from Sleepy Creek to the mouth is generally moderate.

Bottom Materials: Poor visibility attributable to brushy banks and a narrow canyon prevented assessment of the bottom materials above Sleepy Creek during the aerial survey. The steep gradient in this section is not considered to be conducive to the formation of spawning beds. Below Sleepy Creek, ground observations over about 75 per cent of the stream indicated that 10 per cent of the bottom materials are gravel.

Obstructions and Diversions: Three log jams (I-L-2) were sighted from the air in the upper half of the surveyed section (Appendix B, Table VI). The degree of obstruction could not be accurately determined. From the mouth of Lightning

Creek to Sleepy Creek, 5 possible low flow barriers (debris jams, I-L-1) were observed during ground surveys. These were located from 1.5 to 8 miles above the mouth, and were intermixed with numerous other jams which appeared definitely passable. The locations of the possible barriers are given in Figure 94.

No operative diversion ditches were noted on Lightning Creek.

Impoundment and Hatchery Sites: Expanded sections of valley floor located between Sleepy Creek and the mouth of Lightning Creek provide several sites for the construction of off-channel impoundments. Some of these areas are presently utilized for producing hay. In-channel impoundments involving the construction of dams may be feasible, but would require further investigation into annual fluctuation in discharge and general suitability of sites. No sites adaptable to hatchery development were observed.

Flow and Temperature Data: Observed flows on Lightning Creek ranged from 5 c.f.s. at the mouth on September 12, 1957, to 35 c.f.s. just below Rhodes Creek on April 29, 1958. A water temperature of 74°F. was recorded at the mouth on July 17, 1959, at 4:30 p.m. On this same date, a water temperature of 65°F. (air temperature was 100°F.) was recorded just above the confluence of Sleepy Creek at 3:15 p.m. Available temperature and estimated flow data are given in Table 85.

Tributaries: Sleepy Creek is the only important tributary of Lightning Creek. This stream enters the main stem about 9 miles above the mouth, and is approximately 10 miles in length. It is accessible to fish at the mouth and appears to have a potential for the production of steelhead.

<u>Anadromous Fish Populations</u>

Salmon: None of the species of salmon are known to utilize Lightning Creek.

Steelhead: Although no adult steelhead were observed on Lightning Creek during the surveys, there were indications that this species is present. On the survey of July 17, 1959, numerous small rainbow trout fingerlings were noted in the first 4 miles of the stream below Sleepy Creek. Many of these young trout were present at the confluence of Lightning and Sleepy Creeks. Also, a redd typical of that of a steelhead or salmon was observed about 0.2 mile below Sleepy Creek.

DISCUSSION AND RECOMMENDATIONS

Although the Imnaha System supports sizable populations of chinook and steelhead, it is believed that the ultimate productivity of the basin is not being realized. The main river is considered to be of foremost importance in a program to increase salmon production because it appears to lend itself more favorably to development than do the tributaries. However, some of the larger tributaries might also produce more fish with the application of adaptable rehabilitation techniques.

In this section of the report, streams of the Imnaha System under consideration for development are the main stem of the Imnaha, the South Fork, and Horse and Lightning Creeks. No recommendations are submitted for development of the North Fork of the Imnaha River. This stream has only negligible spawning area and appears inaccessible to anadromous fish due to barriers located near the mouth and on the upper Imnaha River. The Middle Fork, a North Fork tributary, is similarly inaccessible. Big Sheep Creek, the largest of the Imnaha River tributaries, has been considered under a separate report.

Table 35. Spot Observations of Temperatures and Estimated Flows on Lightning Creek.

Date	Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.
9-12-57	Mouth.	5:15 p.m.	--	--	4 - 5
11-12-57	Mouth.	3:45 p.m.	--	39	8
7-17-59	Mouth.	12:30 p.m.	100	74	15
7-17-59	Just above mouth of Sleepy Cr.	3:15 p.m.	--	65	10
7-17-59	Sleepy Cr. at mouth.	3:15 p.m.	--	64	5

Suggested plans to increase production in the Imnaha Drainage include: (1) the development of impoundments for the rearing of salmon on the main stem and lower tributaries; (2) a limited removal of barriers on tributaries; and (3) the introduction of silver salmon and fall-spawning chinook into the system.

Fish Transplants

Field observations have indicated a potential production area for a fall-spawning type of fish on the lower Imnaha River. Because this section of stream has a sizeable volume of discharge, it appears more suited to the propagation of chinook than to silver salmon. At the present time, approximately the lower 35 miles of the river are believed to be either unutilized or only slightly utilized by salmon for spawning. Reasons for this may be: (1) the avoidance of this area by adult spring chinook due to the existence of water temperatures during their period of residence which approach 70°F.; (2) the depletion of former runs of fall-spawning salmon which may have once utilized the area; (3) the existence of a poor incubational environment due to progressively greater erosion and silting of the streambed as distance from the source of the river is increased; and (4) the presence of larger numbers of predaceous and competitive fish than found in the upper stream section.

The first mentioned factor, that of warm water temperatures, prevails only during a portion of the period of residence of adult spring chinook and would not confront a population with later migration and spawning habits. The influence of the other possible conditions have not been adequately determined and are subject only to conjecture. On the optomistic side, it can be stated that a good water supply is present at all seasons on the Imnaha River, and that although not indicated as abundant on a percentage basis, the gravel area of the lower river is important because it involves numerous miles of stream. Also, since irrigation demands are relatively slight and existing diversion ditches are screened, the detrimental effects of irrigation should be negligible.

Investigation of flow and temperature records has provided some information concerning possible problems which may be associated with the introduction of fall-spawning chinook in the lower Imnaha River. In this regard, there is an indication of potential damage to eggs and non-emerged fry by erosion of the streambed during freshets. Gangmark and Broad (1956, p. 44) state that an 18-fold increase in the mean daily flow resulted in complete dislodgement of salmon embryos inhabiting a riffle on Mill Creek, a tributary of the Sacramento River in California. On the Imnaha River, flow records obtained by the U. S. Geological Survey at the gaging station at Imnaha, Oregon, indicate that a discharge volume 21 times greater than that which exists during egg deposition can be expected during the maximum flow period of spring. 1/

An examination of temperature records taken at Imnaha by the U. S. Fish and Wildlife Service (1958) in 1955 and 1956, indicates that the young of introduced fall spawning chinook would be in residence in the gravel during the spring period of maximum flows (Table 86).

Since preliminary investigation into the possibilities of establishing a race of fall-spawning chinook in the lower Imnaha River suggests that a scouring problem may exist, it is recommended that the matter be explored further by employing test plants of eggs in the gravel at several places between the town of Imnaha and Horse Creek. Examination of a series of such plants over the incubation period would assess the incubation mortality for a specific year and form a basis for further decisions.

It appears important to the project personnel that careful consideration be given to the introduction of fall-spawning chinook into the lower Imnaha. Not only is this section of the river unutilized as a spawning area, but also a substantial potential exists because of the sizable area involved. If only the 10-mile section from the town of Imnaha to Horse Creek is considered as a production area, a potential of over 600 redds can be calculated from the amount of stream bottom estimated to be suitable for spawning in that area. 2/

Two other streams which may be suitable for introductions of fish are Horse and Lightning Creeks. Since a superficial survey on these streams has left many issues in doubt, a study to determine the feasibility of such action is needed. This study should encompass: (1) obtaining reasonably detailed temperature and flow data; (2) assessing the general incubational environment of the streams by the combined use of permeability tests and test plants of eyed eggs; and (3) selecting suitable donor stock, if the other objectives of the study prove favorable. Since both streams are of small size, they are believed best suited to introductions of silver salmon. Conditions on the streams advantageous to the production of this species are the apparent existence of perennial flows, the presence of gravel, and an absence of irrigation diversions. At the present time, steelhead are the only anadromous salmonids known to exist in these creeks.

1/ Data extracted from U. S. Geological Survey W. S. P. 1217, 1247, 1287, 1347, 1397, 1447, and 1517, Part 13, Snake River Basin. The base minimum flow that was used was the average daily flow for the month of October from 1951 through 1957. This is believed to depict the typical discharge volume on the lower river during a theoretical period of egg deposition for fall spawning chinook. The maximum flow used in the comparison consists of the day of maximum discharge averaged for the years 1951 through 1957. In each year, the day of maximum discharge was well within the expected incubation period.

2/ Calculation based on a stream distance of 10 miles, a stream width of 50 feet, an estimated bottom area which is 5 per cent suited to spawning, and an estimated redd and inter-redd area for fall chinook of 24 square yards as suggested by Burner (1941).

Table 86. A Comparision of Time of Expected Emergence of Fall Spawning Chinook with Period of Maximum Flows, Imnaha River.

Biological and Physical Factors	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Accululated Thermal Units 1/	110	220	333	395	607	961	1416	1944
Period of Incubation 2/	—	—	—	—	—	—	—	—
Frequency and Time of Annual Peak Flows 1929-57						4	20	4

1/ Temperature cycle of year 1955-1956.

2/ Length of incubation period of chinook salmon based on 1,800 thermal units from time of ova deposition to time of emergence of fry.

One condition which would quite likely confront fish introduced into Horse and Lightning Creeks is that of warm-water temperatures. The few spot-temperatures that have been obtained indicate that the lower reaches, of both of these streams may be subject to summer water temperatures that approach 75°F. Limited flow observations disclose summer flows as low as 6 or 7 c.f.s. near the mouths. It is unknown if these conditions would be detrimental to silver salmon. The fact that this species has the southernmost range of any of the Pacific salmon indicates a tolerance of high temperatures. A study by Brett (1952) on the tolerance of fingerling salmon to temperature lends further evidence of the ability of silver salmon to withstand high temperatures. Also, it can be conjectured that juvenile silver salmon, if so inclined, could escape exposure to the maximum water temperatures on the creeks by avoiding the lower reaches, or by dispersing to the deeper pools of the Imnaha River.

Obstructions and Diversions

Further study is needed to evaluate the practicability of providing fish passage through the upper Imnaha River to potential spawning grounds on the South Fork. The production area to be gained on the South Fork comprises about 1.5 miles of spawning area and possibly 8 miles of rearing area. 1/ The total number of barriers to overcome on the main stem is unknown, but could be large depending on the time of upstream migration of fish which would utilize the South Fork. As viewed during the spring high water (April, May, June), the flow in the 4-mile section of the upper Imnaha River from the Blue Hole to Upper Imnaha Falls is swift to torrential. In addition to the obstructions formed by lower (I-5) and upper (I-6) Imnaha Falls, numerous other low falls and cataracts are present in this area, which are believed to constitute, cumulatively, an impassable situation. Following the abatement of spring high water in the month of July, passage conditions are believed to generally improve below lower Imnaha Falls, but it is not known if adult chinook would be inclined to migrate into this upper area before or after the decrease in flow.

1/ Added rearing area would include about 5 miles of the upper main stem and possibly 3 miles of the lower South Fork, if an upstream dispersal of fingerlings from the spawning area occurred.

Consequently, if only the low water barriers are corrected, there is a chance that the fish would not benefit if their tendency to migrate further upstream has dissipated by the time of reduction in flow. Enlightenment regarding these uncertainties can only be obtained by further investigation to determine which obstructions are impassable at the various water stages and by attaining knowledge of the migration behavior to be expected from introduced fish. Another factor to be considered is the importance of acquiring additional spawning area of the South Fork when the spawning area on the main stem may not be fully utilized. Or, if additional production area is desirable on the Imnaha, would it be more practical to achieve this by encouraging natural propagation on the South Fork through the provision of fish passage facilities or to rely on artificial methods such as the rearing of fish in impoundments or the introduction of eggs or juveniles into the stream?

No removal of log jams is recommended on the Imnaha River. On Horse and Lightning Creeks, the nature of the log and debris jams makes clearance somewhat doubtful with respect to aiding steelhead upstream migration. Existing jams are believed to constitute only low-water obstructions and are, therefore, generally passable to steelhead. At the present time, there are 8 jams (I-H-1) which possibly create low-flow obstructions on the lower 9 miles of Horse Creek. Spot-checks made on Lightning Creek have disclosed the presence of 5 similar jams (I-L-1) in the lower 8 miles of this stream. The concerned areas on both streams are for the most part easily accessible by road. Removal of these barriers would probably be necessary if silver salmon were introduced into these streams, but no clearance is recommended unless such a program is attempted.

All observed ditches diverting water from the Imnaha River are screened. One open ditch (I-S-1) has been reported on Summit Creek by a rancher who lives at the mouth of this stream. This ditch is reputedly diverting downstream migrant steelhead. If the report if found to be true, the ditch should be screened.

<u>Supplemental Rearing</u>

The existence of numerous sites along the Imnaha River which appear suitable for impoundment construction has previously been mentioned. Some of the factors considered to be advantageous to the rearing of salmon in impoundments along the river include: (1) a consistently good supply of high-quality water; (2) the existence of numerous sites for impoundment construction; (3) the presence of a well-established run of the species to be reared; and (4) accessibility of sites during most seasons of the year. Since natural depressions are generally lacking, excavation would be necessary for construction of the recommended off-channel type of impoundments. To attain maximum utilization of observed sites, some removal of timber would be required.

Additional impoundment sites are available on Horse and Lightning Creeks. The general locations of these areas has been previously discussed under the survey data sections of the respective streams. Impoundment development on Horse and Lightning Creeks may be particularly beneficial in the event of silver salmon introductions. The areas suggested for impoundment construction on these lower altitude tributaries are believed to be generally accessible at all times of the year.

A further possibility for the supplemental rearing of spring chinook salmon may exist on the lower South Fork. This stream is presently believed to be inaccessible to adult salmon, and unless some fish passage facilities are provided, it can be brought into production only by the use of artificial methods. Because access to the stream is difficult, the latter type of development might best be accomplished by the use of plantings of eyed eggs. Excellent gravel areas are available for planting eggs should the South Fork be considered for supplemental rearing. Once out of the gravel, fish could disperse upstream for at least 3 miles without encountering an obstruction, and downstream 6 miles before reaching the upper limit of the present spawning area.

As regards egg donations for the stocking of supplemental rearing areas, either in impoundments or in the stream, these could be provided by the run of spring chinook which inhabit the Imnaha River. Even if supplemental rearing was not successful, there is little cause to believe that reasonably planned egg contributions would be harmful to this sizable population of fish. The establishment of an incubator station on the river for development of eggs and fry for distribution to rearing areas is suggested if a program for the supplemental rearing of salmon is adopted.

Stream Improvements

Habitat improvement, by means of sill logs and deflectors, may be applicable in certain sections of the Imnaha Drainage if trial installations of these devices suggested elsewhere are attempted and prove beneficial. Because of steep gradients, the lower reaches of Horse and Lightning Creeks, especially may be adaptable to this type of development.

BIG SHEEP CREEK

Introduction

Big Sheep Creek is the major tributary of the Imnaha River. It originates on the northeastern slopes of the Wallowa Mountains, near the headwaters of the Imnaha River, and flows north and east approximately 40 miles to join this stream just above the town of Imnaha, Oregon (Figure 94). Throughout much of its course, Big Sheep Creek is in a deep, rugged canyon which traverses a forested plateau in the upper reaches and a semi-arid plateau in approximately the lower half. Elevation on the stream varies from about 8,000 feet in the headwaters to 1,940 feet at the mouth.

The important tributaries of Big Sheep Creek are the Middle and South Forks, and Lick, Little Sheep, and Camp Creeks. The lengths of these streams are 4, 2, 16, 27, and 14 miles, respectively. Lick Creek and the two forks are headwater tributaries, while the other two streams enter near the mouth. Surveys were conducted on all of these streams as well as on the main stem.

Both chinook salmon and steelhead inhabit the Big Sheep Creek basin. The chinook are of the spring-run type and have been observed only in the main stem of Big Sheep Creek.

The discharge pattern of Big Sheep Creek is typical of most of the streams draining the Wallowa Mountains. The months of maximum flows are May and June, while minimum flows usually occur during late summer, fall, and winter. Below the confluence of the forks, the natural flow pattern is substantially altered by the removal of water for irrigation. The watershed area is approximately 300 square miles.

Logging has occurred in the past and is presently occurring throughout much of the drainage. Recently, extensive logging operations have been underway on Big Sheep Creek near the forks, and on Little Sheep Creek along most of its length.

Irrigation practices on Big Sheep Creek and on tributaries, Little Sheep and Camp Creeks, are at the point of being harmful to fish life.

Big Sheep Creek is accessible by road in the lower 25 miles except for a 2-mile section between Timber and Squaw Creeks (Figure 94). In the upper reaches, a road to Lick Creek Ranger Station and Coverdale Forest Camp crosses the stream approximately 2 miles below the forks. A recently constructed logging spur now extends from this road up to the forks. All remaining areas of the creek are accessible by trail.

Inventory Surveys - Dates and Areas

Inventory surveys were conducted on October 2, 1957, August 14 and 15, 1958, and June 25 and August 6, 1959. The surveys covered all parts of the main stem except for an 8-mile section from Lick Creek to Carrol Creek. This area was familiar to the surveyors from former spawning ground surveys. The survey of the lower 3 miles of the stream was in the nature of spot checks made while investigating diversion ditches for the presence of fish screens. Some of this area was also observed from the road which parallels the creek.

Survey Data

Terrain and Gradient: Big Sheep Creek canyon is intermediate between narrow and wide except for a 10-mile narrow section extending from Marr Creek to 4 miles above the mouth. The canyon walls are typically rugged and formed partially of rimrock ledges. The stream gradient is generally moderate (average 1.5 per cent) from Lick Creek to the mouth (Figures 109 and 110). Above Lick Creek to the forks, there is a 3-mile section of steep to torrential gradient (average 7.5 per cent). 1/

Slope and Bank Cover: To the vicinity of 3 miles above the mouth, the slope cover is a combination of conifers, grasses, and rock outcroppings. Below this point, grass and rimrocks prevail. Streambank cover is a mixture of coniferous and deciduous timber, brush, and small open grassy areas. The coniferous timber thins out along the lower part of the stream.

Shade: Shading of the stream is partial as far down as Coyote Creek. Below here, it varies between partial and open.

Stream Cross Section: The stream cross section is generally moderate. However, a wide shallow section almost a mile in length is present about 2 miles below Squaw Creek.

Bottom Materials: The largest concentrations of gravel are found from the mouth of Lick Creek to 0.75 mile above Coyote Creek. In this approximately 11-mile stream section, 20 per cent of the bottom materials are estimated to be gravel. The section of secondary importance as regards quantity of gravel extends from Timber Creek to 3 miles above the mouth of Little Sheep Creek. This section comprises about 14 miles of stream estimated to be 10 per cent suitable for spawning. The gravel in this area is generally of larger diameter than that found in the area of primary gravel concentration. With exception of the torrential uppermost 4 miles of Big Sheep Creek which consists predominantly of a boulder bottom, rubble is the dominant bottom material. The location and relative abundance of the gravel deposits on Big Sheep Creek are presented in Figure 94.

1/ Stream gradients expressed as percentages were obtained from U. S. Geological Survey Topographic maps, Cornucopia, Harl Butte, and Imnaha quadrangles.

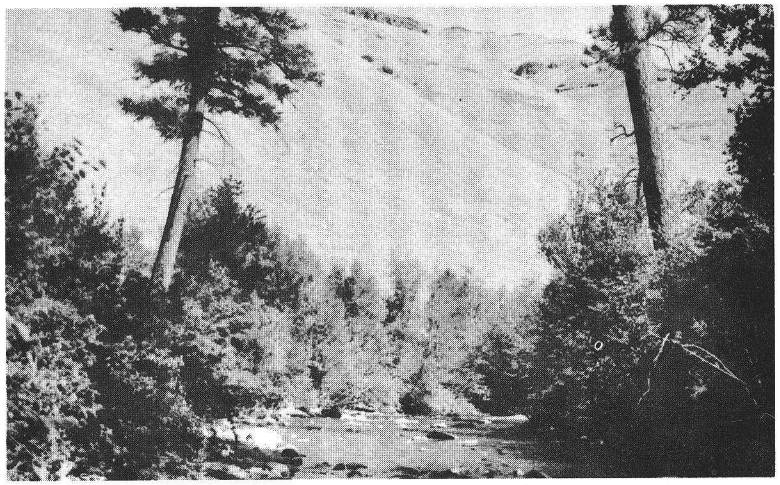

Figure 109. Terrain and Gradient Typical of Much of Big Sheep Cr. Below Coyote Cr. This Photo was Taken About 2.5 Miles Below Coyote Cr. on 8-15-58.

Figure 110. A Portion of the 3-Mile, Steep to Torrential Section of Upper Big Sheep Cr. above the Mouth of Lick Cr. Which may be Almost Completely Impassable to Upstream Migrants.

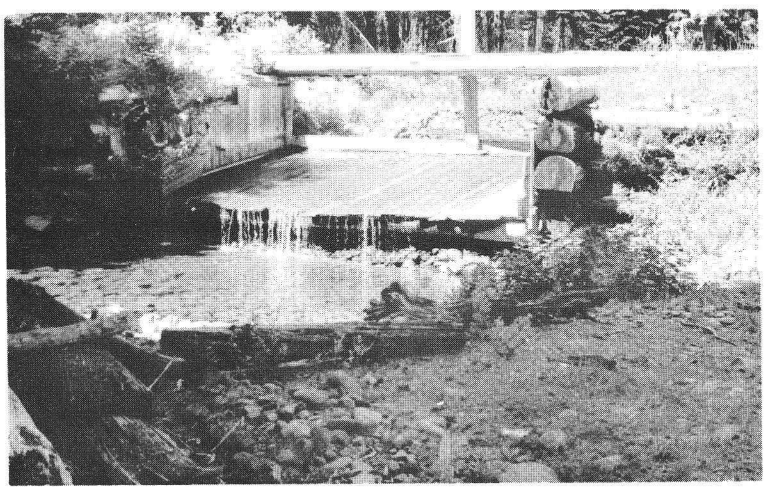

Figure 111. The Diversion Structure at the Confluence of the Middle and S. Fks. of Big Sheep Cr. Which Diverts Irrigation Water to the Wallowa Valley (6-25-59).

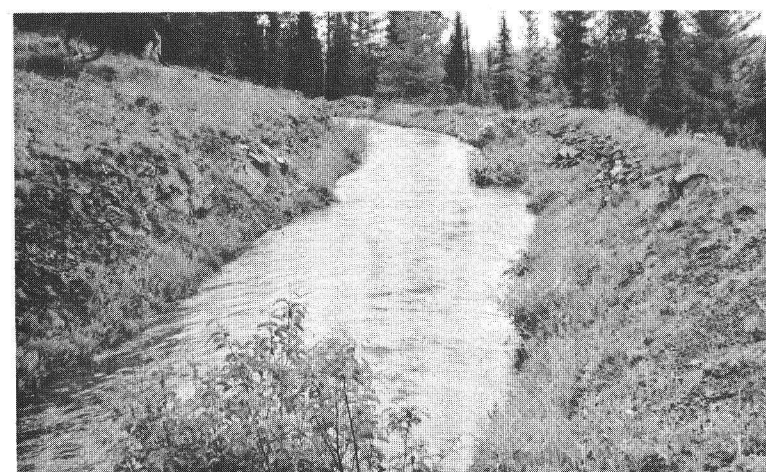

Figure 112. The Wallowa Valley Improvement Canal Which Takes the Entire Flow of Upper Big Sheep Cr. During Much of the Irrigation Season.

Obstructions and Diversions: Access to the forks of Big Sheep Creek may be seriously impaired by three obstructions comprised of: (1) a 3-mile section of steep to torrential gradient (I-BS-3) on upper Big Sheep Creek; (2) a small diversion dam (I-BS-5) for the Wallowa Valley Improvement Canal located immediately below the forks; and (3) a low flow area (I-BS-4) created below the dam by the withdrawal of water during the irrigation season. At high flows, the dam is not believed to be impassable, but the torrential nature of the stream below this structure may prevent its access to some upstream migrants. During the summer, an impassable area is created below the dam due to removal of water for irrigation (Figure 111). The dam, which is a wooden structure about 2 feet in height, diverts water into a canal extending from Big Sheep Creek to Little Sheep Creek, where it is eventually re-diverted into a ditch serving the Wallowa Valley (Figures 94 and 112). At the time of the August 7, 1958 survey, the entire flow of Big Sheep Creek (an estimated 40 c.f.s.) was being diverted, except for a slight leakage of less than 1 c.f.s.

Other obstructions of a temporary nature are two log and gravel diversion dams (I-BS-2) constructed each year on Big Sheep Creek, about 3 miles above the mouth of Little Sheep Creek. These dams are present from July until September, and as viewed on two occasions, have appeared impassable to upstream migrants. Other dams of this type may be constructed each year at diversions located further downstream.

Nine operating diversion ditches were noted during the survey. Of these, three small ditches (I-BS-1) in the vicinity of Carrol Creek were unscreened on August 6, 1959. Also, two other unscreened ditches (I-B-S-1) found below the mouth of Little Sheep Creek would take water during high flow periods. These were de-watered in July of 1959. It is not known if they will be used in the future.

No log jams which appeared to form obstructions were noted on the survey.

The locations of obstructions and unscreened diversion ditches on Big Sheep Creek are indicated in Figure 94.

Impoundment and Hatchery Sites: On Big Sheep Creek, the area which appears to be the best adapted to impoundment development is between Owl Creek and Timber Creek. This section of stream is about 7 miles in length, is paralleled by a road, and comprises approximately the lower half of the spring chinook spawning area. The total area which appears suitable for impoundment construction has not been measured, but it is estimated that it would exceed 50 acres. Off-channel impoundments constructed in this area would require excavation. The general location of the impoundment sites is presented in Figure 94.

No sites believed suitable for hatchery development were observed.

Flow and Temperature Data: During most summers, low flows and warm water temperatures prevail in the spawning and holding areas of spring chinook salmon on Big Sheep Creek. This low volume of the summer discharge is due primarily to the diversion of Big Sheep Creek water into the Wallowa Valley Improvement Canal. On several occasions, flows as low as 15 c.f.s. have been observed in the spawning areas (Table 87). The highest recorded water temperature is 72°F. at Coyote Creek near the lower limit of the known spring chinook spawning area.

During the inventory survey of Big Sheep Creek, flow conditions were favorable. On August 14, 1958, the flow was estimated to be 40 c.f.s. between Carrol Creek and Coyote Creek, and water temperatures ranged from 68°F. at 2:00 p.m.

near Carrol Creek to 70°F. at 5:00 p.m. near Coyote Creek. On the survey of the following day, a flow estimate of 75 c.f.s. was obtained just below the mouth of Little Sheep Creek.

Tributaries: Other than numerous short gullies, approximately 10 tributaries enter Big Sheep Creek. The larger of these streams are Lick, Little Sheep, and Camp Creeks. The remaining streams are considerably smaller and probably do not average over 5 linear miles of drainage each. During a survey made on October 2, 1957, Lick Creek was flowing approximately 6 c.f.s. at the mouth. On August 15, 1958, Marr Creek had a flow of about 3 c.f.s., and Squaw Creek was estimated to be flowing 4 c.f.s. Little Sheep Creek was discharging an estimated 25-30 c.f.s. at the mouth on this same date.

Table 87. Spot Temperatures and Estimated Flows for Big Sheep Creek, 1953-58. 1/

Date and Year	Approximate Location	Time	Temp. in °F. Air	Temp. in °F. Water	Flow in c.f.s.
1953					
6-12-53	Bridge near Lick Cr. Ranger Station.		--	--	30
8-26-53	Near Coyote Cr.	5:45 p.m.	58	55	20
1954					
8-22-54	Just above mouth Lick Cr.	9:30 a.m.	54	42	10
1955					
8-1-55	At Coyote Cr.	5:30 p.m.	--	72	--
8-13-55	Confluence Lick Cr.	1:00 p.m.	65	55	7
8-13-55	1 mi. below Coyote Cr.	7:00 p.m.	59	65	25
8-19-55	2.5 mi. below Lick Cr.		--	--	15
8-26-55	2.5 mi. below Lick Cr.	8:40 a.m.	48	45	--
8-26-55	1.5 mi. below Owl Cr.	9:30 a.m.	64	54	--
8-31-55	1.5 mi. below Owl Cr.		--	--	15
9-6-55	1.5 mi. below Lick Cr.	1:40 p.m.	71	62	15
9-6-55	Near Owl Cr.	5:20 p.m.	72	65	--
1956					
8-14-56	1.5 mi. below Owl Cr.		--	--	15
8-14-56	2.5 mi. below Lick Cr.		--	--	12
8-14-56	Just above mouth Lick Cr.		--	--	2
8-14-56	Just below mouth Lick Cr.		--	--	12
8-20-56	2.5 mi. below Lick Cr.	11:30 a.m.	76	60	--
8-20-56	1.5 mi. below Owl Cr.	1:00 p.m.	--	--	20
8-20-56	Near Carrol Cr.	6:00 p.m.	--	62	--
8-26-56	2.5 mi. below Lick Cr.	9:30 a.m.	55	46	20
8-26-56	1.5 mi. below Owl Cr.	10:45 a.m.	57	54	35
9-1-56	2.5 mi. below Lick Cr.	10:00 a.m.	69	46	--
9-1-56	1.5 mi. below Owl Cr.	11:45 a.m.	76	55	20
9-1-56	Near Carrol Cr.	2:40 p.m.	78	60	--
9-7-56	Near Owl Cr.	9:55 a.m.	69	50	15

Table 87. Spot Temperatures (continued)

Date and Year	Approximate Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.
1957					
8-26-57	Near Carrol Cr.	2:00 p.m.	70	62	--
9-13-57	Just below Little Sheep Cr.	10:25 a.m.	--	58	--
9-13-57	4 mi. above Little Sheep Cr.	12:00 Noon	--	58	--
9-13-57	6 mi. below Squaw Cr.	2:10 p.m.	62	--	--
9-13-57	2 mi. below Squaw Cr.	12:35 a.m.	--	58	--
10-2-57	Just above mouth Lick Cr.		--	--	6
10-14-57	Near Griffith Cr.	4:00 p.m.	--	46	20
10-14-57	6 mi. above Little Sheep Cr.	11:50 a.m.	44	38	--
1958					
4-28-58	Just below Little Sheep Cr.	2:30 p.m.	--	47	--
8-7-58	Just below S. Fk. and Wallowa Valley Diversion Canal.	11:45 a.m.	--	--	3
8-14-58	At Carrol Cr.	2:15 p.m.	87	68	40
8-14-58	Just above Griffith Cr.	3:40 p.m.	--	69	40
8-14-58	At Griffith Cr.	2:15 p.m.	85	69	40
8-14-58	1 mi. above Coyote Cr.	3:05 p.m.	84	70	40
8-14-58	Coyote Cr.	3:45 p.m.	85	70	40
8-14-58	Near Timber Cr.	5:10 p.m.	--	70	--
8-15-58	Near Timber Cr.	7:30 a.m.	61	56	45
8-15-58	Just below Little Sheep Cr.	8:00 a.m.	73	60	75
8-15-58	Timber Cr. to Marr Cr.	9:15 a.m.	73	58	45
8-15-58	1 mi. above Little Sheep Cr.	9:15 a.m.	78	63	50
8-15-58	2 mi. above Little Sheep Cr.	10:15 a.m.	84	67	50
8-15-58	At Marr Cr.	10:30 a.m.	83	60	50
8-15-58	3 mi. above Little Sheep Cr.	11:15 a.m.	87	67	50
8-15-58	1 mi. below Squaw Cr.	11:45 a.m.	83	64	55
8-15-58	4 mi. below Squaw Cr.	12:15 p.m.	89	69	50
8-15-58	2 mi. below Squaw Cr.	1:05 p.m.	86	68	55

1/ Observations made by Oregon Fish Commission biologists.

Anadromous Fish Populations

Big Sheep Creek supports runs of spring chinook salmon and steelhead trout. To date, no substantiated record of silver salmon has been found.

Spring Chinook Salmon: As indicated by spawning ground observations made annually during the period 1953-57, substantial numbers of spring chinook salmon migrate into the spawning areas of Big Sheep Creek in some years (Table 88).

During this time, the principal area of utilization has been from Lick Creek to Carrol Creek, and the area of secondary importance to spawning has been between Carrol and Coyote Creeks. The uppermost point at which chinook are known to spawn is 0.25 mile above Lick Creek. The lowermost point is at Coyote Creek.

Table 88. Annual Spawning Ground Counts of Spring Chinook Salmon in Index Units on Big Sheep Creek, 1953-57. 1/

Date	Distance and Approx. Location Between Lick and Carrol Creek	Number of Fish		Redds
		Live	Dead	
8-26-53	0.8 mile - lower end.	1	2	7
8-22-54	3 miles- upper and lower ends.	3	1	1
8-25/9-6-55	8 miles-upper 2/3 2/	12	2	29
8-20/8-26-56	8 miles-upper 2/3 2/	66	11	138
8-26-57	8 miles-upper 2/3	69	103	147

1/ The locations and distances of the index units on Big Sheep Creek were variable from year to year, but the units in general, were located within the 11-mile stream section between the mouths of Lick and Coyote Creeks. All surveys were conducted by personnel of the Oregon Fish Commission.

2/ Maximum counts used from series of 5 surveys made over the span of the spawning season.

During the inventory surveys in mid-August 1958, 3 chinook fingerlings which ranged from 1-5/8 to 2 inches in fork length were collected between Carrol and Griffith Creeks. Also, an estimated 200 chinook fingerlings were observed trapped in a side pool near Squaw Creek. By-pass trapping at fish screens on lower Big Sheep Creek irrigation ditches in 1954, 1955, and 1957 resulted in the capture of 843 chinook fingerlings, primarily in the months of August, September and October (Table 89).

Steelhead: The distribution and abundance of steelhead in Big Sheep Creek is unknown at this time. Evidence of the presence of this species is found in the capture of rainbow fingerlings in fish screen by-pass traps on lower Big Sheep Creek. However, the contribution of some of the tributaries to this catch cannot be determined. As indicated by the trap records, the greatest numbers of downstream migrant rainbow are captured in August, September and October (Table 90).

MIDDLE FORK OF BIG SHEEP CREEK

Introduction

The Middle Fork is the principal tributary in the headwaters area of Big Sheep Creek (Figure 94). This stream flows entirely within the Wallowa Mountains through a steep-walled canyon and joins the South Fork to form Big Sheep Creek. It is approximately 4 miles in length.

There has been evidence that chinook salmon at times may ascend the upper, torrential section of Big Sheep Creek to reach the Middle Fork. However, in general, the stream is regarded to be of only minor value to the production of anadromous fishes.

Table 89. Monthly Catch Records of Chinook Salmon Captured in By-Pass Traps at Certain Irrigation-Ditch Fish-Screen Installations on Big Sheep Creek, 1954, 1955, and 1957. 1/

Year	Period of Capture	Month of Capture							Total
		Apr.	May	June	July	Aug.	Sept.	Oct.	
1954	6-24 to 10-30	-	-	3	6	0	74	270	353
1955	4-8 to 10-23	6	22	20	8	68	173	150	447
1957	9-1 to 10-7	-	-	-	0	0	3	40	43
	Total	6	22	23	14	68	250	460	843

1/ Information by courtesy of Oregon Game Commission.

Table 90. Monthly Catch Records of Rainbow Trout Captured in By-Pass Traps at Certain Irrigation-Ditch Fish-Screen Installations on Big Sheep Creek, 1954, 1955, and 1957. 1/

Year	Period of Capture	Month of Capture							Total
		Apr.	May	June	July	Aug.	Sept.	Oct.	
1954	6-24 to 10-30	-	-	2	10	23	24	42	101
1955	4-8 to 10-23	8	21	64	139	514	408	132	1,286
1957	9-16 to 10-2	-	-	-	0	0	52	27	79
	Total	8	21	66	149	537	484	201	1,466

1/ Information by courtesy of Oregon Game Commission.

The Middle Fork is accessible by way of a recently constructed logging road which parallels Big Sheep Creek for about 2 miles below the confluence of the Forks.

Inventory Surveys - Dates and Areas

The Middle Fork was surveyed on August 7, 1958, from the mouth upstream approximately 2.5 miles to an impassable falls.

Survey Data

Terrain and Gradient: The Middle Fork Canyon was classified as intermediate between narrow and wide, except for a one-quarter mile section of gorge located approximately 1 mile above the stream mouth. Within the surveyed area, the gradient is steep in the first mile above the mouth, moderate to steep in the next mile, and steep to torrential in the upper half mile. As determined from a USGS map of the Cornucopia quadrangle, the overall gradient is between 6.5 and 7.0 per cent.

Slope and Bank Cover: The slope cover is a mixture of conifers, grasses, and exposed rock. The stream bank cover is predominantly coniferous timber with an intermixture of deciduous brush.

Shade: The lower 2 miles of stream were partially shaded and the upper 0.5 mile was partially to densely shaded.

Stream Cross Section: The stream is generally moderate in cross section throughout the surveyed area.

Bottom Materials: In the first 2 miles above the mouth, gravel comprises less than 10 per cent of the total bottom materials and rubble and boulders are the principal bottom types. In the next one-half mile, rubble and boulders become more abundant, and no gravel area was observed.

Obstructions and Diversions: A falls (I-BS-M-1) 6 to 8 feet in height and a combination jam and falls (I-BS-M-1) 10 feet in height were observed approximately 1 mile above the mouth (Appendix B, Table VI). The passage of upstream migrants at these obstructions is questionable even during high water. Another log jam (I-BS-M-2) which may constitute a partial block, is present 1.3 miles above the mouth. The survey was terminated in the vicinity of 3 impassable falls (I-BS-M-3) located approximately 0.25 mile above the mouth of the North Fork. In an upstream order, the estimated heights of these 3 falls were 15 feet, 15-20 feet, and 30-40 feet. The locations of the various obstructions on the Middle Fork are given in Figure 94.

No diversion ditches were observed on the Middle Fork.

Impoundment and Hatchery Sites: No sites which appeared suitable for hatchery or impoundment development were observed.

Flow and Temperature Data: Flow and temperature records on the Middle Fork of Big Sheep Creek are limited to those obtained on the survey. On August 7, 1958, the flow at the mouth was estimated to be 35 c.f.s. Water temperatures at the mouth and at the upper boundary of the survey were 53°F. at 11:40 a.m. and 57°F. at 4:00 p.m., respectively. Because of the relatively high altitude of the watershed, summer conditions of temperature and flow are probably favorable.

Tributaries: The major tributary of the Middle Fork is the North Fork, which was discharging about 5 c.f.s. on August 7, 1958. Several other smaller tributaries within the observed area had flows ranging from 1 to 3 c.f.s.

Anadromous Fish Populations

Salmon: The Middle Fork appears to be of little value to chinook salmon other than contributing water to the system. No individuals of this species were observed on the survey of August 7. Although a few riffles suitable for spawning are present, it is believed that access is generally prevented by obstructions on upper Big Sheep Creek and on the lower Middle Fork. Evidence that a few chinook may occasionally ascend to the Middle Fork is provided by the observation of a chinook fingerling in Kinney Lake by Game Commission personnel. Kinney Lake is a small impoundment in the Wallowa Valley Improvement Canal system which is accessible to fish only from the forks of Big Sheep Creek or from upper Little Sheep Creek. 1/ Since no known run of chinook salmon is present in Little Sheep Creek and access of fish to the area connected to the canal system would be difficult, the fingerling may have originated in the Middle Fork.

Steelhead: No records are available concerning the utilization of the Middle Fork by steelhead. In considering the usual time of upstream migration of this species, prior to the irrigation season and also very possibly preceding the period of maximum flows, it seems plausible to assume that the Middle Fork is more accessible to steelhead than to chinook. Trout of undetermined species were observed about midway between the mouth of the Middle Fork and the upper boundary of the survey. These fish were estimated to be 10 or 12 inches long.

SOUTH FORK OF BIG SHEEP CREEK

Introduction

The South Fork is a small, steep stream slightly over 2 miles in length. It flows entirely within the Wallowa Mountains and combines with the Middle Fork to form Big Sheep Creek (Figure 94). The stream is accessible by the same route taken to reach the Middle Fork.

Inventory Survey - Dates and Areas

The South Fork was surveyed on August 7, 1958, on the same date as the Middle Fork. Observations were terminated approximately 0.25 mile above the mouth at a long section of torrential flow which appeared to be impassable to salmon and steelhead.

Survey Data

The only spawning area observed on the South Fork was a gravel bar which extended upstream approximately 50 to 100 yards above the mouth. Beyond the gravel bar the bottom is composed of rubble and boulders. As indicated by the U. S. Geological Survey topographic map of the Cornucopia quadrangle, the gradient above the upper terminus of the survey exceeds 10 per cent. The stream is subject to the same access difficulties as the Middle Fork in that it is located above the torrential section of upper Big Sheep Creek.

The water temperature at the mouth of the South Fork was 49°F. at 11:40 a.m. on August 7, 1958, and the flow was estimated to be 10 c.f.s. Due to the high elevation of the watershed, cool water temperatures are believed to prevail.

LICK CREEK

Introduction

Lick Creek originates in the high Wallowa Mountains near the source of the South Fork of Big Sheep Creek (Figure 94). It is approximately 11 miles in length,

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1/ Kinney Lake is located about 1 mile west of upper Little Sheep Creek on the divide which separates this stream from the Wallowa Valley.

and joins Big Sheep Creek about 3 miles below the confluence of the South and Middle Forks.

This small stream supports a run of spring chinook salmon and is reported to have a run of steelhead.

Lick Creek is accessible from the road leading from Joseph, Oregon, to Coverdale Forest Camp on the Imnaha River.

Inventory Survey - Dates and Areas

No inventory survey was conducted on Lick Creek in 1958 or 1959, since its characteristics were familiar to the surveyors from prior spawning season observations. The following information concerning Lick Creek has been obtained for the most part from notes taken on these surveys. The stream has been observed in the lower 3 miles.

Survey Data

The upper 1.5 miles of the observed section of Lick Creek is in a mountain valley. The gradient is moderate and perhaps 20 per cent of the bottom is suited to spawning. Bottom materials consist of gravel, rubble, and some silt and sand. Slope and bank cover are predominantly coniferous timber and grass. During the spawning season in late summer, the volume of flow is usually low (5-7 c.f.s.). However, the channel is sufficiently narrow in most places to create water depths favorable to spawning. Because of the relatively high altitude of the Lick Creek watershed (5,200 feet or greater), stream temperatures during the summer are favorable to spawning (Table 91). Below the valley, the stream gradient becomes steep and the basin undergoes change to a medium canyon. In this section, the stream bed materials are largely rubble and boulders. Very little of this 1.5 mile length of canyon appears suitable for spawning except for a short section immediately above the mouth.

Two potential impoundment sites are present on Lick Creek. These consist of meadows located adjacent to and within a mile below Lick Creek Ranger Station which may be suitable as construction sites for off-channel or in-channel impoundments (Figure 113). The total area which appears adaptable to impoundment development is estimated to exceed 20 acres. Existing flood water distributaries located in the meadow areas may be usable for diverting water from the stream into off-channel ponds. Superficially, this area seems to provide excellent opportunity for the development of impoundments for the supplemental rearing of salmonids. The locations of the impoundment sites are indicated in Figure 94.

No sites which appeared suited to hatchery use were noted.

As previously indicated, Lick Creek supports a run of spring chinook salmon and very likely has a run of steelhead. The chinook utilize the stream for spawning throughout the 1.5 mile length of valley wherever conditions are suitable. On September 19, 1957, 15 redds were observed in this area. At the time of the survey, spawning was over and no live fish or carcasses were noted. The main areas of utilization were the first 0.5 mile immediately below Lick Creek Ranger Station and a 300-yard stream section just above the point where Lick Creek descends into the lower canyon.

No observations of steelhead have been made on Lick Creek. However, U. S. Forest Service personnel have observed this species in the section of stream

Figure 113. A 20-Acre Section of Meadow Area on Lick Cr. about 1.5 Miles Above the Mouth Which is Believed Adaptable to Impoundment Development.

Figure 114. Forest Debris in Little Sheep Cr. 3 Miles Below the Source. Conditions More Serious Than This on a Lower Section may Impair Access to Steelhead.

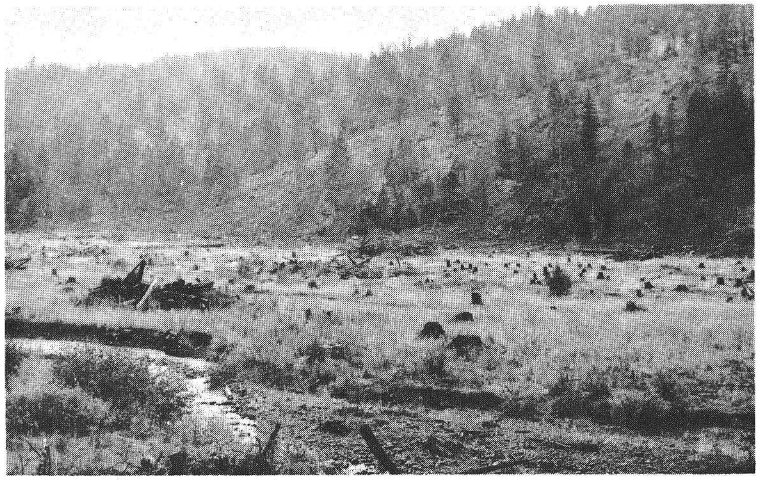

Figure 115. A Potential Off-Channel Impoundment Site on Little Sheep Cr. a Short Distance Below the National Forest Boundary.

Table 91. Spot Temperatures and Estimated Flows on Lick Creek, Tributary of Big Sheep Creek.

Date and Year	Location	Time	Temp. in °F. Air	Water	Flow in c.f.s.
6-12-53	Lick Creek Ranger Station.		—	—	40
8-13-55	Lick Creek Ranger Station.	11:00 a.m.	56	53	8
8-13-55	Mouth.	1:00 p.m.	65	55	10
8-14-56	Mouth.		—	—	10
9-19-57	Lick Creek Ranger Station.	12:00 Noon	48	46	5
9-19-57	1 mile above mouth.	1:30 p.m.	—	50	6
11-2-57	0.75 mile above mouth.	9:30 a.m.	27	33	7

adjacent to and below the ranger station. Also, it seems likely that steelhead may spawn in Lick Creek above the section used by chinook.

There has been no indication that silver salmon are present in Lick Creek.

LITTLE SHEEP CREEK

Introduction

Little Sheep Creek is the major tributary of Big Sheep Creek. It originates near the 8,000 foot level and drops abruptly out of the Wallowa Mountains to eventually join Big Sheep Creek 3 miles above the mouth at an altitute of 2,200 feet (Figure 94). Most of the stream course is across a plateau deeply dissected by the various streams of the Imnaha Drainage. Little Sheep Creek is about 27 miles in length.

Steelhead trout are the only species of anadromous salmonid presently known to inhabit Little Sheep Creek. The stream is reported to have formerly supported a run of salmon.

Farming and logging are both practiced in the Little Sheep Creek basin. Recently, logging has intensified and timber is being cut along much of the length of the stream. Except for the extreme upper end, Little Sheep Creek is accessible by roads leading from Joseph, Oregon, to the Imnaha River.

Inventory Surveys - Dates and Areas

Surveys were conducted on Little Sheep Creek on April 17, May 8, and June 25, 1959. The surveys started about 25 miles above the mouth at the Wallowa Valley Improvement Canal diversion and continued downstream for 11 miles through the section considered to be suitable for the spawning of salmon and steelhead

(Figure 94). In addition, 6 miles of the Wallowa Valley Improvement Canal were surveyed above its effluence at Little Sheep Creek for the purpose of assessing value for spawning. Altogether, about 16 miles of Little Sheep Creek were not surveyed in entirety. However, approximately 14 miles of this area, from the lower survey terminus to the mouth, were repeatedly spot checked. Also, the section was observed from the standpoint of locating unscreened diversion ditches. The remaining unsurveyed portion of Little Sheep Creek consists of 2 miles of precipitous area in the Wallowa Mountains near the source of the stream, which is thought to be of no value for the production of anadromous fishes.

<u>Survey Data</u>

Terrain and Gradient: The canyon is predominantly of moderate width. The gradient ranges from moderate to steep except for the upper 2 miles of the surveyed section which is entirely steep. Data obtained from the USGS Topographic maps of the Joseph and Imnaha quadrangles, indicates an average gradient of approximately 7-8 per cent in the steep area and a 2-3 per cent gradient in the lower 24 miles.

Slope and Bank Cover: The slope cover undergoes a transition from conifers and grass in the upper half of the surveyed area to grass, rock outcroppings, and scattered conifers in the lower half. Bank cover is comprised predominantly of conifers, brush, and grass with the conifers diminishing in frequency as the mouth of the stream is approached. Beginning at a point 3 miles below the upper boundary of the survey, logging of both past and present occurrence has denuded a 2-mile section of stream bank. During the survey, timber was being logged along much of the creek below the Coverdale Forest Camp-Imnaha roads junction.

Shade: The creek is partially shaded except for the 2-mile long open section which has been logged.

Stream Cross Section: In general, the channel is moderate in cross section the entire length of the stream.

Bottom Materials: The bottom composition within the survey boundaries was estimated to be 10 per cent silt and sand, 20 per cent gravel, 50 per cent rubble, and 20 per cent boulders. As indicated by road observations, the remaining 14 miles of stream to the mouth is considered to be of marginal value for spawning purposes. 1/ On the Wallowa Valley Improvement Canal, about 20 to 30 per cent of the bottom is gravel. However, much of the gravel in this waterway is heavily silted and may not be satisfactory for spawning. The relative abundance and location of gravel concentrations on Little Sheep Creek are shown in Figure 94.

Obstructions and Diversions: Twenty-four log and debris jams (I-BS-LS-2) were observed on Little Sheep Creek between the upstream boundary of the survey and a point 2.5 miles above the Coverdale Forest Camp-Imnaha roads junction (Appendix B, Table VI). Twenty-two of the jams were located in the 5-mile section immediately below the upper boundary of the survey (Figure 114). Two of the barriers in the upper 2 miles were classified as probably impassable. The cumulative affect of the other barriers may impair the passage of upstream migrants to spawning area.

1/ An estimated 25 per cent of the stream bottom in the lower 14 miles of Little Sheep Creek is observable from the road. Much of the remainder of this portion of the stream is situated close enough to the road to permit general observations to be made concerning gradient, which is an indicator of bottom type.

The dam (I-BS-LS-3) which diverts water into the Wallowa Valley Improvement Canal from Little Sheep Creek is believed to form a total barrier to upstream migration except possibly during peak flow periods. It should be explained that a short section of upper Little Sheep Creek, about one-eighth of a mile in length, is included as an integral part of the canal system which conveys irrigation water from the forks of Big Sheep Creek to the Wallowa Valley (Figure 94). The above-mentioned dam serves the purpose of rediverting the Big Sheep Creek water from Little Sheep Creek into a canal leading to the Wallowa Valley. Judging from the low flows sometimes observed in Little Sheep Creek below the dam, there is reason to believe that part of the flow of this stream is also diverted into the canal.

A total of 5 small, operating diversion ditches (I-BS-LS-1) was observed, none of which were screened. These were located from about 6 miles below the upstream boundary of the survey to 0.75 mile below Threebuck Creek. The locations of barriers and unscreened ditches on Little Sheep Creek are presented in Figure 94.

Impoundment and Hatchery Sites: Numerous sites which appear adaptable to the construction of impoundments are present along Little Sheep Creek. The most promising sites are in a 5-mile section extending from the Coverdale Forest Camp-Imnaha roads junction to the National Forest Boundary (Figures 94 and 115). These sites appear suitable for the development of off-channel impoundments. The total acreage involved has not been measured, but it is considerable.

No sites which appeared suitable for hatchery use were observed.

Flow and Temperature Data: Flow and temperature data for Little Sheep Creek are limited to those obtained during the survey program. In general, it is believed that low flows and warm water temperatures prevail during the summer. This condition is probably seriously aggravated by the withdrawal of water for irrigation.

On the survey of April 17, 1959, the flow was estimated to be 40 c.f.s. near the Coverdale Forest Camp-Imnaha roads junction. The water temperature in this general area varied from 34°F. at noon to 40°F. by 2:30 p.m. On the survey of May 8, 1959, water temperatures ranged from 40°F. near the Wallowa Valley Improvement Canal intake (25 miles above the mouth) to 46°F. at a point 5 miles below the intake. Two observations of fall flows in this vicinity are 6 c.f.s. on September 19, 1957 and 10 c.f.s. on October 7, 1957. In the past, near this same area, flows of a similar volume have been noted in late July and August.

Tributaries: None of the tributaries of Little Sheep Creek were surveyed. In general, the tributaries are of short length and have low to intermittent summer flows. The three largest tributaries are Bear Gulch, Threebuck, and Lightning Creeks (Figure 94).

Anadromous Fish Populations

Salmon: No salmon are known to inhabit Little Sheep Creek. Reports from local pioneers indicate that salmon, possibly chinook, were present in the stream many years ago.

Steelhead: The size of the steelhead run in Little Sheep Creek is unknown. During the inventory surveys in the spring of 1959, no redds and only 2 adult steelhead were observed. Habitat which appears favorable for steelhead spawning exists through much of the 11 mile long surveyed section.

CAMP CREEK

Introduction

Camp Creek is approximately 14 miles in length. It originates in the plateau west of Big Sheep Creek at the relatively low altitude of 4,800 feet, and enters this stream about a mile above the mouth at an elevation of 2,100 feet (Figure 94).

Camp Creek supports a run of steelhead; however, salmon are not believed to utilize the stream.

The lower 2.5 miles of the creek are accessible by road from the Joseph-Imnaha Highway, and another road, which ascends the tributary Trail Creek, crosses the main stem near the headwaters. Access to the stream between these two roads can be made by trail.

Logging has occurred in the timbered areas of Camp Creek Canyon, and water for irrigation is diverted from the creek in the lower 2.5 miles.

Inventory Surveys - Dates and Areas

The lower 8 miles of Camp Creek were surveyed on foot on April 28, 1959.

Survey Data

Terrain and Gradient: The terrain changes gradually from a narrow canyon in the upper mile of the surveyed area to a wide canyon 2 miles above the mouth. The gradient was classified as moderate to steep. The U. S. Geological Survey topographic map for the Imnaha quadrangle indicates an average grade in the surveyed area of approximately 3 per cent.

Slope and Bank Cover: Grass and rocks are the predominant slope cover (Figure 116). Bank cover is brush, rocks and grass. Also, deciduous timber is present along the banks in the lower 4 miles.

Shade: Shading of the stream was classified as open in the upper mile, partial to dense in the next 2.5 miles, and partial in the lower 4.5 miles (Figure 117).

Stream Cross Section: The stream cross section is moderate except in the uppermost mile where it is shallow.

Bottom Materials: The bottom composition was estimated to be 10 per cent silt and sand, 20 to 30 per cent gravel, 50 per cent rubble, and 10 per cent boulders. Figure 94 shows the location and relative abundance of gravel.

Obstructions and Diversions: Four log jams (I-BS-C-1) classified as partial barriers were observed on Camp Creek (Appendix B, Table VI). Two small jams were noted just below the Tibbett Ranch House which is about 2.2 miles above the mouth. One medium-sized jam was observed 300 yards below the first occupied dwelling above the mouth (about 1 mile) and a large jam was noted adjacent to some abandoned farm buildings about one-third mile above the mouth. The locations of the observed obstructions on Camp Creek are presented in Figure 94.

No unscreened diversion ditches were found. Three screened diversion ditches were noted within the lowermost 3 miles.

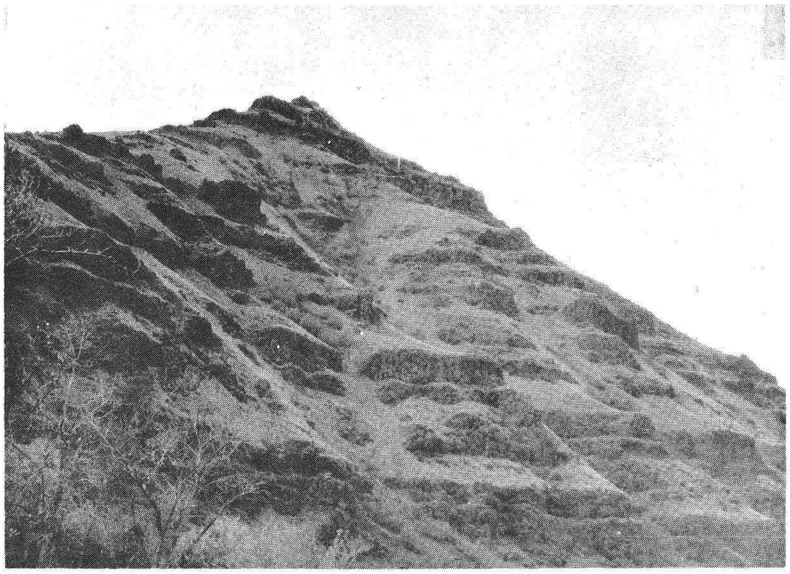

Figure 116. Typical Slope Cover of Basalt Out-Croppings and Grass Found in Camp Creek Canyon. This Photo was Taken about 5.5 Miles above the Mouth of Camp Creek in April 1959.

Figure 117. Camp Creek about 5 Miles above the Mouth Near the Site of a Spring-Tributary. At the Time the Picture was Taken in April of 1959, the Stream was Discharging About 12 c.f.s. in the Depicted Section. Notice the Good Quality of the Shading Along this Section of the Stream.

Impoundment and Hatchery Sites: There may be a restricted amount of space for impoundment development along the lower 2 miles of Camp Creek. This area needs further investigation, especially regarding flow limitations. The general locations of the sites are indicated in Figure 94.

No sites believed adaptable to hatchery development were noted.

Flow and Temperature Data: At the time of the survey on April 28, 1959, the flow of Camp Creek ranged from an estimated 12 c.f.s. at the upper end of the surveyed section to 24 c.f.s. at the mouth. According to a local rancher, the stream within the surveyed section is fed by a spring located about 5 miles above the mouth, and the flow is perennial. The spring, when observed during the survey, was discharging about 5 c.f.s. As indicated by the Imnaha quadrangle topographic map, Camp Creek is an intermittent stream above the 8-mile point.

The water temperatures on Camp Creek during the survey ranged from 45°F. at 11:50 a.m., 4 miles above the mouth, to 52°F. at 2:00 p.m., at the mouth. There is no record of water temperatures during the summer, but considering the factors of altitude, climate, and temperatures of other streams of the general area, it is likely that temperatures on Camp Creek approach or possibly exceed 70°F.

Tributaries: Trail Creek, the only noteworthy tributary of Camp Creek, is reported to go dry in the summer. This stream was discharging about 4 c.f.s. on April 28, 1959.

Anadromous Fish Populations

Salmon: There is no evidence of the presence of salmon in Camp Creek. Oregon Game Commission fish-screen by-pass trap records show no capture of juvenile salmon in the 2 years of trapping operations on irrigation ditches on this stream.

Steelhead: Camp Creek appears well suited to steelhead production in the surveyed section. In 1956, approximately 1,250 juvenile rainbow-steelhead trout were trapped in fish-screen by-pass traps in the months of July, August, and September. 1/ In 1957, the traps were operated during these same months, but no trout were captured. During the survey of Camp Creek on April 28, 5 adult steelhead and 17 redds were observed.

Much good spawning and rearing area is present on Camp Creek in the lower 6 miles. The remaining upper 2 miles of the surveyed area appear to be generally submarginal as fish habitat due to a wide exposed stream bed and a lack of pools.

DISCUSSION AND RECOMMENDATIONS OF TRIBUTARY STREAMS

From a salmon management standpoint, the major problems of the Big Sheep Creek drainage are those of low flows and high summer water temperatures, resulting principally from losses of water to irrigation diversions, and to a lesser extent, removal of watershed vegetation. It has been previously indicated that nearly the entire flow at the forks of Big Sheep Creek is diverted into the Wallowa Valley for irrigation purposes. During the irrigation season, groundwater inflow and the flows of a few small tributaries located below the diversion are often the sole sources of water in the spawning areas of Big Sheep Creek. Since Little Sheep Creek also supplies water to the Wallowa Valley irrigation system, flow conditions during the irrigation season are somewhat similar on

1/ Information by courtesy of the Oregon Game Commission.

this stream. Briefly, it appears that warm water conditions once probably typical of only the lower reaches of these streams, have invaded former cool water habitat utilized by spawning salmon and steelhead. Some methods of attempting to offset the resultant loss of production area are suggested in the following discussion.

Fish Transplants

On Big Sheep Creek, spring chinook salmon spawn over an 11-mile length of stream which extends from Lick Creek to Coyote Creek. Unutilized for the reproduction of these fish, are approximately the lowermost 20 miles of the stream. Because the factor restricting this area from use by adult spring chinook superficially appears to be that of excessive water temperatures during the holding and spawning periods and not a lack of gravel, an introduction of fall-spawning chinook or silver salmon may be feasible.

In an attempt to indicate the value of this section for the production of a fall-spawning type of salmon, the potential numbers of redd sites for fall-spawning chinook and silver salmon have been estimated. 1/ These estimates suggest that adequate spawning area exists on lower Big Sheep Creek for 500 redds of a fall-spawning type of chinook or 900 silver salmon redds.

Two other streams in the Big Sheep Creek basin which may be suited to the production of fall-spawning fish are Little Sheep and Camp Creeks. These streams are both of small size and may be best adapted to the production of silver salmon. Following the termination of the irrigation season and the start of fall rains, it is believed that the flows in these streams would be adequate to accommodate adult salmon. In respect to conditions of summer flow, Camp Creek is reported to have a favorable discharge above the area of irrigation influence due to the presence of springs. This should be investigated. The flow pattern of Little Sheep Creek during the irrigation season may be even more uncertain and would definitely require study prior to an introduction of fish.

To provide a crude measure of the value of Little Sheep and Camp Creeks for the production of silver salmon, the redd potentials of these streams have been estimated. The estimates include only those portions of the 2 streams believed most favorable to the reproduction of salmon. Based on 11 stream miles, the indicated potential for Little Sheep Creek is 200 silver salmon redds. 2/ This estimate excludes 6 miles of the Wallowa Valley Improvement Canal which presumably could become accessible to anadromous fish through adequate obstruction clearance on upper Little Sheep Creek. However, the value of this area for salmon production

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1/ Estimates made on the following basis: (1) there are 20 miles of stream with an average width of 7 yards; (2) the bottom materials assessment consists of 10 per cent gravel of which 0.5 of it is located where conditions are suitable for spawning; and (3) the redd and inter-redd space requirements are 24 square yards for fall chinook and 14 square yards for silver salmon as indicated by Burner (1951).

2/ Estimate of redd potential of Little Sheep Creek made with the following assumptions: (1) there is a usable stream distance of 11 miles with an average width of 6 feet; (2) the bottom materials are 15 per cent gravel of which one-half is located where conditions are favorable for spawning; and (3) the redd and inter-redd space requirements of silver salmon are 14 square yards as indicated by Burner (1951).

under existing conditions of flow is dubious. 1/ The estimated potential for Camp Creek is 150 silver salmon redds for the lowermost 6-mile section of stream. 2/

Prior to the initiation of a salmon introduction program in any of the mentioned areas, investigation should be undertaken to assess the quality of the respective incubational environments. Methods for determining the influences of silting and scouring on the mortality of eggs and fry have been suggested previously in the reports of other drainages. Also of much benefit to a transplant program would be studies to provide information on the temperature and flow conditions that exist on the stream considered for development.

The selection of donor stocks should necessarily follow a detailed appraisal of environment, if this appraisal proves encouraging. The selection of suitable donor stocks of silver salmon may be difficult and will require investigation beyond the scope of the initial program. Silver salmon presumably do not exist in the Imnaha drainage and do not appear to be strongly established in the Grande Ronde drainage. Suitable transplant stock of summer chinook may be available from Washington tributaries of the Columbia.

Obstructions and Diversions

Recommendations for obstruction removal in the Big Sheep Creek drainage are limited largely to the clearance of log jams on Little Sheep and Camp Creeks. Obstructions and diversions are listed in Appendix B, Table VI. Obstruction clearance is needed on Little Sheep Creek if the full length of the spawning area is to be made accessible to steelhead. Out of a total of approximately 24 small- to medium-sized jams (I-BS-LS-2) located on this stream, 16 are recommended for removal with fisheries funds. The jams recommended for removal include 11 jams located between the Wallowa Valley Improvement Canal intake and the forest boundary marker, 5 jams from 0.5 to 1.5 miles below the forest boundary marker, and 1 jam approximately 2.5 miles above the Coverdale Forest Camp-Imnaha roads junction (Figure 94). The remaining 8 jams, located in the first 0.5 mile below the forest boundary, were caused by a recent logging operation and the obligation of removal should be with the logging contractor. Preliminary action to obtain removal of these jams has been taken.

On Camp Creek, 4 log and debris jams (I-BS-C-1) located on the lower 2.2 miles of the stream are recommended for removal (Figure 94). Although adult steelhead were observed above these jams, they were considered serious enough to be classified as partial obstructions in need of correction.

1/ Preliminary investigation has indicated the following problems to exist in introducing anadromous fish into the Wallowa Valley Improvement Canal: (1) during the winter, only a small volume of flow, possibly 2 to 4 c.f.s. is maintained in the canal to reduce ice jams and resultant bank overflow and erosion damage; (2) much of the gravel in the canal is heavily silted; (3) the canal diversion from Little Sheep Creek would require screening and the dam would require a ladder; and (4) jam clearance would be necessary on upper Little Sheep Creek.

2/ Estimate of redd potential of Camp Creek made with the following assumptions: (1) there is a usable stream distance of 6 miles with an average width of 6 feet; (2) the bottom materials are 20 per cent gravel of which one-half is suitably located for spawning use; and (3) the redd and inter-redd space requirements for silver salmon are 14 square yards as indicated by Burner (1951).

No action is recommended to improve fish passage through the torrential section of upper Big Sheep Creek (I-BS-3) or at the various falls or jams (I-BS-M-1, 2 and 3) on the Middle Fork. The amount of spawning area to be gained would not justify the expense of such action. Only a limited amount of gravel area is present on the Middle Fork, and the South and North Forks appear to be of little or no value to the production of anadromous fishes because of swift to torrential flows.

Screening of diversion ditches may be needed on both Big Sheep and Little Sheep Creeks. It is recommended that unscreened ditches on these 2 streams be investigated to determine if they are diverting fish and that screens be installed if losses are found to occur. Five unscreened, operating diversion ditches (I-BS-LS-1) are present on Little Sheep Creek while 3 unscreened, operating ditches (I-BS-1) and 2 unscreened ditches (I-BS-1) which may be used part time, are present on Big Sheep Creek. All operating ditches on Camp Creek are screened and Lick Creek has no diversion of water for irrigation or other purposes.

Supplemental Rearing

As previously indicated, several sites which appear suitable for impoundment construction are present in the Big Sheep Creek drainage. These sites are located on Big Sheep, Lick, Little Sheep, and Camp Creeks. Provided that the experimental rearing of salmon in impoundments currently being undertaken by the various fisheries agencies of the Pacific Northwest proves feasible and results in a favorable return of adults, it is recommended that impoundment development be considered in the Big Sheep basin. On Big Sheep and Lick Creeks, spring chinook may be the best type of salmon to rear since natural runs of these fish already exist. In event of the introduction of silver salmon into Little Sheep and Camp Creeks, the rearing of salmon in impoundments on these streams may be advantageous as a means of further encouraging the establishment of runs.

A possible deterrent to the development of impoundments on Big Sheep, Little Sheep, and Camp Creeks, is the existence of low flows and warm water temperatures from mid-summer to fall as a result of irrigation withdrawals. Under present conditions, the discharges of these streams in July and August may sometimes be critical for the production of salmon. It cannot be predicted if the development of impoundments would aggravate this condition, but it is believed that any notable increase in water temperatures on these streams should be avoided. This is particularly true on Big Sheep Creek, where a run of spring chinook is present.

Limited opportunities for the rearing of salmon in inaccessible areas of stream are available on Upper Big Sheep Creek, the Middle Fork and the Wallowa Valley Improvement Canal. Although the rearing capacity of these areas is unknown, field observations have indicated their suitability in certain sections for the rearing of fish. The combined distance of these stream areas is approximately 15 miles, of which approximately one-half consists of steep gradient. One major disadvantage to the rearing of fish in these sections of stream is the presence of the Wallowa Valley Improvement Canal intake on upper Little Sheep Creek. This diversion sometimes has a flow as great as 70 c.f.s. and would be costly to screen.

Stream Improvements

Sill log and deflector placement may be useful as a means of improving the quality and quantity of spawning and rearing area in marginal sections of Big and Little Sheep Creeks. On Big Sheep Creek, environmental improvement would benefit existing runs of spring chinook and steelhead, and on Little Sheep Creek, any improvement would aid the existing steelhead run and also silver salmon, if this species is introduced. Experimental installations of a few logs on each stream is recommended to evaluate the practicality of additional development with this device. The suggested installation area on Big Sheep Creek is between Carrol and Coyote Creeks. On Little Sheep Creek, test installations of sill logs should be made below Threebuck Creek.

Another stream improvement technique which is recommended on an experimental basis on Big Sheep Creek in conjunction with the introduction of fall-spawning chinook, is the use of a D-6 or comparable type tractor, equipped in the rear with a 3-pronged plow-like implement called a ripper, to loosen the streambed materials. It is believed that such devices could be used to advantage on Big Sheep Creek in the vicinity of Squaw Creek to increase the ground water flow, remove silt from the gravel, and loosen the larger bottom materials which predominate in this area to make them more easily available to fish for spawning.