fig 43 (cont.) Wallowa R 1959

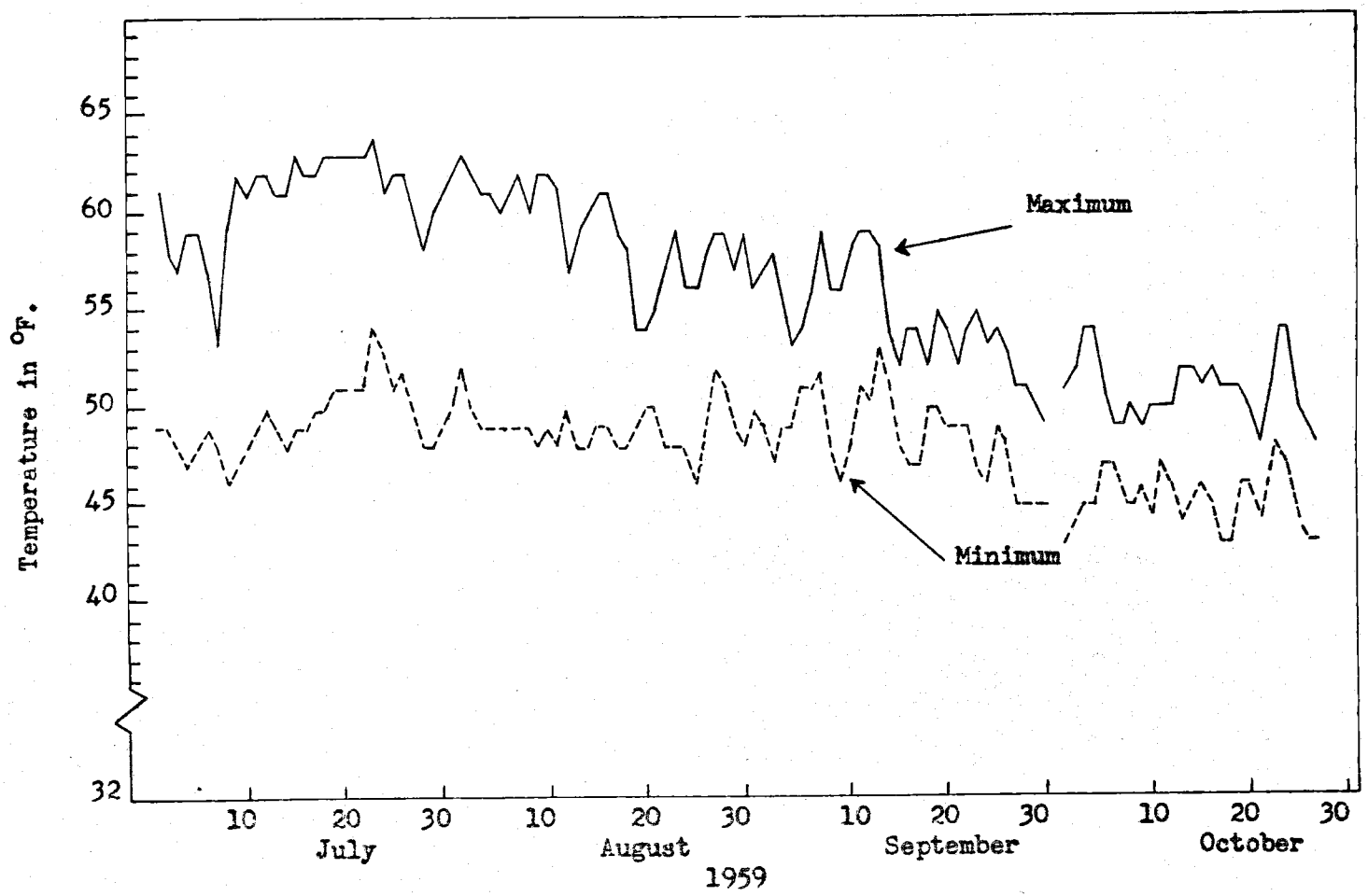

Figure 43. Daily Water Temperatures of the Wallowa River (cont.)

Fig. 44 Wallowa R. 1959

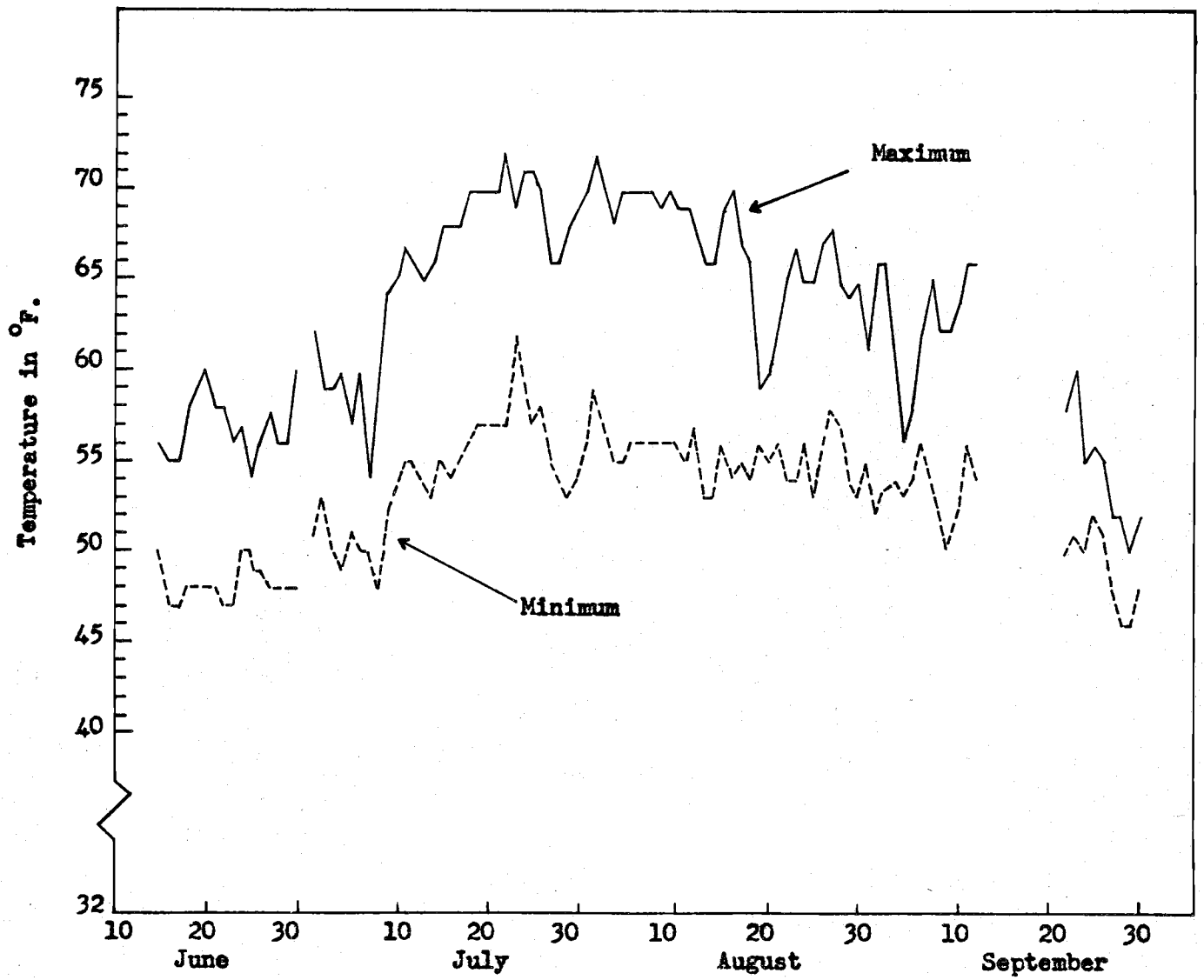

Figure 44. Daily Maximum and Minimum Temperatures of the Wallowa River, 3 Miles Above Minam, Oregon, 1959.

Fig 45 Wallowa R 1957

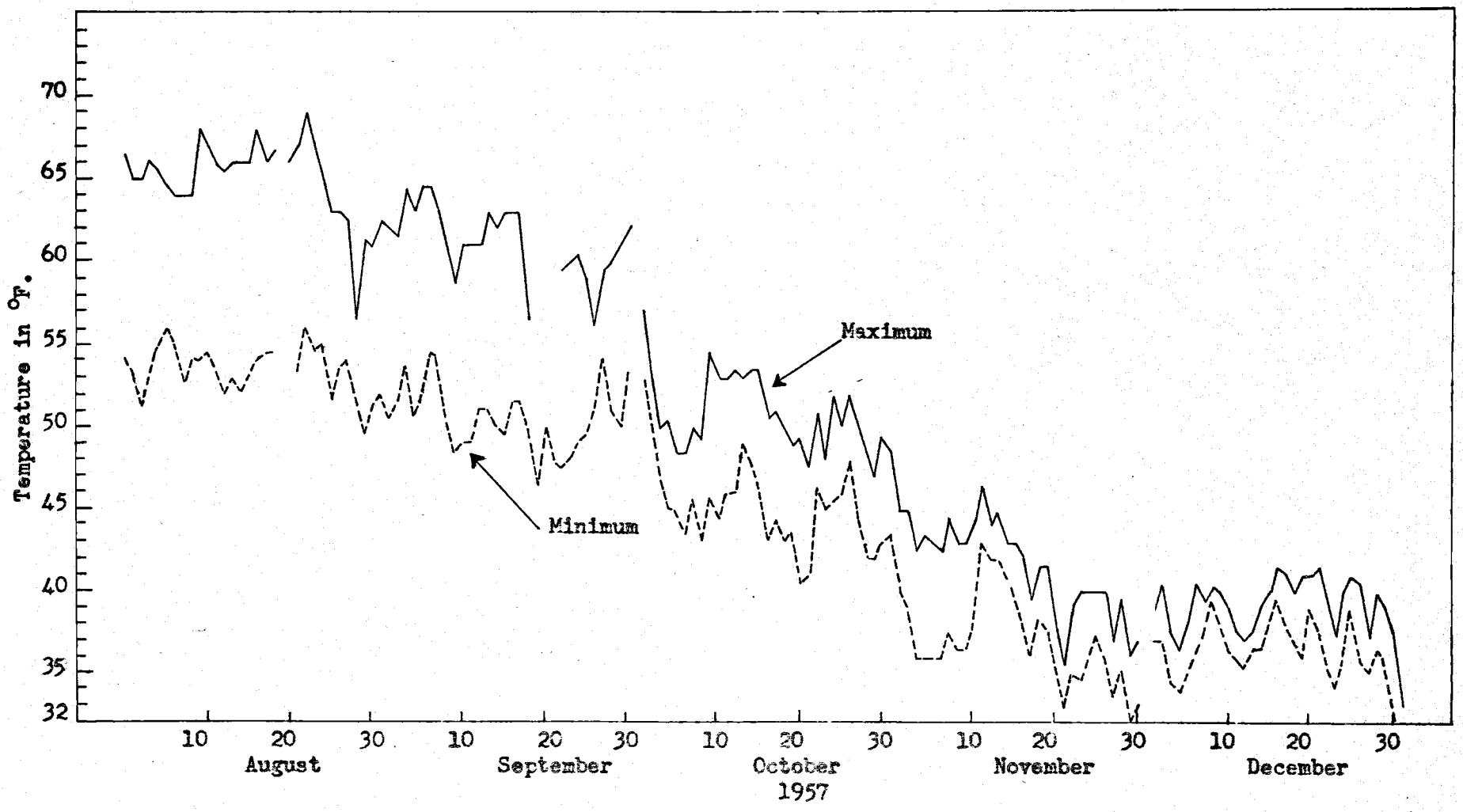

Figure 45. Daily Maximum and Minimum Temperatures of the Wallowa River, 1 Mile Below Wallowa, Oregon, 1957. (Data obtained from U. S. Fish and Wildlife Service report entitled "Air and Water Temperature Studies for 1957, Middle Snake Drainage", April 1958.)

1. Prairie Creek: Inventory surveys were made on Prairie Creek on August 8, September 21, and October 17 and 18, 1959. The surveys extended over approximately 16 miles of stream, from 1 mile below the source to 1 mile above the mouth. This small stream enters the upper Wallowa River at Enterprise. It originates on the northern slopes of the Wallowa Mountains near an altitude of 7,700 feet, and flows approximately 18 miles prior to joining the main stream. In the upper 3 miles, Prairie Creek flows through steep mountainous terrain which gradates within the next two miles into the Wallowa Valley. From this point to the mouth, the flow is through flat valley land (Figure 46).

At its source, the creek is fed by a series of small springs which collectively discharge about 6-8 c.f.s. The flow conditions which exist on Prairie Creek vary from favorable in some sections to poor in others. In the lower 5 miles the volume of flow is generally satisfactory due to the influx of irrigation waste water. Above here, the extensive use of the stream for irrigation results in the presence of some areas of seriously restricted flows. Two such areas were observed on the survey of September 2, 1959, at approximately 7 and 10 miles above the mouth. Both areas were about 0.25 mile in length and one section contained no flow while the other was flowing about 1 c.f.s. In regard to the period of spring freshet, Prairie Creek is reported to flood at an earlier date than the Wallowa River due to the relatively lower altitude of the watershed. On Prairie Creek, the major spring runoff occurs usually in April or May. Flow data obtained during the survey of this stream are presented in Table 26.

Table 26. Spot Observations of Temperature and Flow During the Inventory Survey of Prairie Creek, 1959.

Date	Location Above Mouth (Miles)	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.
8-25	15	2:00 p.m.	64	46	6-7
8-25	14	3:30 p.m.	68	55	7
8-25	12	4:00 p.m.	72	61	4-5
8-25	11	5:00 p.m.	72	64	6
9-2	11	11:00 a.m.	70	58	8
9-2	9	11:30 a.m.	70	62	5
9-2	9	12:45 p.m.	75	66	5
9-2	7.5	2:30 p.m.	77	65	10
9-2	6	3:00 p.m.	---	62	---
9-2	6	3:30 p.m.	80	61	15
10-18	3	11:25 a.m.	58	50	100

Figure 46. Prairie Creek 11 Miles Above the Mouth. Note the Almost Complete Lack of Bank Cover (9-21-59).

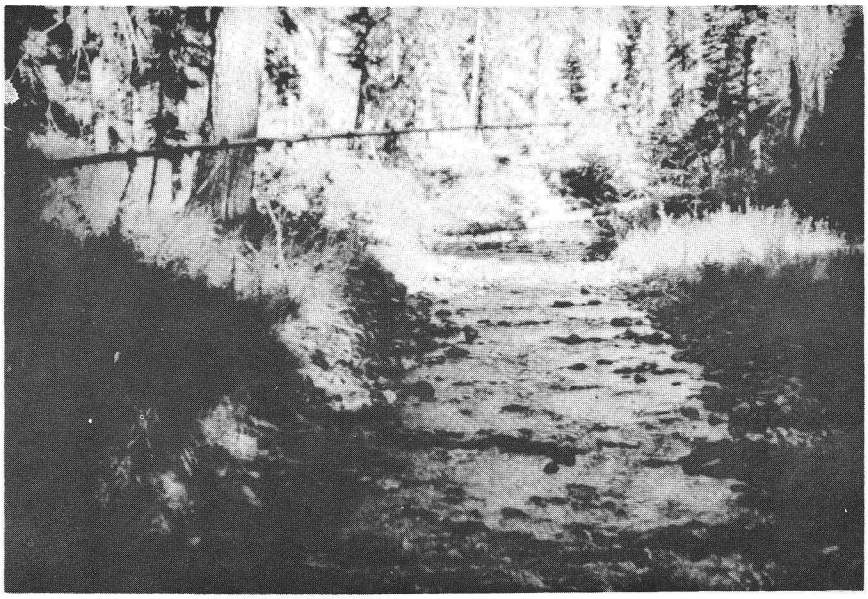

Figure 47. Bank Cover, Gradient, and Bottom Composition Typical of Much of Big Canyon Creek. The Area Shown is Located About 4.5 Miles Above the Stream Mouth (7-31-58).

With exception of the steep headwater section, the gradient of Prairie Creek is generally moderate and conducive to the deposition of gravel and other smaller bottom materials. Gravel constitutes an estimated 35 per cent of the total channel deposits; silt and sand, 45 per cent; and rubble, 20 per cent. Much of the gravel is compacted due to the influence of finer bottom materials which are introduced into the stream by the return of irrigation waste water. Also, an additional source of siltation is erosion of the streambanks. During the survey, silting and turbidity were extensive enough in some sections to impede the observation of the bottom materials.

Relatively little information is available concerning the water temperatures which exist on Prairie Creek. There is reason to believe that water temperatures on the upper creek are somewhat moderated as a result of the spring origin of the stream. An interview with a resident living about 5 miles below the stream source has indicated that the creek does not freeze in this section during the winter, despite frequent periods of fairly severe cold weather. Also, records obtained in August during the survey of this section suggest the presence of moderate summer water temperatures (Table 26). As regards the central and lower portions of Prairie Creek, the limited data obtained on the survey indicate a greater range in water temperatures than for the upper section. Some factors which interact to determine the maximum temperatures attained by the stream in the lower two-thirds of its length are: (1) the presence of low summer flows in the central portion of the creek with more favorable flows in the lower creek, (2) the existence of streambed cover which provides only moderate to poor protection from the sun and, (3) the prevalence of moderate to warm air temperatures in the upper Wallowa Valley during the summer.

Obstructions noted on Prairie Creek consist of 10 jams, 3 irrigation dams, 1 culvert, 21 unscreened diversion ditches and an area of low flow. Further information covering these obstructions is presented in Table 27 and Figure 37.

2. Big Canyon Creek: Big Canyon Creek joins the Wallowa River approximately 12 miles above the mouth (Figure 37). It arises in the Wallowa Mountains near the 7,000 foot elevation, and is about 18 miles in length. The course of flow is northerly, predominantly through plateau area bordering the Wallowa Mountains. Access to the lower 8 miles of the stream can be made via a logging road which diverges from State Highway 82 between Elgin and Wallowa, Oregon.

The inventory survey of Big Canyon Creek was conducted on July 31, 1959, and extended from the mouth to Sage Creek, a distance of 8 miles. In the observed section, the stream flows through a medium canyon which is forested with coniferous timber. Bank vegetation is composed of brush and conifers which provide the stream with moderate shade (Figure 47). The gradient varies between moderate and steep. With the exception of a one-mile section of stream located 1.5 to 2.5 miles below Sage Creek, the bottom composition was estimated to be only 10 per cent suited to spawning. The excluded one-mile section was estimated to be 20 per cent suitable for spawning.

At the time of the survey on July 31, 1958, Big Canyon Creek was discharging about 7 c.f.s. at the mouth. During the span of the field work (September 1957 to November 1959), the stream was never observed to be dry at the mouth, although the flow became considerably reduced in late summer prior to the onset of fall precipitation. Available water temperature data for Big Canyon Creek are presented in Table 28.

Sage Creek, a tributary located 8 miles above the mouth of Big Canyon Creek, was discharging 1 c.f.s. at the mouth on the day of the survey. The temperature of this small stream was 51°F. at 12:55 p.m.

Table 27. A List of Obstructions to Fish Migration Noted on Prairie Creek During Surveys in August, September, and October 1959.

Number and Type of Obstruction	General Location (miles above mouth)	Remarks
1 unscreened ditch (WaP-1)	2 to 3	
1 unscreened ditch (WaP-2)	5 to 6	
8 debris jams (WaP-3)	6 to 9	Jams believed to be low water obstructions.
Area of low summer flow (WaP-4)	6 to 9	
2 unscreened ditches (WaP-2)	6 to 9	
1 diversion dam (WaP-5)	6 to 9	Wood dam and apron 1' high x 8' wide x 4' long-possible low water block.
1 unscreened ditch (WaP-2)	10 to 11	
1 diversion dam (WaP-6)	10 to 11	Earth dam 50' wide x 4.5' high-discharge regulated by culvert and stop boards--possible velocity block at high water.
1 culvert (WaP-7)	10 to 11	Stream underpasses Silver Lake irrigation ditch through two 18 inch culverts, possible velocity block at high water.
16 unscreened ditches (WaP-2)	11 to 15	
2 jams (WaP-3)	11 to 15	Possible low water obstructions.
1 diversion dam (WaP-5)	11 to 15	Wooden dam constructed in 2 steps--upper step only 1' rise but would necessitate jump from apron--possible low water block.

Table 28. Spot Observations of Temperature and Flow Obtained During the Inventory Survey of Big Canyon Creek on July 31, 1958.

Location (miles above mouth)	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.
8 (just above mouth Sage Creek)	12:50 p.m.	80	60	6
7	1:45 p.m.	83	60	6
6	3:00 p.m.	85	61	7
5	3:30 p.m.	90	64	7
3	4:30 p.m.	73	65	7
1	5:20 p.m.	75	65	7

No definite barriers to upstream migration were noted in the surveyed portion of Big Canyon Creek. However, much forest debris is present along the creek, and numerous log and debris jams were noted, especially in the section from 5 to 8 miles above the mouth. Two small irrigation ditches (WaBi-1) were observed on the lower end of Big Canyon Creek. The intake of the uppermost ditch is located about 1 to 1.25 miles above the mouth, and the entrance to the lower ditch is from 0.25 to 0.5 mile above the mouth. Screens were not observed on either ditch. Juvenile trout, appearing to be fish of the year, were noted in the lower 6.5 miles of the stream on July 31, 1958.

3. Trout, Whiskey, Dry, and Howard Creeks: Trout, Whiskey, Dry, and Howard Creeks enter the Wallowa River at approximately 40, 25, 19, and 3 miles, respectively, above the mouth. All of these tributaries originate in the upland plateau to the north and east of the Wallowa River, and because of relatively low headwater elevations, are subject to very low flows in late summer. The drainages range in length from about 8 to 12 miles. None of these streams were surveyed. Isolated observations of discharge were obtained on Trout, Dry, and Howard Creeks during the survey of the Wallowa River. These data are presented in Table 29 along with flow estimates obtained from a U. S. Fish and Wildlife Service survey conducted in the fall of 1940. As far as is known, these small streams are of no value to the production of salmon, but are probably of importance to the propagation of steelhead.

Table 29. Spot Observations of Discharge at the Mouths of Trout, Whiskey, Dry, and Howard Creeks.

Stream and Location	Date	Estimated Flow in c.f.s.
Trout Creek 1/	10-12-40	10
Trout Creek	9-9-58	8
Whiskey Creek 1/	10-16-40	Under 1
Dry Creek 1/	10-14-60	50 2/
Dry Creek	10-17-59	15 2/
Howard Creek	10-28-58	3

1/ Estimates of flows obtained from U. S. Fish and Wildlife Service, Special Scientific Report: Fisheries No. 39, Survey of the Columbia River and Its Tributaries, Part VI, Parkhurst, Z. E., 1950*a*.

2/ Discharge increased over natural flow due to inflow of waste irrigation water upstream from point of flow estimation.

4. West Fork Wallowa River: The West Fork flows entirely within the rugged topography of the Wallowa Mountains. It originates in glacially formed cirque lakes within the mountain area known as the Lake Basin. The stream flows about 10 miles before combining with the East Fork to form Wallowa River. A spot check survey was made on the West Fork on October 24, 1958, from the mouth upstream about 7 miles. Access to the stream is by trail. In the lower 4 miles the West Fork is in a canyon which becomes a steep gorge in the lower half and culminates at 2 falls of 25 to 30 feet each, just above the mouth. These barriers have never been provided with fishways and are impassable to the upstream movement of fish. From about 5 to 7 miles above the mouth, the stream gradient moderates and there are gravel deposits in the channel. Above here, the gradient again steepens.

Although there is no flow gaging station on the West Fork, the volume of runoff of this drainage can be estimated by subtracting the discharge of the East Fork from the discharge of Wallowa River below Wallowa Lake Dam. By use of flow data collected by the USGS during 2 recent years, it can be seen that the West Fork contributes about 5 to 6 times as much volume to the discharge of the Wallowa River below Wallowa Lake Dam as does the East Fork (Table 30).

Converted to average daily flow in c.f.s., the runoff of the West Fork in 1956 was approximately 150 c.f.s. and in 1957, 125 c.f.s. Although these data do not portray seasonal fluctuation in flow this is indicated by the discharge cycle of the East Fork. On the East Fork, the high volume of runoff occurs in June with elevations in flow extending from May into July. The mean monthly flow on this stream during the freshet period may range from 3 to 5 times greater than in other months. Water temperature records are not available for the West Fork. However, the altitude, topography, and climate of the region are indicative of freezing temperatures in the winter and moderate to cool water temperatures during the summer.

5. East Fork Wallowa River: The East Fork is about 5 miles in length. Within the lower 4 miles the canyon floor rises 3,000 feet, and above here, the gradient moderates to form a large park-like area. At approximately 1.25 miles above the mouth, water is diverted to a hydroelectric plant located at the lower end of the East Fork canyon. Because of its lack of potential for the production of anadromous salmonids, this stream was not surveyed.

Table 30. A Comparison Showing the Contribution of the West and East Forks Toward the Flow of Wallowa River Below Wallowa Lake Dam, Water Years 1956-57.

Water Year	Disch. Wallowa R. Below Wallowa L. Dam (in acre-feet)	East Fork Disch. in Acre-Feet	Remaining Disch. or Disch. of West Fork in Acre-Feet
1956 1/	128,800	20,130	108,670
1957 2/	110,400	18,240	92,160

1/ U. S. Geological Survey W. S. P. 1447, Part 13, Snake River Basin, 1958. Flow records of Wallowa River and East Fork adjusted for diversion of water above gaging stations.

2/ U. S. Geological Survey W. S. P. 1517, Part 13, Snake River Basin, 1959. Flow records of Wallowa River and East Fork adjusted for diversion of flow above gaging stations.

Anadromous Fish Populations (Wallowa River, and Prairie, Big Canyon, Trout, Whiskey, Dry, and Howard Creeks)

Anadromous salmonids which utilize the Wallowa River include chinook and silver salmon, and steelhead trout.

Chinook Salmon: Spring chinook salmon are the principal race of chinook known to utilize the Wallowa River. In the past, from 1952 through 1957, Fish Commission personnel conducted annual surveys to count spring chinook salmon on the spawning grounds of this stream (Table 31). Generally, observations of fish and redds were made within a 2.5 mile section extending from 3.5 miles below Joseph to Enterprise. For reasons not entirely explainable, the index unit counts have not indicated a concentrated use of the Wallowa River by spring chinook. One of the factors which has possibly contributed to low counts of fish and redds in the past is the difficulty of timing single, annual spawning ground surveys on each stream so that near maximum counts are obtained. Because the surveys of eastern Oregon streams during the spawning season have generally been conducted on the basis of a single trip originating from the main laboratory of the Fish Commission in western Oregon and because the time which could be allocated to these surveys was necessarily limited, emphasis was placed on timing the observations to include peak spawning activity on as many streams as possible. On the Wallowa River, there has been strong indication that spawning is generally late and may not coincide with peak activity on many of the other streams within the region. For this reason, a near maximum attainable count of salmon may have seldom been made on this stream.

In regard to timing of the spawning period of spring chinook on the Wallowa River, spawning activity is believed to typically start just prior to mid-August and terminate by mid-September. This has been indicated by observations made during a series of surveys which spanned the spawning seasons in 1955 and 1956. During these years, the peak of spawning within the index unit occurred between August 20 and 26 in 1955 and between August 30 and September 4 in 1956.

The area of the Wallowa River which is presently known to be utilized by spring chinook for spawning extends for a distance of 25 miles, from 2 miles below Joseph to 3 miles below Wallowa. The degree of use of much of this area is unknown and would be difficult to determine due to the somewhat consistent turbidity of the river below the mouth of Prairie Creek.

Although there have been no observations of fall spawning chinook on the Wallowa River, it is believed probable that fish of this type are present. The principal reasons for this belief are the existence of a few late spawning fish, possibly summer chinook, on the Lostine and Minam Rivers, and the presence of historical accounts of large numbers of fall spawning chinook in the Wallowa system in the early 1900's.

As a result of trapping operations at irrigation ditch fish screen installations on the Wallowa River, the Oregon Game Commission has obtained information regarding the times of outmigration of the various anadromous species. These data indicate that juvenile salmon are captured from March through October and that the peak downstream movement may occur from late winter to early summer (Table 32). Also substantial numbers of juvenile salmon are sometimes taken in August, September, and October.

As previously stated, spring chinook salmon also utilize Prairie Creek for spawning. The extent of this use is unknown, and would be difficult to determine due to the constant turbidity of this stream. Information concerning spring chinook on Prairie Creek consist of limited observations made during the spawning season of 1955.

Table 31. Annual Spawning Ground Counts of Spring Chinook Salmon Within an Index Unit on the Wallowa River, 1952-57. 1/

Date and Year	Number of Fish Live	Number of Fish Dead	Number of Redds
8-16-52 2/	0	0	0
8-24-53	19	0	4
8-25-54	0	0	0
8-26 and 9-7-54 3/	6	6	29
9-4-56 4/	52	2	40
8-27-57	30	1	28

1/ Surveys made by Oregon Fish Commission personnel. Index unit located from 3.5 miles below Joseph to lower perimeter of Enterprise, a distance of 2.5 miles.

2/ Spot checks only, and not within index unit.

3/ Data obtained from multiple surveys--maximum counts selected from surveys of 8-26 and 9-7.

4/ Data obtained from multiple surveys--maximum counts selected from survey of 9-4.

Table 32. Monthly Catch Records of Juvenile Salmon Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on the Wallowa River. 1/

Year	Period of Trapping	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	3-1 -- 10-15	617	410	546	723	234	167	57	22
1954	3-24 -- 10-30	8	25	575	272	270	94	149	197
1955	4-10 -- 10-23	--	67	2,150	475	94	92	155	100
1956	5-1 -- 10-30	--	--	1,676	335	201	55	56	26
1957	4-1 -- 10-23	0	6	59	8	24	19	76	9
1958	4-1 -- 9-15	--	436	911	64	25	7	1	0

1/ Data by courtesy of Oregon Game Commission.

At this time, a few spawning chinook and redds were noted in the lower 0.4 mile of Dobbin Creek, a tributary of lower Prairie Creek, and also in Prairie Creek, at a point approximately 1 mile above the mouth of Dobbin Creek.

On Dobbin Creek, one observation of two live salmon and four redds was made on September 7, 1955. Ralph Kaye, Superintendent of the OGC hatchery at Enterprise, has stated that fair numbers of chinook spawn in Dobbin Creek in some years.

Another small tributary of the Wallowa River on which a few spawning chinook have been noted is Spring Creek. This stream joins the main stem just below Enterprise and is part of the water supply of the OGC fish hatchery. Fish can ascend Spring Creek approximately 0.5 mile to the vicinity of the hatchery. In 1955, 2 adult spring chinook and a redd were noted below the trout hatchery dike.

Silver Salmon: Records of the Oregon State Department of Fisheries in 1906 indicate that 188 silver salmon females were spawned at the Wallowa Hatchery below the town of Minam, Oregon, from October 9 to November 10. Later, the run of this species is believed to have become largely depleted. At the present, Wallowa River is one of two streams in eastern Oregon known to support a run of silver salmon. In 1955, this species was reported in the river system by OGC personnel when downstream-migrant silver salmon were observed and captured. In 1956, Game Commission personnel observed adult silver salmon spawning in the river above Enterprise. In 1957, OFC biologists under the current inventory survey program, conducted surveys on the Wallowa River to determine the following information concerning silver salmon: (1) the numbers of this species utilizing the stream for spawning; (2) the distribution of spawning; and (3) the time of occurrence of the spawning season. Table 33 presents the results of these surveys. The combined observations in the different areas yielded a total of 51 live silver salmon, 1 carcass, and 64 redds. The area of known utilization extended from 2 miles below Joseph downstream a distance of 4 miles to the lower limits of Enterprise. Since the survey was terminated at this point, the density of silver salmon spawning in lower areas is unknown. However, redd observations were progressively less frequent as the lower survey boundary was approached. The primary area of utilization extended from 2 to 4.5 miles below Joseph, and in greater part, coincided with the major spawning area of spring chinook.

As indicated by the surveys, silver salmon spawning commenced on the Wallowa River in 1957, sometime between October 7 and 18. Spawning activity appeared to peak in the latter few days of October and the first few days of November. The time of termination of spawning activities is unknown. However, on the Lostine River spawning was believed to be completed by November 20 in 1957.

In 1958 and 1959, time could not be allocated for continued investigation of the spawning population of silver salmon on the Wallowa River. However, on November 7, 1958, a cursory survey was made through a 1-mile section of the area utilized by spawning silver salmon in 1957, and 9 redds and 5 live fish were observed. Reports in 1959, indicated a relatively large run of silver salmon in the river in the fall of that year.

As in the case of juvenile chinook salmon, downstream-migrant silver salmon are captured each spring in traps operated at fish screen installations on ditches diverting irrigation water from the Wallowa River. Game Commission personnel who operate the screens and traps have indicated that silver salmon outmigrants are captured from the time of screen installation, usually in late April, into July. During the period of trap operation, the greatest downstream movement of fish occurs in May and June.

Table 33. Spawning Ground Counts of Silver Salmon on the Wallowa River, 1957. 1/

Date	Location	Number of Fish		Redds
		Live	Dead	
October 7	West branch, 3.5 to 4 miles below Joseph	0	0	0
October 18	West branch, 3.5 to 4.75 miles below Joseph	4	0	8
October 28	2 to 3.5 miles below Joseph downstream	26	0	24
October 28	East branch, 3.5 miles below Joseph downstream 0.5 mile	5	0	13
October 30	West branch, 3.5 to 5.5 miles below Joseph to lower limit of Enterprise	20	1	37
November 20	Joseph downstream 1 mile	0	0	1 (possible)
November 21	1 to 2 miles below Joseph	0	0	1 (possible)

1/ Survey conducted by Oregon Fish Commission personnel.

Data are scarce regarding the time of entrance of adult silver salmon into the Wallowa River. On September 18, 1957, a sport fisherman was observed with a freshly caught silver salmon between the towns of Wallowa and Minam. During a tagging program conducted by the Oregon Fish Commission on the Snake River near Lewiston, Idaho, from the fall of 1953 to the fall of 1956, a few adult silver salmon were captured in two years during the month of September (Thompson, Haas, Woodall, and Holmberg, 1957).

Steelhead Trout: As on many of the streams of eastern Oregon, specific information is lacking concerning the distribution of steelhead on the Wallowa River and tributaries. In general, steelhead are found in all streams that are accessible, that have spawning area, and that have a flow which continues late enough into the season to enable the fry to emerge and become located in a rearing area. In some instances, steelhead have been observed to use intermittent streams, where the young apparently escape to larger streams before the parent stream becomes dry.

Only one survey to observe spawning steelhead was conducted on the Wallowa River. This survey was made on April 16, 1958, and extended from 3.5 to 4.5 miles below Joseph. Although no spawning steelhead were sighted, 4 newly constructed redds were observed. The area containing the redds coincided with that utilized by spring chinook and silver salmon for spawning.

It is believed, however, that Prairie, Trout, Whiskey, Dry, Big Canyon, and Howard Creeks are important to the production of steelhead. Big Canyon Creek, especially, is considered to be a good steelhead stream. The survey on July 31, 1958, extended over the lower 8 miles of this stream, and young rainbow-steelhead trout were noted throughout the lower 5.5 miles. Larger trout were observed to the upper survey boundary.

It is also very probable that Dry Creek supports a steelhead run. A statement made by a Dry Creek resident indicates sightings of several adult steelhead where the creek flows through his land about 2.5 miles above the mouth.

As a result of trapping done by OGC personnel at irrigation-ditch fish-screen installations, some indication of the downstream movements of steelhead on the Wallowa River has been obtained (Table 34). These data show that juvenile rainbow trout, presumably steelhead, are captured primarily in the spring and early summer. The period of capture extends from March through October. Although in some years the period of capture of rainbow juveniles reflects the period of trap operation, the data are believed to be generally indicative of the pattern of downstream migration.

Blueback Salmon: According to historical accounts, blueback salmon were at one time the most abundant species of salmon to utilize the Wallowa River. They are no longer present in the system. Irrigation diversions and the construction of dams were the principal factors in the extermination of these fish.

The possibility of restoring runs of blueback into the Wallowa River has been considered in recent years and, in this respect, several preliminary studies have been made. The latest study (included as APPENDIX A) was conducted from May to October 1959, and comprised a survey of factors relative to the feasibility of restoring blueback runs into Wallowa Lake.

Table 34. Monthly Catch Records of Juvenile Rainbows Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on the Wallowa River. 1/

Year	Period of Capture	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	3-1 -- 10-15	13	89	421	247	85	49	4	2
1954	3-24 -- 10-30	28	34	382	179	252	78	56	34
1955	4-10 -- 10-23	--	305	290	283	104	62	30	30
1956	5-1 -- 10-23	--	--	205	95	104	24	15	6
1957	3-23 -- 10-7	102	157	24	37	30	11	26	2
1958	4-1 -- 10-7	--	200	273	11	1	10	21	4

1/ Data by courtesy of the Oregon Game Commission.

HURRICANE CREEK

Introduction

Hurricane Creek enters the Wallowa River approximately 44 miles above the mouth, at Enterprise, Oregon (Figure 37). The stream is 18 miles in length, and in common with the other major tributaries of the Wallowa River, it originates in the Wallowa Mountains. From its source at approximately the 8,000-foot elevation, Hurricane Creek flows through a deep, glaciated canyon for 10 miles prior to emergence into the Wallowa Valley. Elevation at the mouth is approximately 3,700 feet. In the lower 10 miles, the stream is accessible by road from Enterprise, Oregon. The stream section above Falls Creek Forest Camp is accessible by trail.

Inventory Surveys - Dates and Areas

Inventory surveys were conducted on Hurricane Creek over a 14-mile section extending from one mile above Slickrock Creek to the mouth. Table 35 presents the locations and dates of the surveys. In addition to the inventory surveys, other surveys were made in the fall of 1957 to investigate the possibility of silver salmon utilization of the stream.

Survey Data

Terrain and Gradient: In the upper 10 miles, Hurricane Creek flows through an extremely deep, narrow canyon. On the western side, this canyon is separated from the Lostine Basin by Hurricane Divide, which attains an elevation of 9,500 feet, and to the east, the high Matterhorn and Sacajawea Peaks form a division between Hurricane Canyon and the West Fork of the Wallowa River. The stream flow is in a generally northerly direction. Below the canyon, Hurricane Creek traverses an inclining glacial outwash to the Wallowa River.

The gradient of the stream within the surveyed area varies from steep to torrential in the upper 6.5 miles; is generally steep in the next 1.5 miles to Hurricane Grange; and is moderate in the lower 6 miles. In the upper section numerous falls are present. The most favorable spawning area is in the lower 4 miles.

Table 35. A List of Inventory Surveys Made on Hurricane Creek, 1957-59.

Location of Survey	Survey Date	Survey Distance (Miles)	Type of Survey
1 mile above Slickrock Ck. to Falls Ck.	6-1-59	4	aerial
Slickrock Ck.. to Falls Ck.	7-24-59	3	foot
Falls Ck. to Hurricane Ck. grange	4-16-49	4	foot
Grange to 3.5 miles above mouth	9-24-59	2.5	foot
Lower 3.5 miles	10-24-57	3.5	foot

Slope and Bank Cover: The slope cover in Hurricane Canyon consists of coniferous timber, grass, and rocks (Figure 48). Where the stream flows within the canyon, the bank cover is primarily coniferous timber, brush, and rocks. In the valley section, bank cover is composed of coniferous and deciduous timber, brush, and rocks.

Shade: The shading of the stream is generally moderate throughout the surveyed area. However, some densely shaded areas are present in Hurricane Canyon, and open meadow land occurs along the stream in the Wallowa Valley.

Stream Cross Section: The channel cross section was classified as generally moderate throughout the area of survey. Assuming the maintenance of favorable flows, the configuration of the channel is not conducive to excessive stream temperatures.

Bottom Materials: A large majority of the gravel observed within the surveyed section of Hurricane Creek occurs in the lower 6 miles. The most extensive gravel deposits are found within the lower 4 miles. In this stream section, 30 per cent of the bottom was estimated to be suitable for spawning. Other areas of lesser gravel concentration are a 1.5-mile section of stream above Hurricane Grange and a 1.5-mile length of stream between Dunn and Thorpe Creeks. The gravel component of the latter stream section was estimated to be 5 per cent or less, and the area is inaccessible to anadromous fishes due to the existence of a 10-foot dam and several falls on the stream below. A packer who works in the drainage has reported the presence of additional gravel concentrations in meadow areas above the upper survey terminus. However, as indicated by U. S. Geological Survey topographic mapping, the gradient of this area is steep and does not appear conducive to the formation of extensive gravel deposits. Also, this stream section is located above additional impassable barriers. Table 36 presents the location and estimated abundance of gravel in the different sections of Hurricane Creek which occur within the survey boundaries. Also, similar data are illustrated in Figure 37.

Obstructions and Diversions: Obstructions observed on Hurricane Creek consist of several falls, 3 irrigation dams, and a 2.5-mile section of intermittent summer flow. The various falls (WaH-7) are located from about 8 to 12.5 miles above the mouth and obstruct passage to what is considered to be only a negligible amount of spawning area, within the section of survey (Figure 37). As previously stated, the existence of important amounts of gravel from the upper terminus of the survey to the stream source is believed doubtful due to the presence of an average gradient of about 290 feet per mile in this 5-mile length of stream. 1/ The observed irrigation dams are located from 6.5 to 7.5 miles above the mouth. The uppermost dam (WaH-5) is about 10 feet in height, and has no provision for the passage of fish. Only a small amount of spawning area is present above this structure. The two lower dams (WaH-4), which are located about one-eighth mile apart, may form barriers during periods of low flow. However, throughout much of the irrigation season, fish passage is obstructed below these structures due to an area of intermittent flow (WaH-3). This problem area extends from approximately 3.5 to 6 miles above the mouth of Hurricane Creek, and is caused primarily by the withdrawal of irrigation water at the 3 aforementioned dams, and by the presence of a permeable stream bottom which in some sections will not retain small volumes of flow. Gravel suitable for spawning exists within the intermittent flow area and also above it and the two lower dams.

1/ U. S. Geological Survey Topographic map, Joseph quadrangle.

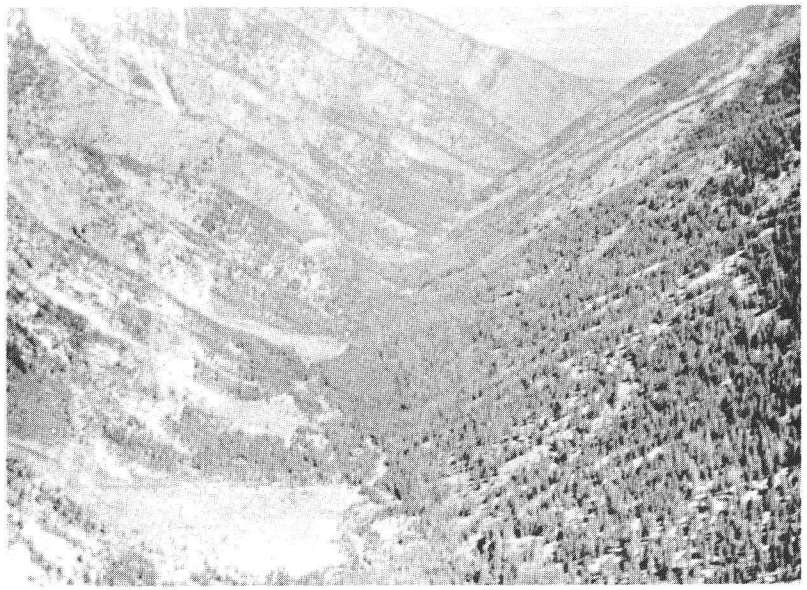

Figure 48. Cover of Conifers, Grass, and Rock in Hurricane Canyon. Area Shown Inaccessible to Salmon Due to Dam and Falls Below.

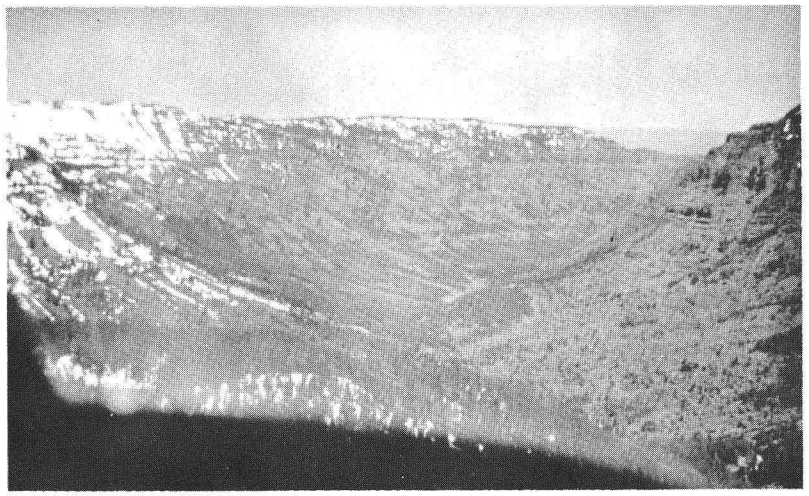

Figure 49. Slope Cover and Rugged Terrain of Upper Bear Creek. Area Shown Inaccessible Due to Falls Below.

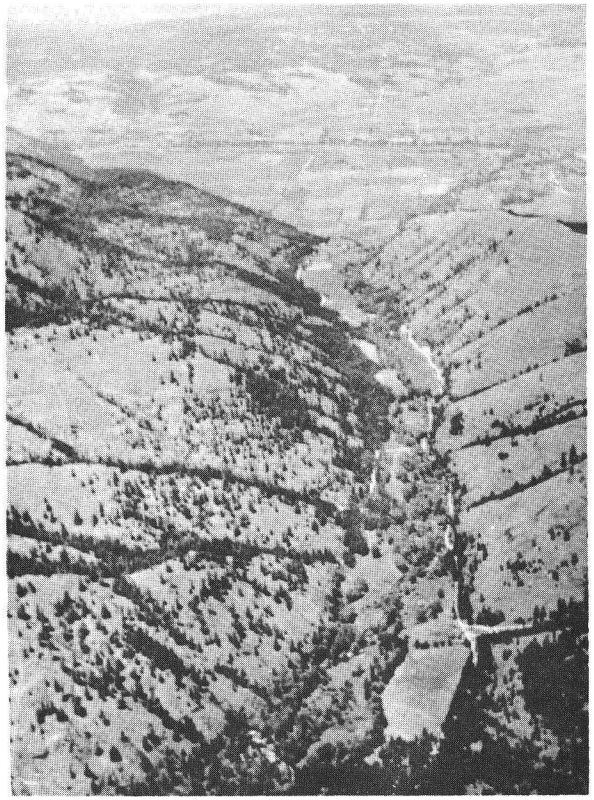

Figure 50. Terrain and Cover of Lower Bear Creek Canyon. Area Shown Subject to Summer Flow Loss Due to Irrigation. Principal Spawning Areas of Salmon are Above This Point.

Table 36. Location and Estimated Abundance of Gravel Deposits Within the Surveyed Section of Hurricane Creek.

Stream Section	Distance in Miles	Estimated Per Cent of Gravel in Bottom Materials
Slickrock Creek to Thorpe Creek	0.5	0
Thorpe Creek to Dunn Creek 1/	1.5	5
Dunn Creek to uppermost irrigation dam 1/	3.5	0-5
Dam to Hurricane Grange	1.5	5-10
Grange Hall to 3.5 miles above mouth	2.5	20
Lower 3.5 miles	3.5	30

1/ Abundance of gravel estimated from observation of approximately 50 to 75 per cent of stream bottom.

Six unscreened diversion ditches are known to be present on Hurricane Creek. An additional ditch, not herein considered to be unscreened, has had a screen installed in the past which is not presently operated due to lack of evidence of the diversion of fish (WaH-2). 1/ Two of the unscreened ditches (WaH-6) are located above the uppermost irrigation dam (WaH-5) and are, therefore, inaccessible to anadromous fish. This leaves four accessible, unscreened ditches (WaH-1), one of which has been screened in the past but which presently has no operative screen due to technical difficulties. The location of the unscreened ditches are presented in Figure 37 together with observed obstructions on Hurricane Creek.

Impoundment and Hatchery Sites: As on the Wallowa River, the valley terrain of lower Hurricane Creek appears suited to the development of impoundments for the rearing of salmonids. Since natural depressions of a desired acreage were not observed, the excavation of impoundments may be necessary.

No suitable locations for hatchery sites were noted.

Flow and Temperature Data: With the exception of an area of intermittent flow which occurs during the irrigation season, the volume of discharge and the water temperatures existing on Hurricane Creek are generally favorable to the reproduction of anadromous salmonids. As measured at the USGS gaging station, located 8 miles above the mouth of Hurricane Creek and above all diversions, the average maximum and average minimum monthly flows in the period 1951 to 1957 were 289 and 20 c.f.s., respectively. Table 37 presents the average monthly flows for this same period of time.

1/ Only one rainbow fingerling was trapped during two seasons of operating a bypass trap at this screen. To further check the diversion of fish, the Oregon Game Commission has indicated that a trap will be operated on this ditch in 1960.

Table 37. Average Monthly Flows in Cubic Feet Per Second on Hurricane Creek at a Point 8 Miles Above the Mouth. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	53.9	52.7	40.8	35.5	34.2	28.8	75.9	170	189	155	54.8	31.7
1952	33.8	31.5	28.8	24.1	22.2	20.5	72.3	205	313	213	72.8	36.0
1953	19.4	22.5	22.0	22.5	23.6	22.1	43.5	125	268	355	102	43.1
1954	27.6	23.4	21.0	19.8	18.8	19.5	37.6	193	187	199	58.2	33.8
1955	25.6	20.4	16.7	14.7	12.1	10.2	14.0	76.3	328	164	56.6	31.2
1956	34.1	41.4	35.2	34.3	30.1	25.4	72.1	243	329	207	76.9	43.6
1957	29.9	24.9	27.4	25.3	18.4	19.4	32.9	257	313	154	53.8	27.2

1/ Flow data obtained from U. S. Geological Survey Water Supply Papers 1217, 1247, 1287, 1347, 1397, 1447, and 1517.

During the surveys, the observed flows ranged from no flow on September 24, 1958, in part of the stream section extending from 3.5 to 6 miles above the mouth, to an estimated 100 c.f.s. between Falls and Slickrock Creeks on July 24, 1959. Stream temperatures ranged from 40°F. at points 6 to 10 miles above the mouth at 1:30 and 3:00 p.m. on April 16, 1959 to 53°F. near Dunn Creek at 3:00 p.m. on July 24, 1959. Table 38 presents additional temperature and flow data for Hurricane Creek from the following sources: U. S. Geological Survey spot records; the inventory surveys; and spawning ground surveys.

Tributaries: None of the tributaries of Hurricane Creek appear to have a potential for the production of salmon or steelhead. The majority of these small streams have a precipitous gradient and drain cirque lakes located high on the western ridge of Hurricane Canyon. Also, all of the tributaries are located above barriers on the main stem. Flow estimates for some of these streams as obtained during the survey of July 24, 1959, are as follows:

Falls Creek	25 c.f.s.
Deadman Creek	6 c.f.s.
Thorpe Creek	15-20 c.f.s.
Slickrock Creek	15 c.f.s.

Anadromous Fish Populations

Spring chinook and steelhead are the only anadromous salmonids known to utilize Hurricane Creek. A survey conducted on October 24, 1957, to investigate the possibility of utilization of the stream by silver salmon or a late spawning variety of chinook did not result in the observation of either of these types of fish.

Table 38. Spot Observations of Temperature and Flow in Hurricane Creek.

Date and Year	Location Above Mouth (Miles)	Time	Temperature in °F. Air	Temperature in °F. Water	Est. Flow in c.f.s.
8-19-49	0.0	10:50 a.m.	—	54	4-5
8-20-50	0.5	9:00 a.m.	74	53	—
8-18-52	1.0	10:05 a.m.	63	55	20
8-24-53	2.5	4:30 p.m.	—	53	30
8-25-54	1.0	8:15 a.m.	50	46	30
8-2-55	3.0	10:50 a.m.	—	58	—
8-15-55	0.5	6:00 p.m.	68	60	—
8-20-55	2.5	5:50 p.m.	65	55	—
8-26-55	2.5	4:00 p.m.	70	—	7
9-6-55	2.5	10:05 a.m.	70	52	—
9-6-55	1.0	11:20 a.m.	80	58	—
9-13-55	1.0	2:00 p.m.	66	56	—
8-29-56	2.5	2:10 p.m.	66	54	20
9-4-56	2.0	11:00 a.m.	68	52	—
9-10-56	2.5	9:10 a.m.	62	53	—
11-6-56 1/	7.5	3:00 p.m.	42	41	31
1-31-57 1/	7.5	2:00 p.m.	32	33	22
3-13-57 1/	7.5	2:00 p.m.	32	38	19
4-30-57 1/	7.5	3:00 p.m.	65	50	80
8-27-57	2.5	2:25 p.m.	—	52	—
8-27-57	2.5	2:35 p.m.	—	54	30
10-21-57 1/	7.5	2:00 p.m.	45	44	31
12-3-57 1/	7.5	10:00 a.m.	27	34	24
1-15-58 1/	7.5	10:00 a.m.	30	36	20
2-26-58 1/	7.5	10:00 a.m.	35	36	25
7-8-58 1/	7.5	3:00 p.m.	66	52	149
8-26-58 1/	7.5	7:00 p.m.	55	52	45
9-15-58 1/	7.5	3:00 p.m.	63	50	33
9-24-58	6.0	12:10 p.m.	46	51	5
9-24-58	3.5	1:40 p.m.	34	50	7
10-27-58 1/	7.5	3:00 p.m.	48	44	32
12-4-58 1/	7.5	10:00 a.m.	27	35	57
1-12-59 1/	7.5	1:30 p.m.	33	37	72
4-16-59	9.0	2:23 p.m.	39	40	75-90
4-16-59	7.5	1:35 p.m.	44	40	60
4-16-59	6.0	3:00 p.m.	44	41	40
7-24-59	10.5	4:00 p.m.	67	53	100

1/ Data obtained from U. S. Geological Survey, La Grande, Oregon. Other data collected by Oregon Fish Commission personnel.

Spring Chinook Salmon: Evidence that Hurricane Creek supports a good run of spring chinook has been obtained over a period of 9 years of spawning ground surveys on this stream. In general, the spawning survey index unit extended from about 0.25 to 2.25 miles above the mouth. Table 39 presents the numbers of spawning chinook salmon observed in the index area through 1957. 1/ The low counts are believed due to conducting of surveys prior to the onset of concentrated spawning activity. As an example, in 1955, a survey conducted on August 20 resulted in the observation of only 14 live chinook, 2 dead, and 7 redds. On later surveys extending through September 7, 1955, maximum counts included 82 live, 91 dead, and 131 redds. Earlier counts would have given the impression of a very poor escapement in the 1957 season.

As indicated by multiple surveys made throughout the spawning seasons in 1955 and 1956, peak spawning activity of spring chinook on Hurricane Creek can be expected during the last few days of August and the first week of September. Spawning is generally distributed throughout the lower 3.5 miles of stream, above which the creek is inaccessible due to an area of intermittent flow (WaH-2).

Table 39. Annual Spawning Ground Counts of Spring Chinook Salmon Within Index Areas on Hurricane Creek, 1948-57. 1/

Date and Year	Location Above Mouth (Miles)	Number of Fish		Number of Redds
		Live	Dead	
8-19-49	0.25 to 2.25	0	0	0
8-22-50	0.25 to 1.25	2	0	2
8-18-52	0.25 to 1.25	0	0	0
8-24-53	1.25 to 2.25	8	1	0
8-25-54	1.25 to 2.25	10	0	20
9-1 and 9-13-55 2/	0.25 to 3.5	82	91	131
9-4 and 9-10-56 3/	0.25 to 3.5	38	9	73
8-27-57	0.25 to 2.25	46	1	47

1/ Exclusive of the year 1951, when no survey was made. All surveys conducted by Oregon Fish Commission biologists.

2/ Data obtained from multiple surveys. Maximum counts selected from surveys of September 1 and September 13.

3/ Data obtained from multiple surveys. Maximum counts selected from surveys of September 4 and September 10.

1/ Exclusive of the year 1951 when no survey was made.

Information concerning the outmigration of juvenile salmon on Hurricane Creek is not available. These fish have apparently not entered irrigation ditches where the Oregon Game Commission has maintained by-pass traps.

Steelhead Trout: It is believed that at the time steelhead spawn, the stream is accessible in the lower 7.5 miles, up to the base of the uppermost and highest irrigation dam (WaH-5). As in the case of salmon, juvenile rainbows have not been captured during the operation of by-pass traps on the screened irrigation ditches on Hurricane Creek.

BEAR CREEK

Introduction

Bear Creek originates in the Wallowa Mountains near an altitude of 7,000 feet. From its source, the stream flows in a northerly course for approximately 24 miles prior to entering the Wallowa River 22 miles above the mouth at Wallowa, Oregon (Figure 37).

Bear Creek is accessible by road from Wallowa, Oregon, in the lower 8 miles. Above this, access is by trail.

Inventory Survey - Dates and Areas

The inventory survey of Bear Creek extended from the mouth upstream 19 miles to Granite Creek. During two years, surveys were made shortly after the spawning season of spring chinook salmon to investigate the distribution of this species in the stream. The locations and dates of the various surveys conducted on Bear Creek are presented in Table 40.

Survey Data

Terrain and Gradient: In the upper 10 miles of the observed stream section, Bear Creek is in a canyon which becomes progressively more rugged as the stream is ascended (Figure 49). Near Goat Creek, the canyon floor widens to form approximately a 2-mile meadow area. In the lower 8 miles, the flow is through predominantly valley land consisting of lower Bear Creek Canyon and the Wallowa Valley (Figure 50).

Slope and Bank Cover: The slope cover is a combination of conifers, grass, and rock outcroppings. Cover along the banks is composed of conifers, deciduous trees, and brush. In the lower valley section and in the meadow section above Goat Creek, open grassy areas are extensive.

Shade: Streambed shading was classified as generally moderate throughout much of the surveyed area. Considering the prevailing moderate summer climate of the region and the quality of the streambank cover, shading is believed adequate for the maintenance of stream temperatures favorable to the propagation of salmon and steelhead.

Stream Cross Section: The stream cross section was classified as moderate. No wide and shallow problem areas were noted except where flows are seriously diminished by irrigation withdrawals near the mouth.

Bottom Materials: The largest observed concentrations of gravel are in the immediate two-mile length of stream above Goat Creek. As regards bottom materials only, 50 per cent of this section was estimated to be suitable for spawning.

Table 40. A List of Inventory Surveys Conducted on Bear Creek in 1957-59.

Location of Survey	Survey Date	Survey Distance (Miles)	Type of Survey
5 to 8 miles above mouth	10-3-57	3	Spot check (foot and vehicle)
8 to 11 miles above mouth	10-10-57	3	Foot
11 to 13 miles above mouth	5-1-58	2	Foot
13 to 17 miles above mouth	6-6-58	4	Foot
12 to 14 miles above mouth 1/	9-12-58	2	Foot
12.5 to 18 miles above mouth	6-1-59	5.5	Aerial
Mouth upstream 5 miles	7-31-59	5	Foot and vehicle, spot check approximately 50% of section.

1/ Survey made to investigate distribution and density of spring chinook spawning in upper Bear Creek.

However, the occurrence of unfavorable flows in some years is known to detract from the value of much of this area. Below Goat Creek, the stream is considered to be about 5 to 10 per cent suitable for spawning. Much of this area has a steep gradient and the gravel was found to exist either in small patches above boulders or in occasional short sections where the gradient moderates. The location and relative abundance of gravel deposits on Bear Creek are depicted in Figure 37.

Obstructions and Diversions: Probably the most serious impairments to fish migration on Bear Creek are two areas of low flow that occur during the summer. One such area (WaB-1) is located on the lower reach of the stream and is due to the combined effects of irrigation withdrawals and the natural reduction of flow during the summer. Depending on the climatic conditions, which determine both water supply and degree of usage, the time of flow depletion in this section of stream may vary somewhat from year to year. Unfortunately, records which indicate the dates of flow loss have not been obtained. In the summer of 1958, flows which were adequate to pass adult salmon were observed at the mouth of Bear Creek in mid-July. However, based on the sizeable acreage irrigated by Bear Creek water (2,300 acres) and the considerable reduction in flow prior to mid-July in some years, it is believed that an earlier depletion of flow may sometimes occur. The dates of recurrence of flow in this area are not specifically known. But it seems likely that the stream flow would generally return in the month of September due to the discontinuance of irrigation and the onset of fall rains.

The utilization of gravel concentrations above Bear Creek guard station is restricted by low summer flows in this section of Bear Creek (WaB-4) (Figure 37).

Such a condition was noted during the survey of September 12, 1958, at which time, the area above the guard station appeared of no value to spawning fish due to the presence of only 3 c.f.s. of flow.

Other observed obstructions to fish migration consist of one low diversion dam (WaB-3), 4 unscreened diversion ditches (WaB-2), 2 cataract sections in narrow gorges (WaB-5), and 2 impassable falls (WaB-6). The cataracts and falls are located on upper Bear Creek in the area of low summer flow. Table 41 presents the descriptions, locations, and pertinent remarks concerning definite and possible barriers on Bear Creek.

At the time of the survey of July 31, 1959, five rotary fish screens were observed on irrigation ditches on Bear Creek in approximately the lower 3 miles. Three of these screens were operating.

Impoundment and Hatchery Sites: Areas suitable for the construction of impoundments for the rearing of salmon are present on both upper and lower Bear Creek. The lower sites are situated from the mouth upstream 8 miles and the upper sites are located from approximately 12.5 to 14 miles above the mouth, near the Bear Creek Guard Station. The upper area may be suitable for the construction of a large in-channel impoundment. No promising hatchery sites were noted.

Flow and Temperature Data: As previously indicated, low flows may be expected in two sections of Bear Creek during the summer. It is not definitely known if the flow on upper Bear Creek customarily becomes as low as that observed on the survey of September 12, 1958 (3 c.f.s.). However, a condition such as this is indicated since the snow pack in the Wallowa Mountains in the winter of 1957-58 was above average and since the U. S. Geological survey records for Bear Creek in the fall of 1958 do not indicate unusually low flows.

The low flow area at and above the mouth of Bear Creek is apparently an annual occurrence resulting from excessive irrigation demands made on this section of the stream.

In general, it is believed that conditions of summer flow in other sections of Bear Creek are not so adverse to the reproduction of anadromous salmonids as in the aforementioned two sections. Table 42 presents the average monthly flows obtained at the USGS Gaging Station located 4.5 miles above the mouth of Bear Creek for the period 1951 through 1957. During this period, the average maximum and minimum monthly flows were 459 and 10.6 c.f.s., respectively.

Stream temperature data on Bear Creek are quite limited. Regarding summer water temperatures, conditions favorable to the propagation of salmon and steelhead are indicated with an increase in elevation. During the survey of Bear Creek, the highest recorded water temperature was 63°F. at 11:45 a.m., July 31, 1959, at a point 5 miles above the mouth. The flow was 15 c.f.s. and the air temperature was 88°F. Table 43 presents temperature and flow data both from the survey of Bear Creek and from spot observations made by the USGS.

Tributaries: Little Bear, Doc, and Goat Creeks are the main tributaries of Bear Creek (Figure 37). These streams are all small (average length about 5 linear miles) and steep in gradient. Of these three tributaries, Goat Creek was the only stream on which flow and temperature observations were made. Goat Creek enters Bear Creek approximately 12.5 miles above the mouth. On May 1, 1958, this tributary was discharging an estimated 15-20 c.f.s. at the mouth and on September 12, 1958 flow at the mouth was approximately 3 c.f.s. Goat Creek is accessible to anadromous fish at the mouth and may provide limited space for steelhead spawning. A short distance above the mouth, the stream becomes too steep for spawning.

Table 41. A List of Obstructions to Fish Migration on Bear Creek During Surveys, 1957-59.

Type of Obstruction	Location Above Mouth (Miles)	Remarks
Area of no flow during August and September (WaB-1).	At and above mouth for approximately 2-3 miles.	Stream flow depleted by irrigation withdrawals--condition believed to exist from late July into September.
Unscreened ditch (WaB-2).	1.8	Ditch dry but recently used on 7-31-59.
Unscreened ditch (WaB-2).	3	Ditch designed for use during high water only--flowing 3 c.f.s. on 7-31-59--4' wide x 2' deep.
Unscreened ditch (WaB-2).	3.5	Ditch dry on 7-31-59--width 2'.
Diversion dam (WaB-3).	4.5	Dam 45' wide, 1' high, 15' long--may be impassable during low flows--diverts water for domestic use to city of Wallowa.
Unscreened ditch (WaB-2).	5	Ditch flowing 1 c.f.s. on 7-31-59--ditch 2.5' wide.
Area of low flow during late summer (WaB-4).	13 and above	Condition observed on 9-12-58--prevented passage to and utilization of more than 1 mile of gravel area for spawning.
Cataract areas in rock gorges (WaB-5).	16 to 16.5	Noted on 6-6-58--two areas of this type noted--passage at the lowermost area questionable, but passage at uppermost area very unlikely.
Falls (WaB-6).	16.5	Impassable falls 15' high located at upstream end of 100-yard section of cataracts--as indicated by aerial survey, stream section above would have only a negligible amount of spawning area.
Falls (WaB-6).	19	Specific height unknown--appeared impassable from the air.

Table 42. Average Monthly Discharge in Cubic Feet Per Second for Bear Creek, 1951-57. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	37.2	59.4	73.1	47.2	89.9	64.1	213	342	270	82.7	16.2	11.1
1952	36.7	40.6	41.3	24.1	27.3	33.2	254	430	436	163	22.9	12.4
1953	8.3	8.2	7.3	40.3	65.4	55.9	173	315	435	248	34.2	14.6
1954	10.5	19.3	36.8	27.2	51.6	63.9	167	373	329	145	25.6	16.4
1955	7.6	9.2	7.7	10.0	9.7	46.2	422	513	234	27.4	9.4	8.2
1956	28.8	65.7	87.6	72.2	56.5	88.4	283	531	452	133	23.5	13.2
1957	13.8	28.5	70.5	26.2	35.2	84.8	152	584	460	95.2	20.3	12.4

1/ Records from U. S. Geological Survey W. S. P. 1217, 1247, 1287, 1347, 1397, 1447, 1517 for Gaging Station located 4.5 miles above the mouth of Bear Creek. In the years 1951 and 1952, water for the irrigation of about 100 acres was diverted above the gaging station during the irrigation season. In the years 1953 through 1957, the records indicate that water for 483 acres of irrigated land was diverted from Bear Creek and a tributary above the station.

Table 43. Spot Observations of Temperature and Flow in Bear Creek, by Month.

Date	Location (Miles above mouth)	Time	Temperature in °F. Air	Temperature in °F. Water	Estimated Flow in c.f.s.	Source of Data
1-12-59	4.5	10:00 a.m.	48	41	125	USGS
1-13-58	4.5	10:00 a.m.	34	32	33	"
1-30-57	4.5	10:00 a.m.	-6	32	14	"
2-25-58	4.5	12:00 noon	46	39	240	"
3-12-57	4.5	12:00 noon	34	36	103	"
4-30-57	4.5	9:00 a.m.	61	47	343	"
4-8-58	4.5	10:00 a.m.	51	41	44	"
5-19-58	4.5	12:00 noon	68	47	752	"
5-28-58	4.5	11:00 a.m.	66	45	803	"
5-1-58	8.5	1:25 p.m.	63	47	70	OFC
5-1-58	10	2:25 p.m.	67	48	---	"
5-1-58	13	4:30 p.m.	66	45	42	"
6-5-58	4.5	4:00 p.m.	76	52	522	USGS
6-6-58	15.5	10:00 a.m.	72	44	150	OFC
6-6-58	16.5	11:05 a.m.	---	46	170	"
6-6-58	17.5	11:55 a.m.	---	46	50	"
6-6-58	18	1:35 p.m.	---	45	---	"
7-29-57	4.5	11:00 a.m.	78	62	40	USGS
7-7-58	4.5	10:00 a.m.	68	55	129	"
7-31-59	5	11:45 a.m.	88	63	15	OFC
8-26-58	4.5	10:00 a.m.	78	59	19	USGS
9-15-58	4.5	11:30 a.m.	65	55	16	"
9-12-58	13	11:45 a.m.	---	50	5	OFC
9-12-58	15	12:30 p.m.	47	52	3	"
10-21-57	4.5	10:00 a.m.	42	38	15	USGS
10-27-58	4.5	9:30 a.m.	45	38	31	"
11-6-56	4.5	10:00 a.m.	46	40	24	"
12-3-58	4.5	8:00 a.m.	39	40	149	"

Anadromous Fish Populations

Two anadromous species, spring chinook salmon and steelhead trout, are known to utilize Bear Creek. Routine, annual surveys to determine spawning utilization by spring chinook salmon have never been conducted on Bear Creek by the Fish Commission. Perhaps the best evidence of an established run of this type of fish in Bear Creek is the records of the Oregon Game Commission which indicate the numbers of downstream migrant salmon captured in by-pass traps at certain irrigation ditch fish screen installations from 1953 to 1958 (Table 44). As indicated by the numbers of fish trapped, August and September are the peak months of downstream migration.

As previously stated, observations of adult chinook on Bear Creek have been limited. Table 45 presents the results of the 3 surveys which have been conducted on the stream to determine the status of spring chinook spawning. The data obtained thus far indicate that chinook spawn in the section from 7 miles above the mouth to Bear Creek Guard Station, located 13 miles above the mouth.

The numbers and distribution of steelhead in Bear Creek is unknown. Data obtained from the Game Commission indicate that downstream migrants of the rainbow species are captured in by-pass traps at irrigation ditch fish screen installations principally in the summer months (Table 46).

Table 44. Monthly Catch Records of Juvenile Salmon Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on Bear Creek. 1/

Year	Period of Capture	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	5-24 — 10-23	0	0	2	2	1	74	98	31
1954	6-16 — 10-7	---	0	0	1	14	67	22	1
1955	5-16 — 10-15	---	---	1	7	12	223	112	11
1956	5-1 — 10-30	---	---	2	0	3	106	95	10
1957	5-10 — 9-23	0	0	1	33	33	23	3	0
1958	8-24 — 10-15	---	0	0	0	0	38	63	114

1/ Data by courtesy of Oregon Game Commission.

Table 45. Numbers and Distribution of Spring Chinook Spawning on Bear Creek 1957-58. 1/

Date of Observation	Number of Fish Live	Number of Fish Dead	Number of Redds	Miles Above Mouth
10-3-57	0	2	2	7 to 8.25
10-10-57	0	2	13	8 to 11
9-12-58	0	1	2	8 to 8.5
9-12-58	0	0	7	12.5 to 14

1/ Observations by Oregon Fish Commission personnel.

Table 46. Monthly Catch Records of Juvenile Rainbow-Steelhead Trout Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on Bear Creek. 1/

Year	Period of Capture	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	5-16 -- 10-23	0	0	34	213	75	179	29	54
1954	5-24 -- 9-30	-	0	21	46	81	36	46	0
1955	5-16 -- 10-15	-	-	43	96	111	108	33	17
1956	5-1 -- 10-30	-	-	21	32	67	126	71	26
1957	5-1 -- 9-30	0	0	313	47	123	18	7	0
1958	8-24 -- 10-15	-	0	0	0	0	24	123	3

1/ Data from Oregon Game Commission.

DISCUSSION AND RECOMMENDATIONS-(Wallowa River Main Stem and Hurricane and Bear Creeks)

The following discussion considers all surveyed sections of the Wallowa System except the Lostine and Minam Rivers, which will be dealt with later.

Fish Transplants

Fall-Spawning Chinook Salmon: It is recommended that an attempt be made to rehabilitate runs of fall-spawning chinook salmon in the Wallowa River, possibly both through the use of fish introductions and the artificial manipulation of the existing remnant stock. Records of the Oregon State Department of Fisheries, from 1903 through 1907, indicate a once sizable migration of fall-spawning chinook into the Wallowa River (State of Oregon, 1904 and 1908). As evidenced by the records of a hatchery operated by this agency below Minam in 1903-07, a large proportion of the chinook salmon which were artificially spawned attained sexual maturity between September 15 and the latter part of October. All available information indicates that this stock of fish became depleted many years ago. However, at the present time, there appears to be a remnant run of fall-spawning chinook in 2 of the Wallowa River tributaries, the Lostine and Minam Rivers, and possibly in the Wallowa River main stem.

It is recommended that a study of the most serious factors limiting the production of fall chinook salmon be undertaken and that additional recommendations be submitted when these factors are identified.

An estimate of the redd potential of the Wallowa River between Enterprise and the mouth has afforded a rough indication of the basic value of this section of stream for the production of fall-spawning chinook. This section of stream has been selected because of the belief that it is used to a lesser extent for spawning by spring chinook and silver salmon than is the area above Enterprise, and because it is more or less typical of areas occupied by spawning fall chinook on other streams. The length of this part of the stream is approximately 42 miles. The average stream width is estimated to be 40 feet and the gravel component 15 per cent. If it is assumed that 50 per cent of the gravel comprises suitable spawning area, and that the redd and inter-redd space requirement for fall-spawning chinook is 24 square yards (Burner, 1941), then a conservative estimate of spawning potential is approximately 3,000 redds.

As previously stated, it may be feasible to use two methods to reestablish a run of fall-spawning chinook in the Wallowa River. These consist of fish introductions and the fostering of existing stock, primarily through the use of artificial methods of propagation. Fish introductions could be accomplished either by plants of eyed eggs or by releases of reared juveniles into the stream. If the rearing of salmon in impoundments under natural conditions is found advantageous, then it is recommended that juveniles be reared locally by this method prior to release. Because the natural period of outmigration of fall-spawning chinook in eastern Oregon may be mainly in the spring or early summer, the rearing of juveniles in impoundments would likely be on a short term basis.

Prior to introduction attempts, an assessment of the incubational environment of the Wallowa River should be undertaken. Such a study is believed important due to the silting conditions present on the stream below Enterprise, as a result of the inflow of waste irrigation water. The adequacy of subsurface oxygen levels and groundwater flows for the incubation of salmon eggs could be determined either by use of the standpipe method or by experimental plants of eyed eggs. The selection of a donor stock will require investigation. In order to successfully propagate

existing fall-spawning chinook by artificial methods, facilities would be required with which to trap adults, incubate eggs and rear juveniles, for at least a short period of time. For egg incubation purposes, the establishment of a drip incubator station along the Wallowa River may be advantageous. Alternatives would be the use of hatchery facilities in other areas, or the possible use of facilities at the Oregon Game Commission hatchery at Enterprise. To attain maximum survival of spawn, the rearing of juveniles is believed desirable. This could be done in impoundments under natural conditions, provided this method proves to be feasible.

Silver Salmon: Under proper management, the Wallowa River (also Lostine River) run of silver salmon may provide donor stock for the introduction of this species into new areas within the Wallowa system, and also, into other river systems of eastern Oregon. Because of a native occurrence in the region, this stock of fish would appear to be the logical source for silver salmon transplants. From indications of the past few years, the Wallowa River silver salmon run has recently increased which could result in an expansion of the population in the future. In the event that a natural increase in numbers does not occur, the location of an alien, but adaptable, donor stock may be desirable to supplement local production.

Streams within the Wallowa system which may be suitable for introductions of silver salmon are Hurricane, Bear, Prairie, and Big Canyon Creeks. As previously stated in the presentation of the survey data for Hurricane Creek, this stream has considerable gravel deposits which cannot be utilized by spring chinook due to the presence of seasonal low flows resulting from irrigation withdrawals. The feasibility of putting this section of stream into the production of silver salmon is contingent primarily upon the timing of flow return. To achieve production, an adequate flow for spawning purposes would have to be present by October. USGS flow records indicate that the basic flow of Hurricane Creek in October is favorable (Table 37). The critical factor, therefore, appears to be the degree of water consumption. Theoretically the irrigation season terminates at the end of September. Nevertheless, the withdrawal of water may continue past this time due to the need of stock water in the ditches and the neglect of concerned individuals to adjust water control structures following the end of the season. It is recommended that this situation be investigated to determine the prevailing flow conditions on Hurricane Creek in October, and if such conditions are found to be unsatisfactory, action should be taken to determine the feasibility of obtaining increased flow. Information is needed concerning: (1) the quantity of the actual discharge of Hurricane Creek which is diverted for stock watering, etc.; (2) the extent to which this diversion of flow could be curtailed without hardship to users; and (3) the adequacy of maximum attainable flow (natural flow minus necessary consumption) for the spawning of silver salmon. If, following investigation, these factors are found encouraging, it is recommended that an introduction of silver salmon be made in Hurricane Creek.

In discussing the introduction of silver salmon into Hurricane Creek, the possibility of damaging the existing run of spring chinook salmon due to interspecific competition cannot be overlooked. In great probability, silver salmon spawning would overlap into the area utilized by spring chinook. Also, competition among the juveniles in the rearing areas might be expected to occur. In the instance of juvenile competition, it can be theorized that if overcrowded rearing conditions should develop, the dispersal of fish to the Wallowa River would occur.

An estimate of the spawning potential for silver salmon in the area advocated for the introduction of this species on Hurricane Creek is approximately 200 redds. 1/

As on Hurricane Creek, the feasibility of introducing silver salmon into Bear and Big Canyon Creeks is dependent principally on the prevailing flow conditions on these two streams during the silver salmon spawning season in October. It is possible that with the customary increase of precipitation in the fall and the termination of irrigation in September the flow in these streams may be adequate for silver salmon use. However, this fact has not been substantiated either by direct observation or flow records and further study is needed to determine fall flow conditions. On Bear Creek, the status of discharge during the fall in the critical flow area near the mouth is of the utmost importance in determining the value of this stream to silver salmon. On Big Canyon Creek, the adequacy of stream flow in the lower 8 miles during the silver salmon spawning season is a deciding factor as to whether an introduction should be undertaken. For these reasons, it is recommended that introductions of silver salmon be considered for these two streams but that such introductions be contingent on the outcome of flow observations made over a sufficient number of years to provide a reasonable record of the fall flow conditions to be expected. Assuming the presence of favorable flow, the estimated spawning potential for silver salmon on Bear and Big Canyon Creeks are: Bear Creek, approximately 300 redds 2/; Big Canyon Creek, approximately 300 redds. 3/

Since considerable gravel and favorable autumn flows are present on lower Prairie Creek, an introduction of silver salmon into this stream may be worthy of consideration. A possible deterrent to the success of establishing silver salmon in Prairie Creek is the almost constant turbidity of the stream caused by the inflow silt-laden waste irrigation water. This factor is believed to be of primary importance in determining the suitability of this stream for fish introduction. In this regard, it is recommended that experimental plants of eyed eggs be undertaken to assess the incubational environment of lower Prairie Creek. If, following the conductance of such tests, undue mortality of eggs and fry is not indicated,

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1/ Estimate based on the following assumptions: (1) that fish would be introduced into 4 miles of stream of which 2.5 miles would contain 20 per cent gravel and 1.5 miles would contain 7.5 per cent gravel (between 5 and 10 per cent); (2) that the stream section concerned would have an average width of 5 yards; (3) that one-half of the existing gravel would be situated in locations suitable for silver salmon spawning; and (4) that each silver salmon would require 14 square yards of redd and inter-redd space (Burner, 1941).

2/ Estimate of spawning potential of Bear Creek based on the following assumptions: that silver salmon would spawn in two miles of stream of which 50 per cent of the bottom materials are estimated to be gravel; (2) that the stream section concerned would have an average width of 5 yards during the silver salmon spawning season; (3) that 0.5 of the existing gravel would be suitably located for selection as spawning sites; and (4) that each silver salmon would require 14 square yards of redd and inter-redd space (Burner, 1941).

3/ Estimate of spawning potential on Big Canyon Creek based on the following assumptions: (1) that silver salmon would utilize an 8 mile length of stream consisting of 7 miles of 10 per cent gravel bottom and 1 mile of 20 per cent gravel bottom; (2) that the stream section concerned would have an average width of 5 yards; (3) that 0.5 of the existing gravel would be suitably located for selection as spawning sites; and (4) that each silver salmon would require 14 square yards of redd and inter-redd space.

an introduction of silver salmon into the lower 5 mile section of Prairie Creek should be considered. Releases in this area would assure favorable flows to introduced fish, and a minimum of irrigation ditch screening would be required. The spawning potential for silver salmon on lower Prairie Creek is estimated to be approximately 500 redds. 1/

Steelhead Trout: The utilization of Prairie Creek by steelhead is unknown and should be determined. Because the central and lower portions of Prairie Creek are subject to almost constant silting, an investigation of the incubational environments of these areas should be made. A decision to release steelhead into Prairie Creek would depend on the outcome of these studies.

Obstructions and Diversions

Wallowa River Main Stem: For ease of presentation, recommendations concerning barriers on the Wallowa River have been presented in tabular form (Table 47). Also included in Table 47 are recommendations concerning obstructions on the East and West Forks of the Wallowa River.

Prairie Creek: The utilization of Prairie Creek by chinook salmon is believed to be largely restricted to the lower 5 or 6 miles of stream due to the occurrence above this point of an area of low summer flow. Within this lower section, there is one irrigation ditch (WaP-1) located approximately 2 miles above the mouth which should be investigated for the diversion of downstream migrants. If this ditch is found to take fish, the installation of a fish screen is recommended.

The screening of irrigation ditches (WaP-2) or the correction of high flow barriers (WaP-6 and WaP-7) on other sections of Prairie Creek should be conditional either on evidence of the presence of steelhead or of the existence of a reasonable potential for this species. In the latter instance, gravel permeability tests or test plants of eyed eggs could provide an indication of potential. Since the water-use practices which prevail on central and upper Prairie Creek are not compatible with the production of an anadromous species which migrates during periods of low discharge, the removal of low flow barriers is not considered important.

Hurricane Creek: As previously stated, obstructions on Hurricane Creek consist of 5 falls, 3 irrigation dams, an area of intermittent flow, and 6 unscreened diversion ditches. Since the falls (WaH-7) are not located below important spawning area, it is not recommended that passage at these barriers be considered. Likewise, the uppermost irrigation dam (WaH-5) is not located below important spawning area. The lowermost 2 irrigation dams (WaH-4) are both low head structures and are believed to constitute low-water blocks only. However, since the access of anadromous fish to these dams during low water is prevented by an area of intermittent flow further downstream, they are not known to actually create obstructions. Nevertheless, blocks could materialize at these dams if an introduction of silver salmon into Hurricane Creek succeeds. The practicality of the latter plan is contingent on the improvement of flow conditions in the intermittent flow area of Hurricane Creek during the fall. Therefore, it is recommended that passage at these two irrigation dams be assured if silver salmon are introduced into the stream.

1/ Spawning potential of silver salmon on lower 5 miles of Prairie Creek estimated on the basis of the following assumptions: (1) that 2 miles of stream contain 40 per cent gravel bottom and that an additional 2 miles contain 10 per cent gravel bottom; (2) that the section of stream involved has an average width of 8 yards; (3) that 0.5 of the gravel is suitable located for the spawning of silver salmon; and (4) that the space requirement for each silver salmon redd will be 14 square yards as indicated by Burner (1941).

Table 47. A List of Recommendations Concerning Obstructions and Diversions Located on the Main Stem of the Wallowa River.

Obstruction	Recommendations and Remarks
Falls on West Fork (WaW-1)	Passage facilities not recommended. Height of falls and extent of spawning area above are not believed compatible to the justification of such a project at this time.
Falls and torrential area on the East Fork (WaE-1)	Passage facilities not recommended due to the extensive amount of precipitous gradient and the general lack of spawning potential.
Wallowa Lake Dam (Wa-7)	Passage facilities recommended only in the event of the successful introduction of blueback salmon into Wallowa Lake. 1/
Unscreened diversion ditches between Wallowa Lake and Joseph (Wa-6)	Screening of these ditches is not recommended unless an introduction of blueback into Wallowa Lake is undertaken. Spawning area in this section for chinook, silvers, and steelhead is negligible. Seven ditches are present in the area, including some of the largest ditches on the Wallowa River. 1/
Area of low flow below Joseph (Wa-4)	Action to obtain transportation flows not believed justifiable unless blueback introduced into Wallowa Lake. Amount of spawning area for chinook and silver salmon, and steelhead in and above this section is negligible. However, if lower barriers are eliminated, this area may provide some rearing for anadromous salmonids if an upstream dispersal of juveniles from the spawning areas occurred.
Log jam in low flow area below Joseph (Wa-3)	Removal not recommended unless blueback are reintroduced into Wallowa Lake. 1/
Unscreened diversion ditches between low flow area and Dry Creek (Wa-1)	This includes all unscreened diversion ditches on the Wallowa River below Joseph. It is recommended that the 30 unscreened ditches be investigated to determine the diversion of downstream migrants and that all ditches found taking fish be screened. The general locations of unscreened diversion ditches are given in Table 22 and Figure 37.
Small diversion dams (Wa-2 and Wa-5)	There are 4 dams on the Wallowa River at which the passage of fish during low water is questionable. Two of these dams (Wa-5) are at Joseph and would affect only the passage of blueback. The remaining 2 dams (Wa-2) are located approximately 2.5 and 2.6 miles below Joseph (see survey data and Figure 37) and are believed to obstruct passage to some spawning area for chinook and silver salmon. It is recommended that action be taken to assure passage over these dams. Because these dams are of the type which employ stop boards, passage may be possible in some years and not in others, depending on the number of boards utilized for the diversion of water.

1/ APPENDIX A

It appears unlikely that the intermittent flow area (WaH-3) of Hurricane Creek can be improved. Voluntary curtailment of diversion flow after the irrigation season might be considered.

There are 7 diversion ditches which withdraw water from Hurricane Creek. Two of these ditches (WaH-6) divert water above the uppermost dam (10 feet in height) and are, therefore, inaccessible to downstream migrants. In the past, two other ditches were provided with fish screens which are presently not operated, one due to technical difficulties and the other due to lack of evidence of the diversion of fish. The screen at the ditch where no diversion of fish has been indicated (WaH-2) will be installed again in the spring of 1960 for further testing. In respect to the four other unscreened ditches (WaH-1), it is recommended that observations be made to ascertain if fish are diverted, and if downstream migrants in numbers are taken, these ditches should be screened.

Bear Creek: The only action recommended on Bear Creek is the investigation of 4 unscreened ditches (WaB-2) to determine if fish are being diverted. Screening recommendations would necessarily follow this investigation. Also, in event of the introduction of silver salmon into Bear Creek, fish passage should be assured at the City of Wallowa water supply dam (WaB-3) located 4.5 miles above the mouth. This dam is considered to be a low-water block.

Provision for fish passage at the various falls (WaB-6) on Bear Creek is not recommended since little spawning area is rendered inaccessible. The only solution known for the improvement of late summer flow conditions on upper (WaB-4) and lower (WaB-1) Bear Creek is the construction of a headwater reservoir. The determination of the feasibility of such a project would require further investigation. Depending on the location of a reservoir, the benefits might include additional spawning and rearing area and year-around access of the stream to fish.

Big Canyon Creek: Recommendations on this stream are limited to the investigation of two small diversion ditches (WaBi-1) in the lower 1.25-mile section to determine if downstream-migrant steelhead are diverted. If sufficient fish loss is shown to occur, these ditches should be screened.

Impoundments and Hatcheries

Since numerous sites appearing suitable for the construction of off-channel impoundments are present along the Wallowa River, and Prairie, Hurricane, and Bear Creeks, these areas are believed to have an excellent potential for the rearing of salmon. Sites large enough for impoundment development are also present on Big Canyon Creek. Factors which contribute to the value of the Wallowa Valley as a rearing area for salmon are the general abundance of water and the existence of favorable stream temperatures during the summer. One possible complication which might be encountered in impoundment development in some locations is difficulty in impounding water due to the permeability of underlying ground materials.

Two areas are present in the Wallowa Valley which may be adaptable to use as incubator stations and/or impoundments. One such site, situated on the Renthrow Farm near the confluence of the Wallowa and Lostine Rivers, has two springs which flow an estimated 3 c.f.s. at a temperature of about 55°F. The development of this site into a drip incubator station and impoundment area is advocated in conjunction with the previously suggested plan to augment the productivity of the small population of silver salmon existing in the Wallowa system. Such a technique might also be used to increase the stock of fall-spawning chinook of the Wallowa system, which at this time may be close to extinction. In addition to the Renthrow site, other springs have been reported in this same area. Another area which may

have potential for development as a drip incubator station is upper Prairie Creek. The upper reach of this stream is spring-fed and is reported not to freeze in the winter. Further investigation is needed at both areas to determine the value for fish-cultural purposes.

Stream Improvements

Because of the presence of steep gradients on Bear and Big Canyon Creeks, much of these streams may be unsuitable or only of marginal value for the spawning of salmon and steelhead. In this regard, the production of fish may be benefited by the installation of sill logs in marginal areas to decrease water velocities and increase the deposition of gravel. Also, with the use of this technique, rearing conditions may be improved due to the formation of more pool area, and cover for adult fish would be increased. On Bear Creek, the area suggested for sill log installation is from the end of the road, 8.5 miles above the mouth, to the mouth. In the extreme lower end of this section, the installation of deflectors in the place of sill logs is suggested to decrease the width of a wide shallow section of the channel. On Big Canyon Creek, sill log installation is advocated in the lower 8 miles, from the mouth to Sage Creek.

THE LOSTINE RIVER

Introduction

The Lostine River enters the Wallowa River approximately 27 miles above the mouth between the towns of Lostine and Wallowa, Oregon (Figure 51). The main river is 25 miles in length, and is formed by the juncture of the East and West Forks about 5 or 6 miles below their points of origin in the Wallowa Mountains. The direction of flow is, in general, northerly. Elevation in the watershed ranges from more than 10,000 feet at the source to 3,000 feet at the stream mouth. With a drainage area of approximately 90 square miles, the Lostine River is exceeded in size in the Wallowa System only by the Minam River.

The tributaries of the Lostine River are of uniformly small size and originate primarily from the west side due to the development in this area of cirque lakes. 1/ Also, because of precipitous terrain, the tributary streams typically cascade down steep canyon walls and are of little or no importance as production areas of anadromous fishes.

Access to the Lostine River can be obtained from State Highway 82 at Lostine, Oregon. At this point, a county road diverges from the highway and ascends the main river to the forks. The forks are accessible by trail.

Residents of the Lostine basin are dependent on the livestock industry and tourist trade. Several forest camps have been developed along the stream. In the basin proper, logging does not appear to be of commercial importance, possibly due to the difficult terrain of the region. Irrigation is practiced extensively throughout the lower reaches of the stream in conjunction with the production of livestock.

Inventory Surveys - Dates and Areas

Ground surveys to observe the physical characteristics of the Lostine River were conducted on August 27, September 9, and October 3, 1957. At the time of the 2 earlier surveys, the lower 9.5 miles of the stream were checked. On the

1/ Glaciation in the Wallowa Mountains. Lowell, W. R., M.S. Thesis, Univ. of Chicago, 1939.

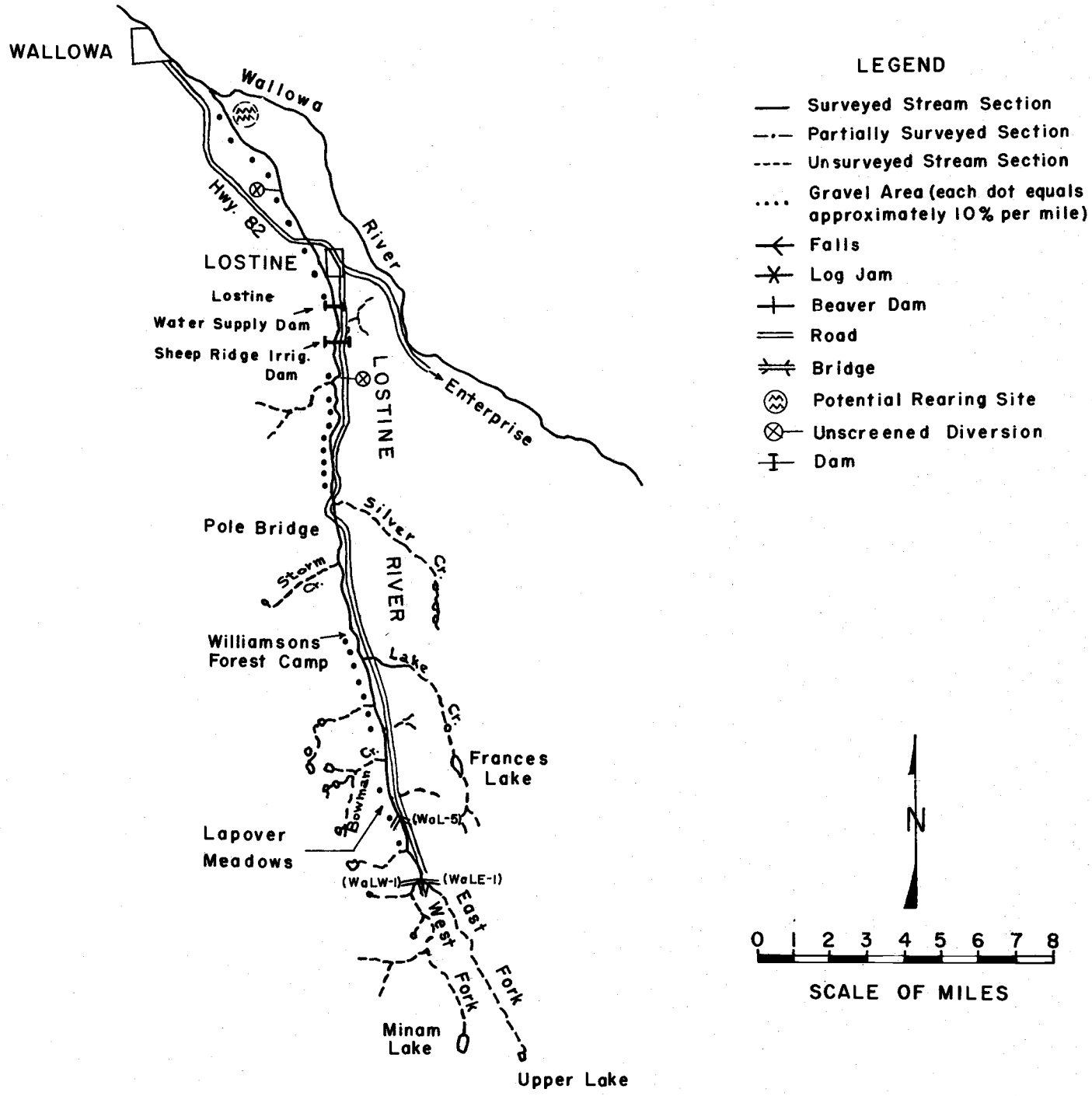

FIGURE 51. LOSTINE RIVER

latter survey, spot observations were made on the upper 2 miles of the main river and in the lower 0.25 mile of each fork. Also, on June 1, 1959, an aerial survey was made over the stream section extending from 12 to 17 miles above the mouth. Other observations included several spot surveys at barriers during the migration season of spring chinook to determine the extent of obstruction of fish passage, and a survey on July 27 and 28, 1959, to locate unscreened diversion ditches. Stream sections not surveyed during the program, but which were familiar to project personnel from previous spawning ground surveys, are as follows: 9.5 to 12.5 miles above the mouth, and 17.5 to 22.5 miles above the mouth. These units were observed by the writers as recently as August of 1957.

Survey Data

Terrain and Gradient: In the upper 14 miles, the Lostine River flows through a deep U-shaped basin where, in some sections, the canyon walls rise almost vertically. The gradient of this part of the stream ranges generally from steep to moderate. At approximately 11 miles above the mouth, near the Pole Bridge, the canyon widens to form a valley. Here the gradient moderates somewhat, but still remains steep in many places. The slopes along this section of the stream are formed of moraine materials and are of much gentler grade and of lower altitude than in the upper basin. At approximately 8 miles above the mouth, the stream emerges into the Wallowa Valley.

There are 2 sections of the main river which are steep to torrential in gradient. These are located just below the forks and just above the Pole Bridge. At the latter point, the stream flows through a steep, narrow gorge.

Slope and Bank Cover: In the Lostine Basin, a majority of the slopes are heavily forested with coniferous timber (Figure 52). In the upper canyon, a considerable amount of rock has been exposed by past glaciers. Bank cover consists of coniferous timber and brush in the mountainous area and deciduous timber, brush, and grass in the valley.

Shade: In general, the shading of the stream is moderate and conducive to the maintenance of water temperatures favorable to the production of salmon and steelhead.

Stream Cross Section: The stream cross section is generally moderate. In many sections, pool and riffle areas are present in abundance.

Bottom Materials: Gravel concentrations have been observed on the Lostine River in the following sections: lower 7 miles, 8.5 to 12.5 miles above the mouth, 17.5 to 20 miles above the mouth, and 21.5 to 22.5 miles above the mouth (Figure 51). In the remaining sections of the stream, the bottom materials are to a very large extent composed of rubble and boulders. A more detailed description of the locations and relative abundance of the gravel deposits on the Lostine River is presented in Table 48.

Obstructions and Diversions: During low water, fish are blocked by 2 dams on the lower Lostine River. The lowermost dam (WaL-2) is the property of the City of Lostine and is used in conjunction with the domestic water supply. This barrier is located 1 mile above the Lostine city limits. Numerous observations made at Lostine Dam during the migration season of spring chinook have indicated that fish passage is restricted. As shown in Figure 53, the dam is of plank and rock-fill construction with concrete abutments at both ends. It extends entirely across the stream and consists of 2 steps separated by a 12-foot plank apron. Although the dam is laddered, the ladder is ineffective during periods of low flow due

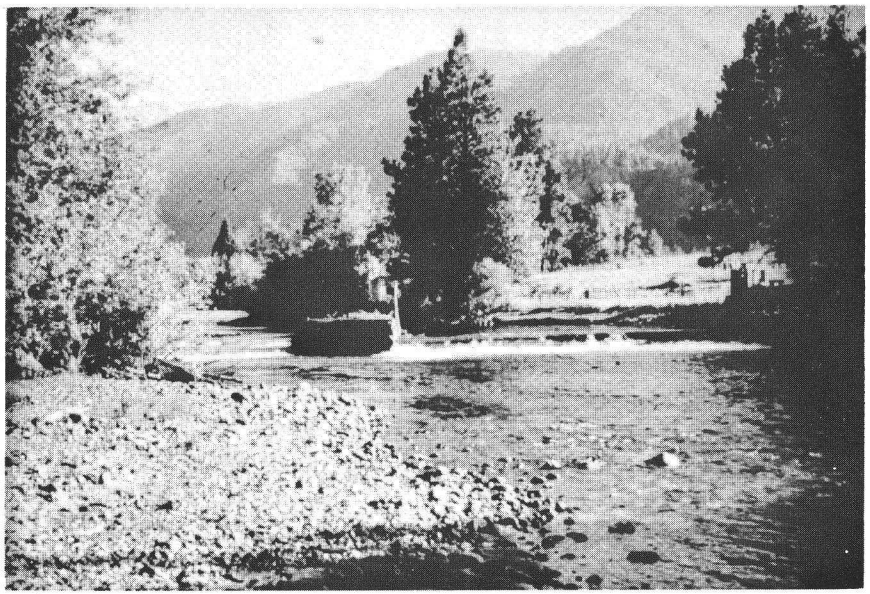

Figure 52. Terrain, Slope Cover, and Gradient of the Lostine River About 8.5 Miles Above the Mouth.

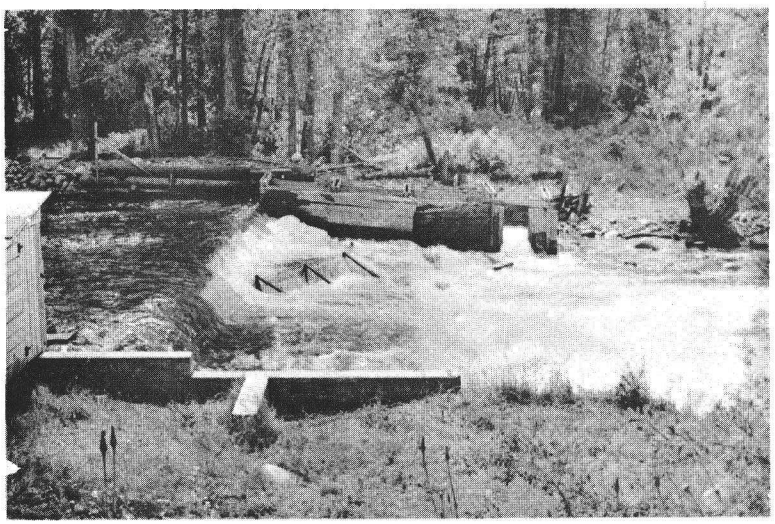

Figure 53. City of Lostine Water Supply Dam, 7 Miles Above Mouth of Lostine River.

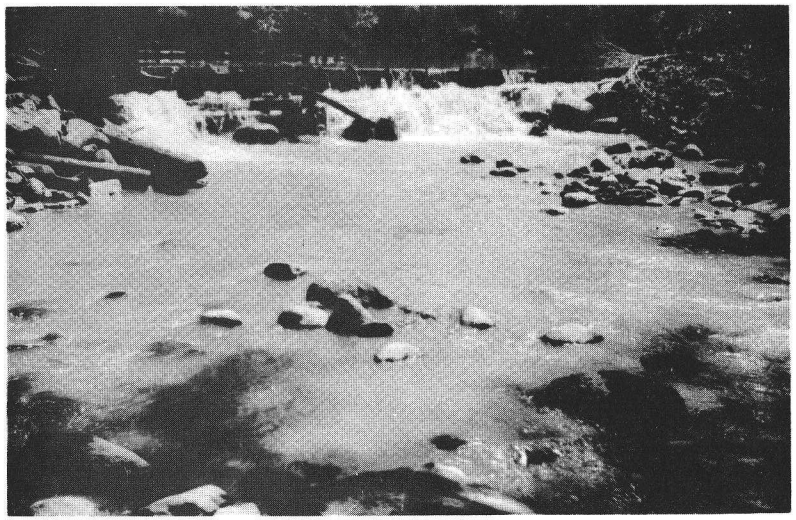

Figure 54. Sheep Ridge Irrigation Dam, Located 8.5 Miles Above the Mouth of the Lostine River.

Table 48. Location and Estimated Abundance of Gravel Concentrations on the Lostine River.

Stream Section in Miles Above Mouth	Distance in Miles	Estimated Per Cent of Gravel Component of Bottom Materials
25 to 22.5 1/	Upper 2.5	5
22.5 to 21.5	1	10
21.5 to 20	1.5	0-5
20 to 17.5	2.5	20
17.5 to 12.5 2/	5	--
12.5 to 9.5	3	30
9.5 to 8.5	1	10
8.5 to 7	1.5	0-5
7 to 0	7	15

1/ Estimated on the basis of spot observations made in the fall of 1957 and from a complete survey made through the area by a Fish Commission biologist in the fall of 1956.

2/ Lack of ground survey in this area prevents estimation of gravel component. However, aerial observations and a review of topographic mapping of the area indicate a steep gradient with negligible spawning area.

principally to an insufficient supply of water. Since obtaining additional water in the ladder would necessitate making alterations to the dam which might weaken it, this situation has not been corrected.

In the summer of 1958 and 1959, chinook salmon were successfully passed over the dam during the period of decreasing flows by the construction of a temporary pool on the apron (Figure 53). With the use of this method, the boards which form the pool must be installed each year at the time of descending flows and removed prior to the onset of high flows.

The upper dam (WaL-3) is located approximately 1 mile upstream from the City of Lostine Dam. This structure diverts water into Sheep Ridge irrigation ditch and is the property of a ditch company composed of 7 water users. The Sheep Ridge Dam is approximately 4 feet in height with stop boards in place, and during low flows, it appears to be impassable (Figure 54). In the summer of 1958, a Mr. Chapman, who was then president of the ditch company, indicated a willingness of the company to cooperate in obtaining fish passage at the dam provided that no loss of irrigation water occurred and that expensive passage facilities were not required. However, no further action has been taken since legal evidence of a fish block has not been obtained.

Other dams of a temporary nature are placed in the river each year in the lower 4.5 miles (WaL-1). These dams are constructed of streambed materials which are built up in the stream with heavy equipment to facilitate the diversion of flow into irrigation ditches. In the summer of 1957, several of these dams were observed on the lower river which were impassable to fish.

As indicated by field observations in July of 1959, 17 ditches withdraw water from the Lostine River, exclusive of the diversion of the water supply for the City of Lostine. Two of these ditches (WaL-4) were unscreened (Figure 51). At the time of the survey, the uppermost ditch was diverting about 2 c.f.s. This diversion is located approximately 8.75 miles above the river mouth. The lowermost ditch, located about 3.5 miles above the stream mouth, was diverting about 10 c.f.s.

Several low falls and a higher falls (WaL-5) which may be impassable to anadromous fishes exist on the upper Lostine River, approximately 1 to 1.5 miles below the forks. The latter formation was observed in the fall of 1956 by a Fish Commission biologist who reported it to be 6 to 7 feet in height with a pool at the base. Shortly below this falls is a less serious falls. Although some gravel is present above these barriers, the amount is considered to be relatively unimportant. In the extreme upper reaches, the gradient of the river becomes torrential. Also, impassable falls are present on the East and West Forks within 200 yards above the mouths (WaLE-1 and WaLW-1). Although the existence of gravel areas on the upper sections of the forks is likely, the precipitous gradients in the lower reaches of these tributaries seems to preclude their development for the production of anadromous fishes.

Impoundment and Hatchery Sites: Numerous construction sites for off-channel impoundments are present along the Lostine River. A fair number of sites exist in the upper canyonous half of the stream, and many promising sites were observed on private land in the lower 10 mile stream section. Due to the presence of a more favorable water supply, the development of impoundments above the city of Lostine is believed advantageous. No sites which appeared well suited to hatchery use were observed.

Flow and Temperature Data: Stream flows and temperatures which prevail on the Lostine River during the summer months are generally favorable to the production of salmon and steelhead. During periods of heavy irrigation, the volume of discharge becomes quite low in the section of stream between the town of Lostine and the mouth; however, a complete lack of transportation flow has not been observed in this area.

As indicated by flow data of the U. S. Geological Survey, the average maximum and average minimum monthly flows on the Lostine River in the period 1951-57 were 820 and 34 c.f.s., respectively. These data were obtained at the flow gaging station located 9 miles above the river mouth. Table 49 presents the average monthly flows of the stream for the period 1951-57.

During the duration of the inventory survey program, the highest recorded temperature on the Lostine River was 60°F. at Lostine Dam at 1:00 p.m., August 26, 1958. Over the same period of time, the record of lowest flow was 15 c.f.s. near the mouth on September 7, 1957. Temperature and flow data obtained on the surveys are presented in Table 50. Also presented in this table are spot observations of temperatures and flows obtained from spawning ground surveys and from the U. S. Geological Survey records. Figure 55 presents daily records of maximum and minimum temperatures on the Lostine River during the fall of 1957.

Table 49. Average Monthly Flows in Cubic Feet Per Second For the Lostine River at a Gaging Station Located 9 Miles Above the Mouth, Water Years 1951-57. 1/

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	96.9	89.1	86.4	71.2	64.8	55.2	201	576	585	336	73.5	43.8
1952	64.9	54.2	51.3	34.4	30.1	28.4	248	630	898	479	106	48.5
1953	35.3	26.2	25.0	44.4	51.6	47.7	147	370	744	839	171	65.5
1954	37.5	38.8	36.7	36.6	39.7	50.2	149	575	590	496	97.6	44.9
1955	38.8	33.5	23.8	21.0	15.9	16.3	48	298	852	381	87.5	51.9
1956	74.5	128	102	89.1	64.4	53.1	267	759	1,024	513	116	47.4
1957	45.7	46.0	64.6	44.5	50.9	63.7	127	745	956	361	74.3	41.6

1/ Data obtained from U. S. Geological Survey Water Supply Papers, Part 13, Snake River Basin.

Table 50. Spot Observations of Temperature and Flow for the Lostine River, Arranged by Month.

Date	Location	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.	Source of Data
1-30-57	Above Lostine Dam	1:00 p.m.	51	41	61	USGS
1-13-58	"	1:00 p.m.	35	38	33	"
1-12-59	"	11:00 a.m.	37	39	132	"
2-25-58	Above Lostine Dam	1:00 p.m.	45	38	116	"
3-12-57	Above Lostine Dam	1:30 p.m.	35	36	70	"
4-30-57	Above Lostine Dam	12:00 noon	68	46	283	"
5-19-58	Above Lostine Dam	1:00 p.m.	73	48	1060	"
5-28-58	"	2:00 p.m.	70	48	1380	"
6-5-58	Above Lostine Dam	11:20 a.m.	—	45	885	"
7-29-57	Lostine Dam	12:30 p.m.	78	59	167	"
7-11-58	"	1:10 p.m.	80	56	318	"
7-10-59	"	10:20 a.m.	—	49	—	OFC
7-27-59	At Hiway 82 Bridge	12:15 p.m.	80	58	—	"
7-28-59	"	11:45 a.m.	68	59	—	"
8-16-49	Williamson Cabin	12:10 p.m.	—	55	—	"
8-19-50	Lostine Dam	1:20 p.m.	—	59	—	"
8-19-50	Lapover Meadow	4:30 p.m.	—	54	—	"
8-20-50	17 mi. above mouth	9:20 a.m.	—	49	—	"
8-20-50	Williamson Cabin	10:30 a.m.	67	52	—	"
8-20-50	11 mi. above mouth	11:30 a.m.	—	54	—	"
8-20-50	7.5 mi. above mouth	12:30 p.m.	—	58	—	"
8-16-52	Lostine Dam	1:05 p.m.	72	58	35	"
8-16-52	17 mi. above mouth	3:00 p.m.	72	57	30	"
8-16-52	Lapover Meadows	3:00 p.m.	76	56	25	"
8-16-52	11 mi. above mouth	5:20 p.m.	64	56	40	"
8-16-52	9.5 mi. above mouth	6:45 p.m.	64	56	—	"
8-27-53	Lapover Meadow	7:45 a.m.	48	46	35	"
8-27-53	9.5 mi. above mouth	5:40 p.m.	62	50	40	"
8-19-54	Lapover Meadow	9:00 a.m.	53	47	—	"
8-9-55	Williamson Cabin	3:00 p.m.	73	58	40	"
8-15-55	11 mi. above mouth	9:00 a.m.	—	52	—	"
8-15-55	Williamson Cabin	2:00 p.m.	—	58	25	"
8-21-55	Lapover Meadows	8:30 a.m.	49	46	—	"
8-27-55	"	11:00 a.m.	67	49	30	"
8-17-56	11 mi. above mouth	10:55 a.m.	72	51	40	"
8-17-56	Lapover Meadow	1:45 p.m.	76	55	—	"
8-21-57	11 mi. above mouth	10:00 a.m.	69	51	35	"
8-21-57	9.5 mi. above mouth	10:20 a.m.	71	54	—	"
8-21-57	Lapover Meadow	2:10 p.m.	74	58	—	"
8-21-57	Williamson Cabin	2:30 p.m.	79	57	35	"
8-27-57	9.5 mi. above mouth	11:30 a.m.	—	52	45	"
8-27-57	Lostine Dam	2:00 p.m.	—	55	25	"
8-27-57	Hiway 82 Bridge	3:55 p.m.	72	59	30	"

Table 50. Spot Observations of Temperature (continued)

Date	Location	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.	Source of Data
8-27-57	3 mi. above mouth	4:55 p.m.	--	59	20	OFC
8-26-58	Near Lostine Dam	1:00 p.m.	76	60	52	USGS
9-12-55	Lapover Meadow down 0.5 mi.	11:00 a.m.	67	49	--	OFC
9-22-55	Lostine Dam	9:30 a.m.	68	52	30	"
9-22-55	At 11 mi. post	2:45 p.m.	73	58	40	"
9-22-55	At 3.5 mi. post	4:30 p.m.	78	57	40	"
9-4-56	Lapover Meadow	1:15 p.m.	60	49	35	"
9-4-57	Above Lostine Dam	1:30 p.m.	74	59	44	USGS
9-9-57	2 mi. from mouth	1:45 p.m.	70	58	20	OFC
9-9-57	1 mi. from mouth	2:45 p.m.	--	57	20	"
9-9-57	Near mouth	3:45 p.m.	--	58	15	"
9-15-58	Above Lostine Dam	12:30 p.m.	70	53	68	USGS
10-3-57	At confluence E and W Fks.	12:55 p.m.	37	39	--	OFC
10-21-57	Above Lostine Dam	12:00 noon	44	42	41	USGS
10-27-58	"	12:00 noon	50	41	66	"
11-6-56	Above Lostine Dam	1:30 p.m.	51	41	61	"
11-1-57	Hiway 82 Bridge	12:00 noon	44	40	25	OFC
11-1-57	0.25 mi. above mouth	12:35 p.m.	46	44	--	"
11-13-57	Lostine Dam	1:30 p.m.	44	41	--	"
11-20-57	11 mi. above mouth	2:10 p.m.	24	38	--	"
12-18-56	Above Lostine Dam	10:00 a.m.	40	36	72	USGS
12-3-57	"	2:00 p.m.	35	36	31	"
12-3-58	"	10:00 a.m.	46	39	250	"

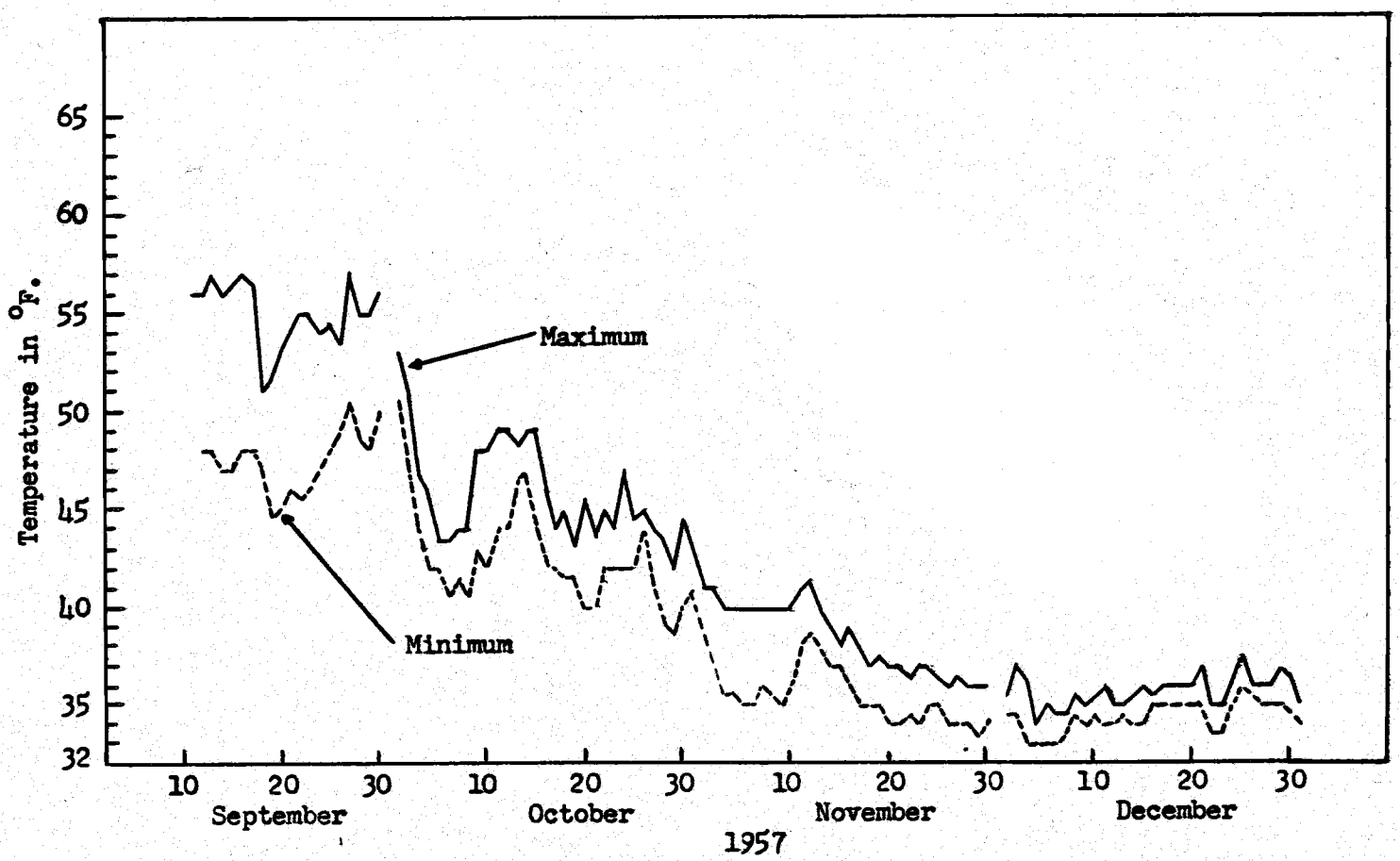

Figure 55. Daily Maximum and Minimum Temperatures on the Lostine River at a Temperature Station 9 Miles Above the Mouth, Fall of 1957, (Data Obtained from U. S. Fish and Wildlife Service).

Tributaries: As previously indicated, the tributaries of the Lostine River have torrential to precipitous gradients, and are therefore, believed to be of little importance to the production of anadromous fishes. The larger tributaries of this stream include Lake and Silver Creeks and the East and West Forks (Figure 51). None of these streams exceed 6 miles in length.

Anadromous Fish Populations

Anadromous salmonids known to utilize the Lostine River include chinook salmon, silver salmon, and steelhead trout.

Chinook: Spring chinook are found to be well established on the Lostine River as indicated by spawning ground counts from 1948 through 1957 (Table 51). 1/ In respect to the timing of the spawning period, evidence obtained thus far indicates that Lostine River spring chinook are relatively early spawners. In 1955 and 1956, multiple surveys made over the span of the spawning season signified that the peak of spawning occurred in approximately the second week of August.

The principal spawning areas of spring chinook on the Lostine River are as follows: (1) Lapover Meadows downstream 1 mile; (2) the 2.5-mile section located immediately above Williamson Cabin Forest Camp; and (3) the 3-mile length of stream extending from 9.5 to 12.5 miles above the mouth. Spring chinook have been observed spawning in all other areas of the stream where gravel concentrations are suitable (Figure 51 and Table 48).

From evidence obtained in the fall of 1957, there may be a fall-spawning race of chinook salmon in the Lostine River. On October 28, 1957, the carcass of a freshly-spawned female chinook was observed by a Game Commission screen maintenance man about 1.5 miles above the river mouth. This fish was 36 inches in length. On November 1, personnel of the inventory survey program noted the carcass of a freshly spawned 28-inch female chinook approximately 1 mile above the mouth during a survey for silver salmon. Also 1 live fish was observed which was tentatively identified as a chinook because of its large size.

Data obtained from the Oregon Game Commission concerning the capture of juvenile salmon at irrigation ditch screen installations on the Lostine River has furnished some indication of the time of outmigration on this stream (Table 52). This information, for the period 1953-58, shows that juvenile salmon are captured from April through October and that the largest numbers of fish are taken in August and September. The records do not differentiate between chinook and silver salmon.

Silver Salmon: With exception of the Wallowa River, the Lostine River is the only stream in Eastern Oregon known to support a run of silver salmon. The existence of these fish in the river has only recently been recognized; therefore, spawning ground survey data are limited. In November of 1957, surveys made on the lower 5 miles of the stream resulted in the following observations:

Location	Date	Live	Dead	Redds
Lower 4.5 miles	11-1-57	35	3	44
4.5 to 5 miles above mouth	11-13-57	4	0	5
4.5 miles above mouth (Spot check)	11-20-57	2	0	0

1/ Spawning ground surveys were made on the Lostine River from 1948 to 1957 with the exception of the year 1951.

Table 51. Spawning Ground Counts of Spring Chinook in Index Units on the Lostine River, 1948-57. 1/

Date and Year	Number of Fish Live	Number of Fish Dead	Number of Redds
8-6-48 2/	13	0	3
8-16-49 3/	28	13	100
8-19 & 20, 1950	25	11	81
8-16-52	35	9	116
8-27-53	0	29	128
8-19-54	101	40	146
8-15 & 9-2-55 4/	140	104	261
8-17-29-56 5/	98	24	102
8-21-57	65	92	239

1/ Counts made by Oregon Fish Commission personnel. In general, index units extended from 9.5 to 12.5 and 17.5 to 22.5 miles above the mouth, a total of 8 miles.

2/ Only one-half of index units surveyed.

3/ One and one-half miles of lower index unit not surveyed.

4/ Maximum counts selected from multiple surveys made over the period of spawning. Live count from survey of 8-15, and dead and redd counts from survey of 9-2.

5/ Maximum counts selected from multiple surveys made over the period of spawning. Live count from survey of 8-23, dead count from 8-29 survey, and redd count from survey of 8-17.

Table 52. Monthly Catch Records of Juvenile Salmon Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on the Lostine River. 1/

Year	Period of Capture	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	5-24 -- 10-15	0	0	7	0	14	684	992	659
1954	4-8 -- 10-7	-	26	73	43	25	1,404	1,622	5
1955	4-24 -- 10-23	-	1	227	6	55	1,829	6,197	597
1956	5-8 -- 10-23	-	-	94	181	167	243	34	3
1957	5-1 -- 8-15	-	-	25	176	151	84	0	0
1958	6-24 -- 9-15	-	0	0	10	61	301	713	0

1/ Data furnished by Oregon Game Commission.

Because only a few surveys were made, the duration of the silver salmon spawning season on the Lostine River was not ascertained. However, the surveys did indicate that spawning was probably completed by November 20.

Although spawning silver salmon were sparsely distributed over the lower 5 miles of the river, the most concentrated spawning occurred in the stream section extending from 1 to 3.5 miles above the mouth.

The period of outmigration of silver salmon on the Lostine River has not been specifically determined. On the Wallowa River, the downstream migration of this species occurs from April into July, as indicated by fish screen by-pass trap records.

Steelhead Trout: The distribution of steelhead spawning on the Lostine River is unknown. Because of the extreme gradients existing on the tributary streams, it is assumed that most of the steelhead spawning occurs on the main river.

Fish screen by-pass trap records indicate that juvenile rainbow trout are captured from April through October in some years (Table 53). In general, the frequency of capture appears to be somewhat evenly distributed over the capture period with a tendency toward greater numbers of trapped individuals in May, August, and September.

Table 53. Monthly Catch Records of Juvenile Rainbow-Steelhead Trout Captured in By-Pass Traps at Irrigation-Ditch Fish-Screen Installations on the Lostine River. 1/

Year	Period of Capture	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
1953	5-24 -- 10-15	0	0	20	16	26	127	40	18
1954	4-8 -- 10-15	-	58	126	54	21	101	103	5
1955	5-8 -- 10-23	-	0	25	38	39	58	83	97
1956	5-8 -- 10-23	-	-	108	50	9	35	61	30
1957	5-1 -- 8-7	-	-	52	33	10	4	0	0
1958	6-24 -- 9-15	-	0	0	2	1	107	234	0

1/ Data from Oregon Game Commission.

DISCUSSION AND RECOMMENDATIONS

Recommended plans for increasing the production of anadromous fishes on the Lostine River include the use of fish transplants, the correction of barriers, and the development of certain existing stocks of salmon, possibly by fish cultural techniques such as the rearing of fish in artificial impoundments.

Fish Transplants

Fall-Spawning Chinook: Plans to increase the production of these fish could be accomplished in conjunction with the development of a run of a similar type of fish on the Wallowa River. As outlined in the discussion of that stream, plans to rehabilitate the runs of fall-spawning chinook might include both fish introductions and the development of existing remnant stock by artificial propagation. In respect to fish transplants, the proximity of the Wallowa and Lostine Rivers leads to the belief that a common donor stock could be used to establish runs in either stream. Similarly, fish-cultural operations for the two streams could be combined. An estimate of the spawning potential for fall-spawning chinook on the lower Lostine River is 500 redds. 1/

It is recommended that transplants of fall-spawning chinook be restricted to the lower 9.5 miles of the Lostine River. Although this area is utilized somewhat by spring chinook for spawning, conditions of temperature and flow are believed to favor a later-spawning fish. The fact that silver salmon also utilize this area does not necessarily preclude increased use by other species, since the requirements of the different species for spawning sites may vary considerably.

Silver Salmon: No transplants of silver salmon are recommended on the Lostine River. However, it is believed that the production of this species could be increased by the use of rearing techniques. This will be discussed later.

Obstructions and Diversions

Obstructions on the Lostine River consist of the Lostine water supply dam (WaL-2), the Sheep Ridge irrigation dam (WaL-3), and various gravel irrigation dams (WaL-1) that are constructed on the lower river during the summer.

The Lostine and Sheep Ridge Dams are about 1 mile apart and form obstructions to fish passage each year during intermediate and low stages of stream flow. In addition to affecting the distribution of late arriving spring chinook on the spawning grounds, these dams may also prevent the migration of silver salmon to favorable spawning areas. This situation was indicated in the fall of 1957, when spawning silver salmon were observed only a short distance below the Lostine Dam, but were not observed in suitable spawning area that exists immediately above Sheep Ridge Dam. Because there is only a negligible amount of spawning area located between the 2 dams, the provision of fish passage over the Lostine Dam would be, to a large degree, ineffectual unless passage is also obtained at the Sheep Ridge Dam. Generally speaking, these 2 barriers probably become impassable at about the same time. It is recommended that the Lostine and Sheep Ridge Dams be provided with efficient fish-passage facilities.

1/ Redd potential for fall-spawning chinook on the lower 9.5 miles of the Lostine River based on the following assumptions: (1) that 7 miles of the stream contain 15 per cent gravel, 1 mile of stream--10 per cent gravel, 1.5 miles of stream--no gravel; (2) that there is an average stream width of 13 yards; (3) that 0.5 of the existing gravel would be located in sites favorable to selection for spawning purposes; and (4) that fall-spawning chinook would require 24 square yards of redd and inter-redd space as indicated by Burner (1941).

The temporary gravel dams on the lower Lostine River should be constructed in such a manner that adequate fish passage is assured.

As indicated by field observations in the summer of 1959, 2 unscreened ditches are present on the lower Lostine River (see Figure 51). It is recommended that these ditches by screened, if necessary.

The provision of passage facilities at the falls on the upper Lostine River is not advocated. In addition to a lack of evidence to substantiate the existence of a block, the amount of spawning area above the falls would not justify the construction of a costly fishway.

Impoundments and Hatcheries

The Lostine River is believed to have an excellent potential for the development of off-channel impoundments for rearing juvenile salmon. In addition to numerous areas suited to impoundment construction, the temperature and flow conditions on this stream during the summer are favorable. Of further advantage is the presence of a good access road to the better impoundment sites above Lostine.

Provided that the rearing of salmon in impoundments is shown to be feasible and results in an increased return of adults to the stream, it is recommended that natural production on the Lostine River be augmented by rearing of silver salmon and spring chinook by this method. This technique may also prove beneficial to the rehabilitation of fall-spawning chinook in this river. Furthermore, rearing salmon in impoundments could be employed in conjunction with artificial propagation involving the use of a drip incubator station. As previously stated in the discussion of the Wallowa River, a promising incubator station site exists on the Renthrow Farm near the confluence of that stream and the Lostine River.

Stream Improvements

No stream improvement projects are recommended for the Lostine River.

MINAM RIVER

Introduction

The Minam River originates at Minam Lake on the alpine slopes of the north-central Wallowa Mountains and enters the Wallowa River at Minam, Oregon, 10 miles above its mouth (Figure 56). From its source, the river drops steeply for the first few miles and then levels off to flow across a forested plateau which eventually grades into the Wallowa River canyon. The 50-mile long canyon through which the river courses is generally deep and narrow with the elevation above mean sea level decreasing from approximately 7,500 feet at Minam Lake to 2,540 feet at the mouth. The direction of flow is north. The drainage area is approximately 240 square miles.

The major tributaries of the Minam River are the Little Minam and North Minam Rivers, which enter the main stem 18 and 31 miles, respectively, above its mouth. The Little Minam River is 15 miles in length and the North Minam River, 8 miles. Surveys were conducted on both of these tributaries in addition to the main stream.

Anadromous salmonids which inhabit the drainage consist of spring chinook salmon and steelhead trout. Also, a few fall-spawning chinook have been observed. Within the basin, salmon have been reported only on the Minam and Little Minam Rivers, whereas steelhead trout probably inhabit some of the smaller tributaries in addition to these two streams.

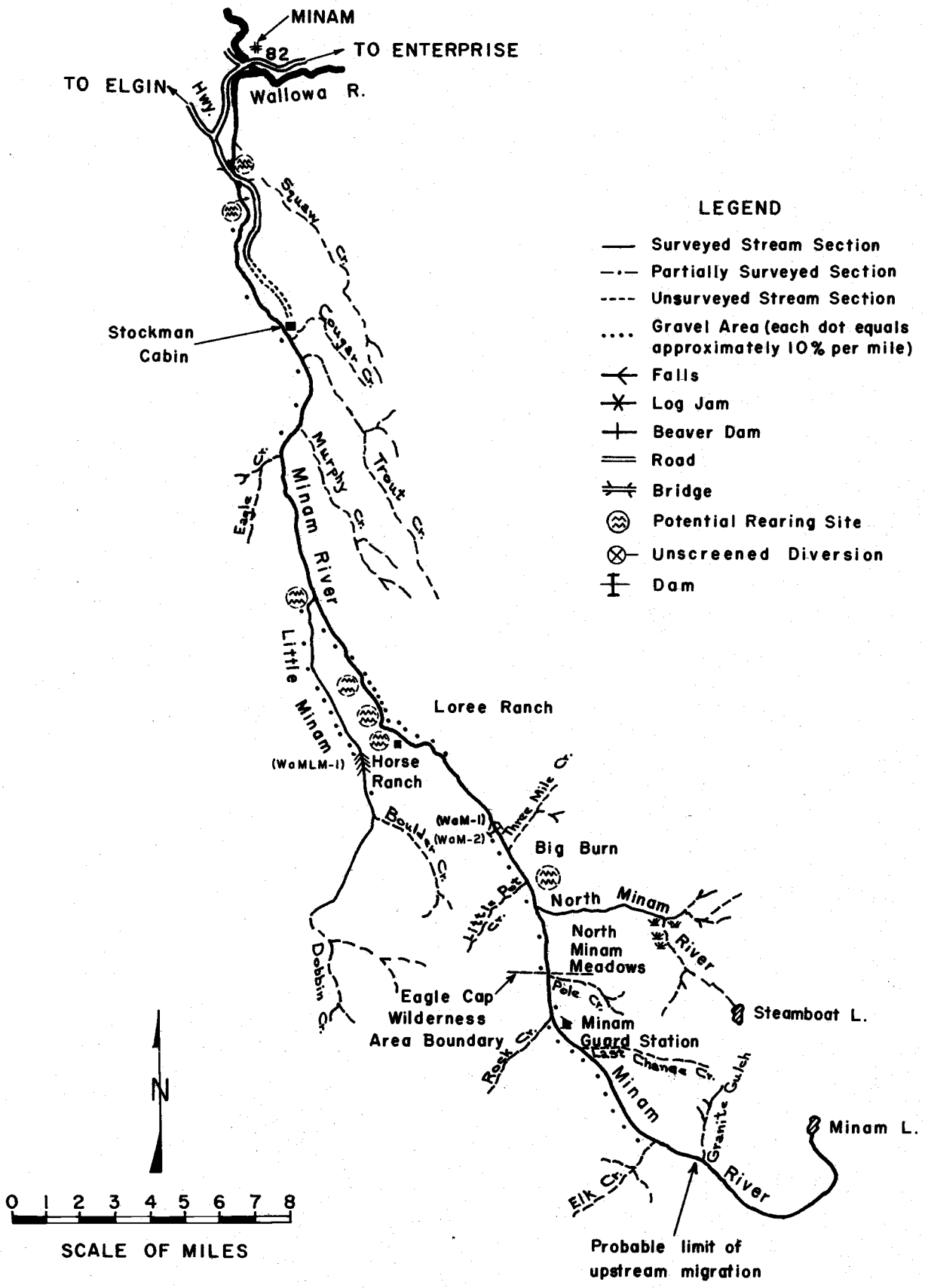

FIGURE 56. MINAM RIVER

Human demands on the Minam River watershed have been relatively slight in recent years. Only a small amount of water is removed for irrigation and little increase is expected in the future due to a general lack of irrigable lands in the canyon. Controlled grazing occurs which consists mainly of cattle in the lower areas and sheep at the higher elevations. Logging has occurred in the past, and may soon be resumed. In this regard, recent information from the U. S. Forest Service indicates that marketable timber will be sold between Stockman Cabin and the mouth of Threemile Creek within the next 5 years. During former logging operations, which occurred some 40 years ago, a splash dam was constructed about 4.5 miles above the Horse Ranch (Figure 56). This dam was partially blown out in 1939, but still remains a serious barrier to upstream migration.

The Minam River is located in a remote area, and above Stockman Cabin is accessible only by trail or air. An airport suitable for use by light planes is located at the Horse Ranch. Anticipated logging operations may result in the construction of roads to the mouth of Threemile Creek in the near future.

Inventory Surveys - Dates and Areas

Surveys to inventory the physical characteristics of the Minam River were conducted from the source to the mouth, excluding a 6-mile spawning ground index unit which extends from 1 mile above the Horse Ranch to the mouth of the Little Minam River. The index unit was omitted from the surveys because the characteristics of this area were known to the surveyors from previous spawning ground surveys. The section from Elk Creek to the mouth was covered by ground surveys, and an aerial survey was made from Minam Lake to Elk Creek. A list of the individual surveys is presented in Table 54.

Table 54. Ground and Aerial Inventory Surveys Conducted on the Minam River, 1957-59.

Date	Type of Survey	Length in Miles	Area
Aug. 30, 1957	foot	3.5	Splash dam to 1 mi. above Horse Ranch.
July 9-10, 1958	foot	13.0	Elk Creek to splash dam.
Sept. 22, 1958	foot	9.0	Stockman Cabin to mouth.
Oct. 23, 1958	foot	9.0	Little Minam to Stockman Cabin.
Apr. 29, 1959	aerial	9.0	Minam Lake to Elk Creek.
Aug. 28, 1959 1/	foot	13.0	Elk Creek to splash dam.

1/ Survey to determine spawning utilization.

Survey Data

Terrain and Gradient: The Minam River canyon is relatively deep and narrow, but the gradient and course are of such character that much good spawning area is interspersed with steeper stretches of rubble and boulders in the middle 20 to 25 miles of its 50-mile length (Figures 57 and 58). With the exception of a torrential stream section in the first few miles below Minam Lake, the gradient varies from moderate to steep.

Slope and Bank Cover: The recovery of slope and bank vegetation from former logging damage is for most purposes complete as indicated by clear stream flows, even during periods of considerable rainfall. The dominant slope cover is coniferous timber with grass and rock outcroppings intermixed (Figures 59 and 60). Cover in the canyon bottoms and along the stream banks consists of conifers and brush, and grass in small open meadow areas. As the lower reaches of the river are approached (below Murphy Creek), grass becomes increasingly abundant on the slopes and deciduous trees intermix with conifers and brush along the stream banks.

Shade: Shading of the stream is partial as far down as Stockman Cabin where it becomes partially shaded to open. With the exception possibly of this lower area, shading is considered adequate for maintenance of environment favorable to the production of salmon and steelhead.

Stream Cross Section: The stream cross section varies between shallow and moderate except for the lower 10-12 miles where the channel is generally wide and shallow (Figure 61). Much of this wide, shallow section coincides with the area of reduced shading, possibly contributing to increased water temperatures in the lower part of the river during the summer.

Bottom Materials: The largest concentrations of gravel are found from 1 mile above the Horse Ranch to 1 mile above the Little Minam River (5 miles) and from Elk Creek to the splash dam (12 miles) (Figures 62 and 63). A section of lesser importance to spawning is the area from 3 miles below the Little Minam River to the mouth (15 miles). A detailed description of bottom materials is given in Table 55.

Obstructions and Diversions: Two obstructions are believed to impair fish passage to spawning areas on the upper Minam River. The lower obstruction is a falls (WaM-1) located in a gorge approximately 4.5 miles above the Horse Ranch (Figure 64). At this falls, the stream drops vertically for 6 or 7 feet over granite bedrock. The width across the spill is approximately 35 feet. The upper barrier consists of a splash dam remnant (WaM-2) located 300 yards above the falls. The initial drop at the face of the dam is vertical for about 8-10 feet and the stream then cascades over an inclining surface for approximately 40 feet (Figure 65). The dam is constructed of wood and is approximately 35 feet wide across the spill. An indication that these barriers are restricting fish from the upper areas on the Minam River was obtained in August 1959 when simultaneous observations were made both above and below the obstructions. In a 6-mile area below the barriers, 155 salmon and 131 redds were counted, while in 11.5 miles of suitable habitat above the obstructions, only 5 fish and 8 redds were observed.

Other obstructions, consisting of a series of impassable falls and cataracts (WaM-3), are present in the 2 or 3 miles immediately below Minam Lake. However, these barriers are not situated below spawning areas. No obstructing log jams or diversion ditches were observed in the surveys.

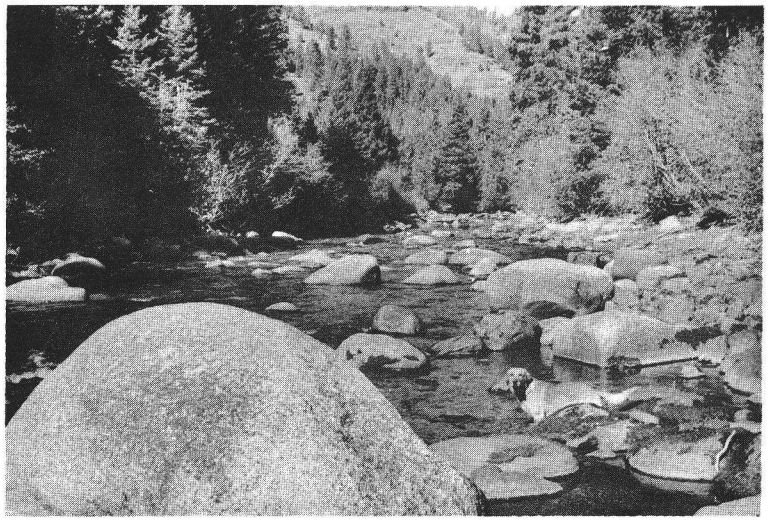

Figure 57. Boulder Section of the Minam River Just Below the Mouth of the Little Minam River.

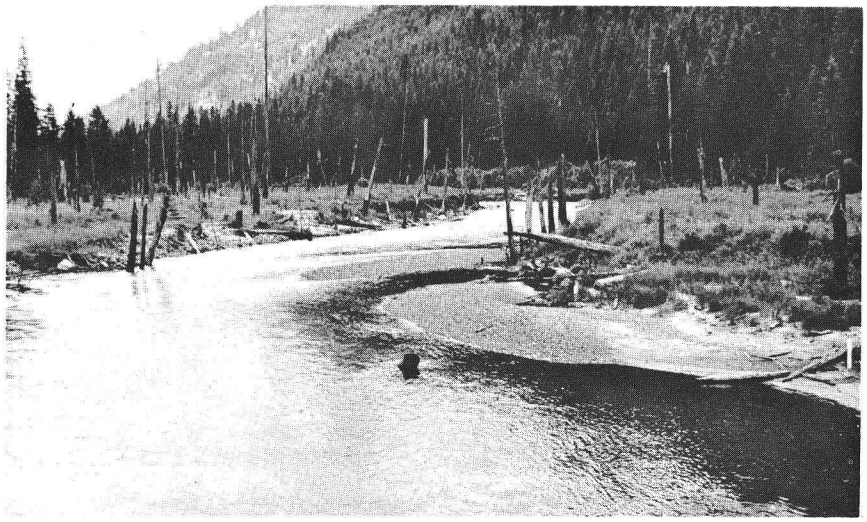

Figure 58. Gravel Deposits on the Minam River a Short Distance Above the Splash Dam Remnant.

Figure 59. Slope Cover of Conifers, Grass and Rock in the Minam R. Basin at Confl. of Minam and Little Minam Rivers. L. Minam R. Enters on Right.

Figure 60. Slope Cover on the Minam River Just Above the Mouth of the North Minam River.

Figure 61. Upper End of Area of Wide, Shallow Stream Cross Section Which is Typical of the Lower Minam River.

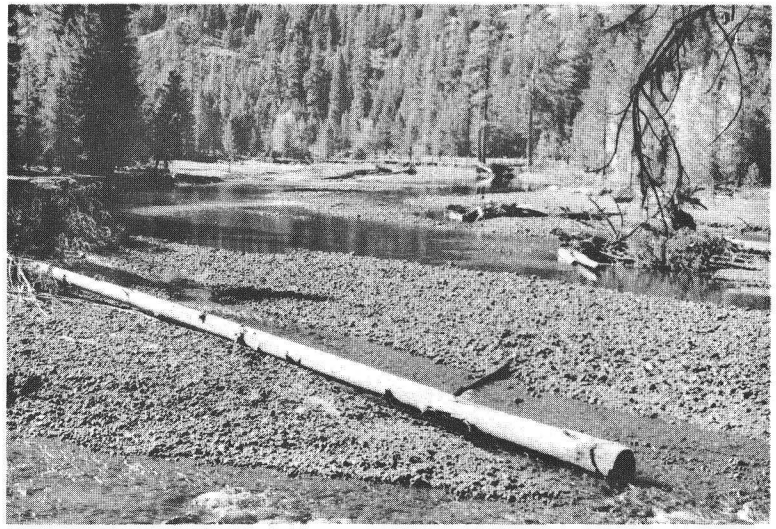

Figure 62. Gravel Deposits in One of Main Spring Chinook Spawning Areas of the Minam River, 2 Miles Below the Horse Ranch.

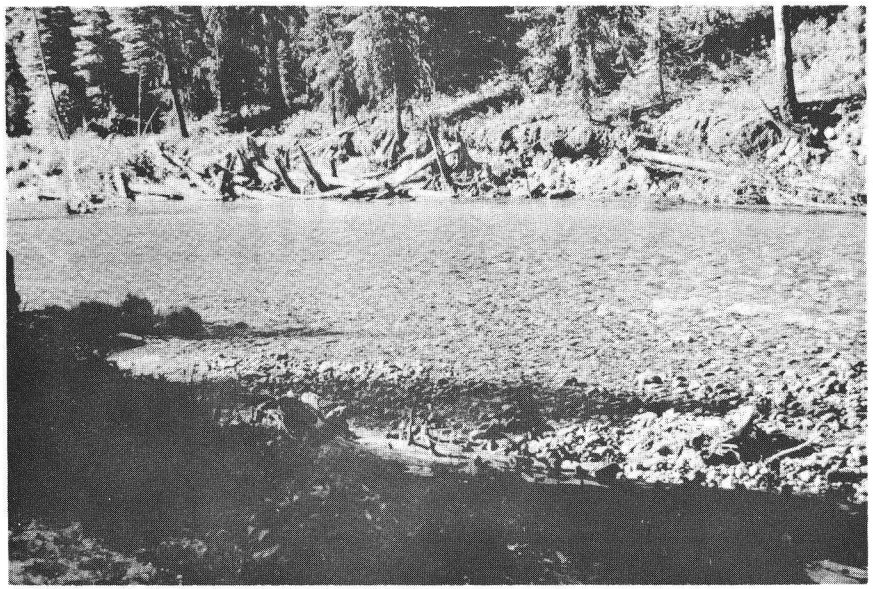

Figure 63. Gravel Bed on the Minam River 11 Miles Above Minam Falls and the Splash Dam.

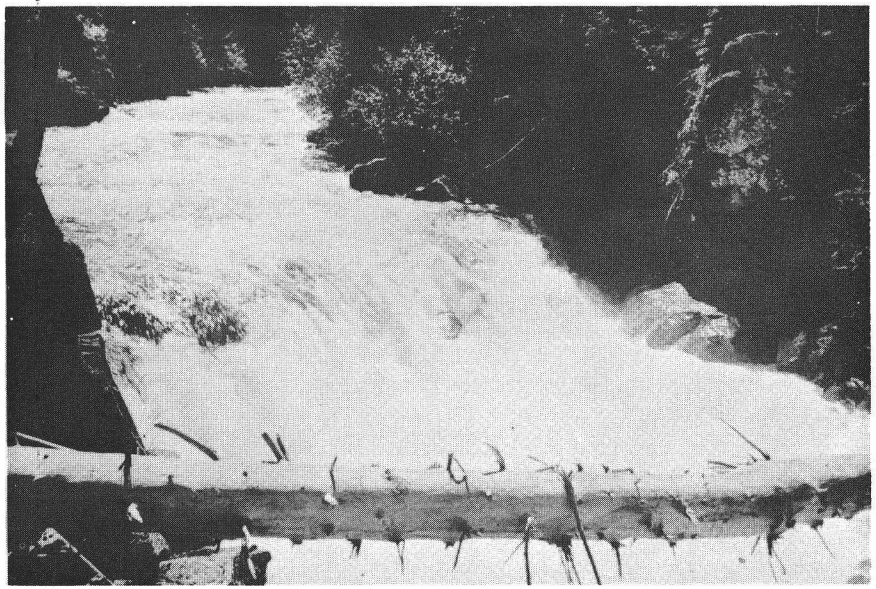

Figure 64. Minam Falls, Located 4.5 Miles Above the Horse Ranch on Minam River. Height of Falls Was Between 6 and 7 Feet as Shown on July 9, 1958.

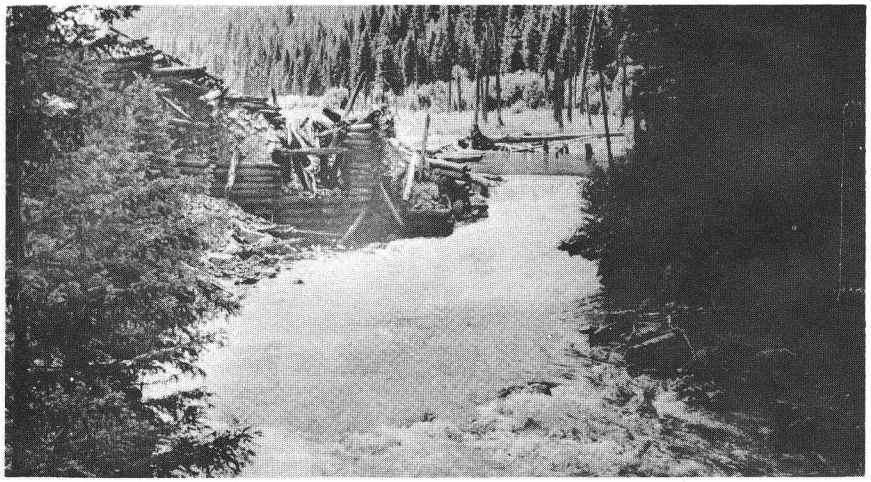

Figure 65. Splash Dam Remnant on Minam River 300 Yards Above Minam Falls. Overall Height of Dam was About 10 Feet as Shown on July 9, 1958.

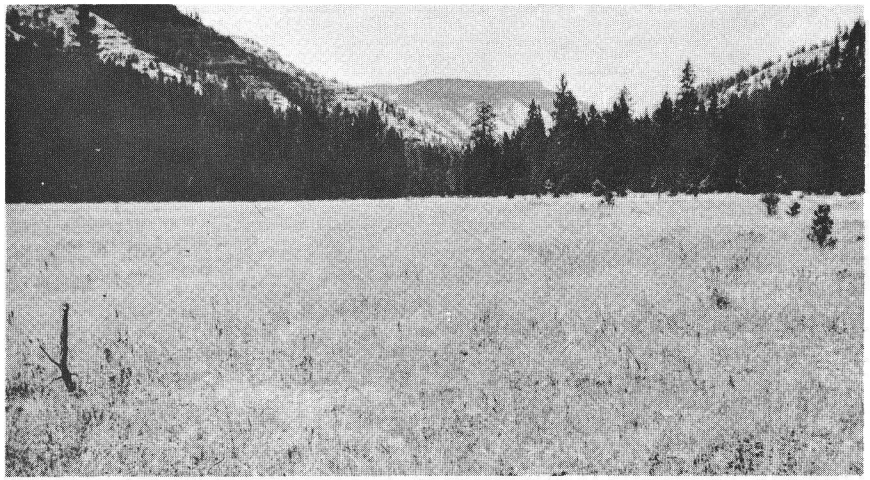

Figure 66. A Possible Fish-Cultural Impoundment Site on Minam River Just Below the Mouth of the Little Minam River.

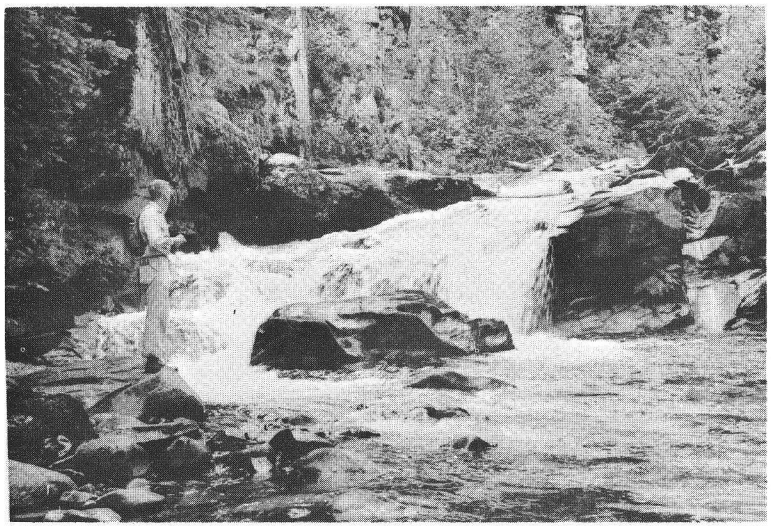

Figure 67. Lower Falls on Little Minam River 5 Miles Above Mouth. A Few Chinook Pass This Falls and Other More Serious Ones Above. Quantity of Gravel Above is Negligible.

Table 55. Estimated Percentages of Bottom Material Components on the Minam River from Elk Creek to the Mouth.

Section	Distance in Miles	Percentage Composition			
		Silt and Sand	Gravel 1/	Rubble 2/	Boulders 3/
Elk Creek to Splash Dam	13	10	15	35	40
Dam to 1 mi. above Horse Ranch	3.5	0	0	50	50
1 mi. above to 4 mi. below Horse Ranch	5	0	25	50	25
4 mi. below Ranch to 3 mi. below Little Minam	4	0	0	50	50
Below Stockman Cabin to bridge	10	0	5	50	45
Bridge to mouth	5	0	5	75	20

1/ Rocks less than 4 inches in diameter but larger than sand grains.

2/ Rocks 4-12 inches in diameter.

3/ Rocks larger than 12 inches in diameter.

Impoundment and Hatchery Sites: Several areas which appeared suitable for off-channel impoundments were observed. Locations of these sites are given in Table 56. Pond site locations are also indicated in Figure 56. Figure 66 is a photograph of one of the observed sites. An aerial view of this site is shown in the center of Figure 59.

Expanded sections of the valley floor near the mouth of the Minam River could be used as hatchery locations, but no outstanding hatchery sites in respect to water supply were noted. The river would be the only source of hatchery water since no springs are known to be present in the area.

The establishment of an incubator station for fall chinook eggs may be feasible near the mouth of the river (T. 1 N., R.41 E., S. 17 or 20). The area is accessible by road, and incubation temperatures in the fall and spring are believed to be more moderate in this lower reach of the river than in the higher altitudes of the upper reaches.

Flow and Temperature Data: In general, the discharge cycle of the Minam River is considered to be favorable to fish life. Critically low flows are not known to occur. Flow records taken near the mouth of the river from June 1912 through March 1914 indicate the maximum and minimum discharge for that period to be 4,500 and

Table 56. Location and Estimated Acreage of Potential Fish-Cultural Impoundment Sites on the Minam River.

Area	Location	Estimated size in acres. 1/
The Big Burn	T. 3 S., R. 43 E., S. 22	10
Meadow above Splash dam	T. 3 S., R. 42 E., S. 15	10
Horse Ranch	T. 2 S., R. 41 E., S. 36	5
Merton Laree Ranch	T. 2 S., R. 41 E., S. 25	20
Meadow below Laree Ranch	T. 2 S., R. 41 E., S. 25	15-20
Mouth Little Minam River	T. 2 S., R. 41 E., S. 10	20-30
Lower Minam River	T. 1 N., R. 41 E., S. 17	5
Lower Minam River	T. 1 N., R. 41 E., S. 20	5

1/ Estimates of acreage were done by visual inspection without the use of any measuring device and are, therefore, only approximate.

90 c.f.s., respectively. Table 57 presents the mean monthly flow for this same period of time. Flow data obtained primarily from past spawning ground observations are given in Table 58.

Of further benefit to fish life in the drainage is a favorable temperature pattern with indications of maximum temperatures which do not generally exceed 65°F. in the principal spawning areas and 70°F. near the mouth (Table 58).

During the inventory surveys of July 9-10, 1958, flows were estimated to be 250 c.f.s. near Elk Creek and 400 c.f.s. at Minam Falls. On this same date, the water temperature ranged from 44°F. at 9:00 a.m. at Elk Creek to 55°F. at 5:00 p.m. near the North Minam River. On September 22, the flow was estimated to be 100 c.f.s. between Stockman Cabin and the mouth of the Minam River and the water temperatures ranged from 51 to 54°F. On October 3, the flow was estimated to be 130 c.f.s. between the Little Minam River and Stockman Cabin and the water temperature varied between 47 and 54°F.

Tributaries: The North Minam River is the principal tributary in the upper Minam drainage. Late summer flow in this stream is believed to range from about 25 to 75 c.f.s. near the mouth (Table 59). In the lower 4 miles the river drops approximately 1,100 feet and the gradient is torrential. The North Minam Meadows are located about one mile above this steep section. Gradient in the meadows is moderate and the stream bottom is composed of very fine gravel and granitic sand. The meadow area is reported to flood and form a lake in the spring. This area comprises several hundred acres and may be suitable for the construction of a large impoundment for the rearing of salmon. Above the meadows, the gradient again becomes torrential. Salmon and steelhead are not known to use this stream.

Table 57. Mean Monthly Discharge in Cubic Feet Per Second of Minam River, Near the Mouth, June 1912-March 1914. 1/

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1912	---	---	---	---	---	---	---	---	2,190	848	276	156
1913	110	141	128	117	134	316	888	1,950	2,370	863	225	112
1914	168	228	186	229	203	444	---	---	---	---	---	---

1/ Data obtained from USGS Water Supply Paper 1317, Part 13, Snake River Basin.

Table 58. Spot Observations of Temperature and Flow 1/, Minam River, 1913, 1940, 1949, 1950, 1952-59.

Date	Location	Time	Temp. in °F. Air	Temp. in °F. Water	Est. c.f.s.	Source of Data
1-5-13	Mouth	---	--	--	90	USGS 2/
5-28-13	Mouth	---	--	--	4500	"
10-14-40	Mouth	---	--	--	150	USFWS 3/
8-19-49	Horse Ranch	4:40 p.m.	--	65	--	OFC
8-20-49	7 mi. below Horse Ranch	1:00 p.m.	--	66	--	"
8-21-49	1 mi. below Horse Ranch	10:00 a.m.	--	54	--	"
8-19-50	Mouth	12:00 noon	82	70	--	"
8-16-52	Mouth	10:40 a.m.	70	64	80	"
8-7-53	Mouth	---	--	--	373	USGS
9-4-53	Horse Ranch	---	--	--	80	OFC
8-6-54	Mouth	---	--	--	170	USGS 4/
8-16-54	Little Minam to Horse Ranch	1:00 p.m.	68	52	--	OFC
8-17-54	2 mi. above Horse Ranch	1:00 p.m.	68	52	--	"

1/ All flow records marked OFC are estimations of discharge, made without the use of flow measuring equipment.

2/ U. S. Geological Survey Water Supply Paper 1317, Part 13, Snake River Basin, 1956.

3/ Parkhurst (1950).

4/ U. S. Geological Survey W.S.P. 1347, Part 13, Snake River Basin, 1956.

Table 58. Spot Observations of Temperature (continued)

Date	Location	Time	Temp. in °F. Air	Water	Est. c.f.s.	Source of Data
8-17-55	Horse Ranch	7:30 a.m.	--	53	--	OFC
8-17-55	Horse Ranch	2:00 p.m.	--	63	40	"
8-23-55	Horse Ranch	10:00 a.m.	68	55	--	"
8-23-55	Salmon Hole	1:15 p.m.	67	61	55	"
8-29-55	Near Little Minam	10:30 a.m.	72	57	40	"
9-4-55	Salmon Hole	2:00 p.m.	84	62	40	"
9-4-55	Horse Ranch	3:10 p.m.	80	64	--	"
8-18-56	Horse Ranch	8:40 a.m.	66	56	45	"
8-18-56	Near Little Minam	11:50 a.m.	73	62	70	"
8-24-56	Salmon Hole	---	--	--	40	"
8-30-56	Horse Ranch	7:30 a.m.	66	58	--	"
9-5-56	Horse Ranch	7:30 a.m.	40	42	--	"
9-12-56	Horse Ranch	7:40 a.m.	--	48	--	"
8-30-57	Salmon Hole	8:15 a.m.	46	48	--	"
7-9-58	1 mi. above North Minam	5:15 p.m.	72	55	270	"
7-9-58	1 mi. above Splash Dam	1:00 p.m.	77	54	400	"
7-9-58	Splash Dam	12:00 noon	79	52	400	"
7-10-58	Elk Creek to Pole Creek	7:20 a.m.	50	44	250	"
7-10-58	Elk Creek to Pole Creek	8:25 a.m.	63	45	225	"
7-10-58	Elk Creek to Pole Creek	9:30 a.m.	70	47	300	"
7-10-58	Elk Creek to Pole Creek	10:30 a.m.	75	--	--	"
7-10-58	Elk Creek to Pole Creek	11:15 a.m.	73	50	300	"
7-10-58	0.25 mi. above Pole Creek	11:18 a.m.	73	50	250	"
7-10-58	1 mi. above North Minam	9:00 a.m.	56	46	270	"
9-22-58	Stockmans Cabin	12:20 p.m.	53	51	100	"
9-22-58	4 mi. below Stockmans Cabin	2:20 p.m.	53	53	100	"
9-22-58	Mouth	3:40 p.m.	53	54	100	"
10-3-58	Just below Little Minam	10:30 a.m.	--	--	130	"
10-3-58	Just above Little Minam	10:30 a.m.	71	47	100	"
10-3-58	3 mi. below Little Minam	1:00 p.m.	72	52	130	"
10-3-58	Near mouth Cougar Creek	12:40 p.m.	70	56	100	"
10-3-58	1 mi. below Murphy Creek	1:30 p.m.	80	54	100	"
2-20-59	Mouth	3:30 p.m.	--	41	--	"
6-24-59	Mouth	5:45 p.m.	--	53	--	"
7-8-59	Mouth	9:15 a.m.	--	48	--	"
7-10-59	Mouth	9:30 a.m.	--	56	--	"
7-20-59	Mouth	10:00 a.m.	--	64	--	"
7-27-59	Mouth	5:00 p.m.	--	67	--	"
8-27-59	Horse Ranch	9:00 a.m.	69	54	90	"
8-27-59	Mouth Little Minam	2:10 p.m.	76	65	120	"
8-28-59	Just above Little Minam	1:30 p.m.	--	62	--	"
9-21-59	Mouth	8:30 a.m.	--	49	--	"
10-18-59	Mouth	9:15 a.m.	--	40	--	"
10-27-59	Mouth	10:00 a.m.	--	67	--	"

Table 59. Spot Observations of Temperature and Flow at the Mouth of Certain Minam River Tributaries.

Date	Name of Tributary	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.
7-9-58	North Minam River	4:00 p.m.	74	56	125
7-10-58	Last Chance Creek	9:00 a.m.	70	47	20
7-10-58	Rock Creek	---	--	--	15
7-10-58	Pole Creek	10:00 a.m.	70	52	20
7-10-58	Little Pot Creek	---	--	--	8
7-10-58	Three-Mile Creek	---	--	--	10
10-3-58	Murphy Creek	2:00 p.m.	80	50	2
10-3-58	Trout Creek	1:00 p.m.	70	50	4
10-3-58	Cougar Creek	---	--	--	1
10-5-59	North Minam River	11:00 a.m.	59	44	50

Aside from the North Minam River, about a dozen small, steep, feeder streams enter the Minam River between Elk Creek and the Horse Ranch. 1/ These streams were flowing an estimated 8 to 20 c.f.s. during the survey of July 9-10, 1958, (latter part of high flow period), but have much reduced flows from mid-summer into fall.

Below the Horse Ranch, the Little Minam River is the largest tributary. On October 3, 1958 (low flow period), this stream was discharging about 30 c.f.s. at the mouth. Other named tributaries in this section number less than a dozen and characteristically have low rates of discharge in late summer and fall. Table 59 presents flow and temperature data obtained at the mouths of tributaries during the survey of the Minam River.

Anadromous Fish Populations

At the present time, spring chinook salmon and steelhead trout utilize the Minam River and some of its tributaries. Past records indicate that runs of silver salmon also once used the stream. Because of the inaccessibility of Minam Lake to adult salmon, it is doubtful that blueback salmon runs have ever existed.

Chinook Salmon: The Oregon Fish Commission has made annual index counts of spawning chinook salmon on the Minam River during the years 1949 and 1953-59. The index unit used in making these counts has included, generally, the 6-mile section

1/ Most of these small streams are not illustrated in the drainage map of the Minam River (Figure 56).

from the mouth of the Little Minam River to 1 mile above the Horse Ranch (Figure 56). The counts of salmon have varied considerably from year to year, possibly due to the combined effects of fluctuation in population size and the difficulty of timing the surveys properly in the spawning season to observe similar proportions of the spawning population each year. The surveys have shown, however, that substantial runs of chinook salmon migrate into the spawning area of the Minam River in some years (Table 60). These fish appear to reach peak spawning activity within a period including the last 10 days of August and the first few days of September.

Although the section of the river utilized by chinook salmon for spawning is widespread, past observations indicate that the main area of utilization is within the boundaries of the index unit. Outside the index unit, spawning chinook and/or redds have been observed as far downstream as 2 miles below Stockman Cabin and as far upstream as the mouth of Granite Gulch. 1/ During the 1958 inventory survey, chinook fingerlings were observed and collected just above the Minam Guard Station.

Table 60. Annual Spawning Ground Counts of Spring Chinook Salmon in Index Units on the Minam River. 1/

Date	Location	Salmon Observed Live	Salmon Observed Dead	Redds	Total Salmon
8-19-21-49	Salmon Hole to Little Minam R.	26	4	31	30
9-4-53	Salmon Hole to Little Minam R. 2/	18	44	0	62
8-24-54	Salmon Hole to Little Minam R.	105	22	82	127
9-4-55	Salmon Hole to Little Minam R.	150	137	153	287
8-24-56	Salmon Hole to Little Minam R.	140	35	198	175
8-30-57	Salmon Hole to Little Minam R.	124	491	224	615
8-21-58	Horse Ranch to Little Minam R.	48	8	16	56
8-27-59	Salmon Hole to Little Minam R.	145	21	152	166
8-28-59	Elk Creek to Splash Dam	3	2	8	5

1/ Surveys conducted by Oregon Fish Commission personnel. Jacks are included.

2/ Complete survey made from Salmon Hole to 2 miles below Horse Ranch. Remainder of index unit spot checked.

1/ Upstream observations made by the Oregon Game Commission in 1958-59. Information obtained orally from W. H. Brown, OGC. During the ground survey of the upper Minam River, time did not permit extension of the upper survey limit beyond Elk Creek. Consequently, the additional mile of stream from Elk Creek to Granite Gulch was not observed from the ground.

Evidence of a few late-spawning chinook was obtained during inventory surveys in September and October 1958 in the area between the Little Minam River and the mouth of the Minam River. On September 22, 2 redds and the carcass of a large, unspawned female were observed in a 2-mile area immediately below Stockman Cabin. By disturbing the gravel of one redd slightly, a viable, uneyed egg was obtained. The water temperature was 51°F. On October 3, 8 redds and 1 live chinook salmon were observed in the area between Trout Creek and 1 mile above Murphy Creek.

Steelhead Trout: Although there is little detailed information concerning steelhead distribution or numbers, it is probably safe to assume that this species is present throughout much of the Minam River drainage. Steelhead are commonly taken on sport gear on the lower river. The presence of abundant spawning area in the basin is believed to make the production of steelhead of considerable importance.

Silver Salmon: Since surveys have never been conducted on the river during the spawning season of silver salmon, information regarding the presence of this species is unavailable. The capture of one silver salmon by a sport fisherman on the lower river has been reported by personnel of the Game Commission.

LITTLE MINAM RIVER

Introduction

The Little Minam River, which is approximately 15 miles in length, is the principal tributary of the Minam River. This stream originates at an elevation of 7,200 feet, and flows in a northerly direction to join the Minam River 18 miles above the mouth near the 3,300-foot level (Figure 56). Due to its remote location, the stream can be reached only by trail.

Inventory Survey - Dates and Areas

The lower 8 miles of the Little Minam River was surveyed on foot on August 28, 1959. An aerial survey was conducted on the lower 12 miles of the stream on June 17, 1959.

Survey Data

Terrain and Gradient: The surveyed section of the Little Minam canyon is intermediate between wide and narrow in the lower 6 miles, and gorge-like in the 2 upper miles. Gradient in the lower 5 miles below the lower falls, is moderate to steep, and in many places conducive to the formation of gravel deposits. Above here, the stream becomes increasingly steeper and culminates in a torrential section in the upper 2 miles to Boulder Creek. As indicated by aerial observation and the U. S. Geological Survey topographic map (Telocaset quadrangle), the gradient above the area surveyed on foot is generally steep to torrential.

Slope and Bank Cover: Slope cover consists of conifers, grasses, and rock. Grasses and rock are dominant in the lower 5 miles, above which, coniferous timber predominates.

Shade: Streambed shading is partial throughout the observed area and is considered to be adequate for maintenance of water temperatures favorable to salmon production.

Stream Cross Section: The channel is moderate in cross section throughout the area of survey.

Bottom Materials: The majority of gravel is located in the first 3 miles below the lower falls. An estimated 25 per cent of the streambed is believed suitable for spawning in this area. Above the lower falls to Boulder Creek (3 miles), a steep to torrential gradient prevails and less than 5 per cent of the bottom materials are gravel. From the mouth upstream for 2 miles, the bottom materials are estimated to be 10 per cent gravel. The location and relative abundance of gravel are depicted in Figure 56.

Obstructions and Diversions: In the 3-mile section of stream from the lower falls upstream to Boulder Creek, 12 falls (WaMLM-1) ranging from 2.5 to 12 feet in height were encountered. There is evidence that some fish pass above all of these obstructions. However, passage at four of the more serious falls appears particularly difficult. The lowermost falls is in 2 steps of 8 and 4 feet each and slopes at about 45 degrees (Figure 67). Approximately 1 mile above the lowermost obstruction there is a 7-foot falls and within the next 1.5 miles there are 2 falls, 8 and 10 feet in height.

Impoundment and Hatchery Sites: Three sites which appeared suitable for off-channel ponds were noted in the stream section from 2 to 4 miles above the mouth. Observed pond sites consist of expanded sections of the canyon floor and involve considerable acreage. No sites adaptable to hatchery use were observed.

Flow and Temperature Data: During the inventory survey of August 28, 1959, the Little Minam River was discharging an estimated 25-35 c.f.s. in all observed sections. Water temperatures ranged from 51°F. at 8:40 a.m. near the lower falls to 58°F. at 12:30 p.m. at the mouth. In general, temperatures and flows are believed favorable to the production of salmon and steelhead. Detailed temperature and flow data are presented in Table 61.

Tributaries: Boulder Creek, the only observed tributary, was discharging an estimated 8 c.f.s. at the mouth during the foot survey on August 29, 1959. This stream enters Little Minam River 8 miles above the mouth.

Anadromous Fish Populations

Chinook Salmon: Index unit counts during six of the last ten spawning seasons indicate that sizable runs of spring chinook salmon sometimes enter the Little Minam River (Table 62). Annual variations in dates of peak spawning, hence poorly timed surveys, have probably contributed to low counts in some years. The principal spawning area extends from the lower falls downstream about four miles to approximately one mile above the mouth. Limited spawning occurs the remaining distance to the mouth. The upper extreme of spawning is unknown, but production above the lower falls is believed negligible.

Steelhead: Information on steelhead utilization is lacking. The presence of steelhead in the Minam River indicates that a population of this species also occupies the Little Minam River.

Silver Salmon: There is no record of silver salmon in the Little Minam River.

DISCUSSION AND RECOMMENDATIONS

Fish Transplants

The section of the lower Minam River between the mouth and the confluence of the Little Minam River is considered worthy of development. At the present time, this area is believed to be only slightly utilized for the reproduction of

Table 61. Spot Observations of Temperature and Flow, Little Minam River, 1949-59.

Date	Location	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.
8-21-49	3 mi. above mouth	5:45 p.m.	--	54	--
8-17-54	Lower falls to 2 mi. below	8:00 a.m.	49	44	--
8-17-55	Mouth	---	--	--	15
8-23-55	Lower falls to 2 mi. below	10:00 a.m.	68	55	15
8-29-55	Mouth	10:30 a.m.	72	49	15
9-4-55	Lower falls	8:30 a.m.	65	50	20
8-24-56	Mouth	---	--	--	20
9-5-56	Lower falls	8:45 a.m.	48	39	25
9-12-56	Mouth	12:00 noon	66	54	--
8-28-59	2 mi. below lower falls	8:40 a.m.	56	51	30
8-28-59	2 mi. above mouth	11:00 a.m.	--	54	--
8-28-59	Lower falls to Boulder Cr.	12:30 p.m.	60	54	25
8-28-59	Mouth	1:30 p.m.	68	58	35
8-28-59	Immediately below Boulder Cr.	2:00 p.m.	70	53	25

Table 62. Spawning Ground Survey Counts of Spring Chinook Salmon, Little Minam River, 1949-59. 1/

Date	Location	Salmon Observed Live	Salmon Observed Dead	Redds	Total Salmon
8-21-49	3 to 4 miles above mouth 2/	1	2	3	3
9-4-53	Lower 2 miles 2/	0	1	0	1
8-17-54	Lower falls downstream 2 miles	32	0	28	32
8-23-55	Lower falls downstream 2 miles	11	1	13	12
8-30-57	Lower falls downstream 2 miles	4	164	109	168
8-28-59	Boulder Creek to lower falls 2/	0	0	2	0
8-28-59	Lower falls downstream 2 miles	10	3	20	13
8-28-59	2 miles below falls to mouth 2/	16	4	34	20

1/ Surveys conducted by Oregon Fish Commission personnel.

2/ Area located outside of index unit, included to indicate comparative spawning utilization.

anadromous fishes. Reasons for this may be: (1) the runs of fall-spawning chinook which reportedly once inhabited the lower reaches of northeastern Oregon streams are now largely depleted; (2) water temperatures in the summer are in excess of those preferred by adult spring chinook for holding and spawning; or (3) the bottom materials are to a large extent rubble. Contributing to warm water temperatures on the lower Minam River are low altitude, poor stream shading, and a wide, shallow stream channel. Since the expense of altering the stream environment for use by spring chinook may be prohibitive, efforts might best be directed toward the establishment of a run of fall-spawning fish.

With one exception, a possible deficiency of gravel, the environment of the lower river appears favorable to the introduction of chinook which spawn in the fall. A remnant run of this type of fish may presently exist. Rearing potentialities in the lower river appear suitable with an abundance of shallow shoreline area which the smaller juvenile salmonids seem to prefer. To determine the incubational qualifications of the area, test plants of eyed eggs of a fall-spawning variety of chinook should be undertaken. If these tests prove encouraging, further plants of eggs should be made in an attempt to establish a run in this section of the river. Since after November, temperatures on the stream are likely to be relatively low, it is suggested that eggs from an early fall (late September or early October) spawning stock be used.

A minimum estimate of the spawning potential of the lower river can be obtained on the basis of bottom materials appearing to be of a size suitable for redd construction. The area suggested for development is approximately 15 miles in length and 20 yards in average width. Assuming that half of the gravel is situated favorably for selection as spawning sites, and that 5 per cent of the bottom materials are gravel, then approximately 13,000 square yards of usable area is present. Conversion of area to number of fall chinook redds by dividing available yardage by a factor of 24 square yards per redd site (Burner, 1951) results in a figure of approximately 550 redds. Other more optimistic estimates, not presented, might be made on the basis of utilization of larger materials or on the basis of an increase in spawning area by the use of gravel collecting devices.

In addition to the development of natural spawning on the lower Minam River, fish could be produced artificially by the establishment of an incubator station. Once a natural run became stabilized, eggs could be obtained for the incubator by use of an off-channel holding pond for adults, located near the mouth of the river.

Obstructions and Diversions

Minam Falls and the splash dam remnant above this formation are serious barriers to the upstream migration of salmon and steelhead on the Minam River. It is recommended that action be taken to provide for passage of fish beyond these barriers. Minam Falls (WaM-1) appears adaptive to the construction of a ladder or possibly to the use of explosives to obtain passage. The remains of the old splash dam (WaM-2) may be suited to laddering or possibly to complete or partial removal of the portion of the structure obstructing the stream. However, it is recommended that explosives not be used unless provision is made to prevent damage to fish habitat downstream. When the dam was partially removed by the use of high explosives in 1939, an accumulation of bottom materials in the forebay reportedly was swept downstream to damage important spawning and rearing areas. Since a considerable build-up of silt and sand still remains behind the dam, this material, if released, would move downstream to settle out in areas of reduced gradient, which are the better spawning sections.

Justification for elimination of the two barriers is provided by the existence of some 14 miles of favorable salmon and steelhead habitat above them. Also, the importance of development of the upper river for salmon and steelhead production is emphasized by the impending threat of logging on the stream below the barriers. A preliminary statement by the U. S. Forest Service indicates that timber sales may commence in 1960 near Stockman Cabin and proceed upstream to Threemile Creek by 1964. These sales will not affect the area above the barriers and future logging in this upper section of stream may not materialize since the timber stands are believed to be of slight commercial importance.

As indicated by the U. S. Forest Service, the preferred development plans for logging include the construction of a water grade road from the mouth of the Minam River to the uppermost logging area. Following the initiation of timber sales, progressive logging operations will extend through all of the present major spring chinook spawning areas, and logging of tributaries will also directly affect steelhead production.

At the present time, a few chinook are known to utilize the Minam River above the falls and splash dam, apparently passing these obstructions during favorable stages of flow. These fish may provide an adequate seed stock nucleus for the natural development of the upper river. However, if supplemental production is needed, eggs for this purpose could be obtained from adults in the lower spawning areas, where the run is well established.

Remedial action to provide for fish passage over the series of falls (WaMLM-1) on the Little Minam River is not recommended. Although a few fish are known to utilize this section of the stream, there is not enough spawning area to justify an expenditure of funds for passage facilities.

No diversion ditches or log jams which form obstructions were observed during the surveys of the Minam River drainage.

Supplemental Rearing

Opportunities for supplemental rearing appear to exist in the Minam River drainage. It is estimated that a total area of possibly 300 acres would be suitable for construction of impoundments on the Minam, Little Minam, and North Minam Rivers. If current experiments to ascertain the success of the rearing of salmon in impoundments prove promising, development of impoundments for the rearing of spring chinook salmon on these streams is recommended. The impoundments could have a screened inlet from the river to obtain water and a fish ladder entrance with a V-trap for the capture and retention of adult fish. In this way, the use of racks in the stream could be avoided. In addition to adequate impoundment sites, factors advantageous to supplemental rearing in the drainage include a good water supply, good quality of water, favorable air and water temperatures, and the existence of a sizable run of the species to be reared.

The sites observed on the Minam and Little Minam Rivers appear suitable to the construction of off-channel impoundments. The specific location of these sites have been indicated previously with the survey data for these two streams. The large site on the North Minam River at the North Minam Meadows could be developed either as an off-channel or in-channel type of impoundment. A spillway which would accommodate fairly large flows would be necessary for the latter type of development.

Stream Improvements

If the seeding of the lower Minam River should result in a reasonable return of adults to the stream, an attempt to improve spawning conditions would be justified. It is suggested that such action be initiated with the use of sill logs on a limited basis. An experimental installation of 4 to 6 logs placed 50 to 100 yards apart in one of the areas of lesser gradient should determine the value of this device. A good supply of gravel is present above the area where the log installations are recommended. A further benefit of sill logs would be increased pool area.

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