BURNT RIVER SYSTEM

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INTRODUCTION

The Burnt River is located in that part of the Snake River plain and upland south of the Powder River and north of the Malheur River. The various headwater tributaries of the stream arise in the Greenhorn Mountains and join at Unity Valley to form the main stem. From this point, the Burnt River flows about 80 miles to enter the Snake River near Huntington, Oregon. The direction of flow varies from east to northeast in the upper half of the drainage to southeast in the lower half (Figure 155). At the mouth, the stream is flooded for a short distance by the Brownlee Reservoir.

The Burnt River region is characterized by moderate to marked relief, slight precipitation and, with exception of the mountainous areas, vegetative development suited to semi-arid conditions. Elevation in the watershed ranges from over 7,800 feet on the upper South Fork to about 2,000 feet at the mouth. The drainage area is between 1,100 and 1,200 square miles.

Surveys of variable intensity were conducted on the more important streams of the Burnt River system. These include the Burnt River main stem, the South, North, West, and Middle Forks, and Camp and Dixie Creeks. The various forks of the river flow into Unity Reservoir which was created in the late 1930's by the construction of Unity Dam. This dam is unladdered and isolates the former spawning areas of the forks.

Information concerning the present status of anadromous salmonids on the Burnt River is not available. However, the majority of evidence points to the extinction of former runs of chinook salmon and the possible decimation of runs of steelhead trout. Dam construction and depletion of flows by irrigation withdrawals are believed to be the primary contributing factors in the decline of these species.

Industries operating in the Burnt River area include ranching, lumbering, and mining. There is approximately 23,000 acres of irrigated lands scattered along the main river and tributary valleys (Department of Interior, 1947), and some mining still occurs on a few of the tributaries. In general, the area is sparsely populated.

Access to the Burnt River and the lower reaches of the various tributaries is provided by U. S. Highways 26 and 30 and State Highway 7 (Figure 155). County and forest roads furnish access to many of the tributaries.

BURNT RIVER MAIN STEM

Introduction

This part of the basin is approximately 80 miles in length and is composed predominantly of agricultural lands which border the stream between Unity Reservoir and Brownlee Reservoir on the Snake River. The numerous small tributaries in this area characteristically have low summer flows. Two surveyed tributaries, Dixie and Camp Creeks, enter the river at distances of approximately 15 and 75 miles, respectively, above the mouth. The small towns of Hereford, Bridgeport, Durkee, Lime, and Huntington, Oregon are located at intervals along the stream.

Inventory Surveys - Dates and Areas

Both ground and aerial surveys were conducted on the Burnt River. Ground surveys were made on December 12, 18, 22, and 23, 1958, over a distance of

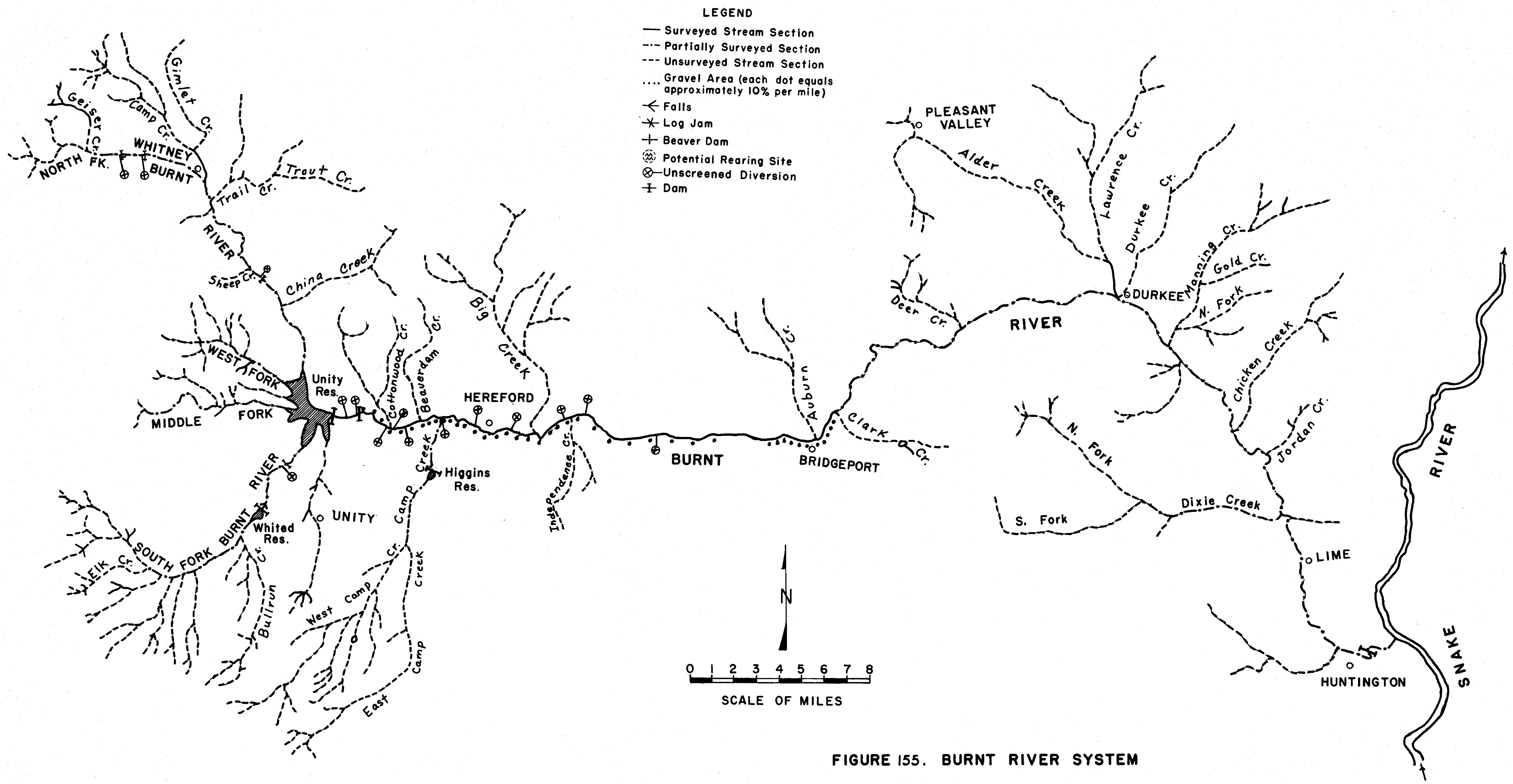

FIGURE 155. BURNT RIVER SYSTEM

approximately 25 miles between Unity Dam and Clark Creek (Figure 155). On June 2, 1959, an aerial survey was conducted from Clark Creek to the mouth, a distance of about 35 miles.

Survey Data

Terrain and Gradient: Terrain adjoining the stream consists of alternate sections of canyon and valley. From Unity Dam to Clark Creek, the river flows through the Hereford and Bridgeport valleys. From Clark Creek to near Durkee, the basin constricts to form a narrow canyon. Near Durkee, the valley formation again resumes and the stream flows through successive short sections of valley and canyon to the mouth. The gradient of the river is generally moderate and conducive to the formation of gravel deposits. Exceptions to this are a short area of steep gradient just above Durkee Valley, and several sluggish sections in Hereford Valley. In the 2 upper valleys, the stream is characterized by an extremely meandering course and, in some sections, by subdivision into 2 or more parallel channels (Figure 156).

Slope and Bank Cover: Except for the mountainous areas, which support growths of pine and fir, the dominant slope cover in the drainage is sagebrush, grass, and juniper. Bank cover is comprised primarily of brush and grass.

Shade: Shading varies with the stream section, but is generally poorer in the lower reaches of the drainage than in the Hereford and Bridgeport valleys. In these upper valleys the shade was classified as partial to dense (Figure 157). In the lower part of the basin, a wider channel combined with a lesser quantity of bank cover, increases exposure of the streambed.

Stream Cross Section: The cross section of the stream channel is moderate to deep throughout a majority of the area of ground survey.

Bottom Materials: Both ground and air observations of the stream bottom were hampered by one or more of the following conditions: turbidity of flow, density of bank cover, and depth of water. In the 25-mile section comprising the Hereford and Bridgeport valleys, the gravel component is estimated to average between 15 and 20 per cent of the stream deposits (Figure 158). The areas of greatest gravel concentrations are: 1 mile below Unity Dam to 5 miles below Hereford (12 miles), and 2 miles above Bridgeport to Clark Creek (3.5 miles) (Figure 155). Much of the gravel in these sections is somewhat compacted as a result of a high content of fines. Below Clark Creek, the evaluation of bottom materials was extremely limited due to the necessity of using an aerial survey. In the section from Clark Creek to Durkee Valley (16 miles), much of the stream bottom was obscured by a muddy discharge from Clark Creek. This area has a moderate to steep gradient which becomes steep just above Durkee valley. Parkhurst (1950-b) reports this general area to contain many good riffles, and states that it has the appearance of the best spawning area on the stream if water temperature is not considered. Below Durkee, the gradient is somewhat similar to that in the upper valleys, and gravel deposits in riffle areas were observed periodically to the vicinity of Huntington. As indicated by Parkhurst (loc. cit.) this area has numerous riffles suited to the spawning of salmon.

Obstructions and Diversions: Obstructions on the Burnt River consist of the 76-foot-high Unity Dam (B-2) and numerous small diversion dams and ditches (B-1). Unity Dam is an unladdered, earth-filled structure located immediately below the mouths of the various forks of the Burnt River (Figure 155). It was constructed in 1936-39 by the Bureau of Reclamation to supplement an inadequate supply of irrigation water obtained prior to that time from small storage

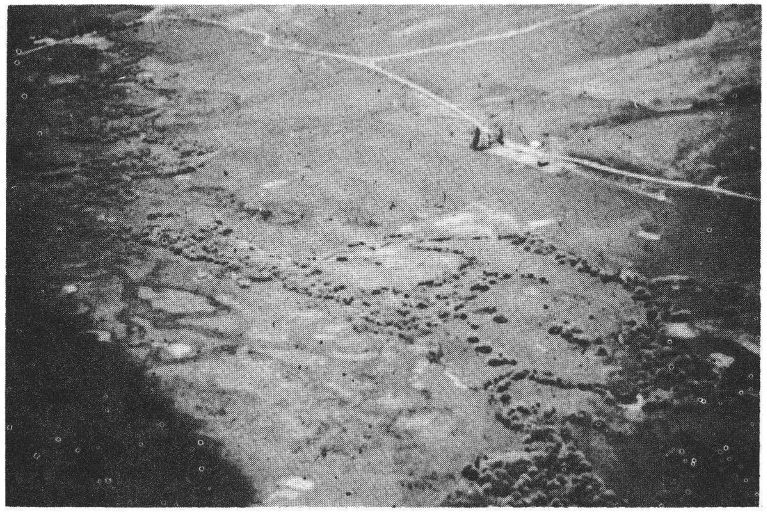

Figure 156. Aerial Photo of the Meandering Stream Course of Burnt River in Bridgeport Valley.

Figure 157. Partial Shading of the Burnt River in Bridgeport Valley.

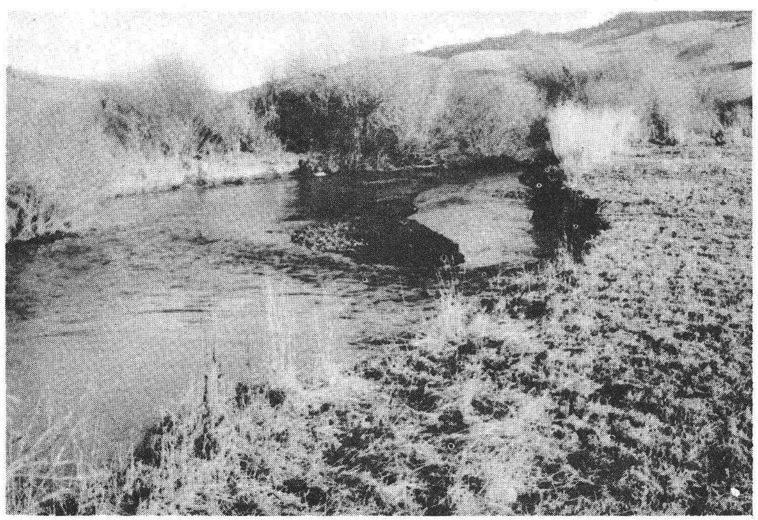

Figure 158. Gravel Bar on the Burnt River in Lower Hereford Valley.

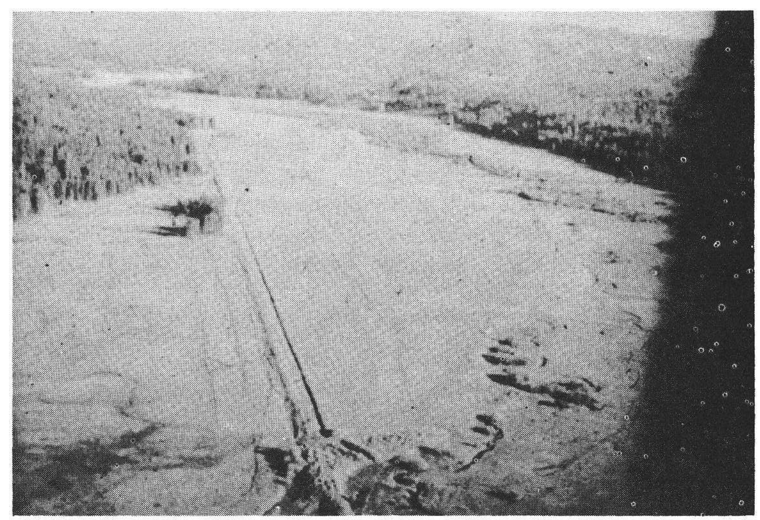

Figure 159. North Fork of the Burnt River About 13 Miles Above the Mouth.

reservoirs located on some of the tributaries (Dept. of Int., loc. cit.). Unity Reservoir has a surface area of 925 acres and a storage capacity of 25,000 acre-feet. The average annual fluctuation in the surface elevation has been about 30 feet for 7 recent years. 1/ The reservoir is stocked periodically with rainbow trout by the OGC and has become a popular place of angling for Eastern Oregon residents.

During the survey of this stream, 11 diversion ditches were noted between Unity Dam and Clark Creek, the upper and lower boundaries of the ground survey. This does not include 5 shallow, flood-type ditches and diversion dams which were observed. Since in some sections of the stream as many as 2 or 3 parallel channels exist, it is believed that the observed ditches may not comprise the total number present in the area. None of the diversion ditches on the Burnt River system are screened. Many of the dams consist of concrete abutments with slots for the insertion of "stop" boards. The height of this type dam is dependent on the number and dimensions of the boards installed. Because the survey was made in December, most of the dams had the boards removed and the degree of obstruction they might create during the migration seasons of anadromous fishes could not be determined. One dam located about 1 mile below Unity Dam, appeared to be a total barrier at a flow of about 40 c.f.s.

In the section of aerial survey, from Clark Creek to the mouth, only 1 obstruction was noted. This was checked later on the ground and was found to be a small diversion dam about 4 feet in height which may form a low water barrier. The location of this dam is about 1 mile below Huntington. Other diversion ditches are known to exist in the several narrow tracts of cultivated valley land located along the river between Durkee and Huntington. However, the specific numbers and locations of these ditches were not obtained. Figure 155 presents the general locations of observed diversion ditches on the Burnt River. Observations made on this stream by USFWS personnel in the fall of 1941 and the spring of 1942 (Parkhurst, loc. cit.) indicated the following numbers of diversion ditches: lower 23 miles above the mouth, 9; next 6.5 miles through Durkee Valley, 7; Durkee Valley to Clark Creek, 3; Bridgeport Valley, 7; and Hereford Valley, 11. No log or debris jams serious enough to obstruct the passage of fish were noted.

Impoundment and Hatchery Sites: Sites which may be suitable for the development of impoundments are numerous along the valley sections of the Burnt River and the North, Middle, and South Forks of this stream. No sites which appeared suited to hatchery use were noted, however.

Flow and Temperature Data: The discharge of the Burnt River is largely regulated by Unity Dam which reflects the storage requirements of Unity Reservoir during the storage season and the needs of irrigationists during the growing season. Also of important influence on the pattern of flow are irrigation withdrawals and the inflow of tributaries below the dam. From 1951 through 1957, the average maximum monthly discharge at the USGS gaging station just below the dam was approximately 345 c.f.s. and the average minimum monthly discharge was about 16 c.f.s. Maximum and minimum flows during this same period varied from no flow in November 1951 to 1,614 c.f.s. in April 1951. 2/ As has been indicated, unfavorably low flows which would be detrimental to the production of salmon exist periodically in the river below Unity Dam during the storage season. Flow records indicate that very low volumes of discharge have occurred below the dam

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1/ USGS Water Supply Papers 1317, 1217, 1247, 1287, 1347, 1397, 1447, 1517, Part 13, Snake River Basin.

2/ USGS Water Supply Papers, Part 13, Snake River Basin.

during 4 years of the 7-year period 1951-57 (Table 120). The duration of these low flows has varied from a few days to almost 2 months. In November 1951, no flow existed for 2 days and in March and April, 1955 a flow of less than 1 c.f.s. occurred almost continuously. It is not known how far below the dam these flow conditions exist. However, Table 121, which presents the flow records at 3 gaging stations on the Burnt River for 1957, indicates that under low discharge conditions at the dam, the flow volume usually undergoes a substantial increase by the time the 25 mile distance to Bridgeport is traversed. Apparently tributary discharge accounts for the majority of this flow increase.

Flow estimates made during the survey of the Burnt River in Hereford and Bridgeport valleys in December 1958 ranged from 45 to 70 c.f.s. Table 122 provides additional flow data in the form of instantaneous observations taken at 3 flow gaging stations in the past 4 years.

Water temperatures on the Burnt River range from freezing in the winter to very warm during the summer. One spot observation taken at Huntington, Oregon, by personnel of the USGS, indicates a water temperature of 81°F. on July 19, 1956 at 3:00 p.m. Water temperatures during the survey of the Burnt River in Hereford and Bridgeport valleys in December 1958 ranged from 32 to 36°F. Since the water temperatures recorded during the survey include only winter temperatures, a greater seasonal range has been attained by presenting spot temperature information obtained from the USGS (Table 122).

Tributaries: Aerial surveys were made on five of the tributaries of the Burnt River on June 13, 1959. The observed streams included the South, North, Middle, and West Forks and Camp Creek. A short time later in June, a spot check survey was made on Dixie Creek.

1. South Fork: The South Fork originates in the mountains south of Unity Reservoir at an altitude of more than 7,000 feet. The stream is about 15 miles in length, and was surveyed for a distance of 10 miles from Elk Creek to the mouth (Unity Reservoir). The watershed is timbered and appears to be in fair condition with the exception of one large burn in the upper reaches. In the observed section, the stream flows through a wide canyon which changes to a valley in the lower half. The gradient varies from moderate to sluggish. Although the accuracy of aerial observations are limited, there appeared to be a considerable amount of gravel throughout the surveyed section. Part of this gravel was silted. Parkhurst (loc. cit.), during a survey of the South Fork in the fall of 1941 noted that approximately 27 per cent of the 5-mile section of stream between the mouth and Whited Reservoir was suited to spawning and that a large amount of silt was present in the area. During this same survey, observation of a 7-mile section immediately above the reservoir disclosed much less silt and the presence of approximately 50 per cent suitable spawning area.

Barriers on the South Fork consist of the following: (1) the Whited Reservoir Dam (B-SF-3); (2) a combination falls and steep section of stream immediately below the dam (B-SF-2); and (3) a diversion dam located 1.5 miles above the mouth (B-SF-1). Whited Reservoir Dam is an earth-fill structure about 40 feet in height located 6 miles above the mouth of the South Fork. It has no fish passage facilities. From the air, the falls below the dam appeared impassable, but the degree of obstruction caused by the dam further downstream could not be determined. Because of the survey method, an accurate count of the number of diversion ditches (B-SF-4) was not obtained. In 1941, Parkhurst (loc. cit.) listed a total of 8 ditches below Whited Reservoir and 6 ditches above.

Table 120. Mean Monthly Discharge in Cubic Feet Per Second for the Burnt River Near Hereford, Oregon, 1951-57. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	55.1	38.3	47.2	27.9	38.3	145	392	153	105	81.6	104	73
1952	36.8	30.5	30.2	34.8	42.8	111	548	132	137	1,029	111	90.9
1953	61.7	25.8	28.7	32.9	39.1	93.1	230	268	326	124	122	95.1
1954	93	63.2	45.1	31.6	20.4	16.5	80.6	128	79.8	77.3	109	95
1955	68.3	33.5	24.1	26.3	11.5	1.4	0.2	87.3	114	63.9	92.7	12.7
1956	2.6	4	3.5	65.1	82.9	249	515	271	138	108	123	68.1
1957	33.4	22.4	16.2	10	7.6	116	394	251	130	134	108	53.6

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

Table 121. Mean Monthly Discharge in Cubic Feet Per Second for the Burnt River Near Hereford, Bridgeport, and Huntington, Oregon in 1957. 1/

Location	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Hereford	33.4	22.4	16.2	10.0	7.6	116	394	251	130	134	108	53.6
Bridgeport	52.6	42.1	40.5	39.8	148	205	498	307	139	95.3	66.3	55.4
Huntington	76.2	67.9	64.7	50.1	233	316	539	383	163	84.7	58.5	54.9

1/ Data obtained from USGS, La Grande, Oregon.

Table 122. Flow and Temperature Observations on the Burnt River, Obtained, Primarily, at Three USGS Flow Stations.

Date		Location Above Mouth-in Miles	Time	Temp. in °F. Air	Temp. in °F. Water	Est. Flow in c.f.s.
January						
1-29-57		73	5:00 p.m.	[illegible]0	33	6
1-28-58		73	11:00 a.m.	36	39	54
1-6-59		73	11:00 a.m.	31	39	30
1-28-58		50	1:00 p.m.	40	34	70
1-6-59		50	2:00 p.m.	38	33	46
1-31-58		3	10:00 a.m.	34	35	162
1-8-59		3	10:30 a.m.	39	33	91
February						
2-10-59		73	11:00 a.m.	32	35	3
2-5-57		50	3:00 p.m.	39	32	19
2-25-57		50	4:00 p.m.	40	36	876
2-11-58		50	1:30 p.m.	44	38	129
2-19-58		50	2:00 p.m.	51	40	235
2-10-59		50	1:00 p.m.	32	32	40
2-5-57		3	12:00 noon	34	32	40
2-26-57		3	12:00 noon	48	38	1,860
2-11-58		3	10:15 a.m.	38	37	214
2-19-58		3	11:00 a.m.	53	41	733
2-10-59		3	3:00 p.m.	35	35	63
March						
3-21-57		50	2:30 p.m.	41	40	251
3-11-58		50	3:00 p.m.	35	34	202
3-21-57		3	11:00 a.m.	48	41	339
3-11-58		3	10:15 a.m.	44	37	328
April						
4-8-58		73	12:00 noon	53	42	252
4-18-58		50	10:30 a.m.	49	46	646
4-18-58		3	2:10 p.m.	62	50	975
4-21-58		3	10:30 a.m.	56	51	1,200
May						
5-27-57		73	12:00 noon	66	60	213
5-17-57		50	3:00 p.m.	71	62	325
5-17-57		3	6:00 p.m.	72	63	387
June						
6-5-58		73	11:15 a.m.	71	62	169
6-5-58		50	2:00 p.m.	79	66	201
6-4-58		3	4:00 p.m.	77	69	333
6-19-59	1/	15	2:30 p.m.	—	79	90
July						
7-24-58		73	11:00 a.m.	87	77	117
7-19-56		50	12:00 noon	90	72	70
7-25-58		50	10:00 a.m.	83	67	106
7-19-56		3	3:00 p.m.	106	81	50
7-30-58		3	8:00 a.m.	78	70	90

Table 122. Flow and Temperature Observations (continued)

Date	Location Above Mouth-in Miles	Time	Temp. in °F. Air	Water	Est. Flow in c.f.s.
September					
9-8-40 2/	80	10:30 a.m.	--	64	---
9-26-57	73	12:35 p.m.	69	58	46
9-25-58	73	1:45 p.m.	58	48	46
9-12-56	50	3:50 p.m.	73	64	78
9-26-57	50	4:00 p.m.	72	60	48
9-11-58	50	2:00 p.m.	81	66	97
9-12-56	3	10:00 a.m.	79	63	70
9-27-57	3	2:00 p.m.	75	65	40
9-12-58	3	3:00 p.m.	72	63	103
October					
10-4-56	73	10:00 a.m.	50	55	41
10-22-58	73	12:00 noon	48	47	46
10-4-56	50	2:00 p.m.	77	57	49
10-22-58	50	2:00 p.m.	50	46	58
10-3-56	3	11:00 a.m.	75	57	63
10-21-58	3	2:00 p.m.	52	49	90
10-30-59 1/	2	11:15 a.m.	--	42	120
November					
11-14-56	73	2:00 p.m.	32	38	16.5
11-1-57	73	11:00 a.m.	50	45	11
11-3-57	73	12:23 p.m.	46	41	11
11-14-56	50	12:00 noon	31	37	38
11-1-57	50	1:00 p.m.	41	43	39
11-14-56	3	10:00 a.m.	35	38	77
December					
12-12-57	73	10:30 a.m.	30	38	28
12-20-56	50	2:30 p.m.	32	34	38
12-11-57	50	2:00 p.m.	32	33	50
12-3-58	50	1:00 p.m.	38	35	65
12-20-56	3	11:00 a.m.	35	33	74
12-11-57	3	10:30 a.m.	31	34	86
12-3-58	3	8:40 a.m.	41	38	106
12-12-58 1/	80	2:35 p.m.	38	36	70
12-12-58 1/	80	4:05 p.m.	36	38	40
12-12-58 1/	75	2:30 p.m.	38	36	65
12-18-58 1/	74	1:30 p.m.	35	36	45
12-18-58 1/	71	1:50 p.m.	36	36	55
12-22-58 1/	65	1:00 p.m.	41	35	60
12-22-58 1/	61	1:30 p.m.	43	35	---
12-23-58 1/	60	1:00 p.m.	35	32	50
12-23-58 1/	56	4:00 p.m.	31	32	---
12-23-58 1/	57	1:30 p.m.	35	32	50
12-23-58 1/	57	3:45 p.m.	32	32	50

1/ Observation made by OFC.

2/ Observation from survey made by W. M. Chapman in fall of 1940.

As indicated by flow records, the South Fork has the most favorable summer flow conditions of any of the Burnt River tributaries. Factors conducive to the maintenance of favorable flows are the high elevation of the watershed and the storage of runoff water in the 700 acre-foot capacity Whited Reservoir. Even with these advantages, the stream is reported to go dry due to irrigation withdrawals. Table 123 presents flow data for the South Fork.

Data obtained from the USFS regarding the sale of timber on Forest Service land, indicates that no timber sales are scheduled in the South Fork watershed by this agency through 1964.

2. North Fork: The **North Fork** enters Unity Reservoir about 2 miles above Unity Dam. This stream is about 20 miles in length, and was surveyed for 16 miles above the mouth to Geiser Creek. In the headwaters, the North Fork attains an altitude of about 6,000 feet, and the slopes are well forested with coniferous timber. Most of the stream course is through valley and wide canyon terrain. The stream gradient is moderate to sluggish and, in the valley, the slight gradient has resulted in a meandering stream channel (Figure 159). During the aerial survey the visibility of the stream bottom was poor due to turbid water conditions. However, some areas of possible value for spawning were noted. During a survey of the North Fork in the fall of 1941 (Parkhurst, loc. cit.) found the bottom materials to be mainly large rubble with only a small amount of suitable spawning area present.

Possible obstructions observed on the survey were 3 diversion dams and ditches (B-NF-1). Two of these ditches are located between Camp and Geiser Creeks and the third ditch is about 1 mile below Sheep Creek.

Table 123. Mean Monthly Discharge in Cubic Feet Per Second for the South Fork of the Burnt River 7 Miles Above the Mouth. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1916	---	---	---	---	---	---	54	50.7	51.1	30.3	21.5	16.8
1917	16.5	19.3	23	22.6	23	23	34	59.3	50	22.5	18	19.3
1918	22	22.1	23.3	22.7	24.1	29.2	32.4	30.6	19.2	16.1	15.3	12.1
1919	12	12.3	23	20.4	20	22.5	42.2	24.4	18.8	15.1	14	9.7
1920	---	---	---	---	---	---	16.8	19.4	15.5	11.6	---	---
1938	---	---	---	---	---	---	66.3	64.1	38.2	22	20.1	19.7
1939	20	20.1	20	19.8	20.3	25.2	30.1	30.3	21.3	17.9	17	17.1
1940	18.9	18.4	19.0	18.0	17.0	23.7	35.5	34.9	20.7	16.5	15.5	18.3
1941	23.5	24.0	25.9	---	---	---	---	---	---	---	---	---

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

As indicated by flow records, the North Fork is characteristically a stream of low summer flows (Table 124). On June 13, 1959, during the aerial survey, the discharge appeared to be somewhere in an intermediate range between moderate and low flows. During an earlier survey by USFWS personnel on September 28, 1941 (Parkhurst, loc. cit.) the stream was discharging less than 1 c.f.s. near the mouth.

Information obtained from the U. S. Forest Service indicates intensity of anticipated logging on the North Fork in the near future. Based on timber sale schedules, logging will occur over 20 square miles of the watershed from 1959 through 1964. The sale areas are located between China Creek and Whitney.

3. Middle and West Forks: The Middle and West Forks arise 7 or 8 miles west of Unity Reservoir at altitudes of 4,500 to 5,000 feet. The entire lengths of these short streams were observed. Near their sources, both forks flow through shallow canyons which emerge into small valleys adjacent to the reservoir. Like the North Fork, these streams typically have low summer flows. Table 125 presents incomplete flow data for 2 years for the Middle Fork. Since the drainage area and location of the West Fork is similar to that of the Middle Fork, the flow pattern of this stream is believed to be comparable. As indicated by the timber sales schedule of the USFS, sales were transacted in 1958 which involved some 20 square miles of area in the Middle and West Fork drainages.

4. Camp Creek: Camp Creek enters the Burnt River about 5 miles below Unity Reservoir. It originates at a similar altitude and location as the South Fork, but lacks the drainage potential of the larger stream. Camp Creek was surveyed over a distance of 7 miles from the mouth to the confluence of the East and West Forks. The stream flows through a canyon in the upper 4 miles of the observed area and a valley in the lower 3 miles. The slope cover is sagebrush and grass. Higgins Reservoir is located about 3 miles above the mouth of Camp Creek; the dam which forms this body of water is impassable to upstream migrants. Higgins Reservoir is a small impoundment estimated to be about 0.2 mile in width by 0.4 mile in length. As indicated by aerial observation, the streambed above Higgins Reservoir has only a small percentage of gravel. The stream bottom below the reservoir is comprised largely of mud. No flow or temperature records have been obtained for Camp Creek. USFS timber sale schedules for the next 5 years, indicate that timber will be sold on East and West Camp Creeks through 1962. Approximately 15 to 20 square miles of area will be involved.

5. Dixie Creek: Dixie Creek enters the Burnt River about 15 miles above the mouth (Figure 155). It arises at an altitude of less than 5,000 feet. A spot check survey was made on the lower 7 miles of Dixie Creek to the confluence of the North and South Forks on June 19, 1959. In the observed area, the stream flows through a medium canyon which widens to form Rye Valley at the upper end. The dominant vegetation on the canyon slopes is sagebrush and grass. The bottom materials were not assessed, but in the sections where spot checks were made some gravel was noted. The water temperature and flow appeared generally unfavorable to the production of anadromous salmonids. At the mouth, a water temperature of 83°F. was obtained at 2:45 p.m. The flow was estimated to be 2 to 3 c.f.s. Another observation made 5 miles above the mouth at 3:05 p.m., indicated a water temperature of 86°F. and a flow of 2 c.f.s. A further check at a point midway between the above two areas of observation showed that the flow had increased to 3 or 4 c.f.s. and the water temperature had decreased to 72°F. at 2:55 p.m. No obstructions were noted on Dixie Creek, however, the presence of irrigation ditches in the valley would indicate that diversion dams may be used.

Table 124. Mean Monthly Discharge in Cubic Feet Per Second for the North Fork of the Burnt River 3 Miles Above the Mouth. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1915	---	---	---	---	---	87.3	89.8	55.0	12.8	4.3	1.2	2.2
1916	5.8	9.4	---	---	---	---	410	260	55.3	7.3	2.8	1.7
1917	4.3	5.4	---	---	---	---	---	---	---	---	---	---

1/ Data obtained from the USGS Water Supply Papers, Part 13, Snake River Basin.

Table 125. Mean Monthly Discharge in Cubic Feet Per Second for the Middle Fork of the Burnt River 4.5 Miles Above the Mouth. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1915	---	---	---	---	---	1.3	2.6	1.7	0.8	0.5	0.4	0.4
1916	---	---	---	---	---	---	32.1	16.6	4.2	1.3	.5	---

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

Anadromous Fish Populations

Only very general information has been obtained regarding the past and present status of anadromous salmonids in the Burnt River system. Chapman 1/ in reporting on a survey of the Burnt River in the fall of 1940, indicates that the newly constructed but unladdered Unity Dam was at that time causing the depletion of the chinook and steelhead runs by blocking them from their spawning areas. He also indicated that a substantial number of anadromous fish died at the dam in the spring of 1940 and that local people were critical of this occurrence. Stout (1957) points out that sizable runs of salmon and steelhead were reported by early settlers on the Burnt River but that these runs are now practically depleted with no recent indication of fish in sufficient numbers to perpetuate a run. He further signifies that gold dredging, which occurred prior to World War I, was an important factor in causing this depletion. Parkhurst (loc. cit.) states that low flows resulting from excessive irrigation demands prior to the construction of Unity Dam were a cause in the depletion of chinook runs of the Burnt River.

1/ Unpublished report by W. M. Chapman, Biologist Washington Department of Fisheries, entitled "Report of a Field Trip to the Snake River Drainage in Idaho and Eastern Oregon, 1940".

As regards the location of former spawning areas, Chapman (loc. cit.) states that the major spawning areas for chinook were on the North and South Forks. Parkhurst (loc. cit.) indicates that considerable spawning area is present on the South Fork but that no potential exists on the North Fork. No information in respect to the utilization of the upper main stem for spawning has been obtained. The only further information concerning anadromous salmonids in the Burnt River basin consists of unsubstantiated statements made by people of the Burnt River area. These statements include the reported capture of a steelhead in Dixie Creek some 10 years ago, various reports of chinook spawning in the upper Burnt River, and a report of the presence of steelhead in the upper river. In the fall of 1954, OFC personnel investigated reported sightings of chinook salmon on the upper Burnt River. Two cursory surveys were made, neither of which indicated the presence of salmon.

Discussion and Recommendations

Additional study will be needed to determine the feasibility of restoring runs of anadromous salmonids in the Burnt River system. Even as shown by the superficial investigation made on this drainage, the problems involved in a fish restoration program are numerous and complex. One question which immediately comes to mind is the degree to which the location of the stream above the present and anticipated major dams on the Snake River will complicate the rehabilitation of the fish runs. As yet, however, the ultimate significance of this problem remains to be determined.

If rehabilitation of the former fisheries resource of the Burnt River is considered, two basic plans for development could be pursued. These are: (1) reinstatement of the former, major spawning areas (South and North Forks) to production; and/or (2) establishment of runs of fish on the main stem below Unity Dam.

In considering Plan 1, of initial concern is the present isolation of former spawning areas by the 76-foot-high Unity Dam. To make the forks accessible to anadromous fish, the construction of a fishway at Unity Dam (B-2) would be necessary. Possibly complicating the design of a fishway for this barrier would be the fluctuating water level of Unity Reservoir, which averages about 30 feet of drawdown annually. Provided that fish passage at Unity Dam was attained, the amount of spawning area which would then become accessible would depend on the laddering of Whited Dam (B-SF-3) and possibly the falls (B-SF-2) on the South Fork. This dam is 40 feet in height and is located approximately in the center of a 12-mile reach of spawning area. Also, immediately below this dam, there is a falls (B-SF-2) which would require modification if it is to be made passable to upstream migrants. (Obstructions created by falls and dam could possibly be overcome with one fishway). A further consideration is the necessity of having to screen irrigation ditches. Parkhurst (loc. cit.) found a total of 14 ditches (B-SF-4) on the South Fork in 1941 and 37 ditches (B-1) on the main stem. Irrigation ditches (B-NF-1) are also known to be present on the North Fork.

As indicated by a survey made by the USFWS previously and aerial observations made under the current survey program, the spawning area above Unity Dam may be of important quantity. Considerable area was observed from the air which appeared to be suitable for spawning and the majority of this area was on the South Fork. In 1941, the USFWS estimated that the South Fork had 18,000 square yards of suitable spawning area below Whited Reservoir and 46,000 square yards of suitable spawning area above this body of water (Parkhurst, loc. cit.). No estimate of the extent of spawning area on the North Fork is available, but it is believed to have a substantially lesser amount than the South Fork.

Low flows which occur during the period of residence of spring chinook may reduce the production area of both forks for this type of fish, but may not be detrimental to the production of a later spawning species such as silver salmon. On the North Fork, low flows are known to occur during the summer and early fall in at least the lower 5 miles of the stream. On the South Fork, flow conditions are better, but even this stream is reported to go dry in the lower reaches during the irrigation season. Water temperature records have not been obtained on either stream, however, the low flows and warm air temperatures which prevail in the Unity Valley area during the summer are conducive to warm water conditions. The occurrence of warm water temperatures during the summer may reduce the value of the lower reaches of the streams to spring chinook, but would not necessarily detract from their value to silver salmon.

Of possible benefit to the production of salmon above Unity Dam is the rearing habitat available in Unity and Whited Reservoirs. The value of these areas for the rearing of salmon can only be determined by investigation. At the present time, Unity Reservoir is stocked periodically with rainbow trout by the OGC. Trout production in this fluctuating reservoir appears to be satisfactory except when populations of coarse fish become excessive. In the past, the reservoir and tributary streams have been treated with rotenone to control coarse fish populations.

Plan 2 for the restoration of anadromous runs in the Burnt River involves the development of salmon production in the stream below Unity Dam. Probably the most promising section of this part of the stream for development is the area between Unity Dam and Durkee Valley. It is not known if this area formerly supported runs of anadromous fish, but assuming that it did, it is doubtful that it has been productive for many years due to the influences of detrimental irrigation practices prior to the construction of Unity Dam.

With one exception, the absence of major barriers, problems associated with the establishment of salmon runs below the dam are similar to those encountered above this structure. Of primary concern is the influence of periodic low flows on the productivity of the area. As has been previously pointed out, the discharge at Unity Dam has been almost completely shut off during past winter storage seasons, and low flows have prevailed for as long as 2 months. Since the occurrence of low flows has usually corresponded with the incubation period of salmon eggs, such a condition could be disastrous if existent over a large section of stream where spawning had occurred. The extent of the low flow area below the dam is unknown. Flow records obtained at Bridgeport, located about 25 miles below Unity Dam, indicate a good recovery of flows at this point during periods of little or no discharge at the dam. However, since about one-half of the area considered for development on the main stem is located between the dam and Bridgeport, more specific information on the extent of the low flow area is needed.

Other factors which should be considered from the standpoint of influence on the production of salmon on the upper Burnt River are the existing conditions of siltation and warm water temperatures. Much of the gravel is silted in the Hereford and Bridgeport valleys. Probably the principal causes of siltation in this area are erosion of the stream banks and lack of sufficient stream gradient to flush out silt. The effect of silting on the incubational environment of the area can only be determined by further study involving such techniques as experimental plants of eggs or investigation of subsurface flows. Because of a steeper stream gradient, the stream section from lower Bridgeport Valley to Durkee Valley does not appear to have a siltation problem.

Due to the presence of hot summer weather throughout much of the Burnt River region, water temperatures on the upper reaches of the stream are often unfavorably warm. Since the highest water temperatures occur during the period of residence of adult spring chinook, it appears doubtful that conditions are suitable for the production of this species. As indicated in Table 122, summer water temperatures in excess of 75°F. can be expected in Hereford Valley even though flows are favorable. A species of fish which may be more adaptable than spring chinook to the thermal environment of the upper Burnt River would be silver salmon. Since the water temperatures in this area decrease in September, adult silver salmon would arrive and spawn under favorable temperature conditions. Also, of importance would be the tolerance of warm temperatures demonstrated by the juveniles of this species (Brett, 1952).

MALHEUR RIVER SYSTEM

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INTRODUCTION

The Malheur River enters the Snake River approximately 360 miles above the mouth near Ontario, Oregon. This stream system drains the plateaus and associated mountain formations of the northern sector of Southeastern Oregon, and comprises a drainage area which exceeds 4,500 square miles. On the north, the basin is bordered by the Burnt River and to the south by the Owyhee River. The major tributaries of the Malheur River consist of the North and South Forks and Bully and Willow Creeks (Figure 160). Superficial surveys in the nature of spot checks were conducted on the two forks and the main stem.

The populations of anadromous fish which at one time utilized the Malheur Drainage may now be entirely depleted. This is almost assuredly true as regards former runs of chinook salmon and is quite probably the case with runs of steelhead trout. Within the system, irrigation development consisting of storage and diversion dams has made the principal spawning areas inaccessible, while unfavorable stream conditions such as low flows, excessive temperatures, unscreened irrigation ditches, and siltation are considered to have rendered the accessible areas generally unsuitable for the production of salmon and steelhead. The following excerpt from a USFWS report (1949) on the Vale irrigation project is given:

> "Before construction of Warm Springs Reservoir, the Malheur River supported large spring chinook salmon runs, and all of the streams in the watershed were well populated with native trout. It is not definitely known, but it seems likely that anadromous steelhead trout and, possibly silver salmon, also occurred in the Malheur River. The streams were largely inaccessible to the fishing public in this period, but local ranchers and sheepherders caught large numbers of salmon and trout in the Malheur River watershed. Between the time when Warm Springs Reservoir was constructed and the construction of Agency Valley Reservoir, the salmon run to the North Fork disappeared, probably resulting in a large measure from private irrigation practices in the lower Malheur River valley."

The climate of the Malheur Region is semi-arid with a somewhat greater precipitation in the higher elevations. Typically, the topography consists of rolling hills, covered with sagebrush and forage grasses, and mountainous areas in which pines and junipers combine with these plant types.

The principal means of livelihood in the Malheur area are agriculture and forestry. In conjunction with crop production and livestock raising, irrigation is practiced extensively in the valleys of the main stem and the larger tributaries. Two major irrigation developments provide water to more than 74,000 acres of arable land in the primary basin. These consist of the Vale project, which has storage facilities at the 191,000 acre-foot Warm Springs Reservoir on the main stem and at the 60,000 acre-foot Agency Valley Reservoir on the North Fork, and the Warm Springs irrigation district, which possesses one-half of the storage rights at Warm Springs Reservoir (Bureau of Reclamation, 1947). Additional major irrigation development exists on a tributary stream, Willow Creek, on which the 49,000 acre-foot Willow Creek Reservoir was constructed near Malheur City in 1911.

THE MALHEUR RIVER

The main stem of the Malheur River is formed by the juncture of Lake and Big Creeks, two small headwater tributaries, in the Strawberry Mountains approximately

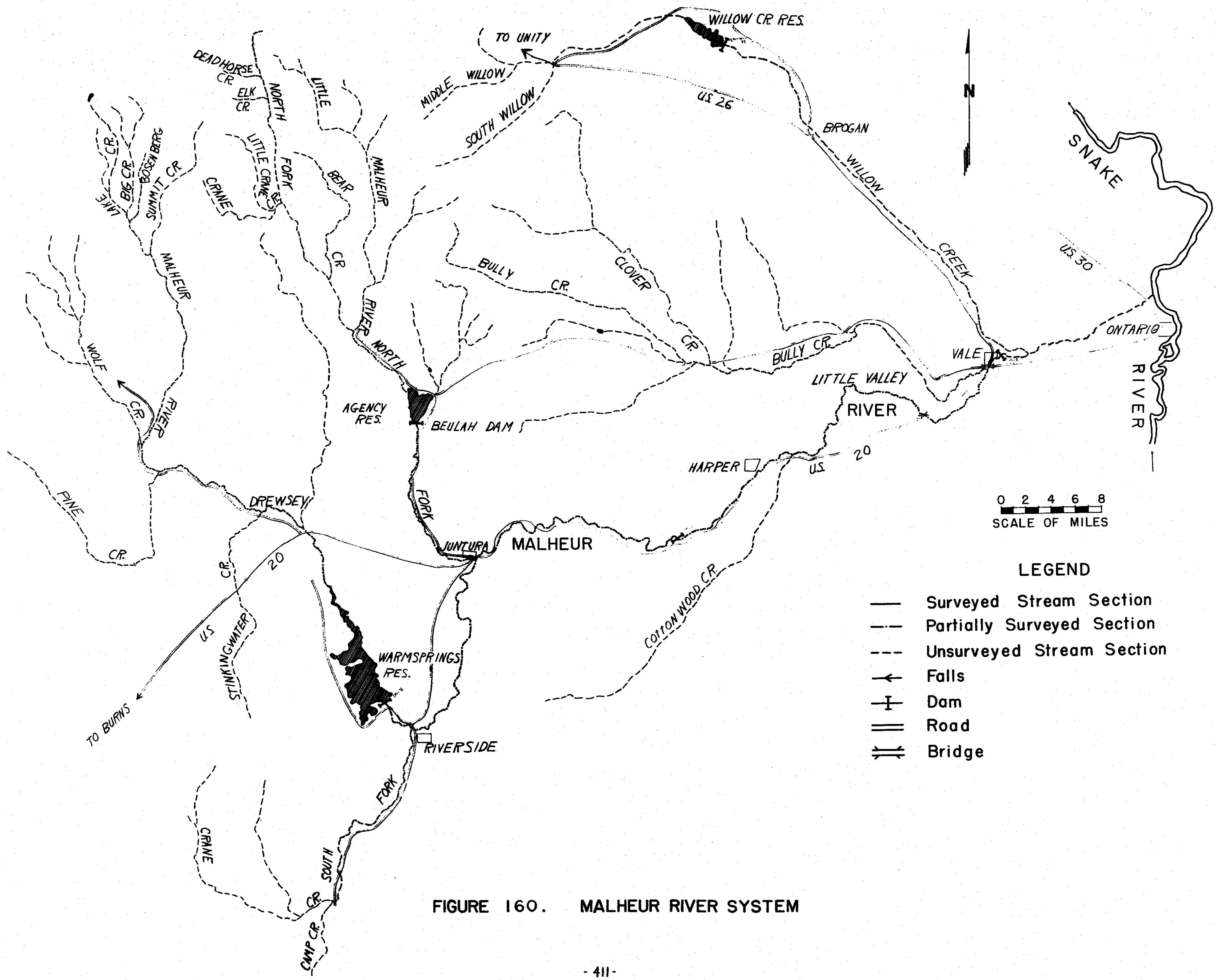

FIGURE 160. MALHEUR RIVER SYSTEM

160 miles above the mouth. At points about 13, 16, 77, and 96 miles, respectively, above the mouth, the major tributaries of Willow Creek, Bully Creek, North Fork, and South Fork join the main river. Warm Springs Reservoir, which is formed by an impassable concrete arch dam 90 feet in height, extends from approximately 100 to 110 miles above the stream mouth. Centers of population consist of Ontario and Vale, Oregon, located along the lower reaches of the basin, and the small communities of Harper, Juntura, Riverside, and Drewsey, situated at intervals of 20 or 30 miles along the central portion of the stream.

A survey which consisted primarily of observations from a vehicle was conducted on the main Malheur River on December 3, 4, and 5, 1957, from Vale, located about 16 miles above the mouth, to Wolf Creek, located about 135 miles above the mouth. Overall, it is estimated that 20 per cent of the stream was observed to a degree which permits discussion of the environment as related to the production of salmon and steelhead. The most extensive observations were made in the following areas: (1) 10 miles above Vale to Juntura (55 miles); (2) Riverside to Warm Springs Reservoir (3.5 miles); and (3) Drewsey to approximately 2 miles above the mouth of Wolf Creek (15 miles).

Within the surveyed area and below this section to the mouth, the Malheur River basin is composed of about two-thirds canyon and one-third valley terrain. Proceeding downstream from the upper terminus of the survey (about 2 miles above the mouth of Wolf Creek) the river passes successively through Drewsey Valley, Juntura Valley, Harper Valley, Little Valley, and Vale Valley. The largest of these valley formations is Vale Valley which extends from the mouth upstream for more than 30 miles. All of the valley lands are either under cultivation or used for the pasturing of livestock.

Along much of the surveyed portion of the stream, the slope cover is composed of sagebrush and grass, and bank vegetation is sparse. There are, however, some sections where willow growth provides stream bank protection, especially in the area above Drewsey. In the vicinity of Wolf Creek, conifers appear on the slopes and the terrain becomes more mountainous in nature.

Due to the method of survey, a detailed assessment of the stream was not possible; however, general impressions are presented. In much of the observed area, conditions are conducive to high stream temperatures during the summer. From Vale to Juntura, a distance of approximately 60 miles, the stream was mostly wide and shallow during the observed stage of winter flow. Shading was poor, but partially offsetting this influence on stream temperature is the prevalence of favorable summer flows resulting from irrigation releases from Warm Springs and Agency Valley Reservoirs (Table 126). Considerable gravel was observed in riffle areas, particularly from Harper to Juntura. Below this section, siltation and larger bottom materials were more pronounced. Just above Little Valley, a large concrete diversion dam (Harper Dam, M-4) was noted. This dam is about 17 feet high and has a fishway which was completely dewatered at the observed stage of flow. At approximately 75 yards above the dam, the large capacity Vale-Oregon ditch diverges from the stream.

A summation of a survey of the Malheur River below Juntura by personnel of the USFWS in July 1942 (Parkhurst, 1950-c) is as follows: (1) the gradient was classified as slight in the valley areas and moderate in the canyons; (2) bottom materials were estimated to be one-half silt and one-half small to medium rubble covered with a heavy silt layer; (3) stream bank shade was generally lacking; (4) water temperatures ranged from 69°F. near Juntura to 71°F. between Harper and the river mouth; (5) flows were favorable at the time of the survey; (6) eight

Table 126. Mean Monthly Discharge in Cubic Feet Per Second for the Malheur River at Three Locations, 1951-57. 1/

Year	Location	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	Drewsey 2/	36	68	126	96	520	411	858	272	66	4	2	3
	Riverside 2/	17	1	1	1	1	1	239	381	332	452	428	339
	Little Valley 2/	30	31	58	84	705	286	196	171	192	218	137	87
1952	Drewsey	50	65	109	64	162	861	2,290	680	164	40	11	20
	Riverside	10	0	0	0	0	0	809	611	384	464	427	296
	Little Valley	42	41	48	48	198	858	1,924	678	212	214	192	122
1953	Drewsey	24	45	65	445	322	292	703	530	436	64	22	12
	Riverside	138	2	2	3	3	4	281	600	558	627	509	318
	Little Valley	60	44	44	158	112	59	167	563	767	297	222	157
1954	Drewsey	33	71	92	118	219	259	415	183	109	17	6	9
	Riverside	54	2	2	2	2	2	374	589	355	523	420	339
	Little Valley	51	50	50	59	80	48	161	217	131	250	147	96
1955	Drewsey	35	62	54	50	60	89	209	275	85	25	7	5
	Riverside	52	0	0	0	0	0	0	344	383	296	68	1
	Little Valley	45	50	42	44	42	49	32	143	135	125	41	21
1956	Drewsey	32	61	247	281	223	860	1,033	528	141	21	13	10
	Riverside	2	0	0	0	0	1	124	284	365	589	434	242
	Little Valley	18	39	81	284	252	327	230	261	195	283	191	126
1957	Drewsey	56	82	89	55	846	664	777	523	137	13	5	7
	Riverside	33	0	0	0	1	142	823	559	534	521	396	302
	Little Valley	75	72	58	39	887	809	1,158	795	276	276	186	130

1/ Data obtained from USGS Water Supply Papers 1217, 1247, 1287, 1347, 1397, 1447, and 1517, Part 13, Snake River Basin. Flows recorded to the nearest cubic foot per second.

2/ Approximate distances of flow gaging stations above the mouth of the Malheur River are: Drewsey 118 miles; Riverside 100 miles; and Little Valley 29 miles.

large and two small diversion ditches were encountered; and (7) two permanent dams were noted, one a low water barrier located 1 mile below Vale 1/ and the other a 17-foot high, total barrier located 11 miles above the town of Harper. 2/

From Juntura to the vicinity of Drewsey, about 40 miles, the river passes through a remote canyon where observations of the stream were very limited. However, the stream was observable for approximately 4 miles above the mouth of the South Fork, and this section appeared similar to that noted near Juntura with exception of the presence of canyon terrain instead of valley. As indicated by the flow records presented in Table 126, the stream flow between Warm Springs Reservoir and the South Fork (approximately 4 miles) becomes extremely low during the winter storage season. The flow is increased below the South Fork, but during some winter months the discharge contribution of this stream may be quite small. Included in the observations conducted on the central reaches of the Malheur River was an inspection of Riverside Dam (M-7). This 90-foot barrier was constructed in 1919 by the Warm Springs Irrigation District and, as previously stated, has no provision for the passage of fish. The Warm Springs Reservoir, which extends above the dam for 10 miles, is subject to great seasonal and annual fluctuation. The mud banks of this body of water sustain no apparent vegetative growth.

A summary of the USFWS survey in July 1942, from Juntura to Warm Springs Reservoir, is as follows: (1) the gradient was classified as moderate; (2) numerous suitable spawning riffles were reported; and (3) a scarcity of pools and bank cover was indicated.

From Drewsey to approximately 2 miles above the mouth of Wolf Creek the stream was generally in close proximity to the road and was observable to a greater degree than from Drewsey to Juntura. Most of this section consists of valley land of slight to moderate gradient with a somewhat steeper gradient above the mouth of Wolf Creek. As indicated by observations made from the road some limited spawning area is present. Flow records obtained near Drewsey suggest the prevalence of low summer flows in this section of stream due to irrigation (Table 126). Table 127 gives the flows below Nevada Dam for the period 1945-50.

Although observations on the main stem of the Malheur River were terminated about 2 miles above the mouth of Wolf Creek, information concerning the stream above this point has been obtained from the OGC and is presented in Table 128. These data indicate that a considerable amount of potential spawning area for salmon is present on the upper river and its tributaries.

North Fork of the Malheur River

The North Fork originates in the Strawberry Mountains north of Juntura and joins the Malheur River one mile below this city (Figure 160). In the uppermost reaches the watershed attains an altitude of about 7,000 feet above sea level. The higher slopes are forested, but above the confluence of the Little Malheur River sagebrush and grass become the dominant slope cover. The stream is about 50 miles in length and has a drainage area of approximately 530 square miles.

The lower 25 miles of the North Fork, to the mouth of the Little Malheur River, was surveyed on December 3 and 4, 1957. The survey was conducted by observing the stream while driving, and it is estimated that about 20 per cent of the streambed was readily visible by this method. The Little Malheur River and Bendire Creek, the two principal tributaries of this section of the North Fork, were not surveyed.

1/ Nevada Dam (M-3), which is still in existence at the time of writing of this report.

2/ Harper Dam (M-4).

Table 127. Mean Monthly Discharge in Cubic Feet Per Second for the Malheur River Below Nevada Dam Near Vale, 1945-50. 1/

Water Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1945	56	127	107	224	774	386	386	163	98	30	41	70
1946	85	124	308	189	318	1,043	607	133	56	42	18	58
1947	118	128	122	92	455	99	11	24	59	24	3	49
1948	94	88	106	117	96	37	3	3	56	15	8	17
1949	76	111	96	48	704	319	80	91	21	8	4	10
1950	71	96	104	90	406	421	112	15	61	9	8	5

1/ Data extracted from USGS Water Supply Paper 1317, Part 13, Snake River Basin. Flow gaging station located 1 mile northeast of Vale. Flow volumes recorded to nearest c.f.s.

Table 128. A List of Potential Spawning Areas for Salmon on the Upper Malheur River (Middle Fork) and its Tributaries. 1/

Stream	Section	Remarks
Malheur R. (Mid. Fork)	Mouth of Wolf Cr. to mouth of Big Cr. (23 miles).	Gravel abundant (believed to comprise at least 30 per cent of bottom deposits), max. temperatures of surface water approach 70°F. in July and August and may reach 72°F. during extremely hot summers.
Big Cr.	Mouth to Strawberry Mountain Wild Area (6 miles)	Gravel present in moderate amount (believed to comprise between 10 and 30 per cent of bottom deposits), good year around flows, max. surface temperatures to approximately 60°F. during summer.
Lake Cr.	Mouth to Strawberry Mountain Wild Area (6 miles).	Moderate quantity of gravel present (believed to comprise between 10 and 30 per cent of bottom deposits), favorable summer flow, max. water temperatures to 72°F. in July and August.
Bosenberg Cr.	Mouth to Logan Valley road crossing (3 mi.)	Slight amount of gravel present (believed to be less than 10 per cent), summer flow of low volume, stream temperatures to 70°F. in hot summers.
Summit and Wolf Cr.		Inadequate summer flows, believed of little potential value to anadromous fish.

1/ Data furnished by Mr. Lawrence Bisbee, OGC.

As previously stated, data relative to the North Fork drainage indicate the depletion of runs of chinook salmon on this stream during the time period which separated the construction of the Warm Springs and Agency Valley Reservoirs (1919 to 1935). Irrigation practices on the lower Malheur River are considered largely responsible for the disappearance of this run. Reports from individuals familiar with the North Fork suggest the presence of adult salmon in the vicinity of Crane Creek during several summers prior to the construction of Agency Valley Reservoir. Information obtained from the OGC has verified the existence of a considerable amount of gravel suitable for the reproduction of salmon on the upper North Fork and tributaries.

Proceeding at the mouth of the Little Malheur River and continuing downstream, the North Fork is in a canyon for the first 5 or 6 miles below which it emerges into the basin containing the Agency Valley Reservoir. Within the canyon the gradient varies from steep to moderate and, in observed sections, the bottom materials consists generally of rubble and boulders. Immediately above the reservoir, the gradient is moderate for a distance of one mile. In this area, and in a few places where the canyon floor widens, the land is in pasture or other crops, and water is withdrawn for the irrigation of about 900 acres. 1/ The flow in this section of the North Fork is generally favorable even during late summer (Table 129). The quality of the streambed shading is poor.

In the 16-mile length of stream from Agency Valley Reservoir to the mouth, the North Fork passes through two approximately equidistant valley sections which are separated by a short canyon. In this area, the gradient is generally slight to moderate. Observations of bottom materials were extremely limited on this part of the stream, however, silted gravel was noted at two check points, one near the mouth and the other in the upper valley. According to flow records, the discharge of this part of the North Fork becomes extremely low during the fall and winter storage season at Agency Valley Reservoir (Table 129). During the survey, the discharge below Beulah Dam was estimated to be less than 5 c.f.s. Lands adjoining the lower North Fork are used primarily for the pasturing of livestock.

A summary of a survey of the North Fork below Agency Valley Reservoir by the USFWS in July 1942 (Parkhurst, 1950-c) is as follows: (1) the gradient was classified as slight in the lower valley, steep in the canyon, and moderate in the upper valley; (2) the streambed gravel was to a large degree silted and was considered to be of no value to anadromous fish; (3) 2 unscreened diversions of 10 and 15 c.f.s. were noted in the centrally-located canyon area; (4) the flow at the stream mouth was estimated to be 285 c.f.s.; and (5) water temperatures of 67 and 65°F. were recorded, the higher one being in the canyon area and the other just below Beulah Dam.

Information regarding the North Fork and tributaries above the upper boundary of the survey has been obtained from the OGC. These data are summarized in Table 130 and suggest that the production potential for salmon on the upper reaches of the stream may be considerable.

<u>South Fork of the Malheur River</u>

The South Fork joins the Malheur River approximately 96 miles above the mouth. The stream originates in the semi-arid plateau south of Warm Springs Reservoir at the juncture of the 2 major tributaries, Camp and Crane Creeks,

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1/ USGS Water Supply Papers, Part 13, Snake River Basin.

Table 129. Mean Monthly Discharge in Cubic Feet Per Second for the North Fork of the Malheur River at Two Locations, 1951-57. 1/

Year	Location	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	Above Beulah 2/	60	54	63	56	123	139	435	228	95	49	39	41
	At Beulah 2/	26	0	0	0	0	0	156	234	352	298	203	158
1952	Above	56	56	57	58	81	275	906	478	192	72	48	46
	At	23	0	1	0	0	2	789	515	335	326	343	244
1953	Above	47	43	54	164	138	174	385	357	388	104	58	53
	At	58	0	0	0	0	1	203	392	482	329	303	322
1954	Above	63	66	58	74	107	129	284	227	118	58	47	51
	At	134	0	0	0	0	1	146	216	172	326	233	136
1955	Above	51	50	45	48	53	60	111	207	127	57	39	44
	At	43	0	0	0	0	0	23	224	244	266	236	237
1956	Above	45	57	105	90	98	332	503	354	146	65	45	50
	At	10	0	0	1	1	19	393	380	310	290	257	201
1957	Above	59	60	62	51	266	224	328	353	154	47	42	39
	At	45	0	0	0	1	48	342	378	309	332	342	176

1/ Data obtained from USGS Water Supply Papers 1217, 1247, 1287, 1347, 1397, 1447, and 1517, Part 13, Snake River Basin. Flows recorded to nearest cubic foot per second.

2/ Approximate locations of flow gaging stations are: above Beulah, 4 miles above Beulah Dam or 20 miles above the stream mouth; and at Beulah, just below the dam or 16 miles above the stream mouth.

Table 130. A List of Potential Spawning Areas for Salmon on the North Fork of the Malheur River and its Tributaries. 1/

Stream	Section	Remarks
North Fork	Mouth of Little Malheur River to Deadhorse Creek (25 miles).	Abundant gravel (believed to constitute at least 30 per cent of bottom deposits), very good year around flow, max. stream temp. in the vicinity of Crane Creek typically 65 to 70°F., max. temp. may attain 72°F. during extremely hot weather.
Little Malheur River	Mouth upstream approximately to source (22 miles).	Abundant gravel (believed to be at least 30 per cent), max. stream temp. in summer vary from 60 to 70°F. depending on weather.
Crane Creek	Mouth to Crane Prairie Guard Station (5 miles).	Small amount of gravel (believed to be less than 10 per cent), fairly favorable flow and temperatures.
Little Crane Creek	Mouth to first road crossing (4 miles).	Small amount of gravel (believed to be less than 10 per cent), fairly favorable flow and temperatures.
Elk Creek	Mouth upstream one mile.	Small amount of gravel (believed to be under 10 per cent), fairly favorable flow and temperatures.
Small tributaries of North Fork above Elk Creek	----------	Unsuitable for salmon spawning.
Bear Creek	----------	Inadequate summer flow for salmon.

1/ Data furnished by Mr. Lawrence Bisbee, OGC.

and flows about 20 miles to combine with the main river. The drainage comprises approximately 630 square miles of primarily sagebrush and grass land. The flow volume is subject to wide seasonal fluctuation with partial regulation by small, tributary reservoirs having a collective capacity of approximately 7,000 acre-feet. According to records of the USGS, irrigation is practiced extensively in the basin, and the discharge becomes critically low (M-SF-1) near the mouth during the summer (Table 131).

Observations on the South Fork were very general and consisted of ascending the stream by vehicle approximately 8 miles and noting the stream from the road, where possible. At the time of the survey on December 4, 1957, the flow in the surveyed area was an estimated 15 c.f.s. At observable points, the gradient was moderate. Shading was almost completely absent and in places the banks were

Table 131. Mean Monthly Discharge in Cubic Feet Per Second for the South Fork of the Malheur River Near the Mouth, During Portions of Some Years. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1927	---	---	---	---	---	111	65	10	15	4	4	4
1928	9	12	8	---	---	---	47	9	5	4	7	9
1929	10	15	---	---	---	---	---	7	3	4	4	---
1938	---	---	---	---	---	---	---	---	3	5	4	5

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

badly eroded. During a survey of the South Fork by the USFWS in July 1942 (Parkhurst, 1950-c), the water temperature near the mouth was 86°F., and the flow was 3 c.f.s. In the report of that survey, it is stated that the South Fork would have a considerable amount of spawning area if suitable conditions of flow could be maintained. No information has been obtained regarding the former utilization of the South Fork by anadromous fish.

Bully and Willow Creeks

Inventory surveys were not conducted on either of these streams. Bully Creek enters the Malheur River 16 miles above the mouth near Vale. The stream has a drainage area in excess of 600 square miles, and is approximately 30 miles in length. The discharge of Bully Creek is used extensively for irrigation (Table 132). When surveyed by the USFWS on July 19, 1942 (Parkhurst, 1950-c), some gravel was noted; however, the streambed was heavily silted from irrigation returns and was considered to be of poor quality for salmonid reproduction. On the same survey, the gradient was classified as slight to moderate, and a water temperature of 67°F. was recorded. The stream is reported to be a leading contributor to occasional flooding of the main Malheur River in Vale Valley. No information was obtained concerning former runs of anadromous fish into Bully Creek.

Willow Creek combines with the Malheur River 13 miles above the mouth just below Vale. This stream drains the slopes of 7,000-foot-high Ironside Mountain, and arises adjacent to Camp Creek of the Burnt River system. The drainage area is similar in size to that of Bully Creek with the main stream extending approximately 55 miles above the lower terminus of the basin. The 49,000 acre-foot capacity Willow Creek Reservoir is located about 40 miles above the stream mouth. The capacity of this reservoir exceeds the flow of Willow Creek for any except abnormally high years of runoff. 1/ The dam (M-W-3) which forms the impoundment is impassable to upstream migrants and exceeds 100 feet in height. Since the flow of Willow Creek is subject to regulation by the reservoir, the natural

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

Table 132. Mean Monthly Discharge in Cubic Feet Per Second for Bully Creek, Approximately 5 Miles Above the Mouth, 1951-57. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1951	14	8	11	11	188	56	39	17	18	15	15	17
1952	15	9	9	10	32	301	426	37	39	30	38	32
1953	17	15	14	154	103	71	68	74	207	23	20	22
1954	19	11	15	41	53	12	16	14	20	16	15	14
1955	14	8	6	7	7	5	5	8	7	7	6	3
1956	2	3	43	55	71	235	26	17	20	17	19	24
1957	29	29	19	17	374	297	88	64	33	19	25	21

1/ Data obtained from USGS Water Supply Papers 1217, 1247, 1287, 1347, 1397, 1447, 1517, Part 13, Snake River Basin.

pattern of discharge is greatly altered with flow (M-W-2) often not occurring below the dam during the winter months but with above normal volumes of water being released during the irrigation season (Table 133). There is evidence that irrigation releases are largely consumed in some sections of the stream (Table 134).

A summary of USFWS observations made on Willow Creek on July 20, 1942 is as follows: (1) the gradient was classified as moderate; (2) numerous riffles and pools were noted; (3) the streambed was heavily silted and considered to be of no value to anadromous fish; (4) no barriers to fish migration were observed below Willow Creek Reservoir; (5) diversions were unscreened; and (6) the flow at the mouth was estimated to be 27 c.f.s. and a water temperature of 66°F. was recorded.

DISCUSSION AND RECOMMENDATIONS

It is recommended that the Malheur River system be further investigated to assess the feasibility of reestablishing runs of anadromous salmonids. Factors which favor the restoration of this fishery resource are: (1) the presence of important gravel concentrations in the headwater areas of the main stem and the North Fork; (2) the apparent existence, within much of this area, of flows and stream temperatures compatible with the reproduction of salmon and steelhead; and (3) the former presence in the drainage of a large run of spring chinook salmon which implies a sizable, but currently unrealized, potential for the production of these fish.

Table 133. Monthly Mean Discharge in Cubic Feet Per Second for Willow Creek Above and Below Willow Creek Reservoir. 1/

Year	Location	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1925	Above	1	1	1	1	35	33	17	12	1	0	0	0
	Below	0	0	0	0	0	0	2	17	33	37	10	4
1926	Above	0	2	3	3	13	13	2	1	0	0	0	0
	Below	0	0	0	0	0	0	2	11	14	8	7	4
1927	Above	0	0	0	1	26	14	12	16	10	0	0	0
	Below	1	1	0	0	0	0	0	19	22	10	24	10
1928	Above	—	—	—	—	—	—	18	8	—	—	—	—
	Below	0	0	0	0	0	0	—	22	14	21	12	1
1929	Above	—	—	—	—	—	—	1	1	—	—	—	—
	Below	—	—	—	—	—	2	1	—	—	—	—	—

1/ Data obtained from USGS Water Supply Paper 1317, Part 13, Snake River Basin. Data recorded to nearest c.f.s. Locations of flow gaging stations are 0.5 mile above Willow Creek Reservoir and 300 feet downstream from the reservoir outlet tunnel.

Table 134. Mean Monthly Discharge in Cubic Feet Per Second for Willow Creek Approximately 9 Miles Below Willow Creek Reservoir Near Brogan. 1/

Year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1912	--	--	--	--	1	1	0	0	0	0	0	0
1913	0	0	1	2	2	3	4	--	--	--	--	0
1914	0	0	2	2	4	19	15	10	4	1	1	1

1/ Data obtained from USGS Water Supply Paper 1317, Part 13, Snake River Basin. Flow regulated by Willow Creek Reservoir which was constructed in 1911.

At the present time there are numerous problems which confront the development of runs of anadromous fishes in the Malheur system. Among the more serious of these are the two storage dams on the main stem and the North Fork. In addition, Harper Dam on the main stem creates a barrier during some flow stages even though this structure is laddered. Since flow regulation, siltation, and warm water temperatures produce conditions unfavorable to the propagation of salmon and steelhead below these barriers, it is obvious that the success of a fisheries rehabilitation program will depend to a large degree on the regaining of access to former spawning areas through the construction of fishways. Possibly complicating the design and operation of fishways at the concerned dams is the occurrence of considerable seasonal and annual water level fluctuation in the associated storage reservoirs.

In event of adoption of a fisheries development program on the Malheur River, an introduction of spring chinook salmon would be a logical choice from the standpoint of minimizing the influence of migrational hazards, since flow conditions favor a spring-run type of fish. On the other hand early spring migrants, which typify some races of steelhead, would encounter critical flow areas below storage reservoirs prior to mid-April. Also, as indicated by USGS flow records, a fall outmigration of juvenile salmonids, unless acutely timed, might be unfavorably influenced in some years by the presence of low volumes of discharge along various sections of the migration route. Critical areas would include the Drewsey Valley in August and September (Table 126); the sections below the storage reservoirs after mid-October (Tables 126 and 129); and Vale to the river mouth, primarily in the months of August and September.

Final factors to be considered in regard to the restoration of anadromous fish runs in the Malheur system are the presence in the basin of numerous unscreened diversion ditches and the location of the stream above several existing and proposed major dams on the Snake River. With respect to the screening of ditches, emphasis should be placed on the main stem and the North Fork since, on the basis of unfavorable flow conditions, the other major tributaries may be of dubious value for the production of salmon.

OWYHEE RIVER SYSTEM

No inventory stream surveys were made by OFC biologists under the CRFDP Project Appraisal Program in 1958-59. However, data of a very general nature concerning the drainage have been extracted from other reports and are presented.

The Owyhee River originates in Nevada and flows in a northerly direction for approximately 280 miles to join the Snake River a short distance above Nyssa, Oregon (USFWS, 1957). The drainage area, which exceeds 11,000 square miles, comprises portions of Nevada, Idaho, and Oregon. Three of the major tributaries, Middle Fork, South Fork, and North Fork, combine near the Oregon-Idaho border to flow through a deep, rugged canyon which widens into a valley near the vicinity of Rome, Oregon (refer to Figure 1). In this area two other large tributaries, Crooked and Jordan Creeks, join the main stem. Below Rome basin, the river trends morthward through a relatively shallow canyon for about 35 miles to Owyhee Reservoir. This 50-mile-long impoundment (maximum pool) was built by the Bureau of Reclamation in 1933 for the storage of irrigation water. It has a capacity of approximately 1,121,000 acre-feet. Owyhee Dam, which forms the reservoir, is 330 feet in height and is a complete barrier to the upstream migration of fish. From Owyhee Dam, the river extends for approximately 25 miles to the mouth.

The Owyhee River system is located primarily on an elevated, sagebrush-covered plateau in which deep canyons have been eroded by stream action. In Nevada, the watershed rises to an altitude of 10,000 feet while elevation at the stream mouth is 2,200 feet. There are no high mountains in the Oregon portion of the drainage, where much of the plateau varies from 3,500 to 4,500 feet in altitude (Bryan, 1929). From 12 to 25 miles above the mouth the river has formed a gorge which is some 2,000 feet in depth.

The principal means of livelihood in the Owyhee basin are livestock raising and agriculture. The climate is semi-arid with about 10 inches of annual precipitation at Nyssa and 8 inches near Rome.

As indicated by Parkhurst (1950-c), the Owyhee River at one time had a run of chinook salmon which became depleted prior to the construction of Owyhee Dam. In its present state, the stream is considered of little or no value to anadromous fish, except for its contribution to the discharge of the Snake River. An important sport fishery for trout and warm water fishes exists in the Owyhee Reservoir.

In July 1942, personnel of the USFWS conducted surveys on the Owyhee River from the mouth to Owyhee Dam. This section of the stream consists of irrigated farmland in the lower 12 miles and a deep gorge in the upper 14 miles to the dam. A summary of the survey is as follows: (1) gradient was slight in the valley and slight to moderate in the gorge; (2) a considerable amount of heavily-silted gravel was present in the gorge section; (3) bank cover was scarce; (4) water temperatures ranged from 76°F. near the mouth to 67.5°F. at the lower end of the gorge to 47°F. at Owyhee Dam; (5) 1 large (capacity of 235 c.f.s.) and several small unscreened diversions were noted; and (6) flow at the mouth was 15 c.f.s. In the report of this survey, Parkhurst (loc. cit.) states that the flow in the lower 12 miles of the stream below the large diversion canal is usually inadequate for fish. Also, USGS records indicate that flow conditions are critical below Owyhee Dam during the winter storage season of October through March. 1/

1/ USGS Water Supply Papers, Part 13, Snake River Basin.

Other reports indicate the prevalence of unfavorable conditions for salmonids in the river above Owyhee Reservoir. An excerpt from a report by the Bureau of Sport Fisheries and Wildlife (USFWS, loc. cit.) concerning fish and wildlife resources affected by proposed storage developments above Owyhee Reservoir is as follows:

> "The 30 miles of the Owyhee River in the Duncan Ferry Reservoir site (located 35 miles above Owyhee Reservoir) supports fish populations of carp, suckers, squawfish, chiselmouth and other non-game species. Attempts to establish trout in this reach by stocking have yielded unsatisfactory results. High temperatures, turbidity, competition from non-game fishes, and extreme variation in flow are probable factors limiting the suitability of this habitat for game fishes."

This report further states that Jordan and Crooked Creeks support small local fisheries comprised almost entirely of non-game species. In the same report Jordan Creek is described as follows: Jordan Creek originates in the Owyhee Mountains of Idaho and flows rapidly over a narrow channel of gravel, rubble, and boulders. The gradient within the Jordan Creek Reservoir site (50 miles above the mouth) is reduced and the stream becomes meandering from here to the mouth. In this area, discharge is greatly increased by tributary inflow and the channel broadens, meanders, and becomes less stable because of bank erosion and the shifting of the sand and mud bottom. Jordan Creek has a total length of approximately 70 miles.

Obviously there are many serious drawbacks to the development of an anadromous fishery resource in the Owyhee drainage. Not only does one extensive storage project for irrigation purposes exist, but others may be in the offing. In addition to unfavorable local conditions, the location of the stream above the several existing and proposed major dams on the Snake River must be considered. At this time, with a lack of observations in the headwater areas, the production potential of anadromous fishes in the Owyhee system is unknown. However, even if this potential were great, the surmounting of existing obstacles with the present conservation methods and fisheries management techniques seems unlikely.