W A T E R Q U A L I T Y S T A T U S R E P O R T

OWYHEE RIVER

OWYHEE COUNTY, IDAHO

1976-1977

Report by:

William H. Clark

1978

Illustration by:

Ron Spidell

Survey Conducted by:

William H. Clark
Jon Wroten
Ron Spidell

Idaho Department of Health & Welfare
Division of Environment
Statehouse
Boise, Idaho 83720

Water Quality Series No. 35

COVER PHOTOGRAPH

High altitude aerial photograph of the Owyhee River, Idaho. The East Fork of the Owyhee River enters from the right side of the photo. Red Canyon Creek (Station 14) enters from the north (top center), the South Fork Owyhee River (Station 10) enters from the south, Crutcher's Crossing (Station 6) is located just east (right) of the mouth of the South Fork. Station 7 (near the Idaho-Oregon border) is just off to the left of the photo. The photograph is from color infrared at a scale of 1:125,000.

Photograph is courtesy of NASA and the Idaho Department of Water Resources.

TABLE OF CONTENTS

	PAGE
Abstract	iii
List of Figures	iv
List of Tables	v
Purpose of Study	1
Introduction	2
Past Studies in the Area	7
Materials and Methods	8
Results and Discussion	11
Waste Sources	11
Dissolved Oxygen	11
Physical Parameters	12
Temperature	12
pH	15
Specific Conductance	15
Flow	17
Chemical Parameters	19
Chemical Oxygen Demand	19
Nutrients	19
Solids	21
Turbidity	22
Hardness	23
Metals	23
Miscellaneous	25
Biological Parameters	27
Bacteriological Water Quality	27

PAGE

Attached Algae..... 30
Macroinvertebrates..... 31
Non-Insect Macroinvertebrates..... 31
Insecta..... 32
Ephemeroptera..... 32
Plecoptera..... 32
Odonata..... 33
Coleoptera..... 33
Trichoptera..... 33
Diptera..... 33
Conclusions..... 34
Recommendations..... 35
Acknowledgements..... 36
References Cited..... 37

A B S T R A C T

A water quality survey of the Owyhee River in S.W. Idaho was conducted from August, 1976 to April, 1977 by the State of Idaho, Department of Health and Welfare, Division of Environment. The survey was conducted to help determine if the Owyhee River in Idaho qualifies for inclusion in the National Wild and Scenic Rivers System.

The Duck Valley Indian Reservation appears to be a major source of nutrients, solids, turbidity, trace metals, and bacteria. The South Fork of the Owyhee River is the only tributary stream with an important discernible source of these same pollutants on the remainder of the river system in Idaho. The river appears to recover rapidly downstream from these sources.

The main stem of the Owyhee River (East Fork) in Idaho below the Duck Valley Indian Reservation is of excellent water quality and suitable from that standpoint to be included in the National Wild and Scenic Rivers System.

LIST OF FIGURES

FIGURE		PAGE
Figure 1	Map of Owyhee River study area located in Southwestern Idaho	3
Figure 2	Dissolved Oxygen (% saturation and mg/l), Owyhee River Survey (1976-77), compared with state standards	13
Figure 3	Temperature and pH, Owyhee River Survey (1976-77)	16
Figure 4	Total Coliform bacteria, Owyhee River Survey (1976-77), compared with state standards	28
Figure 5	Fecal Coliform bacteria, Owyhee River Survey (1976-77), compared with state standards	29
Figure 6	Station 1, Owyhee River near the Idaho-Nevada Border, Duck Valley Indian Reservation	64
Figure 7	Station 2, Owyhee River, Duck Valley Indian Reservation	65
Figure 8	Station 3, Owyhee River, near Pipeline Crossing	66
Figure 9	Stations 4 and 12, Owyhee River at the confluence of Battle Creek	67
Figure 10	Stations 5 and 13, Owyhee River at the confluence of Deep Creek	68
Figure 11	Station 14, Red Canyon Creek near its confluence with the Owyhee River	69
Figure 12	Station 6, Owyhee River at Crutcher's Crossing	70
Figure 13	Station 10, South Fork of the Owyhee River at its confluence with the main stem of the Owyhee	71
Figure 14	Station 7, Owyhee River near the Idaho-Oregon Border	72
Figure 15	General view of the Owyhee River Canyon	73

LIST OF TABLES

TABLE		PAGE
Table 1	Sample Stations, Owyhee River Survey	40
Table 2	Temperature, Owyhee River Survey	41
Table 3	Temperature Stations 3 and 6, Owyhee River Survey	42
Table 4	Dissolved Oxygen, Owyhee River Survey	43
Table 5	pH Values, Owyhee River Survey	44
Table 6	Specific Conductance, Owyhee River Survey	45
Table 7	Flow (CFS), Owyhee River Survey	46
Table 8	Bacteriological Data, Owyhee River Survey	47
Table 9a	Chemical Analyses, Owyhee River Survey 8-16-76	48
Table 9b	Chemical Analyses, Owyhee River Survey 8-16-76	49
Table 10a	Chemical Analyses, Owyhee River Survey 10-20-76	50
Table 10b	Chemical Analyses, Owyhee River Survey 10-20-76	51
Table 11a	Chemical Analyses, Owyhee River Survey 12-21-76	52
Table 11b	Chemical Analyses, Owyhee River Survey 12-21-76	53
Table 12a	Chemical Analyses, Owyhee River Survey 4-7-77	54
Table 12b	Chemical Analyses, Owyhee River Survey 4-7-77	55
Table 13	Nitrate Loadings in Kilograms Per Day Owyhee River Survey	56
Table 14	Total Kjeldahl Nitrogen Loadings in Kilograms Per Day Owyhee River Survey	57
Table 15	Total Phosphorus Loadings in Kilograms Per Day Owyhee River Survey	58
Table 16	Water Quality Data for Miscellaneous Stations in the Owyhee River Area Collected by the BLM 1976-77	59
Table 17	Benthic Macroinvertebrates, Owyhee River Survey	60
Table 18	Macroinvertebrate Diversity at Stations 1, 3, and 6 Owyhee River Survey	63

PURPOSE OF STUDY

The primary purpose of this survey was to provide the Owyhee River Study Team with water quality data to assist in determining the suitability of the river for inclusion in the National Wild and Scenic Rivers System.

Secondary purposes were the establishment of water quality status of the river, to provide background water quality data for the river system, and to make a preliminary assessment of the impact of nonpoint source pollution on the river system.

INTRODUCTION

The Owyhee River System is located in southeastern Oregon, southwestern Idaho, and northern Nevada (see Figure 1). The entire river system has a drainage area of 11,340 square miles (29,370 km^2) (Ross and Savage, 1967). The river begins in the Owyhee, Independence, Santa Rosa, and Tuscarora mountains of southwestern Idaho and northern Nevada. The river flows into Owyhee Reservoir in southeastern Oregon. The reservoir is over 50 miles (80 km) long and has a surface coverage of 13,900 acres (5625 ha) and a total storage of 1,120,000 acre feet (1.38×10^9 m^3) (McHugh, 1972). The river and tributaries flow northerly and meet the Snake River south of Ontario, Oregon at river mile 392.3.

The portion of the Owyhee River under study for possible inclusion in the National Wild and Scenic Rivers System is 170 miles (274 km) in length and runs from the western boundary of the Duck Valley Indian Reservation in southwestern Idaho to the slack waters of the Owyhee Reservoir in southeastern Oregon.

The area of study encompassed by the present study includes the main East Fork Owyhee River from the Idaho/Nevada border to the Idaho/Oregon border, approximately 85 river miles (137 km) in length. The major tributaries studied include Battle Creek, Deep Creek, Red Canyon Creek and the South Fork Owyhee River.

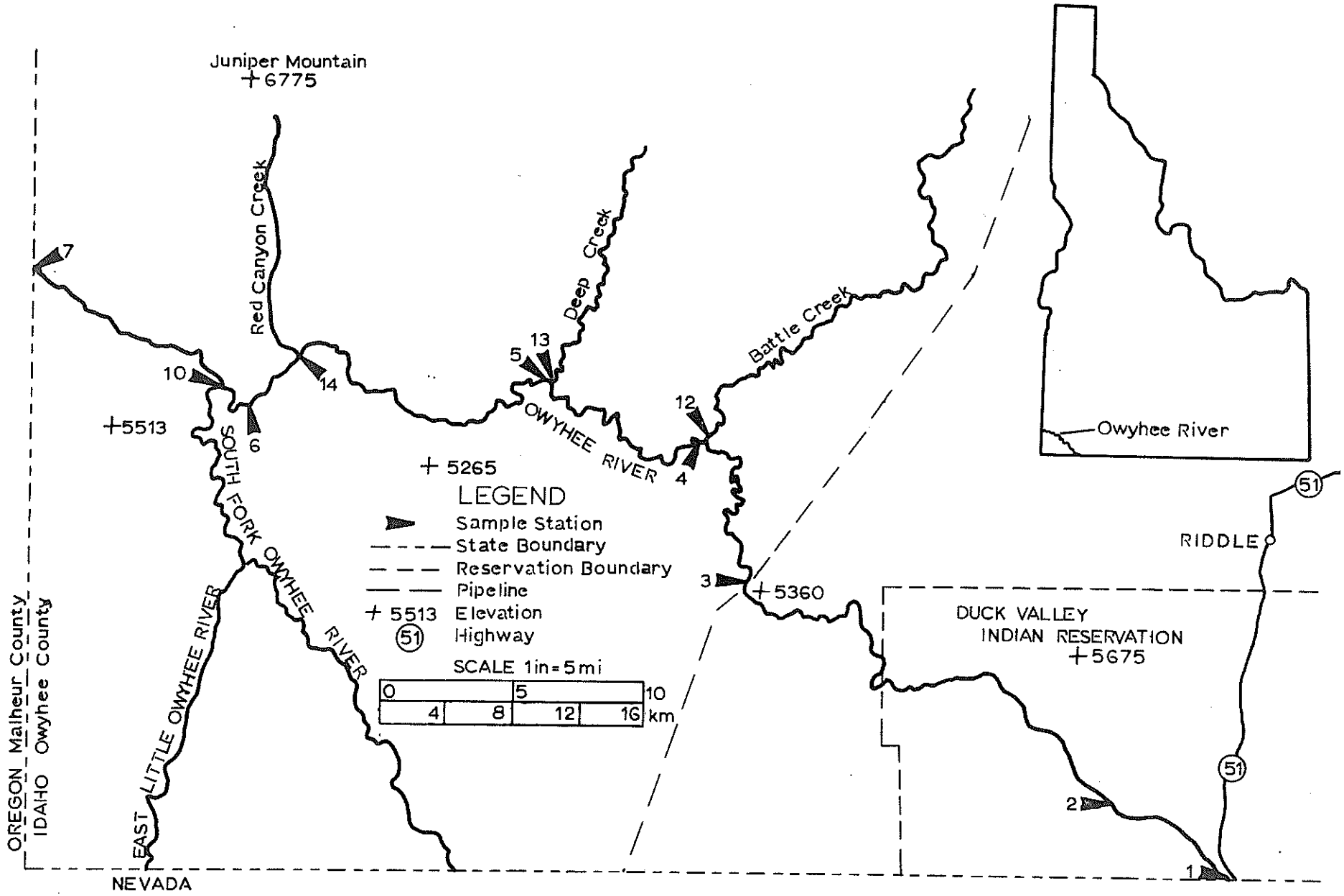

Figure 1. Map of Owyhee River study area located in Southwestern Idaho.

Most of this area is semi-arid, high desert that comprises a plateau of slightly more than 5000 feet (1524 m) in elevation, and lies south and southeast of Juniper Mountain (see Figure 15).

In Idaho the land along the portion of the Owyhee River area of study is under 88% Federal, 9% State (total 97% government), and 3% private ownership. The Bureau of Land Management administers the majority of the land in the area.

The predominant land use along the Owyhee River is grazing. Approximately 93 percent of this land is used in grazing. All of the Federal land area back from the rim of the canyon is used by livestock under permit from the Bureau of Land Management. Some grazing use occurs within the canyon and a major cattle crossing is located at Crutchers Crossing (sample Station 6) (see Figure 12).

The Idaho portion of the Owyhee River is in a free-flowing condition.

The U.S. Army Corps of Engineers and the Federal Power Commission report no projects either existing or pending along the river. In 1965, the Bureau of Reclamation studied two potential dam sites in Oregon above the Owyhee Reservoir but determined that the sites were not economically viable and all withdrawn land has been returned to the Bureau of Land Management. Ross and Savage (1967) list the Owyhee River as the least important of 12 major river systems considered for theoretical water power.

The only structure across the river between the Duck Valley Indian Reservation and the Idaho/Oregon border is the natural gas pipeline (Figure 1).

Presently the only irrigated land is located in the Duck Valley Indian Reservation. This land is mostly in hay production. Idaho Department of Water Resources (IDWR) (1976) has identified a large portion of land south of the Owyhee River with irrigation potential. The U.S. Department of Agriculture (1976) estimates that between 1975-1980, 23,840 acres (9652 ha) will change from range and woodland to irrigated agriculture in Owyhee County. Most of this is along the Snake River. IDWR (1976) notes that as an alternative to present use, 10,000 acres (4090 ha) of land in the Duck Valley Indian Reservation could be placed under irrigation. However, there is generally not adequate water available during the entire season to satify many of the existing water rights along the Owyhee River. The Owyhee Reservoir does not receive sufficient runoff to fill every year.

According to Gullidge (1972) "more than 162,400 acres of irrigated land in this basin (Owyhee Subarea) have inadequate water supplies, and opportunities for developing supplemental water are very limited".

Owyhee County had a 1970 population of 6,422 and a projected 1974 population of 7,500 (IDHW, 1974). The county is sparsely populated with more than one square mile per resident.

Recreation in the form of hunting, fishing, rock collecting, camping and general nature study occur much of the year. The river is being used more and more by float boaters including several commercial outfitters during the high runoff period, mainly portions of April-June, depending on the amount of river flow.

No patented mining claims are located along the Owyhee River. As mentioned previously, some rockhounding occurs in the area.

According to Ross and Savage (1967) geologically the Owhyee River flows through the Owyhee Uplands section of the Columbia Intermontane Province which is a high plateau. Most of the lavas of the Owhyee Uplands are older than those of the Snake River plain to the north. Some basalt flows are present but many of the rocks are rhyolites and welded tuffs. "Structurally, the Owyhee Uplands section is an uplifted area; doming and block faulting are common. Because the section is at a higher elevation and because erosion has been active over a longer time, the Owyhee Uplands is one of the more deeply dissected divisions of the Columbia Intermontane Province" (Ross and Savage, 1967). The river flows through Cenozoic basalt flows of the Idaho and Snake River groups and Chalk Hills formation most of its length in Idaho. A portion of the river in the Duck Valley Indian Reservation flows through an area of late Cenozoic alluvial deposits (Ross and Savage, 1967).

The climate of the Owyhee river area can be briefy described as follows (from Rice, 1971):

Mean minimum temperature (January)	12° F. (-11° C)
Mean maximum temperature (January)	36° F. (2.2° C)
Mean minimum temperature (July)	48° F. (8.9° C)
Mean maximum temperature (July	88° F. (31° C)
Mean annual precipitation	10-15" (25.4-38.1 cm)

The climate is typical cool desert with very hot summers and cold winters. The winter of 1976-1977 produced very little precipitation on the Owyhee River area. The USDA (1972a) reported that the area had 11 percent of average snow water depths as of February 1, 1977. USDA (1976b) stated that the snow water depths as of March 1, 1977 had increased to 24% of average and that the prospective streamflow is 31% of average for most of the Owyhee River area in Idaho.

The vegetation of the Owyhee River system (according to Kuchler, 1964) is entirely sagebrush steppe. This is a dense to open grassland with dense to open shrub synusia. The dominants of the area are big sagebrush (Artemisia tridentata) and bluebunch wheatgrass (Agropyron specatum). Other major components include Artemisia arbuscula, Balsamorrhiza sagittata, Festuca idahoensis, Lithospermum rederale, Lupinus sericens, Oryzopsis hymenoides, Phlox spp., Poa nevadensis, P. secunda, Purshia tridentata and Sitanian spp. Cheatgrass (Bromus tectorum) is a common introduced grass. Riparian vegetation is found in the canyon along the river with occasional scattered juniper trees. Some endangered or threatened plants may occur in the area under study (Henderson et al., 1977).

PAST STUDIES IN THE AREA

No water quality surveys have previously been conducted on the Idaho portion of the Owyhee River.

The U.S. Geological Survey (USGS) has a flow station near Owyhee, Nevada near our station #1. This recorder has been operating since 1939. The USGS also has a flow measurement station on the South Fork Owyhee River just south of the Idaho/Nevada border, operating since 1955. The nearest downstream gage to the Idaho border is located near Rome, Oregon. This station has recorded river flows since 1949 (USGS, 1976).

The Bureau of Land Management, Boise office, is currently conducting some water quality and fish studies on the Owyhee River and its tributaries in Idaho. These studies are part of a program to assess the impact of BLM land use practices on water quality.

The Owyhee River from the western border of the Duck Valley Indian Reservation to the Owyhee Reservoir is currently under study by the Owyhee River Study Team coordinated by the U. S. Bureau of Outdoor Recreation. They have published several documents concerning the river system: BOR, 1976a; 1976b; and 1976c.

Idaho Department of Environmental and Community Services (now Idaho Department of Health and Welfare, IDHW) (1973) has categorized the entire Owyhee River in Idaho as Class A (primary contact recreational waters).

MATERIALS AND METHODS

The major portion of this survey was conducted by helicopter (see Figure 9). The remoteness of the area made it necessary to fly into the stations in order to obtain and return the water samples to the State Laboratory within required holding times recommended by the U.S. Environmental Protection Agency (EPA) (1974). All of the chemical and bacteriological samples were received by the laboratory within 24 hours. The stations were sampled four times approximating the seasons (August, October, December and April). See Table 1 for a list of the sample stations and Figure 1 for their locations.

A Martek Mark 5 Digital Water Quality Analyzer was used to determine field dissolved oxygen (DO), pH, temperature and specific conductance. The instrument was calibrated prior to each survey. Flows were either estimated with a float and a stopwatch or measured with a wade rod and Price AA current meter. Air temperature was taken with an Ertco glass thermometer calibrated with a standard thermometer.

Bacteriological samples were collected in 250 ml Nalgene polyethylene sterile bottles treated with sodium thiosulfate and stored on ice to cool to 4° C.

Chemical samples were collected in two 1 liter Nalgene polyethylene bottles (two 1 liter disposable polyethylene cubitainers in March). One bottle was preserved with 2 ml H_2SO_4 and both placed on ice.

Heavy (trace) metals were collected in one 250 ml glass bottles treated with 2 ml HNO_3 (1 liter polyethylene cubitainers with 10 ml of 1:1 redistilled HNO_3 in March) and placed on ice.

Stream temperatures were recorded for a week In July and August at Stations 3 (Pipeline Crossing) and 6 (Crutcher's Crossing) with a Ryan Model H thermograph.

Biological samples were taken at Stations 1 (Idaho/Nevada Border), 3 (Pipeline Crossing) and 6 (Crutcher's Crossing). Macroinvertebrate (rock basket) samples were placed in riffle areas in the river, using native river rock as a substrate, on July 20 and 22, 1976. These samples were collected on September 20 and 21, 1976. Macroinvertebrates were brushed from the rocks into bottles and preserved with 70% isopropyl alcohol. The samples were sorted and identified in the laboratory with the aid of a dissecting microscope and standard references.

Species diversity was calculated using the formula of Lloyd, Zar and Karr (1968) as presented by Weber (1973).

Periphyton samplers were placed in the river and collected on the same days as the rock baskets. Plexiglass samplers were used that we built for this purpose. The samplers held glass slides (substrate) approximately two inches (5 cm) below the water surface. On removal the slides were placed in the dark, in polyethylene containers and immediately frozen (dry ice). They were transported to the State laboratory and remained frozen until analyzed.

Each station was photographed with a 35mm SLR camera and color slide film during each survey. Field parameters, weather data and other notes were kept in a field notebook.

RESULTS AND DISCUSSION

Waste Sources

No known industrial or municipal waste sources occur on the Owyhee River in Idaho. Some agricultural drain ditches discharge into the river on the Duck Valley Indian Reservation but are generally classified under nonpoint sources.

Natural and nonpoint sources comprise the major input into the river system. Gullidge (1972) states, "This basin (Owyhee Subarea) has the greatest erosion problem of any in the Middle Snake Subregion."

Some cultural nonpoint source pollution enters the Owyhee River on the Duck Valley Indian Reservation (for example see the bacteriological data: Table 8 and Figure 4). Agricultural runoff, septic tank and privy drainage and solid waste are believed to contribute to this source.

Livestock grazing practices are considered to be the single greatest input for nonpoint source pollution along the Owyhee River after it leaves the Duck Valley Indian Reservation. As mentioned earlier the BLM is currently studying this problem.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations were usually good, but 19 of 48 (40%) measurements taken during the survey violated the 90% saturation standard (DECS, 1973) (see Table 4). The stations that violated the percentage saturation standard still had sufficient dissolved oxygen in milligram/liter (mg/l) for aquatic life. The state minimum standard of 6 mg/l was never violated. The minimum amount of DO is between 4-6 mg/l (Environmental Studies Board, 1972). In the section of the river under study for the Wild and Scenic Rivers System 14% of the stations violated the DO saturation standard (n=5).

The mean DO values in July were 8.9 mg/l (120.5%); in August 1976 were 7.9 mg/l (87.3%) for the Owyhee River and 8.6 mg/l (93.5%) for the tributaries; in September 8.8 mg/l (95%); in October 8.4 mg/l (77.4%) for the Owyhee River and 9.2 mg/l (84.7%) for the tributaries; in December 11.2 mg/l (90%) for the Owyhee River and 11.8 mg/l (91%) for the tributaries; and in April 1977 9.3 mg/l (94%) for the river and 9.5 mg/l (97%) for the tributaries.

The tributaries had slightly higher DO values than the Owyhee River (see Table 4).

The two stations on the Duck Valley Indian Reservation were consistently below the 90% state standard (see Table 4). This may be caused in part by higher concentrations of oxygen consuming materials in the water in this area and in part by the relatively slow movement of the water compared with the canyon portion. The highest DO value in percent saturation (162%) was recorded at Station 1 (Idaho/Nevada border); however, this was attributed to a very dense algal growth at the station.

The October survey resulted in the lowest DO values, probably a result of decreased algal activity for this time of year.

The December survey yielded the highest DO values recorded. These are primarily the result of the low temperature (mean -0.6°) recorded for this date.

Physical Parameters

Temperature

Temperatures taken during this survey are listed in Tables 2 and 3 and shown in Figure 3.

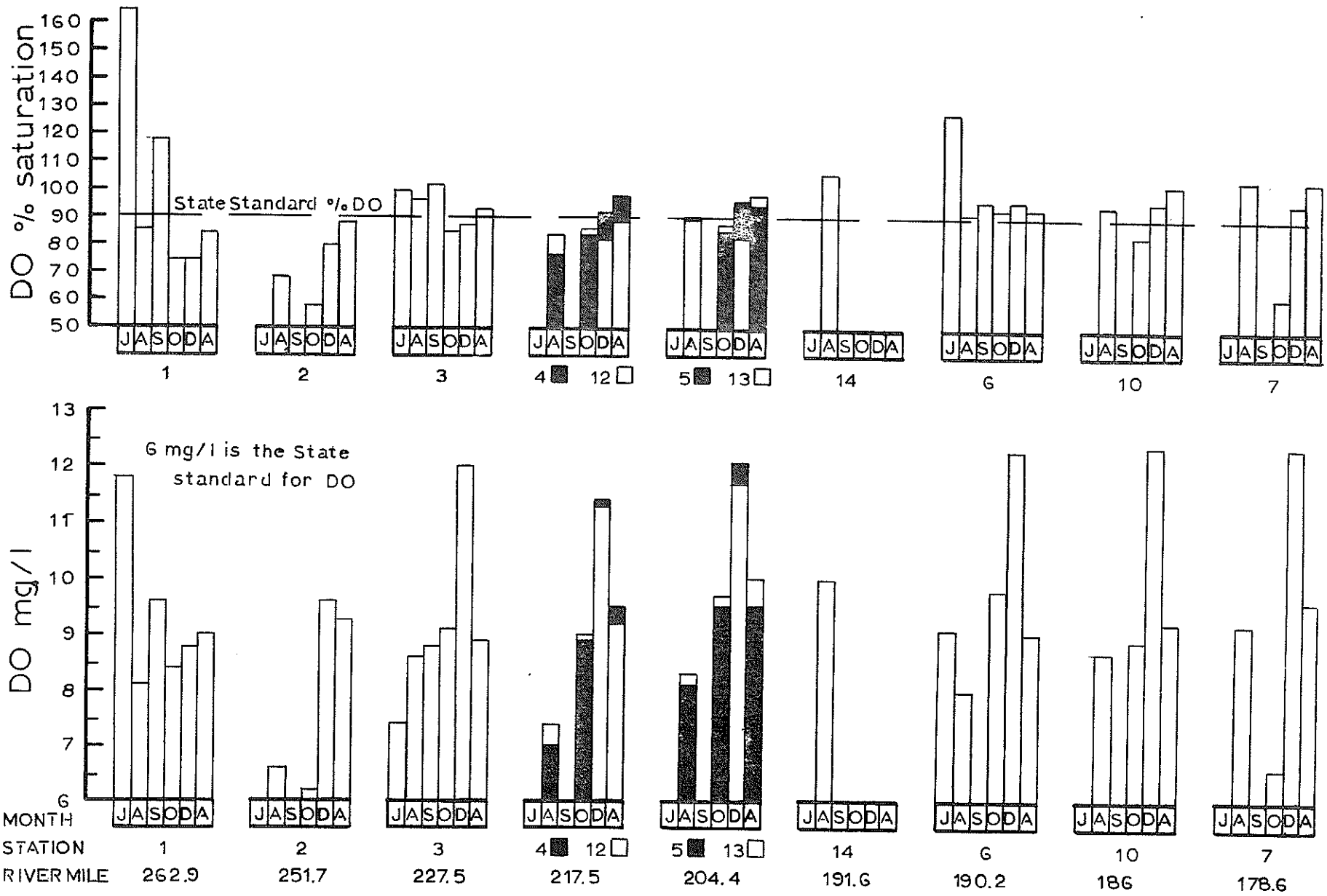

Figure 2. Dissolved oxygen (% saturation and mg/l), Owyhee River Survey (1976-1977), compared with state standards. J = July, A = August, S = September, O = October, D = December 1976; A = April 1977.

Generally the temperatures increased downstream of Station 1 (Idaho/Nevada border) towards Station 7 (Idaho/Oregon border), except in December when the water was fairly uniform (mean - 0.6° C) (see Table 2 and Figure 3).

The temperatures are slightly variable but usually showed this downstream increase. The mean temperature recorded in July was nearly 23° C for the river. In August 1976 the river had a mean temperature of 12.2° C. October was cooler with the mean river temperature at 4.8° C and tributaries at 5.5° C. December showed the most uniform temperatures ranging from -0.4° to -0.8° C (mean -0.6° C) for the river and tributaries. Ice conditions prevailed and ranged from about 50% coverage at Station 1 to nearly 100% coverage of the tributaries. The ice on the South Fork Owyhee River (Station 10) was thicker than the other stations. The April 1977 temperatures averaged 8.6° C for the river and 9.7° C for the tributary stations.

The highest temperature recorded for the survey was 26° C on July 22, 1976 (1800 hours) at Station 6 (Crutcher's Crossing). The lowest temperature recorded was -0.8° C at the same station on December 21, 1978 (1210 hours).

Thermographs were placed in the Owyhee River for a week in July and a week in August at Station 3 (Pipeline Crossing) and Station 6 (Crutcher's Crossing). The resulting minimum and maximum temperatures are given in Table 3.

The higher temperatures at Station 6 were expected (Table 3). The station is lower in elevation; the water is deeper and slower moving; and, the water has had more time to warm up.

It appears that the temperatures in the Owyhee River system are too high in the summer for an extensive salmonid fishery.

pH

The pH values for the entire river system during this survey ranged between 6.9 and 8.9 within the 6.5 - 9.0 range required by the State Water Quality Standards (IDECS, 1973) (see Table 5 and Figure 3).

The East Fork Owyhee River showed slightly greater variation in pH (range 6.9 - 8.9) compared with the tributaries (range 7.5 - 8.8).

On the East Fork Owyhee River the pH increased by about one pH unit between Stations 1 (Idaho/Nevada border) and 7 (Idaho/Oregon border) (Table 5).

The relatively lower pH of Battle Creek (Station 12) and Deep Creek (Station 13) appeared to slightly lower the pH of the East Fork Owyhee River (see Table 5).

Specific Conductance

The specific conductance varied but Station 7 (Idaho/Oregon border) always showed a slight increase when compared with Station 1 (Idaho/Nevada border).

The October survey yielded the highest specific conductance values (mean 201, Owyhee River; mean 157 tributaries (see Table 6). December had the lowest values (mean 45, Owyhee River; mean 39, tributaries), possibly related to the low flow.

The South Fork Owyhee River consistently had the highest specific conductance value of the tributaries studied. Considering the flow of the South Fork it was the greatest single influence of specific conductance on the Owyhee River, usually causing a substantial increase between Stations 6 and 7. Battle Creek (Station 12) and Deep Creek had relatively lower specific conductance values but because of their relatively small flows they only depressed Owyhee River values by a slight amount (see Table 6).

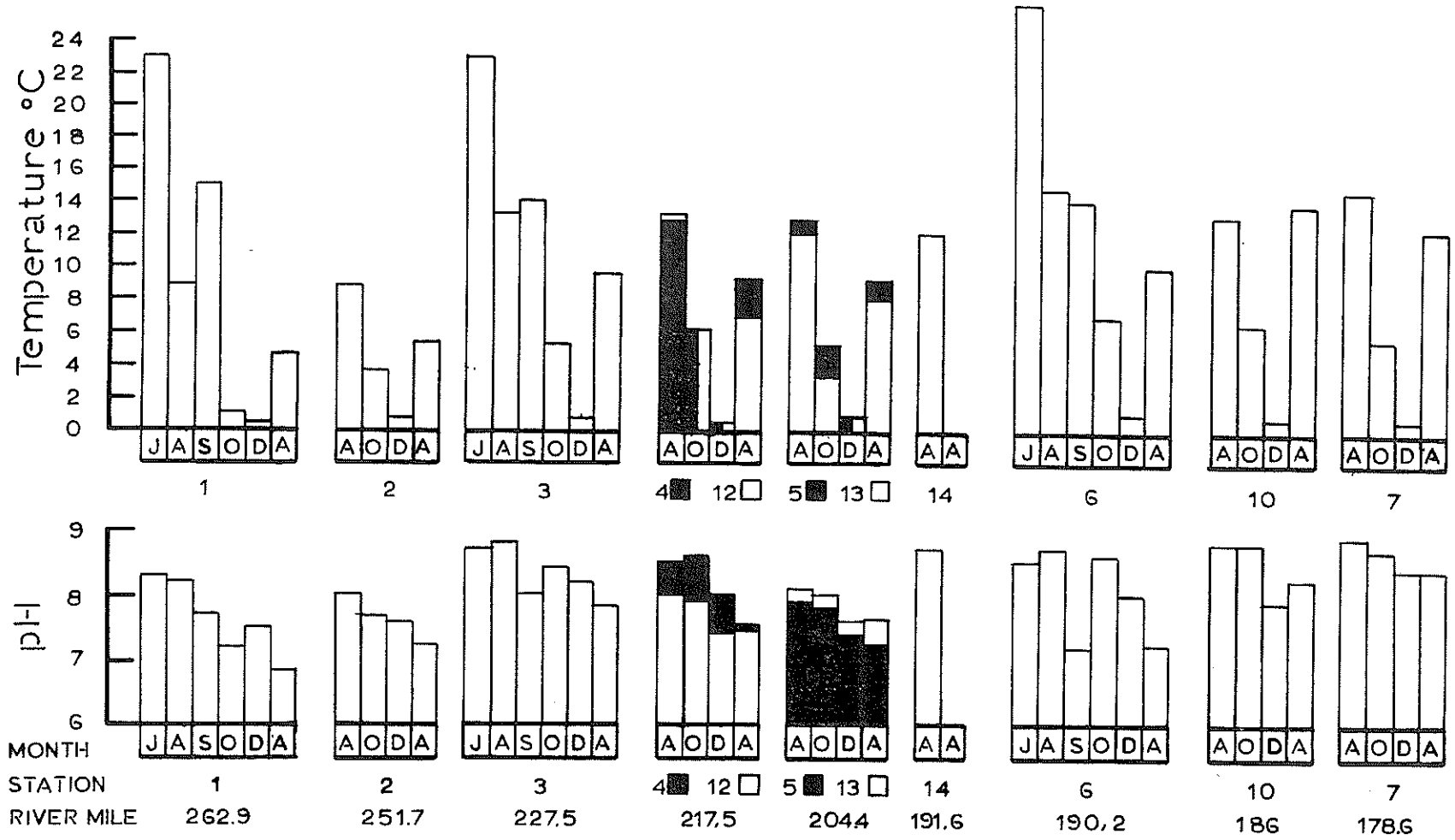

Figure 3. Temperature and pH, Owyhee River Survey (1976-1977). The state standard for pH is 6.5 - 9.0. J = July, A = August, S = September, O = October, D = December 1976; A = April 1977.

Flow (Discharge)

The flow data collected for the Owyhee River survey is presented in Table 7. Flows could only be estimated during the August survey due to weight and space limitations on the helicopter. It was only possible to measure flows a couple of times on the December survey because of extensive ice conditions.

According to the USGS (1976) the flow at Owyhee, Nevada (near our Station 1) is partly regulated by Wild Horse Reservoir in Nevada.

The flows at Station 1 (Idaho/Nevada border) ranged from 5 cfs in December to 153 cfs in April. The flows at the Idaho/Oregon border (Station 7) ranged from 100 cfs in December to an estimated 298 cfs in April. The flow increased by approximately 85 cfs within the State of Idaho. Most of this increase can be attributed to the three main tributaries measured: South Fork Owyhee River, Station 10; Battle Creek, Station 12; and Deep Creek, Station 13. These three tributaries comprise over 2/3 of the inflow to the East Fork Owyhee River.

Red Canyon Creek had a very low flow (3 cfs) the time it was sampled. During the August survey it was nearly dry and during the December survey it was frozen, so further flows were not obtained.

Blue Creek which feeds Mountain View Reservoir on the Duck Valley Indian Reservation usually had very low flow and was swampy below the reservoir; it was not sampled or measured during the survey.

These flows measured for this portion of the Owyhee River in Idaho appear to constitute approximately 65% of the flow at Rome, Oregon for August; 73% in October; and 46% in December (when compared to mean monthly flows for those months, USGS, 1976).

High runoff flows could not be measured because of the very low winter precipitation levels that occurred during the winter of 1976-1977. This "spring runoff" usually occurs between March and June, with May usually having the greatest flow.

It is estimated from comparisons of the percentage flow of the Idaho portion of the river to the flow at Rome that the mean "runoff period" flow at the Idaho/Oregon border would be approximately 2500 cfs.

Riggs and Harenberg (1976) examined the flood characteristics of streams in Owyhee County. They developed a regression relating whole-channel width to a ten-year flood. Using their regression and our measured width of the whole-channel width (270' or 82.3 m) an estimated ten year flood of about 12,000 cfs ($\pm$ 3600 cfs) is obtained for Station 7 (Owyhee River at the Idaho Oregon border).

CHEMICAL PARAMETERS

The chemical water quality for the Owyhee River survey is listed in Tables 9-12. The complete chemical analyses are given in these tables.

A general summary of the significance of these parameters follows.

Chemical Oxygen Demand

Chemical oxygen demand (COD) is used to determine the oxygen equivalent of the organic matter in a sample that is susceptible to oxidation. The COD parameter was examined instead of biochemical oxygen demand (BOD) because it is more applicable to a river system such as the Owyhee which has no major point sources of pollution. On each sample date the COD was significantly higher for stations 1 and 2 than for the remainder of the East Fork of the Owyhee River. The high values for stations 1 and 2 are probably the result of human activities. The COD level usually decreased downstream indicating no major additional organic inputs.

The COD levels on the tributaries sampled was usually relatively low with the exception of station 10, the South Fork of the Owyhee River. Station 10 was always the highest of the tributaries and apparently is partly responsible for the maintenance of COD levels at station 7 (near Idaho-Oregon border) and even an increase in levels as shown in Table 10a for the 20th of October 1976. Here the COD was raised from 3 mg/l at station 6 (Crutcher's Crossing) to 6 mg/l at station 7. Station 10 had a COD level of 12.4 mg/l that day.

The high value for COD (78 mg/l) at station 5, August 16, 1976 remains unexplained.

The COD values were at their minimum during the December survey.

Nutrients

Nutrients are a major concern when examining the water quality of a stream. An inadequate supply of nutrients may yield an "unproductive"

stream yet an excess amount of nutrients may yield a "polluted" stream containing an overabundance of plant and animal growth. The most readily available forms of nutrients available for algal utilization are total inorganic nitrogen (TIN = NH_3 + NO_2 + NO_3) and orthophosphate (O - PO_4).

The level of total inorganic nitrogen (TIN) considered to be critical for algal bloom potential is approximately 0.3 mg/l (Tangerone and Bogue, 1975). Only one of the stations exceeded the 0.3 mg/l level during this survey (see Table 9-12), that was station 12 (Battle Creek) for December 21, 1976 with a TIN value of 0.423 mg/l. Station 10 (South Fork Owyhee River) also had a relatively high value that day of 0.234 mg/l. The main stem stations also showed higher TIN values in December: 0.234; 0.124; 0.266; 0.267; 0.204; 0.203; and 0.214 mg/l for stations 1 through 7 respectively. Nitrate was the major component of the TIN. The only other relatively high values found were 0.194 and 0.188 mg/l for stations 1 and 2 respectively on the Duck Valley Indian Reservation during April.

During the relatively warmer survey dates (August, October, and April) when more decomposition was occuring ammonia (NH_3) was the predominant constituent of TIN.

Concerning the tributaries, station 10 was consistently higher in nitrogen than the other tributaries (See Tables 9b-12b, 13 and 14).

Total Kjeldahl Nitrogen (TKN) increased in amount downstream (See Table 14) but nitrate normally did not (See Table 13). The greatest sources of nitrates appear to be the Duck Valley Indian Reservation and the South Fork of the Owyhee River.

The concentration of dissolved orthophosphate considered to be critical for algal bloom potential is approximately 0.01 mg/l (Sawyer, 1947).

This limit was generally exceeded (Tables 9-12). Only eight stations for the entire survey did not exceed this limit and four of those occurred in April.

Orthophosphate concentrations were highest at stations 1 and 2 during the survey. Concentrations generally decreased as the river moved downstream. (See Tables 9-12).

Concerning total phosphorus loadings (see Table 15) the April runoff period was the greatest. The Duck Valley Indian Reservation provided the greatest source of total phosphorus during the survey. The loadings varied but generally decreased downstream from the reservation. In October, December, and April the South Fork of the Owyhee River (station 10) was the greatest defined source of phosphorus below the reservation. The influence of the South Fork can be seen in Table 15 where the river loading between stations 6 and 7 were increased. The generally higher concentrations of nutrients at stations 1 and 2 are reflected in the increased algal biomass as compared with station 3 (see biological section).

Solids

The analyses for solids give an idea of the nonliquid portion of the material that the river is transporting.

Total solids (residue remaining after evaporation at ca. 105° C) showed a similar trend as did COD: The values were highest at stations 1 and 2; gradually decreased to station 6 and increased at station 7, again presumably because of the increased load of the South Fork of the Owyhee River. The concentration of total solids in the South Fork was usually nearly double that of the other tributaries. Slightly higher levels were present during the April runoff period.

Suspended solids (nonfiltrable residue) are that portion of total solids which exist in a nonliquid state and are dispersed in water to

give a heterogeneous mixture. The suspended solids were significantly greater at stations 1 and 2 again indicating disturbance from human related activities and livestock. Station 3 (pipeline crossing) usually showed a dramatic decrease in suspended solids. The suspended solids load in the river was variable as it moved downstream. Station 10 was also variable having the highest value on two of the sampling dates.

The Environmental Studies Board (1972) listed the following maximum concentrations of suspended solids and corresponding degrees of protection to aquatic life: high level of protection (25 mg/l); moderate (80); low (400); and very low ($>$ 400). Using these guidelines the entire river system usually falls in the "high level of protection" category and only in the April (spring runoff) period does it consistently drop to a lower level of protection. The highest values of 134 and 142 mg/l were found at stations 1 and 2 respectively during April.

It would be expected that during a "normal" runoff year these values would be increased and "low" and even "very low" levels of protection would occur during that high flow period.

The amounts of solids in a river system of this type may be one of the major limiting factors for aquatic life.

Turbidity

Turbidity is another measure of the amount of material being carried in a stream. The water quality standards of the State of Idaho state: "The turbidity other than of natural origin to [should not] exceed 5 Jackson Turbidity Units (JTU) [JTU = FTU]. Whenever the receiving water is greater than 5 JTU, due to conditions other than those caused by man, then no discharge and/or activity either alone or in combination with other wastewater or activity shall cause an increase of more than 5 JTU."

The turbidity was usually greatest at stations 1 and 2 and normally decreased downstream. The highest turbidity values occurred when expected, during the April sample period. (Table 9-12).

The tributaries occassionally increased the downstream turbidity slightly. In April Deep Creek (turbidity of 23 FTU) apparently increased the value for the river from 12 FTU at station 4 (below Battle Creek) to 17 FTU at station 5 (below Deep Creek).

The lowest turbidity values occurred during the December survey when very little stream channel scouring occurred.

Hardness

Hardness is a measure of the capacity of the water to precipitate soap which is due mainly to the concentration of calcium and magnesium ions. Hardness is expressed as the equivalent quantity of calcium carbonate ($CaCO_3$). McKee and Wolf (1963) define "good water" as usually being below 250 mg/l while Hem (1970) states that water having a hardness of over 180 mg/l is "very hard". At no time for the Owyhee River survey did the hardness exceed 180 mg/l. For the first three survey dates stations 1 and 2 had the highest values for hardness. The South Fork of the Owyhee River (station 10) had the highest values for the tributaries and was a main source of $CaCO_3$ for the Owyhee River system as station 7 (near Idaho-Oregon border) was always higher than station 6 (Crutcher's Crossing).

Metals

Trace (heavy) metals are important because of their toxic effects on living organisms. Cadmium (Cd), Copper (Cu), Lead (Pb), Manganese (Mn), Mercury (Hg) and Zinc (Zn) were examined at each of the sample stations during the survey. See Tables 9-12 for results and note that they are reported in ug/l (parts per billion).

No cadmium, lead or mercury were detected in the water on the dates surveyed.

Zinc was the most common trace metal encountered. It occurred at all stations during the October, December and April surveys and was found at stations 1 and 2 in August. Zinc may be a natural constituent in water and may also occur because of mining activities. The zinc values found were small and showed no particular pattern. The increased amount of zinc at stations 1 and 2 may indicate leaching from solid waste materials in the area.

Manganese has been recommended not to exceed 50 ug/l for domestic water supplies (U.S. Environmental Protection Agency, 1977). Nine of forty-one samples for this survey exceeded this criteria recommendation. Manganese always occurred at its highest concentrations at stations 1 and 2 for any given sample date, indicating possible human related pollution sources. The levels dropped off significantly downstream from the Duck Valley Indian Reservation, with the possible exception of the influence of station 10 (South Fork of the Owyhee River) in April. Manganese was found at station 10 but at none of the other tributaries.

Copper was only detected during April. It was found in decreasing amounts from stations 1 (Duck Valley Indian Reservation) through 3 (Pipeline Crossing). It decreased from 130 to 10 ug/l during that stretch of the river and was not detected again. This may also indicate a human related pollution source on the reservation. EPA (1977) gives 20 ug/l as the criteria for salmonids in soft water. Only two of the samples exceeded this limit, both on the Duck Valley Reservation.

Miscellaneous

The river was examined for surfactants during the August and October surveys. None were found hence the parameter was not examined on future surveys. These data indicate that this human related type of pollution was not a problem in the Owyhee River during this survey.

Sodium, potassium, chloride, and sulphate were examined and not found to occur in sufficient concentrations to be considered pollution problems. These data do, however, help characterize the water environment and provide background data for future studies.

Alkalinity is a measure of the buffering capacity of the water. Alkalinity varied in concentration in relation to flow and was found to be less prevalent during the April survey. Station 10 proved to be much more alkaline than the other tributaries.

Iron is another element that is common in natural waters. The Environmental Studies Board (1972) recommends that 0.3 mg/l not be exceeded in public water supply sources. No recommendations are made for other than public water supply sources. The iron concentration varied but usually did not exceed the 0.3 mg/l recommendation.

Silica was found in concentrations of 19.5 to 43 mg/l during the survey. The silica content was highest during the December survey possibly reflecting the greater abundance of diatoms at that time. The silica content was not sufficiently high enough to cause water quality problems. The silica content may also reflect the amount of finely divided or colloidal suspended matter present in the water.

There appears to be nothing in the chemical composition of the Owyhee River water from the border of the Duck Valley Indian Reservation (nearest station is #3 at Pipeline Crossing) to the Idaho/Oregon Border which would preclude consideration of this area for inclusion in the National Wild

and Scenic Rivers system.

Recreational usage of the river may involve its use as an emergency drinking water supply. The river water does not meet the Idaho State Drinking Water Standards for chemical parameters (IDHW, 1977) because it is untreated surface water. Specific parameters not meeting the standards outlined in IDHW (1977) and EPA (1969) are:

Parameter	Standard	% Samples Exceeding Standard
Turbidity	5 FTU	24
Iron	0.3 mg/l	24
Manganese	0.05 ug/l	24

The fluoride levels slightly exceeded the recommended maximum levels of about 1.4 - 1.8 mg/l four times with the highest value of 2.41 mg/l at station 6 (Crutcher's Crossing).

BIOLOGICAL PARAMETERS

Bacteriological Water Quality

The bacteriological water quality of the Owyhee River is good below the Duck Valley Indian Reservation between stations 3 (Pipeline Crossing) and 7 (Idaho-Oregon Border) (see Table 8 and Figure 4).

Fecal Streptococci were found to be present on the reservation. Positive results for Fecal Streptococci were found in much lower densities on the portion of the river under consideration for the Wild and Scenic Rivers system and the tributaries in the August and April surveys. None were found below the reservation during October and December. Fecal strep is a pathogen and an indication of fecal contamination from man and/or animals.

Bacteria of the Fecal Coliform group are also considered indicators of fecal contamination from warm-blooded animals. The State Water Quality Standards (IDECS, 1973) state that a violation occurs if a single sample exceeds 500 organisms per 100 ml of sample. One violation of this standard occurred at Station 2 (Duck Valley Indian Reservation) in August, when 670 organisms/100 ml was recorded. None of the samples of the Owyhee River below the reservation or on the tributaries exceeded this standard.

A second fecal coliform standard (geometric mean of 50/100 ml) was violated at Station 1 (Idaho/Nevada Border) for the study period. A geometric mean of 59/100 ml was found. This standard was not violated on the area under consideration for the Wild and Scenic Rivers system during this suvey.

The State Standard for total coliform bacteria is a geometric mean of 240/100 ml. This standard only applies "where associated with a fecal

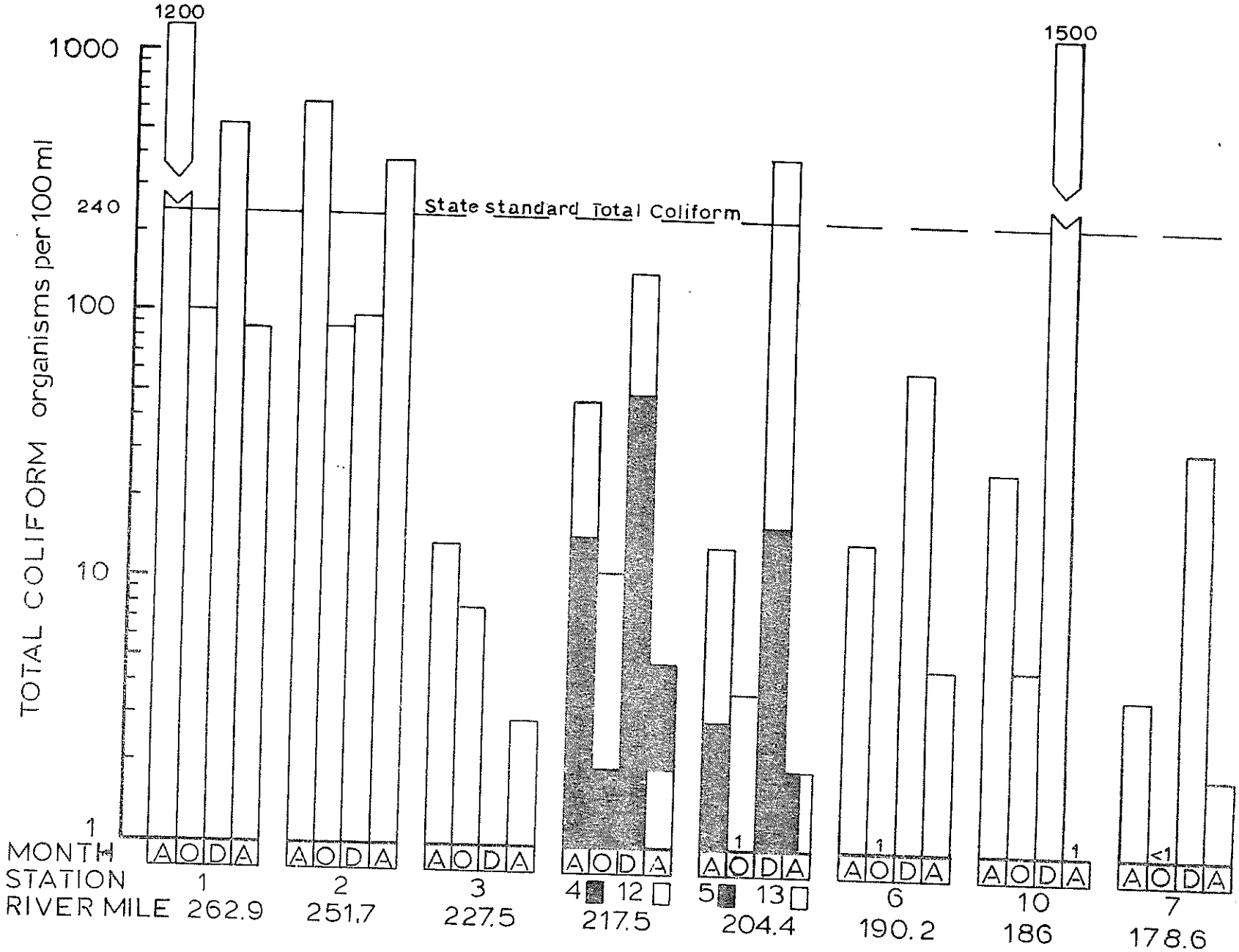

Figure 4. Total Coliform bacteria, Owyhee River Survey (1976-1977), compared with state standard. A = August, O = October, D = December 1976; A = April 1977.

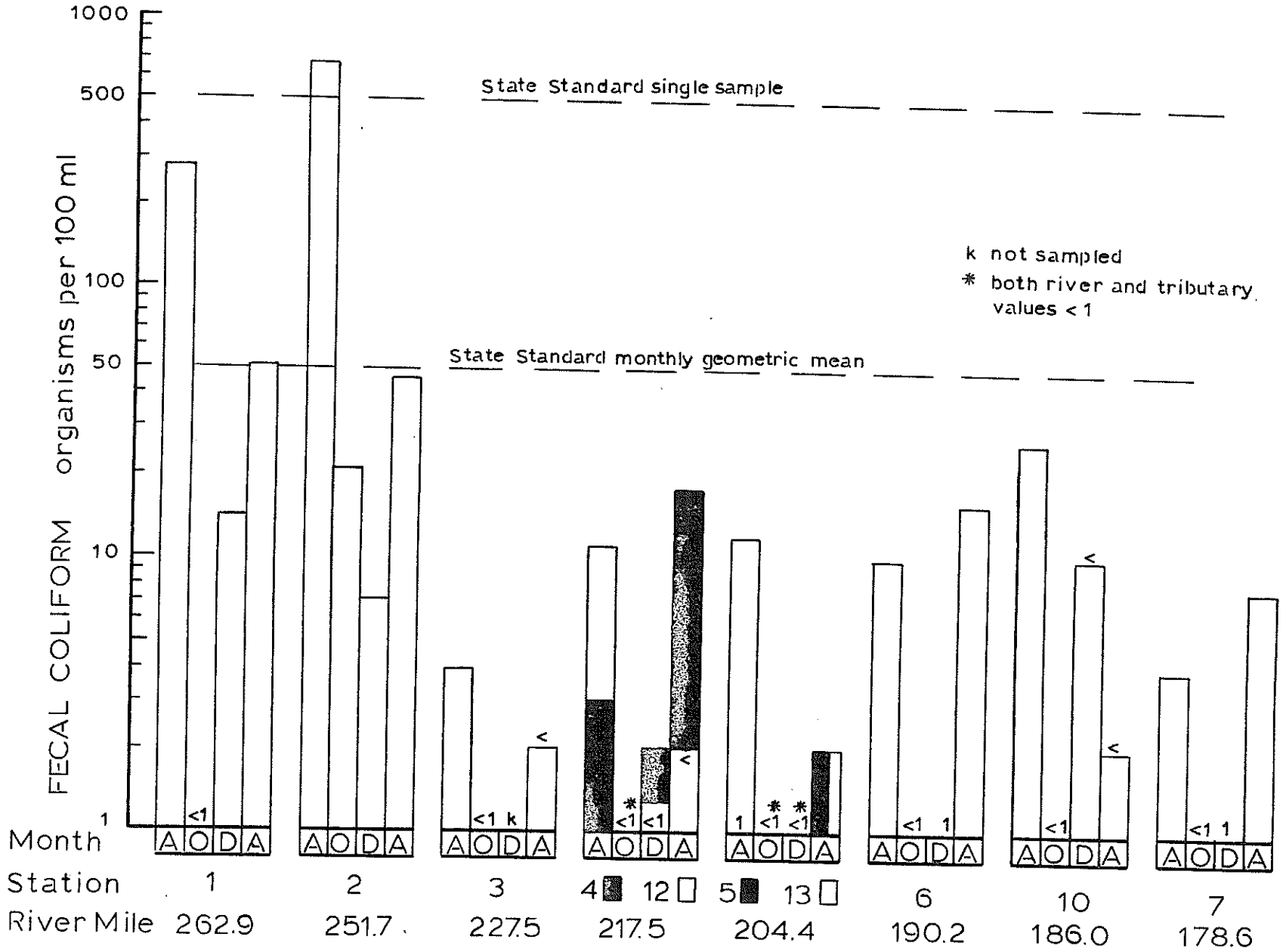

Figure 5. Fecal Coliform bacteria, Owyhee River Survey (1976-1977), compared with state standards. A = August, O = October, D = December 1976; A = April 1977.

source(s)" (IDECS,1973). It is assumed that the total coliform bacteria on the Duck Valley Indian Reservation are associated with a fecal source(s) (livestock and/or human). This standard was violated for Station 1 with a geometric mean of 275/100 ml. This standard was not violated at any other station during the survey.

Using the Fecal Coliform/Fecal strep ratio indicates that the majority of bacterial contamination on the reservation is mixed (human and livestock) origin (ratio of 0.7 - 4) (Clausen, et al., 1977). The ratios for the tributary stations in August appeared to also indicate mixed influence. Station 5 (Owyhee River below Deep Creek) had a ratio of 0.16 indicating livestock contamination (ratio of less than 0.7) (Clausen et al., 1977). The October and December surveys revealed little or no fecal strep and very little fecal coliform bacteria for all stations below the reservation (see Table 8 and Figure 4) making calculation of the ratio not possible.

The April survey yielded interesting results concerning fecal strep contamination. Fecal strep was found at nearly all stations in April as they were in August. What was significant about the April sampling was the fact that five of the stations (1, 3, 5, 10, and 13) had higher fecal strep counts than fecal coliform and at some stations higher counts than total coliform bacteria. This indicates contamination from mammals, probably livestock via runoff.

ATTACHED ALGAE

Floating plexiglass periphyton samplers using standard glass slides for substrates were placed at Stations 1, 3, and 6, July 20-21, 1976. Two samplers each from Stations 1 and 3 were recovered on September 20-21. The samplers at Station 6 were washed up onto the shore and stranded by

storm caused high water (1-2 feet above normal) a week prior (Dennis Swisher, Personal Communication).

The chlorophyll a for the two stations are as follows:

STATION	ug/slide chlorophyll a	n	$\bar{X}$ Chlorophyll a ug/slide
#1 (Idaho/Nevada Border)	105 134	2 5	
			119.5
#3 (Pipeline Crossing)	66 50	2 5	
			58

The algal biomass as indicated by chlorophyll a values supports the nutrients trend at these stations: higher nutrient values at Station 1 compared to Station 3. The August and October survey results yielded results of higher nitrogen and phosphorus concentrations at Stations 1 and 2, compared with downstream stations. Similar trends were shown for the chemical parameters on the December and April surveys.

MACROINVERTEBRATES

Rock basket samplers for benthic macroinvertebrates were placed at the same stations and same times as those for attached algae. Samplers were recovered at all these stations, however. Complete species composition and numbers of the macroinvertebrate samples are listed in Table 17. Table 18 shows the diversity ($\bar{d}$) values for the three stations.

NON-INSECT MACROINVERTEBRATES

Non-insect invertebrates were found at all Stations. Acari (water mites) were collected only at Station 1. Because of the very small size of the mites it is possible that they escaped collection at the other two stations.

Pennak (1953) and Barr (1973) state that aquatic mites are usually found in shallows on aquatic vegetation. The lack of aquatic vegetation near the collection location at Station 6 may also explain this absence. Most mites are carnivorous or parasitic.

The Mollusca were represented only by Gastropoda (snails). Four species representing four genera were found. These organisms are plant feeders and found in most water types.

Turbellaria were found only at Station 1. Since only one flatworm was found they are assumed to be of little importance in the Owyhee River system.

The Annelida were represented by leeches and other worms. Leeches occur naturally in streams and were found in such small numbers that they are not considered to indicate any particular pollution problems.

INSECTA

Aquatic insects comprised the major portion of the macroinvertebrate communities sampled.

EPHEMEROPTERA

Mayflies are algal and detritus feeders and generally are considered to be found in clean water although Roback (1974) notes that they are not as pollution sensitive as has been assumed in the past. Mayflies were absent from Station 1 but were common at Stations 3 and 6. Station 1 apparently was not a favorable habitat for them.

PLECOPTERA

Stoneflies are considered inhabitants of non-polluted waters. They were found only at Station 6. Stoneflies may be carnivorous or detritus feeders.

ODONATA

The nymphal stages of the damselflies are predaceous. Pennak (1953) states that these are rare in polluted waters. They occurred at Stations 3 and 6.

COLEOPTERA

The aquatic beetles (Elmidae and Psephenidae) are of water quality significance. The larvae of both of these beetles and the adults of the Elmidae are truly aquatic. Young (1961) and Sinclair (1964) note that the Elmidae (riffle beetles) are very sensitive to pollution and disappear from polluted waters. These groups may be one of our best pollution indicators. They were only found at Stations 3 and 6 indicating good water quality at these sites.

TRICHOPTERA

Caddisflies were common at Stations 3 and 6. They were found in good diversity at these stations. Only 1 specimen was recovered at Station 1, again indicating an unfavorable habitat there. These larvae are usually omnivorous.

DIPTERA

Flies were found at all stations sampled. They occur in a wide range of waters ranging from clean to polluted.

The species composition of the 3 stations sampled and the diversity valued obtained indicate that the water quality improved slightly below Station 1. The species diversity index most commonly used (0-1 = polluted, 1-2.5 = unstable, and 2.5-3 = unpolluted) indicates that there are presently no serious water quality problems on the river.

CONCLUSIONS

The main stem of the Owyhee River (East Fork of Owyhee River) in Idaho below the Duck Valley Indian Reservation is of excellent water quality and suitable from that standpoint to be included in the National Wild and Scenic Rivers System.

The Duck Valley Indian Reservation and its human related activities appear to be sources of nutrients, solids, turbidity, trace metals, and bacteria to the downstream Owyhee River System. Because there are no other significant sources, the river appears to recover rapidly and is in good condition at station 3 (Pipeline Crossing). The river is of high water quality from here to the Idaho-Oregon border.

The South Fork of the Owyhee River (station 10) appears to be the only major source of nutrients, solids, turbidity, trace metals, and bacteria downstream from the western boundary of the Duck Valley Indian Reservation to the Idaho-Oregon border.

RECOMMENDATIONS

1. The Idaho portion of the Owyhee River generally meets water quality standards and, therefore, should be considered to meet the criteria for inclusion into the National Wild and Scenic River System.

2. It is recommended that the agency involved in administering the Owyhee Wild and Scenic River in Idaho take all necessary precautions required to preserve and not degrade the water quality of the river system and hence not violate the antidegradation section of the State of Idaho's water quality standards.

3. For public health requirements it is recommended that all surface waters be treated before human consumption.

4. A more detailed assessment of the nonpoint source contribution to the Owyhee River System should be made especially in reference to the Duck Valley Indian Reservation and to the South Fork of the Owyhee River.

ACKNOWLEDGEMENTS

Laura Townsend, past Chairman of the Shoshone-Paiute Business Council, Owyhee, Nevada, gave permission to sample on the Duck Valley Indian Reservation.

Thanks are extended to Mr. Dennis Swisher for providing access to Crutcher's Crossing and for other assistance during the survey.

REFERENCES CITED

Barr, D. 1973. Methods for the Collection, Preservation, and Study of Water Mites (Acari: Parasigegona). Royal Ontario Museum of Life Sciences, Misc. Publication, pp. 1-28).

Clausen, E. M., B. L. Green, and W. Litsky. 1977. Fecal streptococci: indicators of pollution IN: A. W. Hoadley and B. J. Dutka, Eds. Bacterial indicators/health hazards associated with water. Amer. Soc. Testing Materials #635: 247-264.

Environmental Studies Board. 1972. Water quality criteria 1972. U.S. Environmental Protection Agency, Washington, D.C. 594 pp.

Gullidge, E. J. Ed. 1972. Main report Columbia-North Pacific Region comprehensive framework study. Pacific NW River Basins Comm., Vancouver, Washington. 373 pp.

Hem, J. D. 1970. Study and interpretation of the chemical characteristics of natural water. U. S. Geological Survey Water-Supply Paper 1472. 363 pp.

Henderson, D. M., F. D. Johnson, P. Packard, and R. Steele. 1977. Endangered and threatened plants of Idaho. Univ. Idaho Forest, Wildlife Range Expt. Sta., Bull. 21: 1-72.

Idaho Department of Environmental and Community Services. 1973. Water quality standards and wastewater treatment requirements. Idaho Department of Environmental and Community Services, Boise. 19 pp.

Idaho Department of Health and Welfare. 1974. Annual summary of vital statistics. Idaho Department of Health and Welfare, Boise. 92 pp.

Idaho Department of Health and Welfare. 1977. Idaho regulations for public drinking water systems. Idaho Department of Health and Welfare, Boise. 44 pp.

Idaho Department of Water Resources. 1976. Conclusions and recommendations for the state water plan - part II Snake River Basins. IDWR, Boise. 116 pp.

Kuchler, A. W. 1964. Potential natural vegetation of the conterminous United States. American Geographical Society. Special Publication No. 36. 116 pp + map.

Lloyd, M., H. Zar and J. R. Karr. 1968. On the calculation of information - theoretical measures of diversity. Amer. Midl. Natur. 79: 257-272.

McHugh, R. A. 1972. An interim study of some physical, chemical and biological properties of selected Oregon lakes. Oregon State Department of Environmental Quality, Portland. 122 pp.

McKee, J. E., and H. W. Wolf, Eds. 1963. Water Quality Criteria. California State Water Resources Control Board, Sacramento, California. 94 pp.

Pennak, R. W. 1953. Fresh Water Invertebrates of the United States. The Ronald Press Company, New York. 769 pp.

Rice, K. A. 1971. Climate of Idaho. U. S. Department of Commerce, NOAA, Climatography of the U.S. 60-10: 1-18.

Riggs, H. C., and W. A. Warenberg. 1966. Floor Characteristics of Streams in Owyhee County, Idaho. U.S. Geological Survey. Water Res. Invest., Open-File Department. 76-88. 14 pp.

Roback, S. S. 1974. Insects (Arthropoda: Insecta). Pp. 313-76. IN: C. W. Hart, Jr., S. L. H. Fuller Eds. Pollution Ecology of Freshwater Invertebrates. Academic Press, New York.

Ross, S. H., and C. N. Savage. 1967. Idaho Earth Sciences. Idaho Bureau of Mines and Ecology, Earth Sciences Series, No. 1. 271 pp.

Sawyer, C. N. 1947. Fertilization of Lakes by Agricultural and Urban Drainage. Jour. New England Water Works Assoc. 61: 109-137.

Sinclair, R.M. 1964. Water Quality Requirements of the Family Elmidae (Coleoptera). Tenn. Stream Poll. Control Board. 14 pp.

Tangarone, D. R., B. Bogue. 1975. Weiser-Lower Payette water quality surveys. EPA working paper 910-8-76-098. Seattle, Washington. 192 pp.

U. S. Bureau of Outdoor Recreation. 1976a. Owyhee wild and scenic river study, a summary of the federal-state study team findings and management alternatives. BOR, NW Regional Office, Seattle. 17 pp.

U. S. Bureau of Outdoor Recreation. 1976b. Preliminary draft environmental statement, proposed designation of the Owyhee River as an element of the National Wild and Scenic Rivers System. BOR, NW Regional Office, Seattle. 95 pp.

U. S. Bureau of Outdoor Recreation. 1976c. Owyhee River Study, preliminary. BOR, NW Regional Office, Seattle. 119 pp.

U. S. Department of Agriculture. 1976. Land of Idaho, a report on soil and water conservation. Soil Conservation Services, U. S. Department of Agriculture, Boise. 13 pp.

U. S. Department of Agriculture. 1977a. Water supply outlook for Idaho, as of February 1, 1977. USDA, SCS.

U. S. Department of Agriculture. 1977b. Water supply outlook for Idaho, as of March 1, 1977. USDA, SCS.

U. S. Environmental Protection Agency. 1969. Manual for evaluating public drinking water supplies. USEPA, Washington, D.C. 62 pp.

U. S. Environmental Protection Agency. 1974. Manual of methods for chemical analysis of water and wastes. USEPA, Washington, D.C. 298 pp.

U. S. Environmental Protection Agency. 1977. Quality Criteria for Water, 1976. USEPA, Washington, D.C. 256 pp.

U. S. Geological Survey. 1976. Water resources data for Idaho water year 1975. USES Water-Data Report ID-75-1. 684 pp.

Weber, C. I., Ed. 1973. Biological field and laboratory methods for measuring the quality of surface waters and effluents. U.S. Environmental Protection Agency, Washington, D.C.

Young, F. N. 1961. Effects of Pollution on Natural Associations of Water Beetles. Purdue Univ. Eng. Bull., Eng. Serv. 15:373-80.

TABLE 1

SAMPLE STATIONS, OWYHEE RIVER SURVEY

Station No.	Storet No.	Station Name	Owyhee River Mile	Latitude (N)	Longitude (W)	Township	Range	Section	Eleva
1	2040058	Owhyee River, E.Fk., Idaho/ Nev. Border, Duck Valley Indian Reservation	262.9	42° 00'	116° 09'	16S	3E	30	5400' (16
2	2040059	Owyhee River, E.Fk., Duck ValleyIndian Res. near canyon head	251.7	42° 04'	116° 16'	16S	2E	9	5300' (16
3	2040060	Owyhee River, E.Fk., Pipeline crossing	227.5	42° 10'	116° 30'	14S	1W	31	5000' (152
4	2040061	Owyhee River, E.FK.. below confluence of Battle Creek	217.5	42° 14'	116° 31'	14S	2W	1	4600' (140
5	2040062	Owyhee River, E.Fk., below confluence of Deep Creek	204.4	42° 16'	116° 38'	13S	3W	25	4600' (140
6	2040063	Owyhee River, E.Fk., Crutcher's Crossing	190.2	42° 16'	116° 51'	13S	5W	25	4400' (134
7	2040064	Owyhee River, E.Fk., Idaho/ Oregon Border	178.6	42° 23'	117° 03'	13S	6W	3	4200' (128
10	2040067	Owyhee River, S.Fk., mouth	186.0/0.1	42° 16'	116° 53'	13S	5W	26	4200' (128
12	2040069	Battle Creek, mouth	217.5/0.1	42° 15'	116° 32'	14S	2W	1	4600' (140
13	2040070	Deep Creek, mouth	204.4/0.1	42° 16'	116° 38'	13S	3W	25	4600' (140
14	2040071	Red Canyon Creek, mouth	191.6/0.1	42° 17'	116° 50'	13S	4W	20	4400' (134

*Est. to nearest 100' (30 m)

TABLE 2

TEMPERATURE, OWYHEE RIVER SURVEY, 1976-1977, °C.

Station	July 21-22	Aug. 16	Sept. 20-21	Oct. 20	Dec. 21	April 7
EAST FORK OWHYEE RIVER						
1. Ida/Nev. Border	23	8.7	15	1	-0.4	4.5
Time*	(1200)	(0820)	(1255)	(0930)	(0925)	(1000)
2. Duck Valley	--	8.7	--	3.5	-0.7	5.1
		(0845)		(1000)	(0950)	
3. Pipeline Crossing	23					
	19	13	14	5.5	-0.6	9.7
Time*	(2000)					
	(0800)	(1910)	(1500)	(1050)	(1020)	
4. Below Battle Creek	--	12.7	--	6	-0.5	9.4
Time*		(0943)		(1120)	(1025)	
5. Below Deep Creek	--	12.7	--	4.9	-0.7	8.8
Time*		(1015)		(1215)	(1125)	
6. Crutcher's Crossing	26	14.5	14	6.8	-0.8	10,2
Time*	(1800)	(1115)	(0830)	(1330)	(1210)	
7. Ida/Ore Border	--	15	--	5.8	-0.7	12,4
Time*		(1230)		(1500)	(1320)	(1500)
TRIBUTARIES						
10. South Fork Owy. River	--	13	--	6.4	-.07	14
Time*		(1150)		(1415)	(1250)	
12. Battle Creek	--	13.2	--	6.2	-0.5	7.0
Time*		(0945)		(1140)	(1045)	
13. Deep Creek	--	12	--	3.8	-0.7	8.0
Time*		(1028)		(1215)	(1125)	
14. Red Canyon Creek	--	12	--	--	--	
Time*		(1100)				

-- STATION NOT SAMPLED
* ALL TIME MDT

TABLE 3

TEMPERATURE (MINIMUM-MAXIMUM, °C) STATIONS 3 (Pipeline Crossing) and 6 (Crutchers Crossing) OWYHEE RIVER SURVEY for JULY & AUGUST 1976.

DATE	STATION 3 (Pipeline Crossing)				STATION 6 (Crutchers Crossing)			
	Minimum	(†ime)*	Maximum	(†ime)*	Minimum	(†ime)*	Maximum	(†ime)*
JULY 21	16	(0900)	20	(1900)	---	---	---	---
22	17	(1000)	20.2	(1800)	---	---	---	---
23	18	(1100)	20	(0400)	23	(0700)	24.5	(2400)
24	16	(1100)	19	(2400)	21	(0600)	23.5	(1700)
25	18.8	(1100)	19.5	(0200)	21	(0700)	24	(1600)
26	18	(1200)	20.5	(0400)	21.5	(0700)	24	(1600)
27	19	(1300)	20.5	(0600)	22	(0600)	25	(1500)
28	18.5	(1400)	20.3	(0600)	22	(0600)	24	(1600)
29	---	---	---	---	22.5	(1100)	23.5	(0100)
30	---	---	---	---	22	(0700)	23.5	(1700)
Mean Min-Max	17.4		20		21.9		24	
Mean of Overlap days only (July 23-28)	17.7		20		21.8		24.1	
AUGUST 16	9.5	(1400)	10	(2400)	---	---	---	---
17	10.5	(0600)	11	(2400)	14.5	(0900)	15.1	(1800)
18	9.5	(2100)	11	(0800)	14.5	(1000)	16	(2100)
19	9	(2400)	11	(1200)	14.5	(0500)	18	(2400)
20	9	(2400)	14.5	(2000)	16.5	(0500)	19.5	(2200)
21	11	(0700)	16	(2400)	17.5	(0500)	21	(2100)
22	13	(1300)	16	(2000)	18.5	(2400)	20.5	(0100)
23	14.5	(2300)	17	(0800)	17.5	(1000)	19.5	(1700)
24	---	---	---	---	17.3	(0500)	20	(2000)
Mean Min-Max	10.8		13.3		16.4		18.8	
Mean of Overlap days only (August 17-23)	10.9		13.8		16.2		18.6	

--- NO DATA RECORDED
* ALL TIME MDT

TABLE 4

DISSOLVED OXYGEN, OWHYEE RIVER SURVEY, 1976-1977
(mg/l and Percent Saturation)

Station	July 21-22 mg/l % Sat.	August 16 mg/l % Sat.	Sept. 20-21 mg/l % Sat.	October 20 mg/l % Sat.	December 21 mg/l % Sat.	April 7 mg/l % Sat.
E.FK. OWYHEE RIVER						
1. Ida/Nev. Bdr. Time*	11.8 162% (1200)	8.1 85% (0820)	9.6 117% (1255)	8.4 74% (0930)	8.8 74% (0925)	9. 84% (1000)
2. Duck Valley Time*	---	6.6 68% (0845)	---	6.2 57% (1000)	9.6 79% (0950)	9.3 88%
3. Pipeline Crossing Time*	7.4 100% 7.5 96% (2000) (0800)	8.6 96% (0910)	8.8 101% (1500)	9.1 85% (1050)	12.0 97% (1020)	8.9 93%
4. Below Battle Creek Time*	---	7.0 77% (0943)	---	9.0 84% (1120)	11.4 92% (1025)	9.5 98%
5. Below Deep Creek Time*	---	8.1 90% (1015)	---	9.5 87% (1215)	12.1 96% (1125)	9.5 96%
6. Crutcher's Crossing Time*	9.1 128% (1800)	8.0 91% (1115)	8.0 97% (0830)	9.9 93% (1330)	12.3 97% (1210)	9.0 93%
7. Ida/Ore Bdr. Time*	---	9.2 104% (1230)	---	6.6 62% (1500)	12.4 96% (1320)	9.6 104% (1500)
TRIBUTARIES						
10. S.F. Owhyee River Time*	---	8.7 95% (1150)	---	8.9 83% (1415)	12.4 96% (1250)	9.2 102%
12. Battle Creek Time*	---	7.4 83% (0945)	---	8.9 85% (1140)	11.3 82% (1045)	9.3 89%
13. Deep Creek Time*	---	8.3 90% (1028)	---	9.7 86% (1215)	11.7 94% (1125)	10.0 94%
14. Red Canyon Creek Time*	---	10.0 106% (1100)	---	---	---	

--- Station Not Sampled
* All Time MDT

TABLE 5

pH VALUES, OWHYEE RIVER SURVEY, 1976-1977

Station	July 21-22	August 16	Sept. 20-21	October 20	December 21	April 7
E.FK. OWYHEE RIVER						
1. Ida/Nev. Bdr. Time*	8.3 (1200)	8.2 (0820)	7.7 (1255)	7.2 (0930)	7.5 (0925)	6.9 (1000)
2. Duck Valley Time*	---	8.0 (0845)	---	7.7 (1000)	7.6 (0950)	7.3
3. Pipeline Crossing Time*	8.7 8.6 (2000) (0800)	8.8 (0910)	8.0 (1500)	8.4 (1050)	8.2 (1020)	7.9
4. Below Battle Creek Time*	---	8.5 (0943)	---	8.6 (1120)	8.0 (1025)	7.6
5. Below Deep Creek Time*	---	8.4 (1015)	---	8.3 (1215)	7.9 (1125)	7.28
6. Crutcher's Crossing Time*	8.5 (1800)	8.7 (1115)	7.3 (0830)	8.6 (1330)	8.0 (1210)	7.3
7. Ida/Ore Bdr. Time*	---	8.9 (1230)	---	8.7 (1500)	8.4 (1320)	8.45 (1500)
TRIBUTARIES						
10. S.F. Owhyee River Time*	---	8.8 (1150)	---	8.8 (1415)	8.4 (1250)	8.3
12. Battle Creek Time*	---	8.0 (0945)	---	7.9 (1140)	7.4 (1045)	7.5
13. Deep Creek Time*	---	8.1 (1028)	---	8.0 (1215)	7.6 (1125)	7.7
14. Red Canyon Creek Time*	---	8.7 (1100)	---	---	---	

--- Station Not Sampled
* All Time MDT

TABLE 6

SPECIFIC CONDUCTANCE, OWYHEE RIVER SURVEY, 1976-1977
(umhos/cm)

Station	August 16	October 20	December 21	April 7
E.FK. OWYHEE RIVER				
1. Ida/Nev. Bdr.	72	212	56	40
Time*	(0820)	(0930)	(0925)	(1000)
2. Duck Valley	64	220	74	46
Time*	(0845)	(1000)	(0950)	
3. Pipeline Crossing	62	216	64	80
Time*	(0910)	(1050)	(1020)	
4. Below Battle Creek	56	218	52	66
Time*	(0943)	(1120)	(1025)	
5. Below Deep Creek	50	130	42	28
Time*	(1015)	(1215)	(1125)	
6. Crutcher's Crossing	62	182	28	46
Time*	(1115)	(1330)	(1210)	
7. Ida/Ore Bdr.	76	232	68	84
Time*	(1230)	(1500)	(1320)	(1500)
TRIBUTARIES				
10. S.F. Owhyee River	90	290	64	118
Time*	(1150)	(1415)	(1250)	
12. Battle Creek	34	95	28	35
Time*	(0945)	(1140)	(1045)	
13. Deep Creek	32	86	26	18
Time*	(1028)	(1215)	(1125)	
14. Red Canyon Creek	30	---	---	
Time*	(1100)			

--- Station Not Sampled
* All Time MDT

TABLE 7

FLOW (CFS), OWYHEE RIVER SURVEY, 1976-1977

Station	July 21-22	August 16	Sept. 20-21	October 20	December 21 **	April
E.FK. OWYHEE RIVER						
1. Ida/Nev. Bdr.	---	90*	45	6	5*	153
2. Duck Valley	---	90*	---	8*	10*	130*
3. Pipeline Crossing	93	93*	94	26	20*	121
4. Below Battle Creek	---	100*	---	40	37	---
5. Below Deep Creek	---	120*	---	44	40*	144
6. Crutcher's Crossing	116	122*	---	53	50*	184*
7. Ida/Ore Bdr.	---	160*	---	103	100*	298*
TRIBUTARIES						
10. S.F. Owhyee River	---	36*	---	51	50*	114
12. Battle Creek	---	10*	---	12	6	15
13. Deep Creek	---	20*	---	6	5*	64
14. Red Canyon Creek	---	3*	---	---	---	---

--- Station Not Sampled
* Flow Estimated
** All Stations Partly Frozen

Table 8. BACTERIOLOGICAL DATA

Owyhee River Survey. 1976-1977
(colonies/100 ml)

STATIONS	August 16, 1976			October 20, 1976			Dec. 21, 1976			April 7, 1977		
	Total	Fecal	Fecal Strep	Total	Fecal	Fecal Strep	Total	Fecal	Fecal Strep	Total	Fecal	Fecal Strep
E.FK. OWYHEE RIVER												
1. Ida/Nev Border	1200	280	120	100	<1	20	530	14	<100	90	52	100
2. Nr. Canyon Head	650	670	260	90	21	10	100	7	<100	140	44	44
3. Pipeline Crossing	14	4	<2	8	<1	<5	*	*	*	3	<2	12
4. Below Bt. Creek	15	3	<2	2	<1	<5	52	2	<10	5	18	2
5. Below Deep Cr.	3	1	6	1	<1	<5	16	<1	<10	2	2	4
6. Crutcher's Crossing	15	10	2	1	<1	<5	68	1	<10	5	16	6
7. Ida/Ore Border	4	4	2	<1	<1	<5	35	1	<10	2	8	2
TRIBUTARIES												
10. South Fork, Mouth	28	26	6	5	<1	<5	1500	<1	<10	1	<2	4
12. Battle Cr. Mouth	15	11	2	11	<1	<5	150	<1	<10	<2	<2	<2
13. Deep Cr. Mouth	14	12	2	4	<1	<5	420	<1	<10	2	2	10
14. Red Canyon Cr. Mouth	320	200	30	--	--	--	--	--	--	--	--	--

-- Station not sampled
* Laboratory Accident

Table 9a. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, August 16, 1976

Parameter	Owyhee River Stations 1	2	3	4	5	6	7
Chemical Oxygen Demand	21.3	22	15.6	14.0	78	12.3	11.9
Nitrate (as N)	<0.002	<0.002	<0.002	0.011	0.013	0.002	<0.002
Nitrite (as N)	0.001	0.005	0.002	0.003	0.002	0.002	0.001
Ammonia (as N)	0.016	0.033	0.016	0.016	0.115	0.008	0.008
Total Kjeldahl Nitrogen (as N)	1.8	1.0	0.8	1.7	0.9	0.8	1.1
Total Phosphorus (as P)	0.17	0.14	0.06	0.07	0.04	0.05	0.02
Ortho Phosphate (as P)	0.06	0.34	0.02	0.03	0.06	0.09	0.06
Total Solids	262	130	178	163	141	155	194
Suspended Solids	38	20	9	7	9	15	9
Volatile Suspended Solids	2	7	5	7	4	6	2
Turbidity (FTU)	11	10	3	4.5	3.5	2.8	3.2
Hardness (as $CaCO_3$)	140	128	112	96	84	88	124
Calcium (as Ca)	38	35	27	22	21	22	26
Alkalinity (as $CaCO_3$)	152	140	120	108	100	208	132
Iron	0.36	0.62	0.12	0.12	0.14	0.09	0.11
Sodium	16.7	14.7	15.6	14.5	15.4	18.4	23.9
Potassium	3.6	4.3	3.6	3.5	3.4	3.2	4.1
Chloride	12	8	10	10	16	8	12
Sulphate (as SO_4)	16	16	14	13	12	14	16
Silica (as SiO_2)	27.5	22.3	20.5	22.3	20.5	20	25.5
Fluoride (as F Dissolved)	0.32	0.32	0.94	0.89	1.14	1.62	1.61
Cadmium (ug/l)	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Copper (ug/l)	<10	<10	<10	<10	<10	<10	<10
Lead (ug/l)	<10	<10	<10	<10	<10	<10	<10
Manganese (ug/l)	20	90	10	10	<10	<10	<10
Mercury (ug/l)	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Zinc (ug/l)	1	14	< 1	< 1	< 1	< 1	< 1
Surfactants	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08

Table 9b. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, August 16, 1976

Tributary Stations

Parameter	10 (S.Fk Owyhee)	12 (Battle Cr.)	13 (Deep Cr.)	14 (Red Canyon Cr.)
Chemical Oxygen Demand	11.5	5.4	7.0	6.6
Nitrate (as N)	0.002	0.003	0.002	0.018
Nitrite (as N)	0.002	0.002	0.001	0.004
Ammonia (as N)	0.025	0.016	0.008	0.016
Total Kjeldahl Nitrogen (as N)	0.9	1.0	0.5	1.1
Total Phosphorus (as P)	0.06	0.03	0.06	0.07
Ortho Phosphate (as P)	0.12	0.06	0.06	0.15
Total Solids	240	112	95	109
Suspended Solids	9	14	13	16
Volatile Suspended Solids	4	7	2	9
Turbidity (FTU)	3.4	5.4	1.1	5.0
Hardness (as $CaCO_3$)	124	44	48	28
Calcium (as Ca)	30	10	11	6
Alkalinity (as $CaCO_3$)	164	60	56	48
Iron	0.06	0.09	0.05	0.17
Sodium	31.4	12.3	9.6	15.3
Potassium	4.7	3.5	3.2	1.3
Chloride	6	6	8	4
Sulphate (as SO_4)	21	<10	<10	11
Silica (as SiO_2)	32.3	33.8	21.5	30.0
Fluoride (as F Dissolved)	1.66	1.24	0.46	2.45
Cadmium (ug/l)	< 5	< 5	< 5	< 5
Copper (ug/l)	<10	<10	<10	<10
Lead (ug/l)	<10	<10	<10	<10
Manganese (ug/l)	10	<10	10	<10
Mercury (ug/l)	< 5	< 5	< 5	< 5
Zinc (ug/l)	< 1	< 1	< 1	< 1
Surfactants	<0.08	<0.08	<0.08	<0.08

Table 10a. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, October 20, 1976

Owyhee River Stations

Parameter	1	2	3	4	5	6	7
Chemical Oxygen Demand	8.5	12.4	10.3	11.1	3.0	3.0	6.0
Nitrate (as N)	0.009	<0.002	<0.002	<0.002	0.014	0.007	0.002
Nitrite (as N)	0.001	0.005	0.003	0.005	0.001	0.001	0.001
Ammonia (as N)	0.008	0.041	0.016	0.033	0.016	0.016	0.025
Total Kjeldahl Nitrogen (as N)	0.6	0.7	1.1	0.9	0.7	1.2	0.7
Total Phosphorus (as P)	0.12	0.08	0.09	0.18	0.03	0.01	0.04
Ortho Phosphate (as P)	0.035	0.026	0.013	0.017	0.004	0.002	0.012
Total Solids	231	224	206	209	117	171	214
Suspended Solids	20	12.5	3	9	6.5	3.5	4.5
Volatile Suspended Solids	3	2	1	2	1	1	1
Turbidity (FTU)	2.2	5.4	3.4	5.7	2.6	2.7	2.3
Hardness (as $CaCO_3$)	148	142	114	118	52	78	108
Calcium (as Ca)	46.4	40	35.2	32.0	11.2	22.4	28.3
Alkalinity (as $CaCO_3$)	158	154	134	130	60	94	130
Iron	0.21	0.31	0.18	0.26	0.13	0.50	0.10
Sodium	16.0	17.4	19.7	19.4	11.5	18.6	25.1
Potassium	3.1	3.6	3.9	4.0	3.0	3.4	4.2
Chloride	7	9	9	9	6	8	11
Sulphate (as SO_4)	18.5	20.2	18.0	20	10.2	19	23
Silica (as SiO_2)	28.2	24.2	27.5	25.1	24.3	26.0	29.3
Fluoride (as F Dissolved)	0.31	0.33	1.49	1.35	0.74	1.95	1.71
Cadmium (ug/l)	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Copper (ug/l)	<10	<10	<10	<10	<10	<10	<10
Lead (ug/l)	<10	<10	<10	<10	<10	<10	<10
Manganese (ug/l)	100	260	10	50	10	10	10
Mercury (ug/l)	< 5	< 5	9	< 5	< 5	< 5	< 5
Zinc (ug/l)	6	8	7	8	4	52	5
Surfactants	< 0.08	< 0.08	---	< 0.08	< 0.08	< 0.08	< 0.08

--- Data Not Reported
* In mg/l unless otherwise indicated

Table 10b. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, October 20, 1976

Tributary Stations

Parameter	10 (S. Fork Owyhee)	12 (Battle Cr.)	13 (Deep Cr.)
Chemical Oxygen Demand	12.4	3.4	3.4
Nitrate (as N)	<0.002	0.002	0.009
Nitrite (as N)	0.001	0.002	<0.001
Ammonia (as N)	0.025	0.016	0.016
Total Kjeldahl Nitrogen (as N)	0.5	1.3	1.0
Total Phosphorus (as P)	0.04	0.01	0.03
Ortho Phosphate (as P)	0.005	0.009	0.004
Total Solids	161	111	95
Suspended Solids	6	3	2.5
Volatile Suspended Solids	1	2	2
Turbidity (FTU)	2.5	3.0	1.7
Hardness (as $CaCO_3$)	140	74	36
Calcium (as Ca)	32.0	9.6	11.2
Alkalinity (as $CaCO_3$)	168	54	52
Iron	0.11	0.14	0.11
Sodium	32.7	12.8	10.0
Potassium	5.0	3.5	2.9
Chloride	9	7	6
Sulphate (as SO_4)	28.5	<10	<10
Silica (as SiO_2)	33.0	33.0	24.1
Fluoride (as F Dissolved)	1.61	1.18	0.45
Cadmium (ug/l)	< 5	< 5	< 5
Copper (ug/l)	<10	<10	<10
Lead (ug/l)	<10	<10	<10
Manganese (ug/l)	10	<10	<10
Mercury (ug/l)	< 5	< 5	< 5
Zinc (ug/l)	3	8	6
Surfactants	< 0.08	<0.08	<0.08

* In mg/l unless otherwise indicated

Table 11a. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, December 21, 1976

Parameter	Owyhee River Stations 1	2	3	4	5	6	7
Chemical Oxygen Demand	4.8	9.6	7.6	3.6	3.6	5.2	4.8
Nitrate (as N)	0.20	0.07	0.23	0.24	0.19	0.18	0.19
Nitrite (as N)	0.004	0.014	0.006	0.007	0.004	0.003	0.004
Ammonia (as N)	0.03	0.04	0.03	0.02	0.01	0.02	0.02
Total Kjeldahl Nitrogen (as N)	0.4	0.6	0.7	0.7	0.8	0.57	0.76
Total Phosphorus (as P)	0.10	0.13	0.10	0.07	0.07	0.09	0.15
Ortho Phosphate (as P)	0.047	0.048	0.023	0.017	0.008	0.004	0.013
Total Solids	245	279	249	231	210	204	260
Suspended Solids	7	16	11	7	11	4	2
Volatile Suspended Solids	2	9	9	4	7	4	2
Turbidity (FTU)	1.4	8.0	2.7	4.4	1.7	2.2	2.5
Hardness (as $CaCO_3$)	168	176	140	132	112	100	172
Calcium (as Ca)	48	51	40	35	29	29	37
Alkalinity (as $CaCO_3$)	176	188	150	138	118	122	162
Iron	0.10	0.53	0.21	0.24	0.16	0.17	0.22
Sodium	17.4	19.9	20.2	18.1	20.1	22.3	27.3
Potassium	3.0	3.4	3.5	3.3	3.2	3.3	4.0
Chloride	7	11	7	7	7	9	11
Sulphate (as SO_4)	19	21	20	18	16	17	23
Silica (as SiO_2)	35.0	33.8	39.8	38.8	36.8	36.5	40.8
Fluoride (as F Dissolved)	0.34	0.38	1.53	1.46	2.06	2.41	2.03
Cadmium (ug/l)	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Copper (ug/l)	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Lead (ug/l)	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Manganese (ug/l)	20	300	10	10	10	< 10	< 10
Mercury (ug/l)	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Zinc (ug/l)	9	7	16	7	9	8	10

* In mg/l unless otherwise indicated

Table 11b. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, December 21, 1976

Tributary Stations

Parameter	10 (S. Fork Owyhee)	12 (Battle Cr.)	13 (Deep Cr.)
Chemical Oxygen Demand	3.6	2.8	2.4
Nitrate (as N)	0.21	0.40	0.02
Nitrite (as N)	0.004	0.003	<0.001
Ammonia (as N)	0.02	0.02	0.02
Total Kjeldahl Nitrogen (as N)	0.57	0.67	0.47
Total Phosphorus (as P)	0.14	0.22	0.16
Ortho Phosphate (as P)	0.17	0.013	0.006
Total Solids	245	124	132
Suspended Solids	2	---	2
Volatile Suspended Solids	2	---	2
Turbidity (FTU)	2.2	2.2	0.52
Hardness (as $CaCO_3$)	172	52	64
Calcium (as Ca)	43	10	14
Alkalinity (as $CaCO_3$)	204	66	60
Iron	0.16	0.13	0.06
Sodium	32.3	13.8	12.5
Potassium	4.8	3.0	2.8
Chloride	13	7	5
Sulphate (as SO_4)	31	10	10
Silica (as SIO_2)	43	40.0	27.0
Fluoride (as F Dissolved)	1.58	1.51	0.55
Cadmium (ug/l)	< 5	< 5	< 5
Copper (ug/l)	<10	<10	<10
Lead (ug/l)	<10	<10	<10
Manganese (ug/l)	10	<10	<10
Mercury (ug/l)	< 5	< 5	< 5
Zinc (ug/l)	10	12	3

--- Data Not Reported
* In mg/l unless otherwise indicated

Table 12a. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, April 7, 1977

Owyhee River Stations

Parameter	1	2	3	4	5	6	7
Chemical Oxygen Demand	26.8	26	13	9.3	8.7	7.5	7.3
Nitrate (as N)	0.08	0.10	0.01	0.01	0.01	0.01	0.01
Nitrite (as N)	0.014	0.018	0.004	0.003	0.011	0.004	0.002
Ammonia (as N)	0.10	0.07	0.07	0.03	0.02	0.02	0.03
Total Kjeldahl Nitrogen (as N)	1.1	1.2	1.5	1.0	0.62	2.09	0.92
Total Phosphorus (as P)	0.28	0.25	0.13	0.08	0.07	0.05	0.06
Ortho Phosphate (as P)	0.055	0.057	0.012	0.013	0.022	0.006	0.006
Total Solids	274	276	226	237	145	152	216
Suspended Solids	134	142	50	68	30	26	38
Volatile Suspended Solids	4	9	<1	<1	<1	<1	<1
Turbidity (FTU)	31	32	13	12	17	6.4	5.0
Hardness (as $CaCO_3$)	66	76	124	100	42	54	100
Calcium (as Ca)	20	22.4	35.2	30.4	10.4	16.0	28.0
Alkalinity (as $CaCO_3$)	56	70	119	104	41	61	113
Iron	3.30	2.59	1.11	.72	.83	.45	.45
Sodium	6.6	7.9	15.2	15.0	8.0	12.3	19.8
Potassium	2.7	2.7	3.3	3.1	1.9	2.4	3.5
Chloride	4	4.	6	6	4	5	7
Sulphate (as SO_4)	18	16	22	17	<10	11	18
Silica (as SiO_2)	20	21.8	22	22.8	19	23.0	24.8
Fluoride (as F Dissolved)	0.22	0.24	0.64	.99	0.58	1.07	1.32
Cadmium (ug/l)	<1	<1	<1	<1	1	<1	<1
Copper (ug/l)	130	70	10	<10	<10	<10	<10
Lead (ug/l)	<50	<50	<50	<50	<50	<50	<50
Manganese (ug/l)	260	230	160	90	30	20	30
Mercury (ug/l)	<.2	<.2	<.2	<.2	<.2	<.2	<.2
Zinc (ug/l)	50	39	6	5	3	2	2

* In mg/l unless otherwise indicated

Table 12b. CHEMICAL ANALYSES*

OWYHEE RIVER SURVEY, April 7, 1977

Tributary Stations

Parameter	#10 S.F. Owyhee River	#12 Battle Creek	#13 Deep Creek
Chemical Oxygen Demand	7.3	4.9	24
Nitrate (as N)	0.01	0.04	0.01
Nitrite (as N)	0.002	0.004	0.014
Ammonia (as N)	0.01	0.02	0.04
Total Kjeldahl Nitrogen (as N)	0.58	0.58	1.36
Total Phosphorus (as P)	0.07	0.03	0.08
Ortho Phosphate (as P)	0.009	0.004	0.028
Total Solids	237	100	116
Suspended Solids	62	26	40
Volatile Suspended Solids	<1	<1	<1
Turbidity (FTU)	10	3.2	23
Hardness (as $CaCO_3$)	108	3.2	20
Calcium (as Ca)	28	3.2	5.6
Alkalinity (as $CaCO_3$)	115	45	24
Iron	.56	.24	1.62
Sodium	26.9	13.7	4.9
Potassium	4.7	2.6	1.7
Chloride	8	5	3
Sulphate (as SO_4)	19	<10	<10
Silica (as SiO_2)	25.0	32.5	19.5
Fluoride (as F Dissolved)	1.34	1.63	0.38
Cadmium (ug/l)	<.1	<1	<1
Copper (ug/l)	<10	<10	<10
Lead (ug/l)	<50	<50	<50
Manganese (ug/l)	70	<10	<20
Mercury (ug/l)	<.2	<.2	<.2
Zinc (ug/l)	2	1	6

* In mg/l unless otherwise indicated

Table 13. NITRATE (as N) LOADINGS IN KILOGRAMS PER DAY (pounds per day), OWYHEE RIVER SURVEY, 1976-1977

Stations	August 16, 1976	October 20, 1976	December 21, 1976	April 7, 1977
E. FK. OWYHEE RIVER				
1. Ida/Nev Border	<0.97* (<2.1)	0.3 (.6)	5.4*(11)	66 (145)
2. Nr. Canyon Head	<.97* (<2.1)	<0.09* (<0.1)	3.4* (7.4)	70* (154)
3. Pipeline Crossing	<1.0* (<2.2)	<0.3 (<.6)	25* (55)	6.5 (14)
4. Below Battle Cr.	6.* (13)	0.4 (.8)	48 (105)	----
5. Below Deep Cr.	8.4* (18)	3.3 (7.2)	41* (90)	7.8 (17)
6. Crutcher's Crossing	1.3* (2.8)	2 (4.4)	49* (108)	10* (22)
7. Ida/Ore Border	<1.7* (<3.7)	1.1 (2.4)	102* (224)	16* (35)
TRIBUTARIES				
10. South Fork, Mouth	0.39* (.8)	<0.55 (<1.2)	57* (125)	6 (13)
12. Battle Creek, Mouth	0.2* (.4)	0.13 (.2)	91 (200)	3 (6.6)
13. Deep Creek, Mouth	0.22* (.4)	0.3 (.6)	65*(143)	3.5 (7.7)
14. Red Canyon Creek, Mouth	0.3* (.6)	----	----	----

* BASED ON ESTIMATED FLOW

---- Not Sampled

Table 14. TOTAL KJELDAHL NITROGEN (as N) LOADINGS IN KILOGRAMS PER DAY (pounds per day), OWYHEE RIVER SURVEY, 1976-1977

Stations	August 16, 1976	October 20, 1976	December 21, 1976	April 7, 1977
E. FK. OWYHEE RIVER				
1. Ida/Nev Border	873* (1845)	19 (41)	11* (24)	907 (1999)
2. Nr. Canyon Head	485* (1069)	30* (66)	32* (70)	841* (1854)
3. Pipeline Crossing	401* (8840)	154 (339)	75* (165)	978 (2156)
4. Below Battle Creek	916* (2019)	194 (427)	140 (308)	-----
5. Below Deep Creek	582* (1283)	166 (365)	172* (379)	481 (1060)
6. Crutcher's Crossing	526* (1159)	343 (756)	154* (339)	2073*(4570)
7. Ida/Ore Border	949* (2092)	389 (857)	410* (903)	1478*(3258)
TRIBUTARIES				
10. South Fork, Mouth	175* (385)	137 (302)	154* (339)	356 (784)
12. Battle Creek, Mouth	54* (119)	84 (185)	31 (68)	47 (103)
13. Deep Creek, Mouth	54* (119)	32 (70)	13* (28)	469 (1033)
14. Red Canyon Creek, Mouth	18* (39)	-----	-----	-----

* BASED ON ESTIMATED FLOW

------ not sampled

Table 15, TOTAL PHOSPHORUS (as P) LOADINGS IN KILOGRAMS PER DAY (pounds per day), OWYHEE RIVER SURVEY, 1976-1977

Stations	August 16, 1976	October 20, 1976	December 21, 1976	April 7, 1977
E. FK. OWHYEE RIVER				
1. Ida/Nev. Border	83* (182)	20 (44)	3* (6.6)	231 (509)
2. Nr. Canyon Head	68* (149)	3.5* (7.7)	7* (15)	175* (385)
3. Pipeline Crossing	30* (66)	13 (28)	11* (24)	85 (187)
4. Below Battle Creek	38* (83)	39 (85)	14 (30)	----
5. Below Deep Creek	24* (52)	7 (15)	15* (33)	54 (119)
6. Crutcher's Crossing	33* (72)	3 (6.6)	24* (52)	50* (110)
7. Ida/Ore Border	17* (37)	22 (48)	31* (68)	96* (211)
TRIBUTARIES				
10. South Fork, Mouth	12* (26)	11 (24)	38* (83)	54 (119)
12. Battle Creek, Mouth	1.6* (3.5)	0.6 (1.3)	7 (15)	2.4 (5.2)
13. Deep Creek, Mouth	6.5* (14)	0.97 (2.1)	4* (8.8)	27.5 (60)
14. Red Canyon Creek, Mouth	18* (39)	----	----	-----

* BASED ON ESTIMATED FLOW

---- not sampled

TABLE 16. Water Quality data for miscellaneous stations in the Owyhee River Area collected by the BLM 1976-1977.

	STATION/DATE									
	E. Fk. Owyhee River (above Deep Cr.) 7-7-77	Deep Creek (Mouth) 10-21-76	8-19-76	7-7-77	E. Fk. Owyhee River (above Red Canyon Cr.) 7-7-77	Red Canyon Cr. (Mouth) 8-19-76	7-7-77	E. Fk. Owyhee River (at Crutchers Crossing) 8-19-76	N. Fk. Owyhee River 8-19-76	7-7-77
PARAMETER*										
Temperature (°C)	**	6.0	13.5	**	**	12.0	**	15.5	20.0	**
Dissolved Oxygen	**	**	**	**	**	**	**	**	**	**
pH	**	**	**	**	**	**	**	**	**	**
Nitrate as N	0.03	**	**	0.02	0.02	**	0.03	**	**	0.01
Ortho Phosphate as P	0.024	**	**	0.005	0.031	**	0.013	**	**	0.004
Total Solids	197	**	**	83	198	**	136	**	**	93
Suspended Solids	4	**	**	4	2	**	2	**	**	2
Total Dissolved Solids	192	**	**	81	183	**	130	**	**	100
Turbidity	1.1	**	**	0.8	1.1	**	5.4	**	**	0.70
Hardness (as $CaCO_3$)	96	**	**	32	86	**	22	**	**	30
Magnesium	6.4	**	**	2.7	5.7	**	1.3	**	**	2.8
Alkalinity (as $CaCO_3$)	123	**	**	51	118	**	56	**	**	38
Bacteria/ 100 ml.										
Fecal Coliform	26	**	**	**	**	**	13	**	**	6
Total Coliform	70	**	**	**	**	**	20	**	**	16

* In mg/l unless otherwise indicated

** Parameter not analyzed

TABLE 17

Benthic Macroinvertebrates - Owyhee River, 20-21 September 1976 (Rock Baskets)

ORGANISM	STATION 1	STATION 3			$\bar{X}$	STATION 6		$\bar{X}$
MOLLUSCA								
GASTROPODA								
Planorbidae								
Gyraulus similaris (Baker)[1]		68	0	29	32.3			
Parapholyx effusa (Lea)[1]		33	45	78	52			
Physidae								
Physa sp.	19	2	1	0	1			
Ancylidae								
Ferrissia fragilis (Tryon)[1]		9	21	9	13	27	45	36
Bulimidae								
Lithoglyphus vitens (Lea)[1]		21	2	89	55.7	8	21	14.5
TURBELLARIA	1							
ANNELIDA	18							
HIRUDINEA -Adult	1	0	0	4	1.3			
Egg Cases	3							
INSECTA								
EMPHEMEROPTERA								
Ephemeridae								
Ephemera simulans Walker (N)		1	0	0	0.3			
Ephemera sp. (N)						4	3	3.5
Baetidae								
Baetis sp. (N)		8	5	6	6.3	35	24	29.5

[1] Det. A. H. Clarke

ORGANISM	STATION 1	STATION 3			$\bar{X}$	STATION 6		$\bar{X}$
Heptageniidae								
Heptagenia sp. (N)		0	41	15	18.7	0	2	1
Tricorythidae								
Tricorythodes minutus Traver (N)		3	85	20	36			
PLECOPTERA								
Perlidae (N)						0	3	1.5
ODONATA								
Zygoptera								
Coenagrionidae (N)		3	0	0	1			
Unidentified nymphal exuvia						0	1	0.5
COLEOPTERA								
Psephenidae (L)								
Psephenus (L)		0	20	1	7	3	11	7
Elmidae								
Dubiraphia sp. (L)		1	2	1	1.3	11	5	8
Optio servus (L)						1	0	0.5
Ordobrevia sp. (L)		2	0	0	0.7			
Zatitzevia parvula (L)						1	2	1.5
Haliplidae								
Haliplus sp. (L)	1							
TRICOPTERA								
Leptoceridae								
Nectopsyche sp. (L)		0	84	0	28	22	30	26
Hydropsychidae								
Hydropsyche sp. (L)		0	88	3	30.3	11	31	21
Brachycentridae								
Brachycentrus sp. (L)		0	4	3	2.3	4	1	2.5
Hydroptilidae (L)								
Ochrotrichia sp. (L)	1	0	11	39	16.7	0	12	6

ORGANISM	STATION 1	STATION 3			$\bar{X}$	STATION 6		$\bar{X}$
Helicopsychidae								
Helicopsyche borealis (Hagen) (L)		2	4	56	20.7	0	1	0.5
Unidentified pupal case		0	1	0	0.3			
DIPTERA								
Chironomidae (L)	37	0	6	25	10.3	5	28	16.5
(P)		0	1	0	0.3			
Simuliidae (L)		0	0	3	1			
Tipulidae (L)	2							
Unidentified pre-adult	1							
LEPIDOPTERA								
Parargyractis sp. (L)		0	0	1	.03			
ACARI								
Hygrobates sp.	8							
Sperchon sp.	1							
Lebertia sp.	1							
TOTALS	94	153	421	382	318.7	132	220	176

N = Nymph(s)
L = Larva (larvae)
P = Pupa

TABLE 18

Macroinvertebrate Diversity ($\bar{d}$)
at Stations 1, 3, and 6,
Owyhee River, 1976
as calculated by the use of the
Machine Formula of Lloyd, Zar, and Karr (1968).
Stations were sampled with rock baskets.

STATION		$\bar{d}$	$\bar{x}$
1	(Idaho /Nevada Border)	2.52	(2.52)
3	(Pipeline Crossing)		
	Sample 1	2.47	
	Sample 2	3.1	
	Sample 3	3.17	
	$\bar{X}$		2.9
6	(Crutchers Crossing)		
	Sample 1	2.9	
	Sample 2	3.28	
	$\bar{X}$		3.12

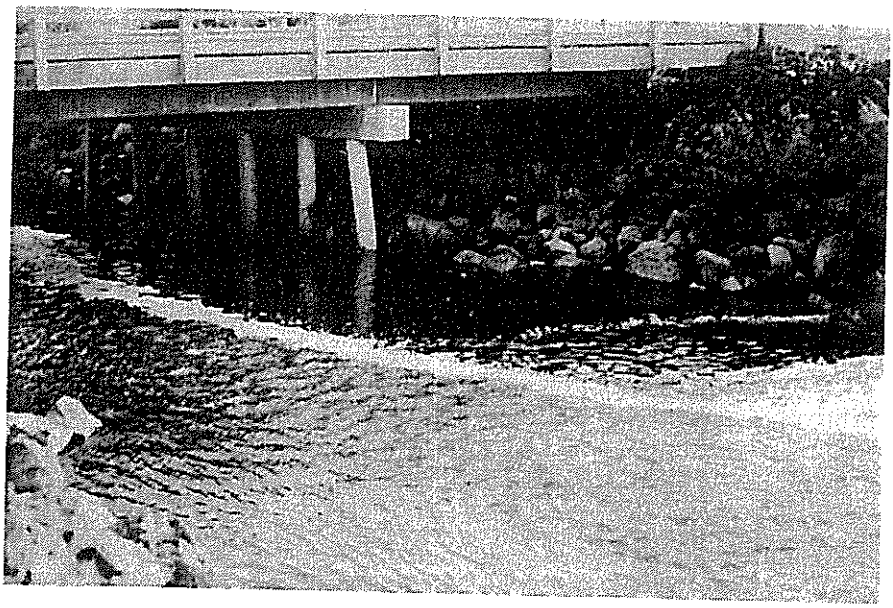

Figure 6. Station 1, Owyhee River near the Idaho/Nevada Border, Duck Valley Indian Reservation. Foam is from agricultural return flow in right-hand portion of photo. Photo taken 16 August 1976.

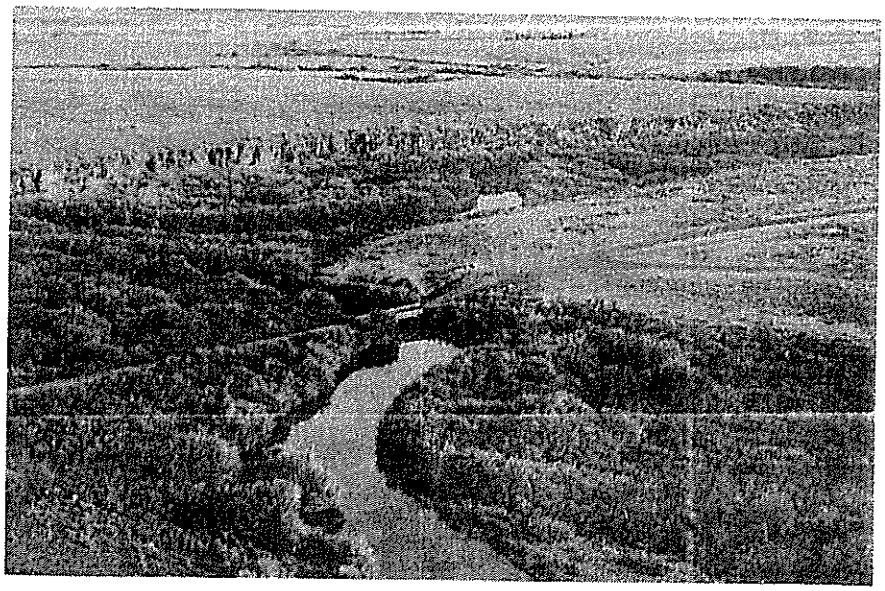

Figure 7. Station 2, Owyhee River, Duck Valley Indian Reservation, facing northwest. Photo taken 16 August 1976

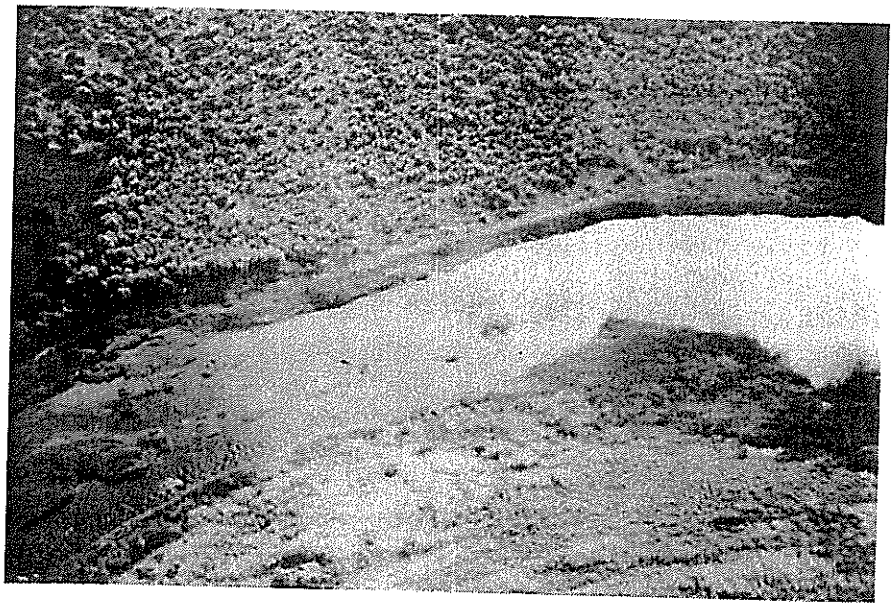

Figure 8. Station 3, Owyhee River, near Pipeline Crossing. River is about 17 m (57 feet) wide at this point. Photo taken on 20 October 1976.

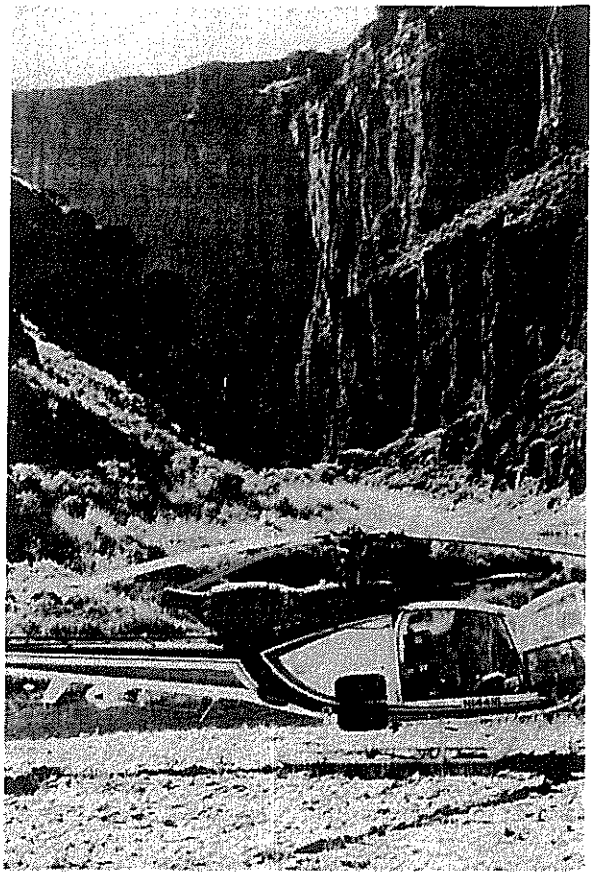

Figure 9. Stations 4 and 12, Owyhee River at the confluence of Battle Creek. Battle Creek enters from the left (north). Photo taken on 20 October 1976.

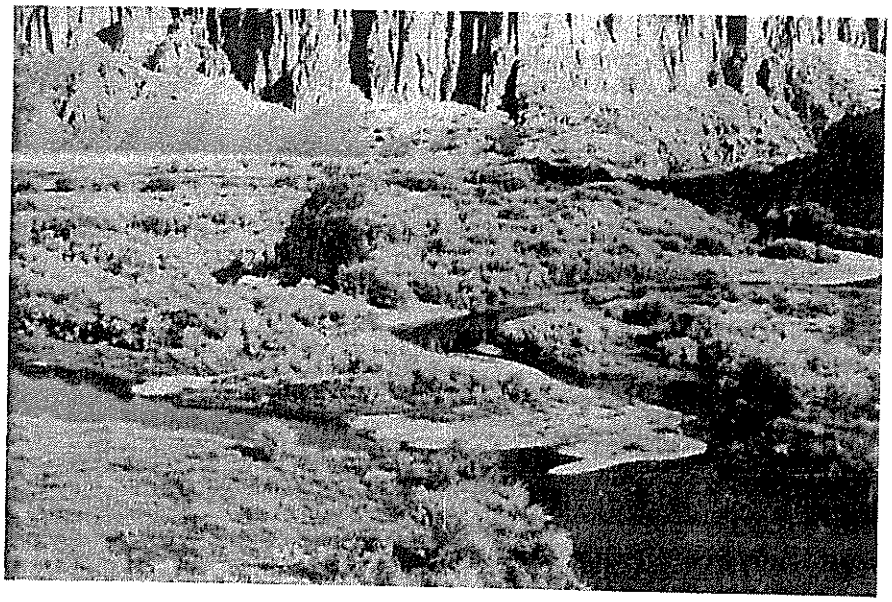

Figure 10. Stations 5 and 13, Owyhee River at the confluence of Deep Creek. Deep Creek enters the Owyhee River from the top of the photo (north). Photo taken on 16 August 1976.

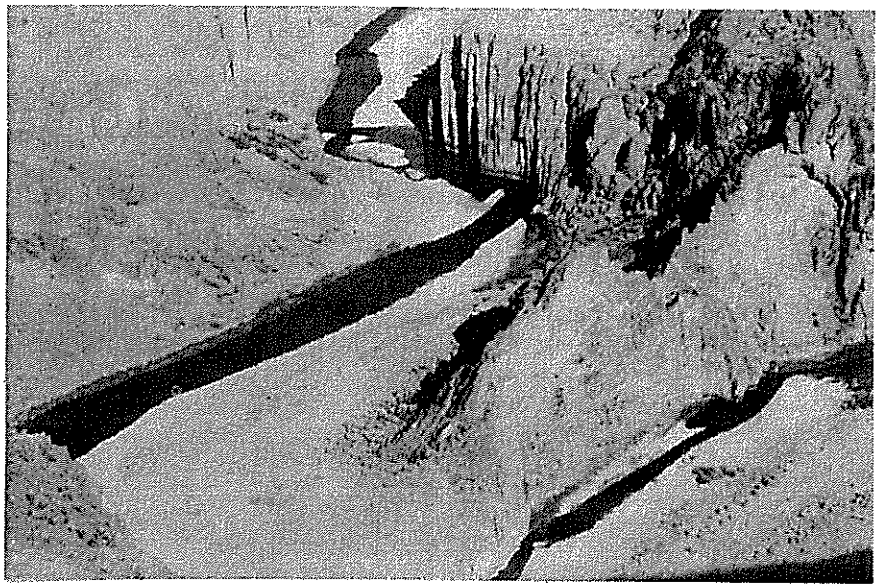

Figure 11. Station 14, Red Canyon Creek near its confluence with the Owyhee River. Photo taken on 16 August 1976.

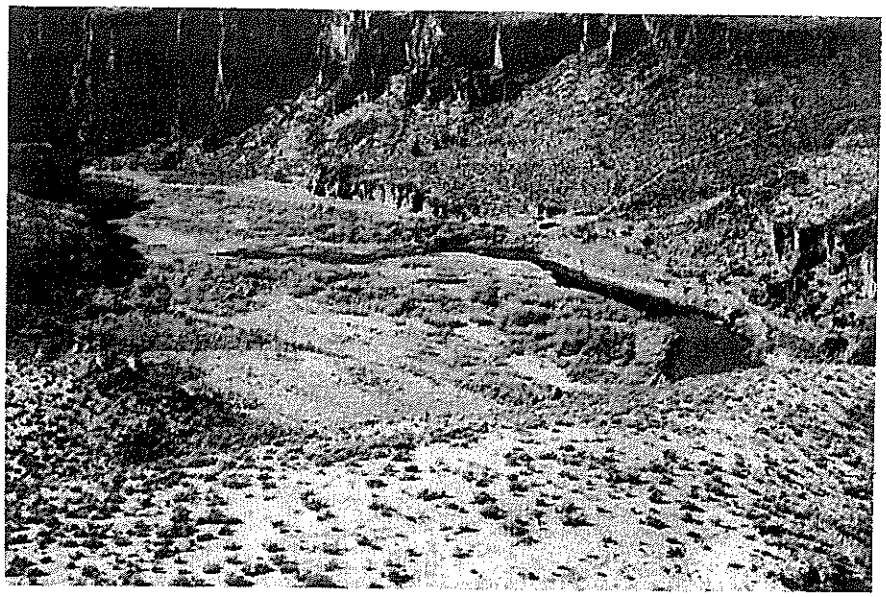

Figure 12. Station 6, Owyhee River at Crutcher's Crossing, facing northwest. The river is about 18 m (60 feet) wide at this point. Photo taken on 16 August 1976.

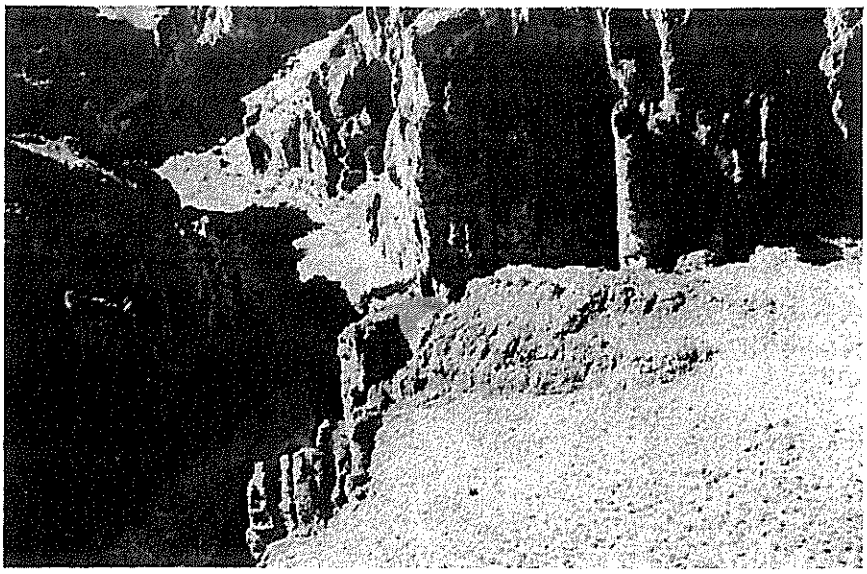

Figure 13. Station 10, South Fork of the Owyhee River at its confluence with the main stem of the Owyhee. The South Fork enters from the upper left (south) of the photo. Photo taken 16 August 1976.

Figure 14. Station 7, Owyhee River near the Idaho-Oregon Border, facing west. The width varies from about 15 m (50 feet) to 30 m (100 feet) along this portion of the river.

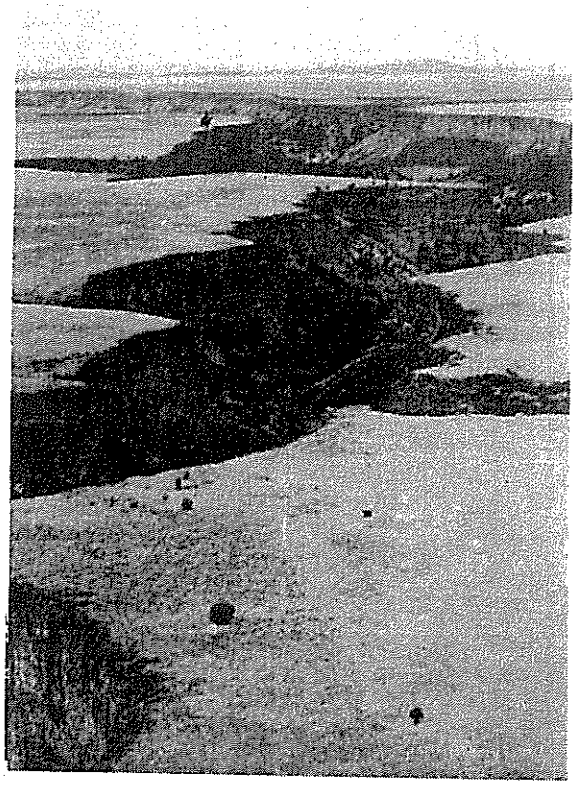

Figure 15. General view of the Owyhee River Canyon, facing west about midway along the Idaho portion of the river. Photo taken 16 August 1976.