UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

QUALITY OF WATER, QUILLAYUTE RIVER BASIN, WASHINGTON

By M. O. Fretwell

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METRIC CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
	2.540	centimeter (cm)
foot (ft)	0.3048	meter (m)
cubic foot per second (ft^3/s)	28.32	liter per second (L/s)
	0.02832	cubic meter per second (m^3/s)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
acre	4047.0	square meter (m^2)
acre-foot (acre-ft)	1233.0	cubic meter (m^3)
	0.001233	cubic hectometer (hm^3)
micromho per centimeter at 25° Celsius (μmho/cm at 25°C)	1.000	microsiemen per centimeter at 25° Celsius (μS/cm at 25°C)
degree Fahrenheit (°F)	F = 9/5°C +32	degree Celsius (°C)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in this report.

QUALITY OF WATER, QUILLAYUTE RIVER BASIN, WASHINGTON

By M. O. Fretwell

ABSTRACT

Ground water in the Quillayute River basin is generally of the calcium bicarbonate type, although water from some wells is affected by seawater intrusion and is predominantly of the sodium chloride type. The water is generally of excellent quality for most uses, with the exception of water in two wells which had iron concentrations that potentially could be tasted in beverages and could cause staining of laundry and porcelain fixtures.

A comparison of the chemical compositions of ground and surface waters showed a strong similarity over a wide geographic area. Proportions of the major chemical constituents in the rivers of the basin were nearly constant despite concentration fluctuations in response to dilution from precipitation and snowmelt.

River-water quality was generally excellent, as evaluated against Washington State water use and water-quality criteria. Fecal-coliform bacteria counts generally were much lower than the total-coliform bacteria counts, indicating that most of the coliform bacteria were of nonfecal origin and probably originated in soils. Fecal coliform concentrations in all the major tributaries met State water-quality criteria.

Water temperatures occasionally exceeded criteria maximum during periods of warm weather and low streamflow; dissolved-oxygen concentrations were occasionally less than criteria minimum because of increased water temperature (warmer water contains less dissolved oxygen than cooler water). Both conditions occurred naturally.

Nutrient concentrations were generally low to very low and about the same as in streams from virgin forestland in the Olympic National Park. However, some slight increases in nutrient concentrations were observed, particularly in the vicinity of Mill Creek and the town of Forks; due to dilution and biological assimilation, these slightly elevated concentrations decreased as the water moved downstream.

The four largest lakes in the basin were all in sub-basins having less than one-percent development. All four lakes were temperature-stratified in summer and one had an algal bloom. In general, the water was of a naturally high quality, nutrient concentrations were moderate, and coliform bacteria counts were well within the State criteria limits.

The Quillayute estuary had salt-wedge mixing characteristics; pollutants entering the salt wedge tended to spread to the toe of the wedge. Upwelling ocean water was the major cause of low dissolved-oxygen concentrations in the estuary; ammonia concentrations in the estuary, however, were increased by the upwelling ocean waters. Oxygen demand of bottom materials generally was slight, except in two areas. The impact of the high oxygen demand in these two areas on the dissolved-oxygen concentrations in the estuary was insignificant. Fecal-coliform bacteria concentrations exceeded State criteria maximum limits at the mouths of two boat basins on both August 19 and September 10, 1976. As in the rivers, total-coliform concentrations in the estuary were greater than fecal-coliform concentrations, indicating that many of the bacteria were of nonfecal origin.

INTRODUCTION

Purpose and Scope

The Quileute Indian Tribe is dependent mainly on its fisheries resource as an economic base. This resource, in turn, is dependent on the streamflow and water quality of the Quillayute River and its tributaries. The tribe had no documentation of the natural streamflow or water-quality characteristics of the river system, and thus no systematic data on which to base management decisions. Consequently, the tribe requested that the Water Resources Division of the U.S. Geological Survey conduct a reconnaissance study, in cooperation with the Quileute Tribal Council, as a first step in alleviating the data deficiencies.

The objectives of the study were to:

1. Document for 3 years the distribution of streamflow in the major tributaries of the Quillayute River;
2. Relate streamflow at stream gaging sites in the lower reaches of the major tributaries to fish-spawning capacity of selected upper reaches;
3. Document for 3 years the sediment discharges and their relation to time and to streamflow in the river's major tributaries;
4. Describe for two summers the water-quality conditions in streams and the Quillayute estuary during low streamflow;
5. Evaluate the water-quality characteristics, sediment discharges, and streamflows, and attempt to determine the causes of differences in these characteristics among the major tributaries;
6. Design a water-quality and sediment network and a streamflow network that would indicate significant changes in water-quality or streamflow that might affect the tribe's fisheries resource.

This report, the second resulting from the study, deals with the water-quality aspects of objectives 4 and 5. The sediment and streamflow aspects of the entire study were dealt with in a report by Nelson (1982). Objective 6 was met by a letter to and a meeting with the Tribal Council.

Data for this study were collected during the late summers of 1976 and 1977. Two water-quality samplings were made in the river system at 53 sites, and four samplings were made in the estuary at 14 sites. The results of these samplings are presented, along with water-quality data collected prior to this study (hereafter referred to as historic data), from two sites on the Soleduck River, four lakes in the Soleduck and Dickey River basins, and nine wells in the Quillayute River basin.

Other Investigations

In two previous years, a reconnaissance was made of seawater intrusion along coastal Washington, including the area near the mouth of the Quillayute River (Walters, 1971; Dion and Sumioka, written commun., 1982), and a study was made on the effect of timber harvesting on fish production in the headwaters of Bear Creek, a tributary of the Bogachiel River. The latter study was conducted by the University of Washington Fisheries Research Institute.

Historic water-quality data for waters of the study area are scant. Water-quality analyses which were made by the U.S. Geological Survey for several years of infrequent samples from the Soleduck River, samples for a single-time reconnaissance assessment of four lakes, and a few ground-water samples, are included in this report. Water-quality analyses of water from Lonesome Creek and from a few wells near the reservation are available in a report on the public water-supply system at La Push (Cornell, Howland, Hayes, and Merryfield, Inc., 1967). The Washington State Department of Fisheries has thermograph records for three spring-fed tributaries to the Soleduck River, and miscellaneous water-temperature data collected in conjunction with spring and summer seining operations on selected reaches of the Soleduck and Bogachiel Rivers (Bill Woods, oral commun., 1978).

Phinney and Bucknell (1975) of the Washington State Department of Fisheries cataloged Washington's streams according to suitability for salmon utilization (spawning, rearing, and passage). Their report includes the Quillayute River and its major tributaries.

The U.S. Army Corps of Engineers Region X Office in Seattle, Wash., has records of dredging operations in the Quillayute Estuary that extend back into the 1940's. These data provide a valuable record of estuary morphology.

Historic streamflow records from several stations in the Quillayute River basin are published in annual reports (U.S. Geological Survey, 1963-64, 1965-75a, 1976) or are available for inspection at the U.S. Geological Survey Water Resources Division office in Tacoma, Wash. An index of those stations is provided in table 1. Several miscellaneous streamflow measurements are also available in a report on potential water supplies for several sites in the Olympic National Park (Walters, 1970) and in a report by the State of Washington (1964).

TABLE 1.--Index of streamflow stations in the Quillayute River basin for which historic data are available

Station name	USGS station number	Drainage area (mi^2)	Period of record: Daily or monthly discharge values (calendar years)	Period of record: Annual peaks (water years)
Soleduck River:				
Soleduck River (head of Quillayute River) near Fairholm, Wash.	12041500	83.8	1917-21; 1933-71	
Soleduck River tributary near Fairholm, Wash.	12041600	0.2	----	1956
Soleduck River at Snider Ranger station, near Beaver, Wash.	12042000	116.	1921-28	
Soleduck River near (at) Quillayute, Wash.	12042500	219	1897-1901, 1976-82	
Bogachiel River:				
May Creek near Forks, Wash.	12042700	2.03	----	1950-68
Bogachiel River near Forks, Wash.	12042800	111.	1975-82	
Grader Creek near Forks, Wash.	12042900	1.67	----	1950-82
Calawah (Calowa or Kalawa) River near (at) Forks, Wash.	12043000	129	1897-1901, 1976-82	
Dickey River:				
East Fork Dickey River near La Push, Wash.	12043080	39.8	1962-68	
Dickey River near La Push, Wash.	12043100	86.3	1962-73, 1976-82	

Description of the Study Area

Geography

The Quileute Indian Reservation encompasses about 1,000 acres of land around the mouth of the Quillayute River (fig. 1) on the west side of the Olympic Peninsula.

The Quillayute River basin is about 45 mi long and 20 mi wide, and drains parts of Clallam and Jefferson Counties. The main stem of the Quillayute River is only about 6 mi long and is formed by the confluence of the Soleduck and Bogachiel Rivers. There are two other major tributaries: the Dickey River, which flows into the Quillayute River 1.3 mi from its mouth, and the Calawah River, which flows into the Bogachiel River 8.2 mi above its confluence with the Soleduck River.

Drainage areas of the Quillayute River and its major tributaries are given below.

River basin	Drainage area, in square miles
Calawah	133
Bogachiel	287 (includes Calawah)
Soleduck	226
Dickey	108
Quillayute	629 (includes all of the above)

The headwaters of the Bogachiel and Soleduck Rivers begin at about 5,000-foot altitude, and the headwaters of the Calawah River at about 3,000 feet, in the rugged Olympic Mountains, and all flow generally westerly. The lower reaches cross an extensive, gently sloping marine terrace. The Dickey River is a lowland stream whose headwaters begin at about 700-foot altitude on the West Fork and at about 1,700-foot altitude on the East Fork. The Dickey River heads in the foothills northwest of the Olympic Mountains and flows generally southward in a meandering fashion across the gently sloping marine terrace. Stream gradients of the major tributaries are diagramed in figure 2.

Most of the Quillayute River basin is covered by coniferous forest of Douglas fir, hemlock, cedar, and some spruce. Large parts of the basin are in the Olympic National Park and Olympic National Forest; the remainder, except in and near the towns of Forks and La Push, is largely undeveloped State or privately owned land.

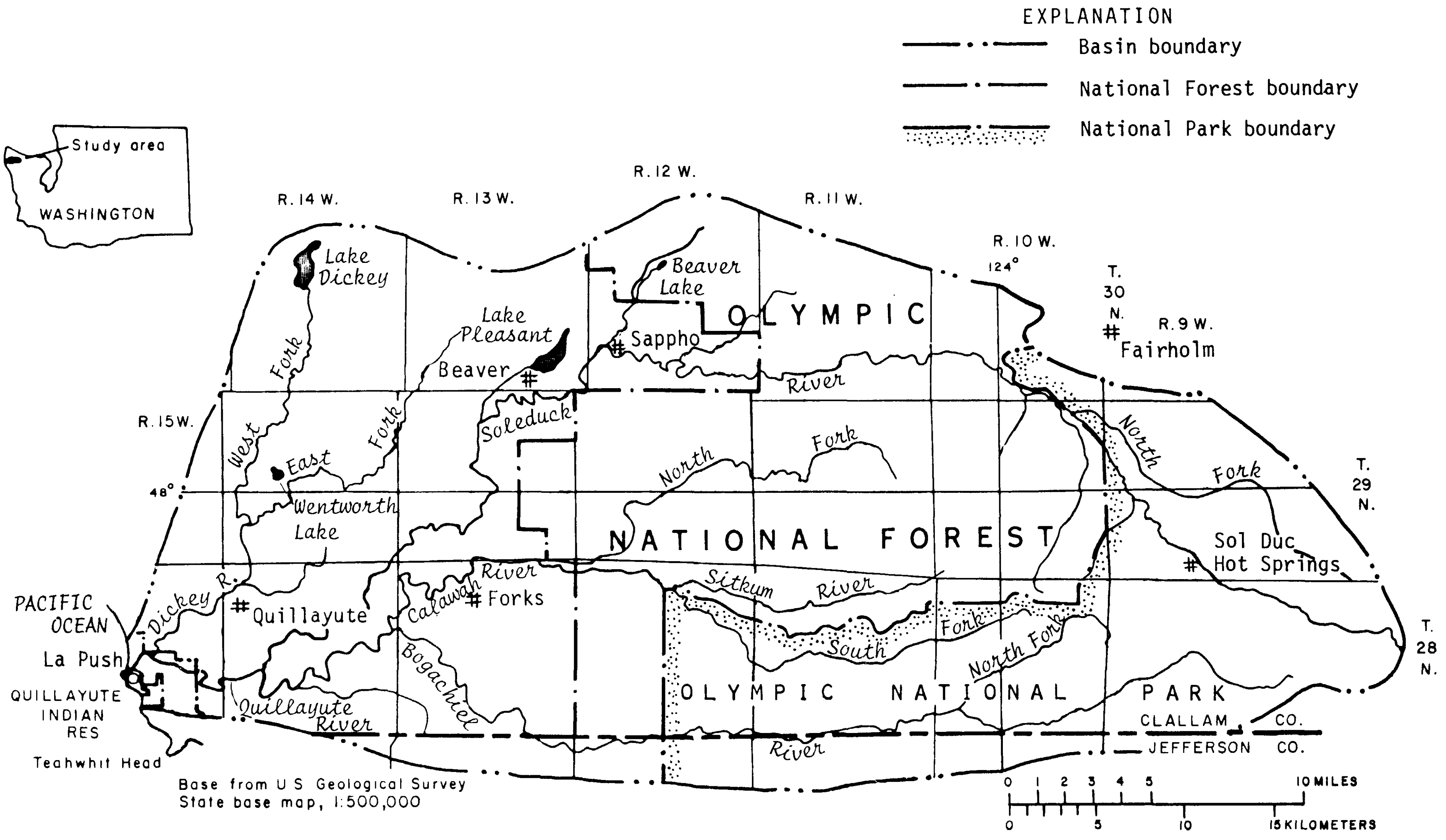


Figure 1.--Location of the Quillayute River basin.

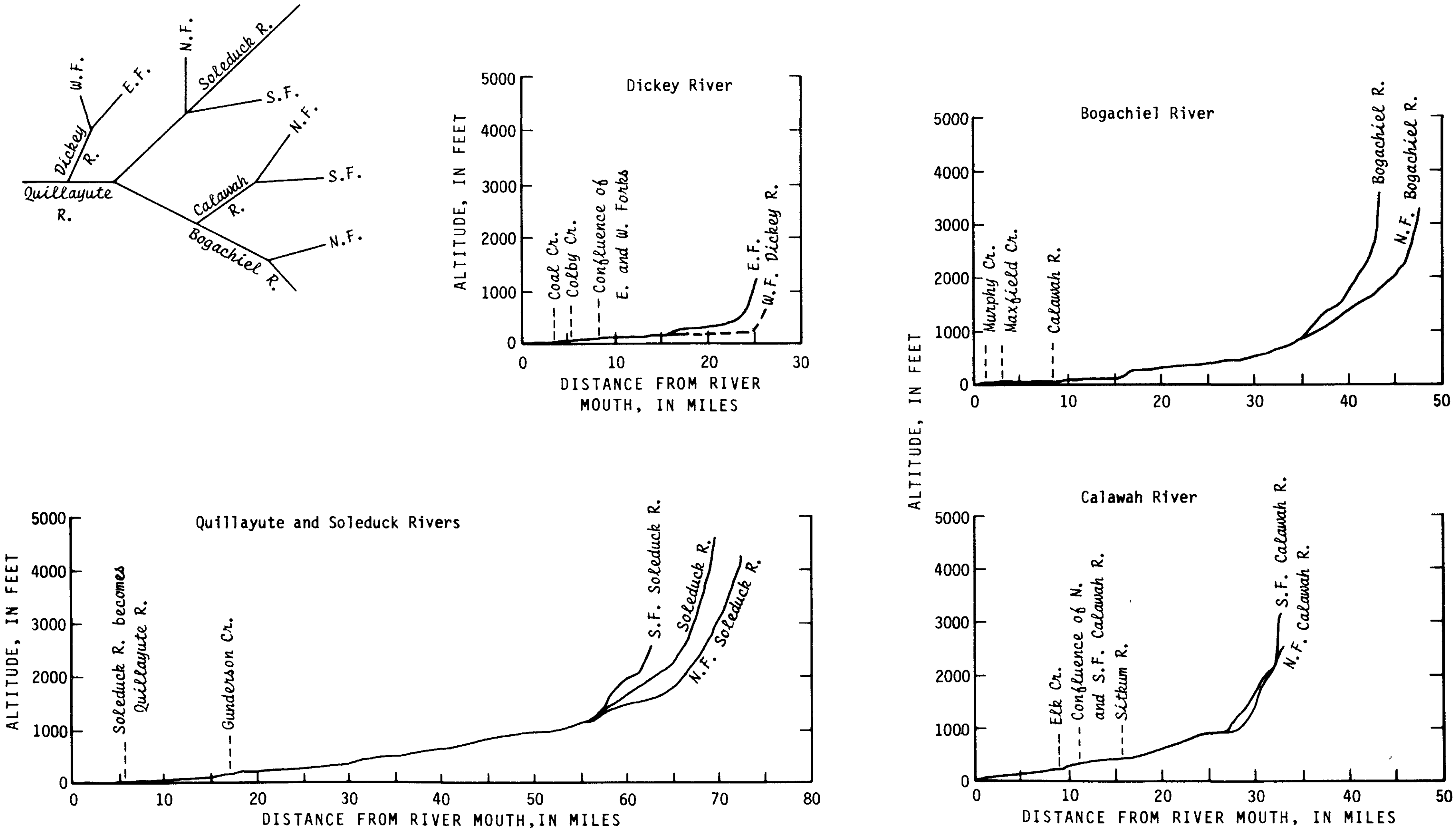


Figure 2.--Schematic diagram of Quillayute River drainage system, and gradient profiles of major rivers.

The major industries in the basin are timber production and commercial and sports fishery for the anadromous salmon and steelhead. The hundreds of miles of tributary streams provide abundant natural spawning habitat for the natural rearing of anadromous fish. The anadromous fishery is also supplemented by hatcheries on the Bogachiel and Soleduck Rivers (locations shown on fig. 4).

Forks, one of the two major population centers in the basin, is a logging town, with a population of about 2,100 and an estimated additional 2-3,000 nearby but outside the town limits. La Push, the other major population center, is situated on the east side of the Quillayute estuary and is the only town inside the reservation. It is an important fishing port, supporting a large commercial and sport salmon industry. During the summer fishing season, the influx of commercial and sports fishermen can swell La Push's normal population of 500 to as much as 7,000.

Climate

The climate of the lowlands, which include La Push and Forks, is of the West Coast marine type, with warm, dry summers and mild, wet winters. Monthly average air temperatures and precipitation at the Quillayute Weather Station near La Push are shown in figure 3; climatic averages at Forks are similar. Farther inland in the basin, the climate is modified by the Olympic Mountains and is progressively cooler and wetter at higher altitudes. Air temperatures in the basin during the study period were cooler than the long-term (1966-75) average.

Annual precipitation in the Quillayute River basin ranges from 105 in. near the coast to 140 in. in parts of the headwaters. The 10-year (1966-75) average at the Quillayute Weather Station is 104.99 in., of which 87 percent falls between October and April (U.S. National Oceanic and Atmospheric Administration, 1966-77). Precipitation in the basin during the study period was below the long-term average (fig. 3).

Snowfall is light in the lower altitudes along the coast, but rapidly increases inland with altitude. The higher peaks of the Olympic Mountains usually remain snowcovered most of the year. Melt water from the snowpack is a major contribution to spring streamflow.

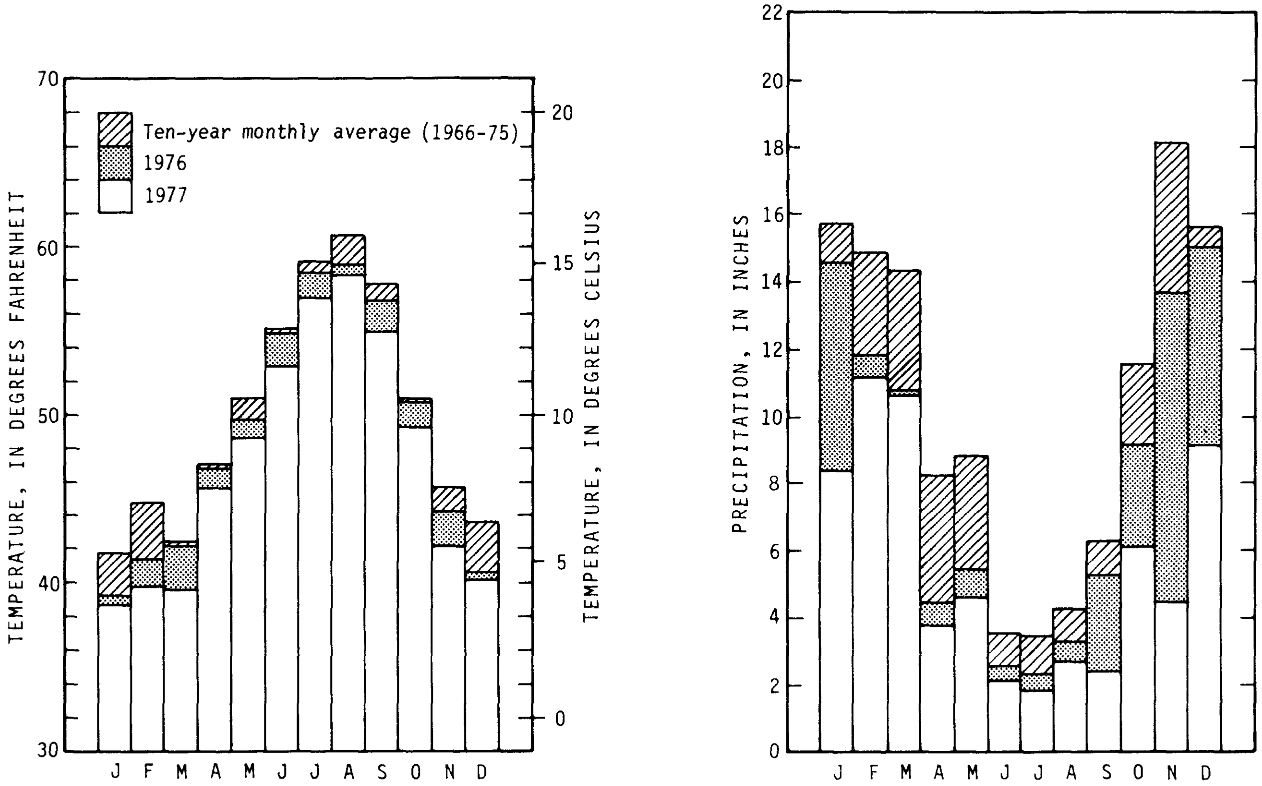
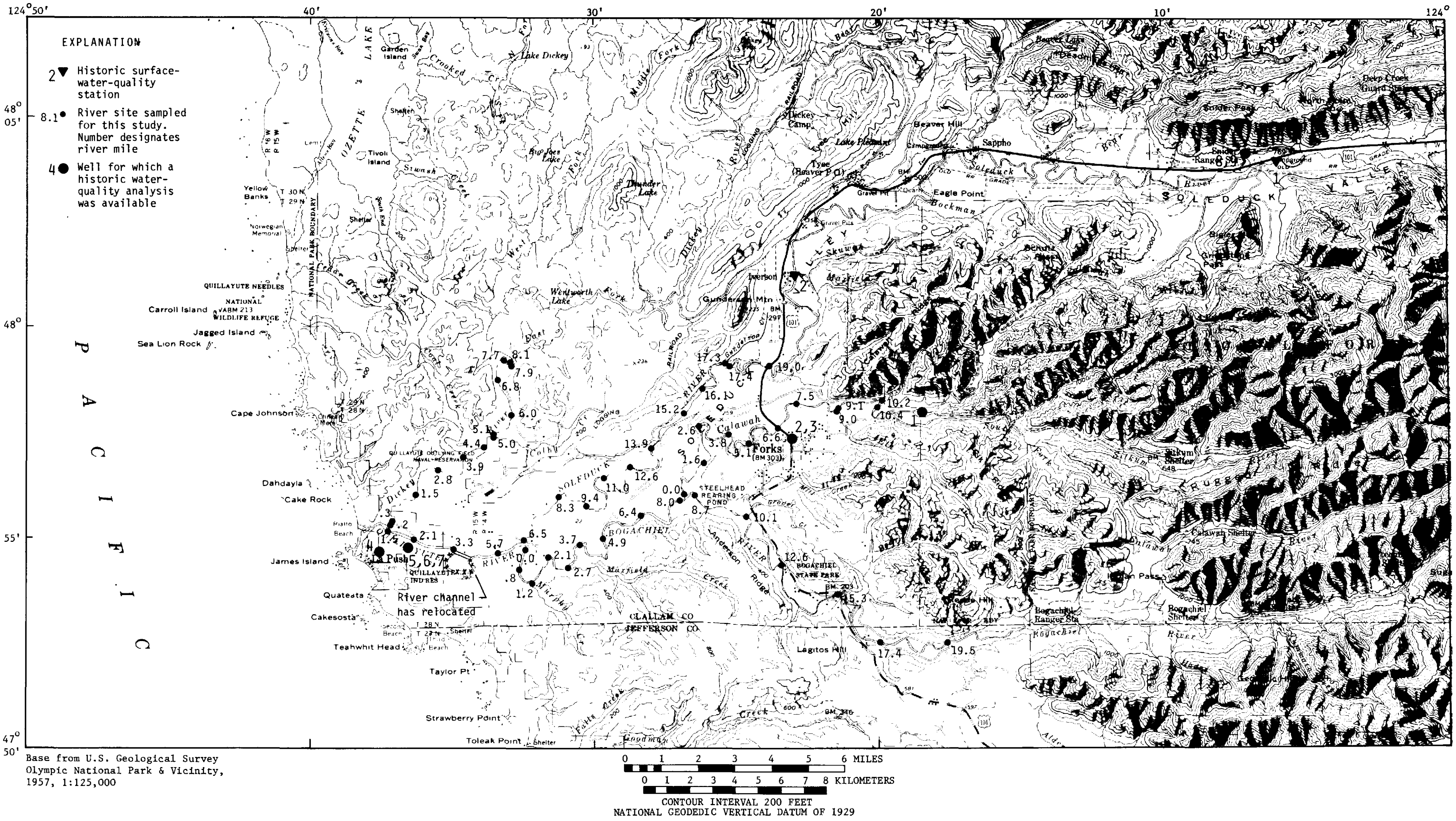


Figure 3.--Monthly average air temperature and precipitation at the Quillayute Weather Station near La Push.



Base from U.S. Geological Survey
Olympic National Park & Vicinity,
1957, 1:125,000

Figure 4.--Lower part of Quillayute River basin showing sampling sites.

Geology

The Quillayute River and the lower reaches of the major tributaries lie on a terrace which extends eastward from the coast. The terrace consists mainly of alluvium in the flood plains and glacial deposits elsewhere. The Quillayute and Soleduck Rivers are the approximate dividing line between glacial deposits of the continental ice sheet and deposits of the Olympic alpine glaciers. The deposits of the continental ice sheet lie to the north of the two rivers, and consist of moraine and stratified deposits that include gravel, sand, silt, and clay and are characterized by rock clasts foreign to the Olympic Peninsula. The deposits of the Olympic alpine glaciers lie to the south of the two rivers, and consist of moraine and stratified deposits that include gravel, sand, silt, and clay and are characterized by rock clasts derived from the Olympic Mountains (Tabor and Cady, 1978).

The upper reaches of three major tributaries lie predominantly in partly metamorphosed, fine-grained sedimentary rocks of marine origin: the Bogachiel and Calawah Rivers above 350-foot altitude and the Soleduck River above 1,400-foot altitude (Tabor and Cady, 1978).

Washington State Water-Use and Water-Quality Criteria

The Washington Department of Ecology (WDOE) has established water-use and water-quality criteria by classes for the streams, lakes, and marine waters of Washington. The criteria were revised, effective 1977 (State of Washington, 1977), as follows:

Class AA	(Extraordinary)
Class A	(Excellent)
Class B	(Good)
Class C	(Fair)
Lake Class	

The streams and marine waters are assigned to one of the first four classes on the basis of their present and (or) potential use and natural and (or) potential water quality. Nonnatural influences that cause the water quality to deviate from the specified criteria constitute a legal violation of Chapter 90.48 RCW. A shortened and simplified criteria summary is given in table 2 to provide a general understanding of the water-quality level that various criteria classes are designed to maintain; for legal purposes, the entire text of the Washington Administrative Code should be consulted. The State revised its water-quality criteria after data collection was completed for this study. Table 2 is based on the new criteria because these will be used in future water-quality evaluations. However, because the old criteria applied at the time of this study, and to provide continuity by comparison, the old criteria will also be mentioned in the subsequent text. The changes from old to new criteria involve mostly changing from total-coliform to fecal-coliform criteria and reassigning the Bogachiel and Calawah Rivers to State Class AA instead of the old State Class A.

The streams in the Quillayute River basin are among the most unadulterated streams in Washington and rival the quality of virgin streams from similar terrain in the Olympic National Park. The water quality is of near-pristine character, and the stream channels are composed largely of gravels suitable for spawning and rearing of anadromous fishes. Because the State, the Indians, and many other people are interested in maintaining the special quality of these waters, the most protective State criteria have been adopted for all but the Dickey River; the Quillayute, Soleduck, Bogachiel, and Calawah Rivers are classified in their entirety by WDOE as Class AA. The Dickey River is Class AA above Dickey Lake and Class A below it. Dickey Lake is in the Lake Class.

TABLE 2.--Summary of Washington State water-use and water-quality criteria (< = less than; > = greater than)

Criteria Class	Water type	Fecal-coliform bacteria,[1] (col/100 mL)	Dissolved oxygen,[2] (mg/L)	Temperature[3] (°C)	pH (units)	Turbidity[4] (NTU exceeding natural conditions)
AA (Extraordinary)	fresh	median < 50	>9.5	<16	6.5-8.5	<5
	marine	median < 14	>7.0	<13	7.0-8.5	
A (Excellent)	fresh	median <100	>8.0	<18	6.5-8.5	<5
	marine	median <14	>6.0	<16	7.0-8.5	
B (Good)	fresh	median <200	>6.5	<21	6.5-8.5	<10
	marine	median <100	>5.0	<19	7.0-8.5	
C (Fair)	fresh	no criteria	>5.0	<24	6.5-9.0	<10
	marine	median <200	>4.0	<22	6.5-9.0	
Lake Class	lake	median <50	no measurable decrease from natural condition	no measurable change from natural condition	no measurable change from natural condition	<5

[1]In estuaries, where the fresh and marine water-quality criteria differ within the same classification, the criteria shall be interpolated on the basis of salinity; except that marine water-quality criteria shall apply for dissolved oxygen when the salinity is one part per thousand or greater, and for fecal coliform bacteria when the salinity is ten parts per thousand or greater.

[2]There is also a criterion for total dissolved gas, which is the same for all Criteria Classes; that is, Total dissolved gas expressed in percentage of saturation should not exceed 110 percent.

[3]Temperature criteria apply if due in part to measurable (0.3°C) increases resulting from human activities.

[4]The criteria are expressed in NTU (nephlometric turbidity units) but the water-quality data are expressed in JTU (Jackson turibidity units). The two units are essentially the same for the low turbidity values observed.

GROUND-WATER QUALITY IN THE QUILLAYUTE RIVER BASIN

Ground-water was not sampled for this study, but historic ground-water-quality data are presented for comparison with surface-water-quality data on the assumption that the ground-water quality has not changed since the time of sampling. The historic data were collected from nine wells (fig. 4) sampled between July 1964 and February 1972; results of the chemical analyses are given in table 2.

The characteristics of water from wells, 1, 2, 3, 5, and 8 were similar (fig. 5). These waters probably represent the general ground-water quality in the basin, for reasons to be explained in the section Relation of Ground-Water Quality to River-Water Quality. Water from well 4, in contrast, contains a greater percentage of sodium and chloride, possibly due to intrusion of seawater induced by well pumping. Wells 5, 6, and 7, drilled adjacent to the river (fig. 4), may also at times show the influence of seawater intrusion; however, the available data cannot be used to substantiate this.

The water from well 9 also contains a greater percentage of sodium than was found in wells 1, 2, 3, 5, and 8, but it has nearly the same anionic percentage composition as those waters. Well 9, although located near well 8, is 107 feet deeper and, thus, derives its water from a deeper water-yielding zone of different mineralogical composition. Well 8 is completed in unconfined alluvial sand and gravel adjacent to the river, whereas well 9 is completed in broken basalt and red clay in which water is confined with sufficient artesian pressure to cause the well to flow. Ion exchange may explain the compositional variations noted between the water from wells 8 and 9. It is not uncommon for the sodium adsorbed to clay particles to exchange preferentially with calcium and magnesium dissolved in ground water, resulting in increases in the percentage of sodium and decreases in the percentages of calcium and magnesium in the water. This situation is exemplified in figure 5, in which basically the same anion percentages, but radically different cation percentages, are plotted for wells 8 and 9.

Ground-water quality is generally excellent for most uses, with one minor exception. Wells 4 and 5 had iron concentrations high enough (generally in excess of 300 micrograms per liter) to potentially be tasted in beverages and to stain laundered clothes and porcelain fixtures.

TABLE 3.--Water-quality data for nine wells in the Quillayute River basin [see figure 4 for locations of wells].

Well	Date of sample	Depth to bottom of water-bearing zone (ft)	Depth to top of water-bearing zone (ft)	Total depth of well (ft)	Depth to bottom of sample interval (ft)	Depth to top of sample interval (ft)	Specific conductance (umho)	pH (units)	Temperature (oC)	Color (platinum-cobalt units)	Hardness (Ca,Mg) (mg/L)	Noncarbonate hardness (mg/L)	Dissolved calcium (Ca) (mg/L)	Dissolved magnesium (Mg) (mg/L)
1	64-09-10	--	--	96	--	--	81	7.4	--	0	26	--	6.5	2.5
	64-12-22	--	--	96	--	--	73	6.9	--	--	28	0	8.0	1.8
2	61-05-02	112	97	135	112	97	155	8.1	9.5	0	6.9	6	22	3.3
3	71-03-10	113	93	113	113	93	128	7.7	8.4	0	68	2	17	3.7
	72-02-29	--	--	113	--	--	129	--	9.2	--	55	--	15	4.3
4	67-01-18	--	--	37	--	--	372	--	--	--	--	--	--	--
	67-09-15	--	--	37	--	--	420	6.3	9.5	10	76	0	14	10
5	67-09-19	--	--	39	--	--	167	6.5	9.0	5	65	0	15	6.6
6	67-01-17	--	--	25	--	--	126	--	--	--	--	--	--	--
	67-09-19	--	--	25	--	--	113	6.2	8.0	5	35	4	8.2	3.5
7	68-05-21	--	--	91	--	--	182	--	--	--	--	--	--	--
8	64-07-08	--	--	43	--	--	78	7.0	--	0	34	-	10	2.1
9	64-07-24	--	--	150	--	--	123	8.7	--	0	14	0	5.0	.5

Well	Dissolved sodium (Na) (mg/L)	Percent (sodium)	Sodium adsorption ratio	Dissolved potassium (K) (mg/L)	Bicarbonate (HCO3) (mg/L)	Carbonate (CO3) (mg/L)	Alkalinity as (CaCo3) (mg/L)	Dissolved sulfate (SO4) (mg/L)	Dissolved chloride (Cl) (mg/L)	Dissolved fluoride (F) (mg/L)	Dissolved silica (SIO2) (mg/L)	Dissolved solids (residue at 180oC) (mg/L)	Dissolved solids (sum of constituents) (mg/L)	Total nitrate (N) (mg/L)	Total iron (Fe) (ug/L)
1	3.3	21	.3	.3	41	0	34	3.2	2.8	0.1	9.1	45	53	0.16	150
	--	--	--	--	35	0	29	--	--	--	--	--	--	--	--
2	4.3	12	.2	.2	76	0	62	11	3.0	.2	15	97	96	.09	70
3	4.6	15	.3	.2	68	0	56	3.0	3.1	.1	20	80	85	--	30
	--	--	--	--	--	--	--	--	3.4	--	--	--	--	--	--
4	--	--	--	--	--	--	--	--	66	--	--	--	--	--	--
	48	57	2.4	2.5	94	0	77	2.4	78	.1	46	260	249	.02	2200
5	8.3	22	.4	.8	79	0	65	.4	12	.1	28	118	110	.00	1300
6	--	--	--	--	--	--	--	--	12	--	--	--	--	--	80
	7.5	31	.6	.8	38	0	31	.4	13	.1	20	83	73	.20	--
7	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--
8	2.7	15	.2	.4	40	0	33	4.0	2.5	.1	8.7	50	51	.02	220
9	22	76	2.5	.2	55	4	52	5.2	4.0	.1	16	83	84	.00	50

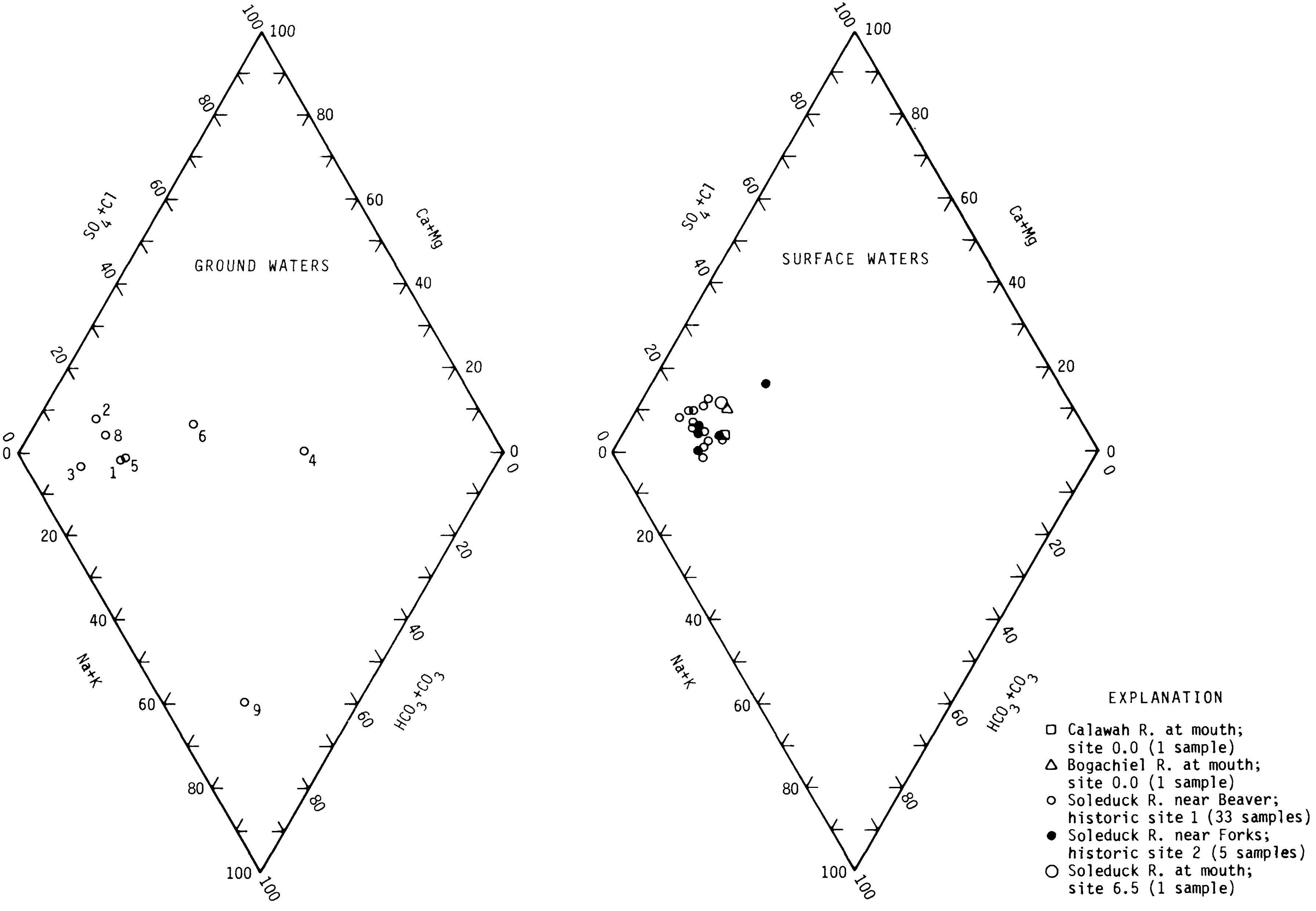


Figure 5.--Chemical composition of ground water and surface waters at selected sites in the Quillayute River basin. (See figure 4 for locations of sampling sites.)

Relation of Ground-Water Quality to River-Water Quality

Although the ground-water-quality data are limited, general knowledge of the relation of ground-water quality to river-water quality, together with the fact that the few wells sampled are in widely scattered areas, allows certain inferences to be drawn from the data.

During periods of low streamflow, the ground-water contribution to a river is commonly the major or entire contributor to the streamflow. Therefore, river-water samples collected at times of low streamflow can indicate the chemical concentrations and composition of contributing ground water. A comparison of the chemical compositions of ground and surface waters (fig. 5) showed a strong similarity over a wide geographic area. This similarity gives support to the inference, stated in the previous section, that ground-water samples from wells 1, 2, 3, 5, and 8 approximate the general ground-water quality of the basin, and that the quality of samples from wells 4, 6, and 9 are explainable departures from it.

The proportions of major chemical constituents in river water are not significantly affected by seasonal changes in streamflow; the concentrations of the constituents are affected, however. These facts, together with the previous finding that river water and ground water are of similar composition, lead to the inference that simple dilution processes are a dominant control of the surface-water chemistry.

In support of this inference, observed specific-conductance values (which are a measure of dissolved-constituent concentrations) in the Soleduck River ranged from 40 to 100 micromhos/cm (at 25°C) for the period of historic record. For all other rivers measured in this study, the data were within the same range. For ground water, as represented by the samples from wells 1, 2, 3, 5, and 8, the specific conductance values ranged from 75 to 170 micromhos/cm. During periods of low streamflow the concentration of chemical constituents is highest, similar to the concentration in ground water. As streamflow increases, the snowmelt and rain water responsible for the increased flow have a simple diluting effect on the concentration of constituents and the concentrations decrease proportionally, none becoming more or less predominant. Ground waters near the ocean, within 1 to 2 mi from shoreline, may have a generalized or localized occurrence of higher-than-normal sodium and chloride concentrations, as evidenced by data for wells 4 and 6.

Ground-water temperatures, as indicated by the data from wells 1, 2, 3, 5, and 8, are close to the mean annual air temperature (about 9.3°C) near La Push. Thus, ground-water inflow to the rivers tends to warm the rivers in the winter and cool them in the summer.

WATER QUALITY OF MAJOR RIVERS IN THE QUILLAYUTE RIVER BASIN

Water-quality data collected in the late summers of 1976 and 1977, documenting low-flow conditions in the Quillayute River, its major tributaries, and the Quillayute estuary, are presented in table 15 at the end of the report. Sampling sites on streams are shown in figure 4. Locations of sampling sites in the Quillayute estuary are shown in figure 22. A discussion of these and historic water-quality data follows.

Soleduck River

More water-quality data are available for the Soleduck River than for any of the other rivers in the Quillayute River basin. Prior to this study, it was the only major tributary for which any water-quality data had been systematically collected. These historic data are presented in full in table 16 (to be found at the end of the report).

Water-quality data were collected at historic site 1 on the Soleduck River (sta. 12042000—Soleduck River near Beaver, Wash.) from 1960 to 1970 as follows:

July 1960 to September 1961----------Monthly,
November 1961 to August 1962---------Quarterly,
December 1962 to June 1970----------Semiannually

From October 1971 through September 1974, water-quality data were collected at historic site 2 (sta 12042300—Soleduck River near Forks, Wash.) at approximately 2-month intervals. Summaries of historic water-quality data for the Soleduck River are provided in table 4, and the distributions of selected constituents in August 1976 and October 1977 are shown in figures 6 and 7.

Nutrients

Nutrient data (table 4; fig. 6) indicate very low concentrations of nitrate, ammonia, and total phosphate in the Soleduck River. There is a slightly higher mean nitrate concentration at historic site 2 than at historic site 1, but mean nitrate concentration at the lowermost site is still very low, 0.10 mg/L as N. The data for August 1976 and October 1977 indicate that Gunderson Creek at its mouth (at river mile 17.3 on the Soleduck River) contained appreciably greater concentrations of nitrate and ammonia than the Soleduck River, but due to its small flows, Gunderson Creek's nutrient load caused only a slight increase in nitrate and ammonia concentrations in the Soleduck River.

TABLE 4.--Mean, minimum, and maximum values of water-quality characteristics for period of record at historic sites 1 and 2 on the Soleduck River

Constituent or Characteristic	Units of Measurement	Mean Site 1	Mean Site 2	Minimum Site 1	Minimum Site 2	Maximum Site 1	Maximum Site 2	Number of samples Site 1	Number of samples Site 2
Specific conductance	micromhos/cm	74	76	38	48	102	100	33	18
pH	units	7.5	7.5	7.0	7.0	7.9	7.8	33	18
Temperature	degrees Celsius	9.3	8.4	3.4	4.4	18.8	16.8	30	18
Color[1]	platinum cobalt units	4	18	0	0	15	55	33	17
Turbidity	JTU	4	6	0	1	35	45	10	17
Dissolved oxygen	milligrams/liter	11.3	12.0	9.2	9.7	13.7	13.0	25	18
Total Coliform bacteria	colonies/100 milli-liters	33	248	0	75	360	660	27	18
Hardness (Ca,Mg)	milligrams/liter	31	29	16	16	43	37	33	12
Noncarbonate hardness	-do-	2	0	0	0	6	4	33	12
Calcium	-do-	10.5	9.3	5.0	5.1	15	12	33	12
Magnesium	-do-	1.2	1.4	.1	.8	2.1	1.8	33	12
Sodium	-do-	2.2	2.8	1.4	1.8	3.6	3.6	33	12
Percent sodium	percent	13	17	10	13	20	23	33	12
Potassium	milligrams/liter	.3	.5	.0	.2	.7	1.9	33	12
Bicarbonate	-do-	35	36	18	24	47	48	33	12
Carbonate	-do-	0	0	0	0	0	0	33	12
Alkalinity	-do-	29	29	15	20	39	39	33	12
Chloride	-do-	1.2	2.2	.7	1.3	1.8	2.7	33	12
Sulfate	-do-	5.8	6.3	2.8	3.1	9.8	12	33	6
Fluoride	-do-	.1	-	.0	-	.2	-	33	0
Silica	-do-	5.5	-	3.5	-	9.5	-	33	0
Dissolved solids (residue)	-do-	46	-	27	-	58	-	33	0
Calculated dissolved solids	-do-	44	-	25	-	60	-	33	0
Nitrite (N)	-do-	-	.00	-	.00	-	.02	0	11
Nitrite (N)	-do-	.03	.10	.00	.01	.14	.26	33	11
Nitrite plus nitrate (N)	-do-	-	.11	-	.02	-	.26	0	17
Ammonia (N)	-do-	-	.07	0	.01	-	.18	0	17
Kjeldahl nitrogen (N)	-do-	-	.12	-	.04	-	.22	0	5
Orthophosphate (P)	-do-	.00	.00	.00	.00	.01	.05	23	17
Total-phosphate (P)	-do-	-	.02	-	.00	-	.11	0	17
Arsenic	-do-	.00	-	.00	-	.00	-	14	0
Boron	micrograms/liter	9	-	0	-	40	-	15	0
Chromium	-do-	4	-	0	-	40	-	16	0
Hexavalent chromium	-do-	1	-	0	-	10	-	14	0
Copper	-do-	18	-	0	-	90	-	16	0
Iron	-do-	68	-	0	-	630	-	25	0
Zinc	-do-	34	-	0	-	50	-	14	0

1/Data are not comparable; different analytical techniques used for the two sites.

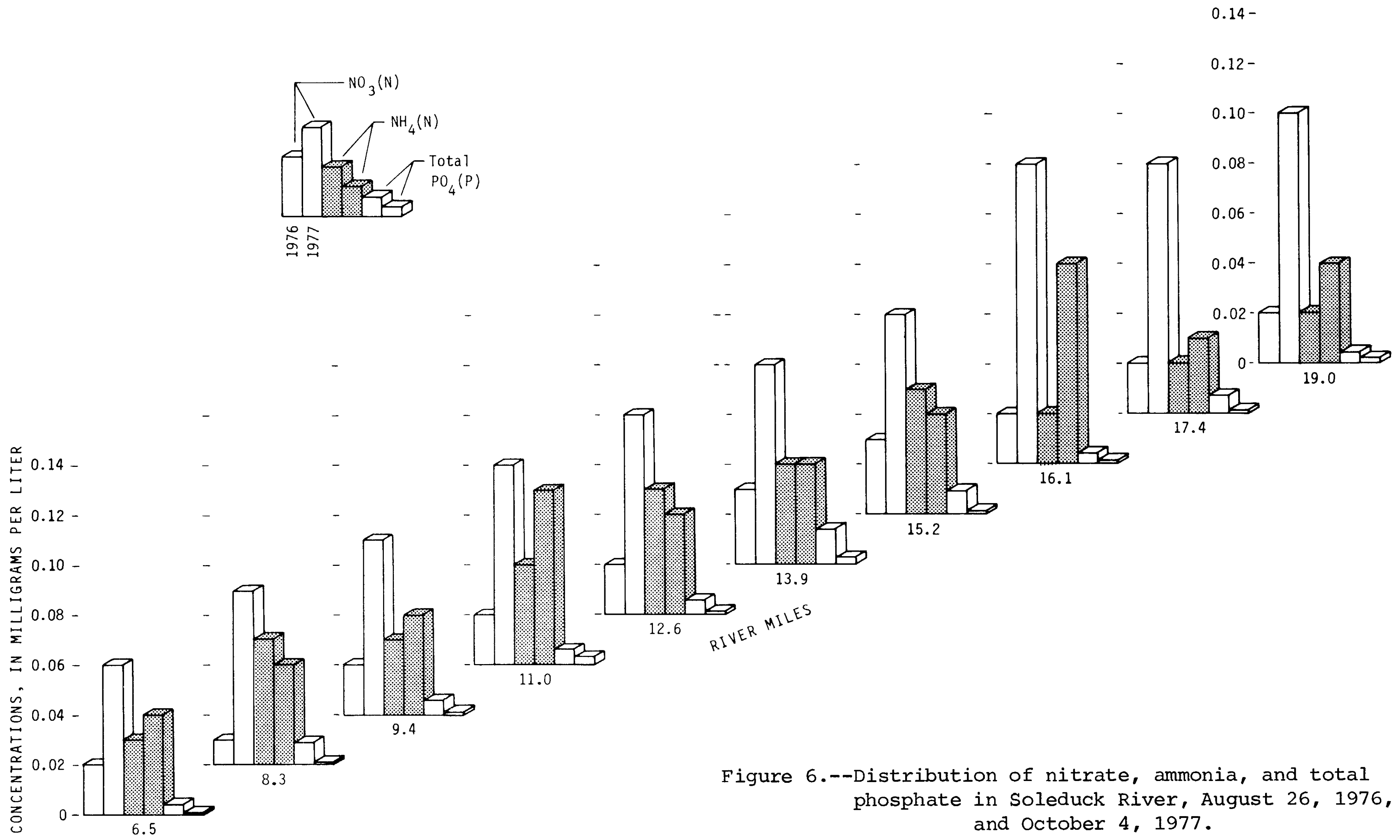


Figure 6.--Distribution of nitrate, ammonia, and total phosphate in Soleduck River, August 26, 1976, and October 4, 1977.

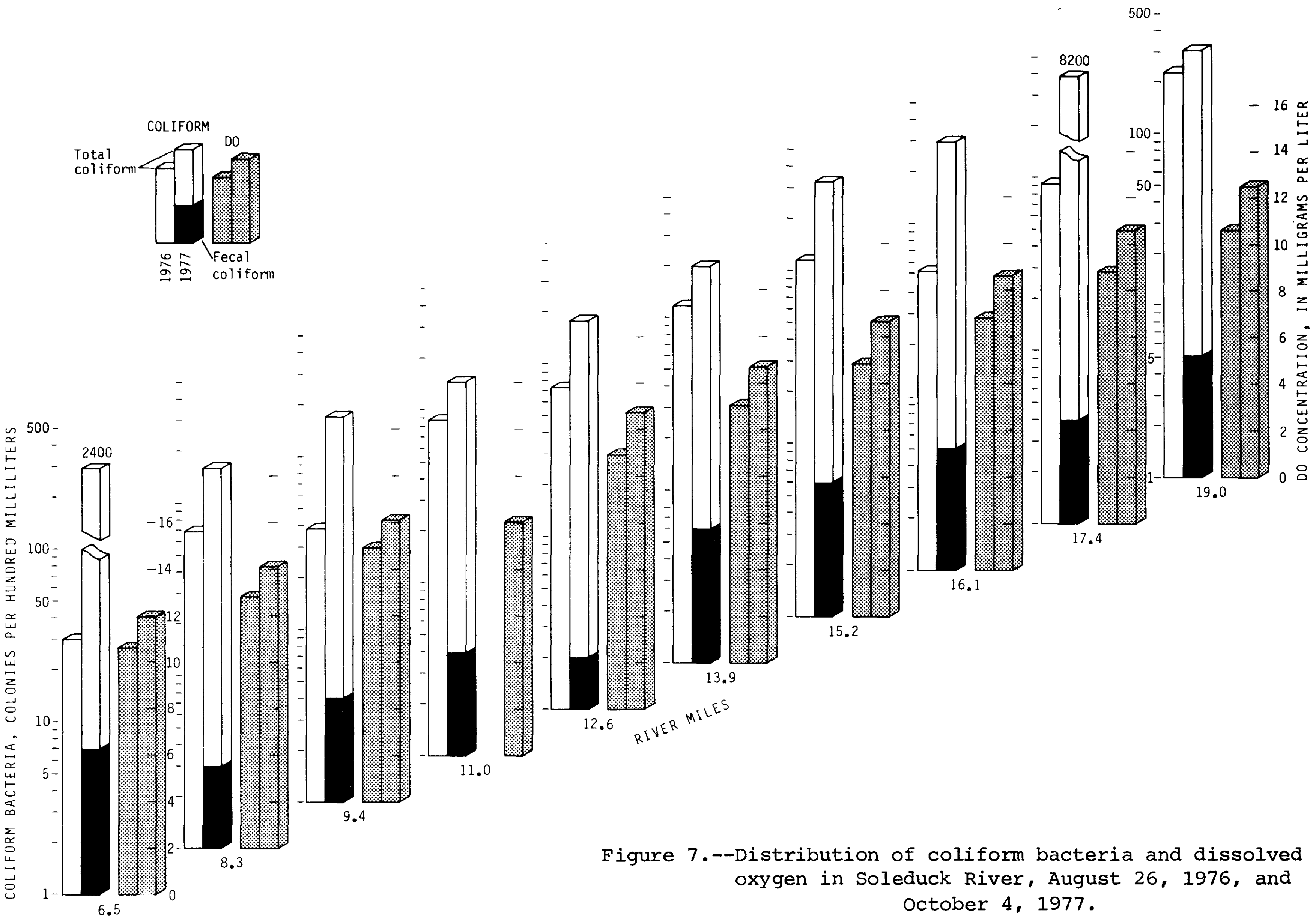


Figure 7.--Distribution of coliform bacteria and dissolved oxygen in Soleduck River, August 26, 1976, and October 4, 1977.

Bacteria

Water quality changed only slightly in the reach between historic sites 1 and 2, except for total-coliform bacteria concentrations, which increased several fold (table 4). Total-coliform concentrations met the old State Class AA criterion most of the time at historic site 1, but exceeded the old criterion limits (see p.12 for comments regarding the old criteria) most of the time at historic site 2. On October 4, 1977, the entire reach of river below river mile 19.0 (4.4 mi below historic site 2) exceeded the old total-coliform criteria limits, and on August 26, 1976, about half of the reach exceeded these limits (fig. 7). For the 1977 sampling, fecal-coliform concentrations were all well below the new criterion limits, and were also about 50 times less than the total-coliform concentrations at most of the sites. The relative proportions of total- and fecal-coliform concentrations at all the sites from river mile 19.0 to 6.5 indicate that most of the total-coliform bacteria were not associated with fecal sources, but probably originated in soils.

Temperature

A harmonic temperature analysis (fig. 8) was done for the Soleduck River using historic data collected at sites 1 and 2 and more current (1976 and 1977) data collected near the mouth of the river. Harmonic temperature analysis was developed by Ward (1963) and refined by Collings (1969) and Steele (1974). It is a means of mathematically approximating the variations in stream temperature that result from seasonal variations in weather. About 70 percent of the variation in stream temperature at these sites was explained by the seasonal harmonic analysis. The remaining "unexplained" variation was in part due to short-term weather changes that directly or indirectly produce perturbations about a generally smooth and repetitive seasonal weather pattern. Temperature maximums and minimums can be expected to remain within the limits defined by the upper and lower 95-percent confidence-limit curves 90 percent of the time. Parts of the upper confidence-limit curves in figure 8 exceed 16°C, the State Class AA criterion maximum limit, which indicates that occasional exceedance of the criterion may be expected; however, these exceedances are probably a result of natural rather than man-induced causes, because development along the river is so sparse. Temperatures that exceeded the maximum limits because of natural causes are not considered violations of the State Class AA criteria.

The harmonic-analysis curve of temperature data collected at the mouth of the Soleduck River (river mile 6.5) in 1976 and 1977 is only slightly different from that of data collected at historic sites 1 and 2.

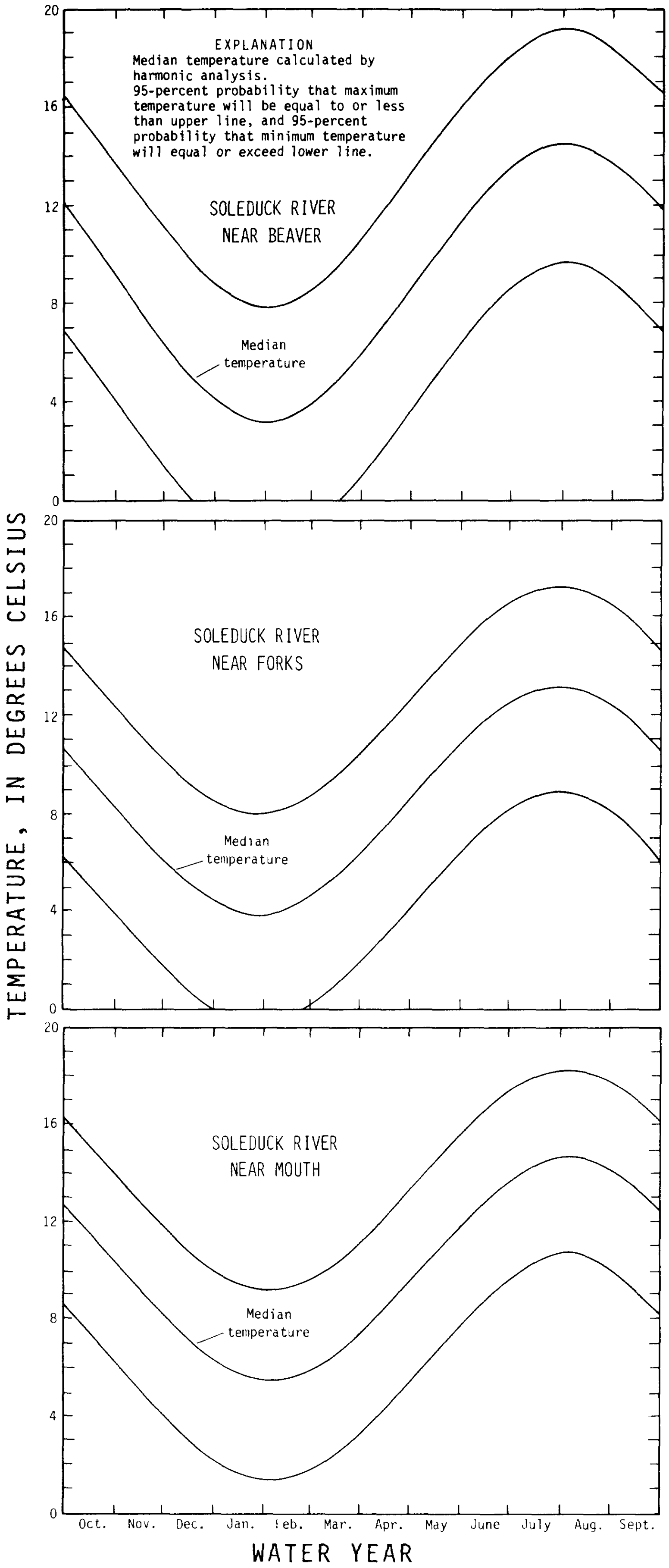


Figure 8.--The 90-percent probability range of stream temperatures in the Soleduck River at selected sites.

Dissolved Oxygen

Dissolved-oxygen (DO) concentrations in the Soleduck River met the State Class AA criterion for all observations at historic site 2 and at all sites sampled under the low-streamflow conditions of August 26, 1976, and October 4, 1977. However, at historic site 1 DO concentrations were below the criterion minimum on July 18, 1960, and July 17, 1961. Such infrequent occurrences can be expected to occur naturally throughout much of the river reach because stream water temperatures occasionally rise above 18°C, the temperature above which oxygen-saturated water naturally contains less than the 9.5 mg/L of DO necessary to meet the State Class AA criterion. DO concentrations that are less than 9.5 mg/L because of natural causes are not considered violations of the State Class AA criterion.

Common Constituents

The relation of specific conductance to the concentrations of various common constituents is given in table 5, and graphical examples of some of the better relations are given in figure 9. Specific conductance is easily determined in the field with a conductance meter. Using the relations in table 5, many of the common-constituent concentrations can then be estimated almost as accurately as they can be analytically determined.

Proportions of the major chemical constituents in surface waters of the Quillayute basin were similar to each other (fig. 5) and to the shallow ground waters of the basin. The proportions of the major chemical constituents in the Soleduck River were nearly constant despite concentration fluctuations in response to dilution from precipitation and snowmelt. Observed mean daily discharges at the two historic sites ranged from 83 to more than 5,000 ft^3/s.

TABLE 5.--Relation of specific conductance to various common constituents at historic sites 1 and 2 on the Soleduck River

[Based on the linear equation y = mx + b, where y = specific conductance]

Constituent (X)	Slope (m)	Intercept (b)	Correlation coefficient	Coefficient of variation (pct)
Historic site 1--Soleduck River near Beaver[1]				
Hardness	0.44	-1.6	0.99	3.3
Calcium	.16	-1.0	.95	7.0
Bicarbonate	.45	1.9	.99	2.3
Sulfate	.10	-1.6	.88	13.3
Historic site 2--Soleduck River near Forks[2]				
Hardness	0.31	5.1	0.88	10.5
Calcium	.10	1.6	.87	11.1
Magnesium	.01	.3	.78	14.2
Bicarbonate	.34	8.9	.81	12.6

[1]Magnesium, sodium, potassium, chloride, and nitrate show little relationship.

[2]Sodium, potassium, chloride, sulfate, and nitrate show little relationship.

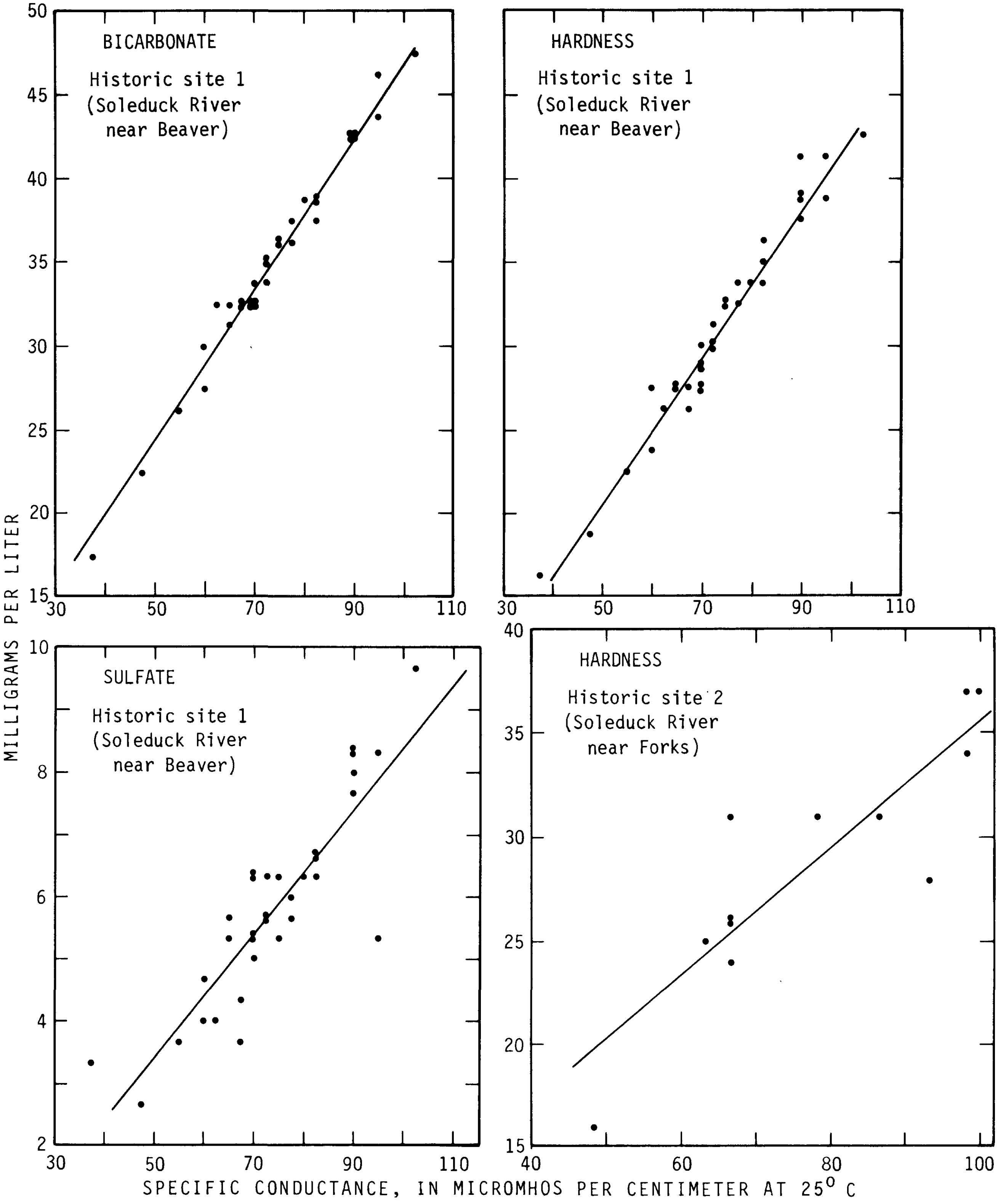


Figure 9.--Relation of specific conductance to selected constituents at the two historic sites on the Soleduck River.

Calawah River

The following discussion is based on data from summer water-quality samplings made during low streamflow conditions (on August 24, 1976, and October 6, 1977), and on intermittent temperature readings taken in conjunction with sediment sampling for this study throughout 1976 and 1977. The results of the sediment sampling are given in the first report from this study (Nelson, 1982).

Nutrients

Three areas of moderately increased ammonia concentrations were observed in the Calawah River on August 24, 1976 (fig. 10). The inflowing North Fork Calawah caused an increase in ammonia concentration at river mile 10.2; a second increase was noted in the vicinity of Forks (river mile 7.5), and a third increase was observed between river miles 2 and 4. The sources were uncertain, but were assumed to be natural. The ammonia was not associated with an increase in coliform-bacteria concentrations, as would be expected if the sources were surficial drainage from rural or urban areas. The concentration variations were subtle and, because of dilution, probably are not apparent during periods of higher flow.

Periphyton (attached algae, commonly but incorrectly referred to as "moss") were observed on the streambed downstream of the two points on the main stem of the Calawah that had increased ammonia concentrations. No periphyton were observed immediately below the confluence of the North Fork Calawah, but the ammonia concentration there was diluted very quickly as the flows of the North Fork and South Fork combined. On October 6, 1977, streamflow was only about 10 percent higher than on August 24, 1976, but the three ammonia concentration peaks observed previously were not evident.

The nutrient concentrations in the Calawah River were generally low, with the exception of those areas mentioned earlier, and even there the concentrations could be considered low-to-average when compared with other streams on the Olympic Peninsula. Maximum observed ammonia concentrations were well below the concentration likely to harm aquatic life. According to the U.S. Environmental Protection Agency (1977), un-ionized ammonia should not exceed 0.02 mg/L to protect freshwater aquatic life. At pH 8 and temperatures of 20°C or less, a total-ammonia concentration of at least 0.52 mg/L is necessary to attain an un-ionized ammonia concentration of 0.02 mg/L. At lower temperature or pH, or both, the concentration of total ammonia can be even greater without exceeding 0.02 mg/L un-ionized ammonia.

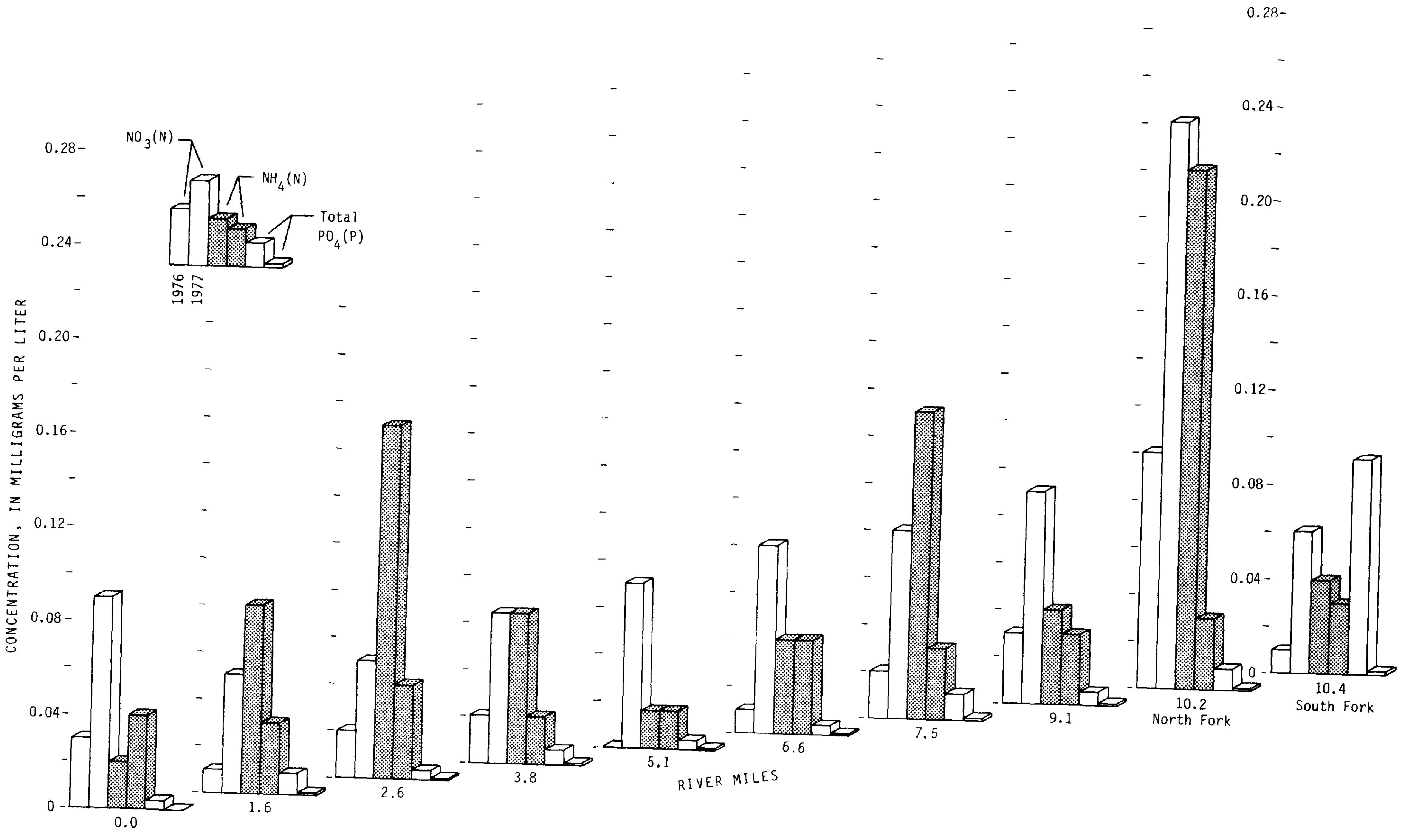


Figure 10.--Distribution of nitrate, ammonia, and total phosphate in the Calawah River, August 24, 1976, and October 6, 1977.

Bacteria

On August 24, 1976, total-coliform bacteria concentrations (fig. 11) all met the old State Class A criterion (<240 col/100 mL), but on October 6, 1977, most exceeded the limit of the old criterion. However, fecal-coliform concentrations on the latter date easily met the limit of the new State Class AA criterion, and were generally about 40 times less than the old total-coliform concentrations. The 40-to-1 ratio indicates that most of the total-coliform bacteria were of nonfecal origin and probably originated in soils. A short but intense rainfall occurred on October 6, 1977, and may have caused many soil bacteria to wash into the streams.

Temperature

The 90-percent probability range of stream temperatures for the Calawah River at its mouth (river mile 0.1) is shown in figure 12. Occasional natural exceedance of the State Class AA maximum temperature criterion (16°C) can be expected during the summer.

Dissolved Oxygen

Dissolved-oxygen concentrations can be expected occasionally to be below the State Class AA criterion's minimum, on the basis of the expected natural occurrence of water temperatures above 18°C. This is the temperature above which DO-saturated water would naturally contain less DO than the 9.5-mg/L State Class AA minimum-DO criterion.

Common Constituents

Proportions of the major chemical constituents in water from the Calawah River are similar to those for the other major tributaries of the Quillayute River system (fig. 5). Only one sample was collected from the Calawah River on August 24, 1976, under summer low-streamflow conditions. As in the Soleduck River, the proportions of the major chemical constituents in the Calawah River probably remain nearly constant despite concentration fluctuations in response to dilution from precipitation and snowmelt.

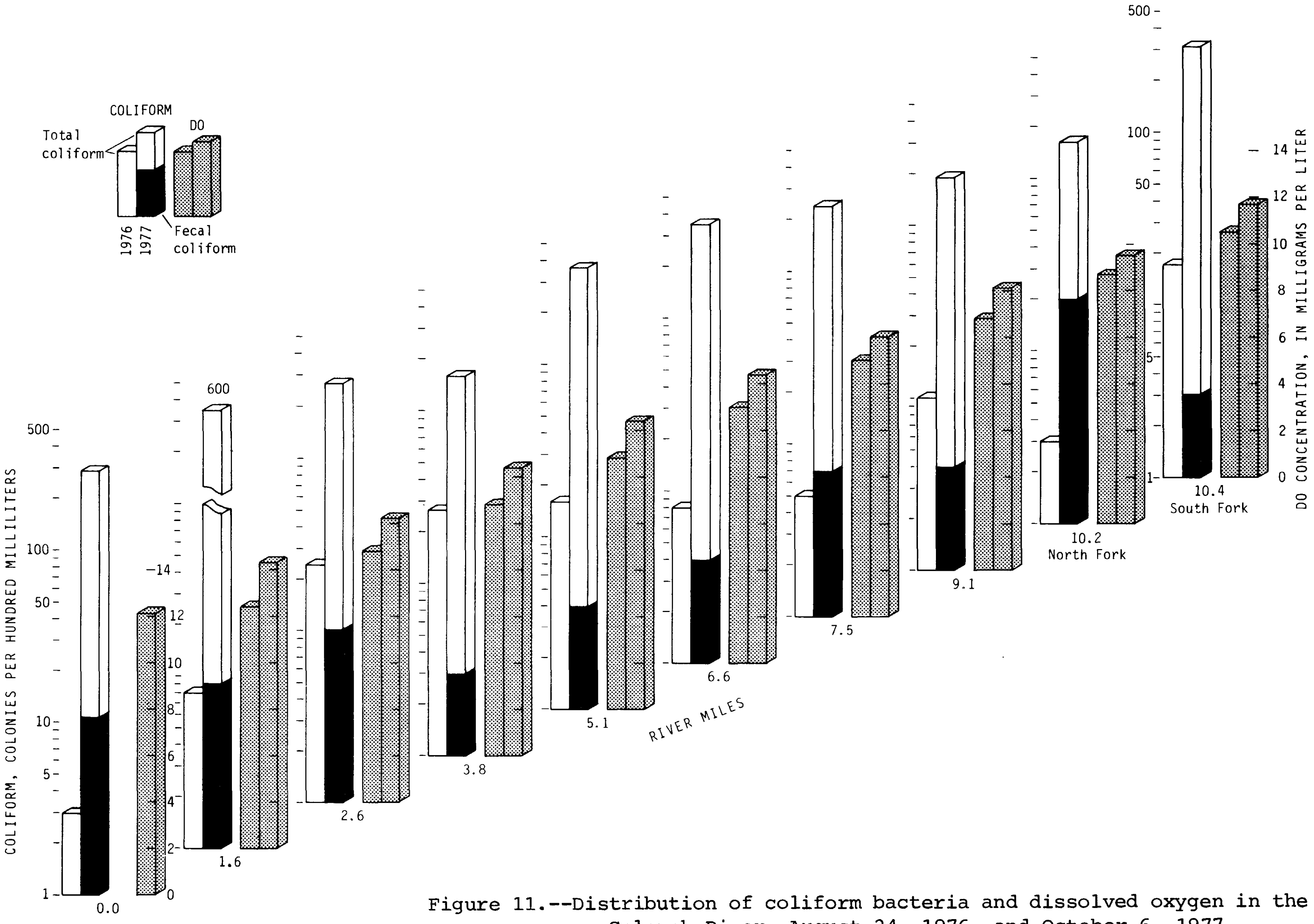


Figure 11.--Distribution of coliform bacteria and dissolved oxygen in the Calawah River, August 24, 1976, and October 6, 1977.

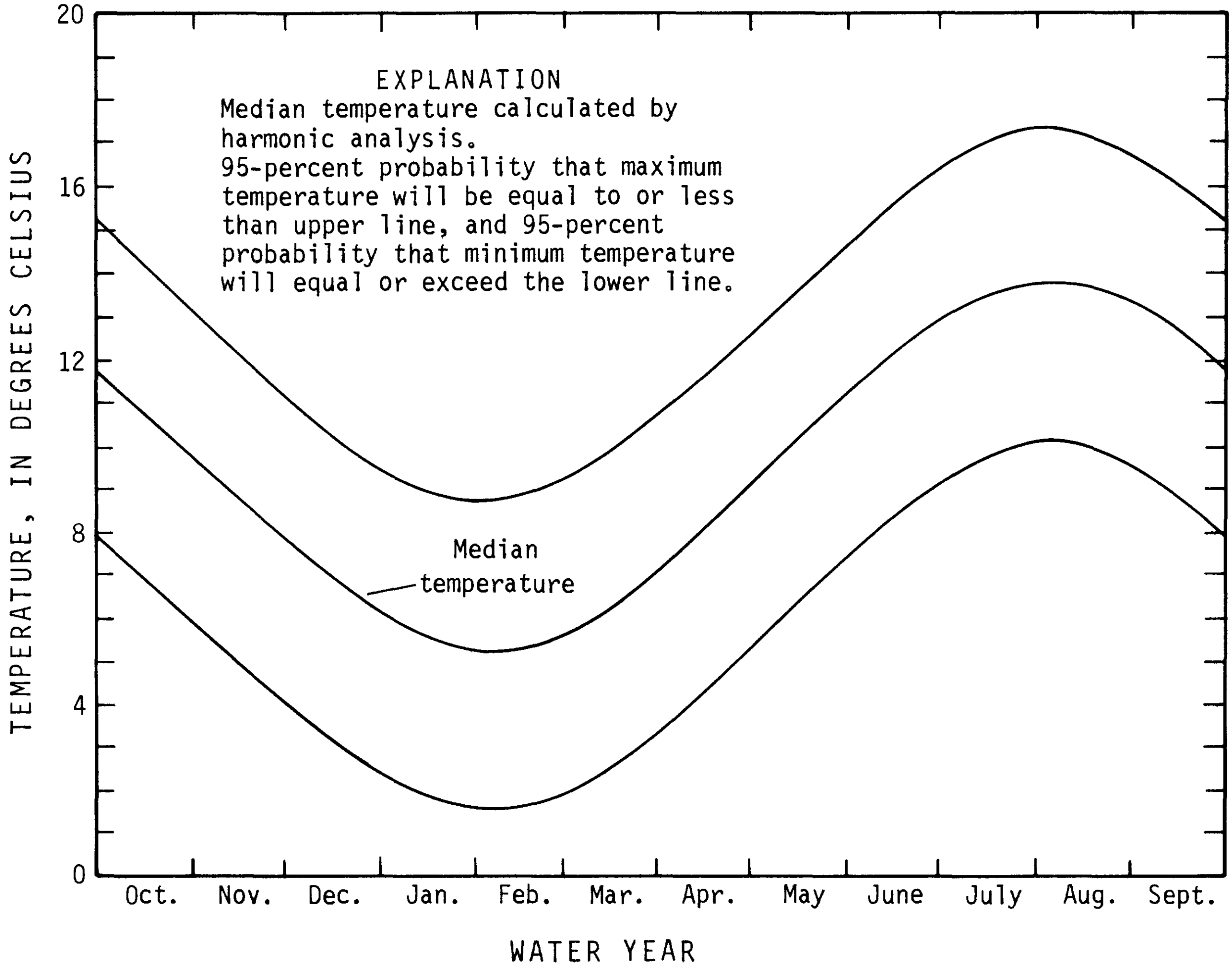


Figure 12.--The 90-percent probability range of stream temperatures for the Calawah River at its mouth.

Bogachiel River

The following discussion is based on data from two water-quality samplings during low streamflow, on August 25, 1976, and October 5, 1977, and on intermittent temperature readings taken in conjunction with sediment sampling in 1976 and 1977 by Nelson (1982).

Nutrients

A moderate increase in ammonia concentration was observed in the vicinity of Forks (river mile 10.1) in both 1976 and 1977 (fig. 13), probably due to inflow from Mill Creek. This stream drains a major part of the town of Forks, and has pastureland and rural homes along its lower reaches. Grader Creek, the only other important local source of inflow, drains steeply canyoned forestland. Practically no development has occurred in the Grader Creek basin (only 2 or 3 homes), and it is unlikely that Grader Creek was a contributor to the increased ammonia concentration observed near Forks.

Below Forks, the ammonia concentrations decreased rapidly, due to dilution by the inflowing Calawah River, to oxidation of ammonia to nitrate, and to uptake of ammonia by periphyton. Drainage from the Bogachiel rearing ponds (steelhead) enters just below the sampling site at river mile 8.7, but probably had negligible impact on the river; at least none could be measured at river mile 8.0.

Comparison of 1976 and 1977 samplings showed, in general, slightly higher ammonia concentrations in 1977 from the uppermost sampling site, near the Olympic National Park boundary, down to the town of Forks (river mile 10.1). The cause of this increase was not apparent, but was probably naturally occurring because the increase was evident at the uppermost site (river mile 19.5) where the river leaves the Olympic National Park. The amount of un-ionized ammonia was much less than the total ammonia reported here. Concentrations of un-ionized ammonia appeared to remain well below the level considered detrimental to aquatic organisms. Nitrate concentrations at all sites were very low and patterns could not be discerned.

Phosphorous concentrations increased sharply 1 to 2 mi downstream of Forks. Assimilation within the stream was rapid, however, and the phosphorous concentrations returned to normal within another mile or two.

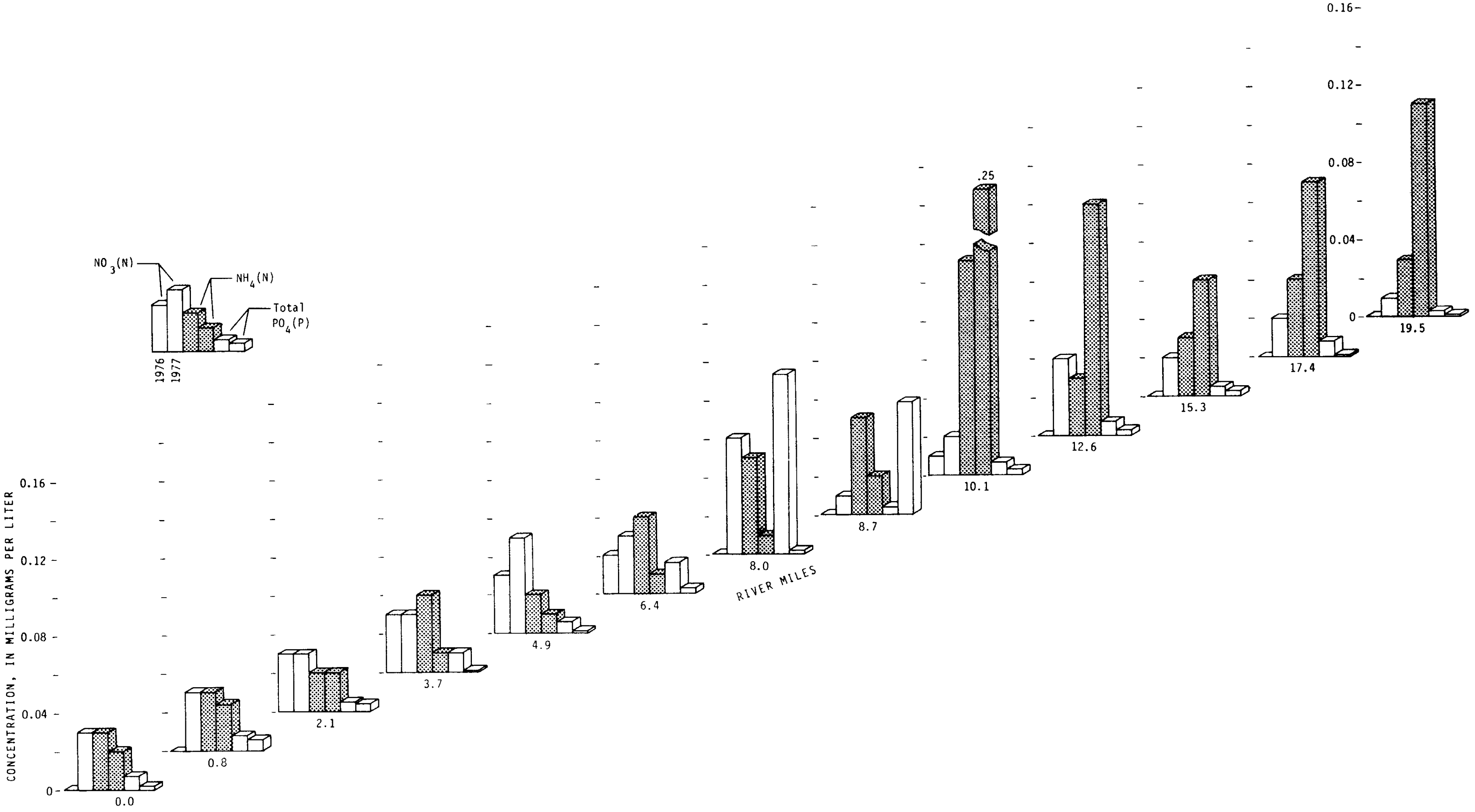


Figure 13.--Distribution of nitrate, ammonia, and total phosphate in the Bogachiel River, August 25, 1976, and October 5, 1977.

Bacteria

Total-coliform bacteria concentrations (fig. 14) met the old State Class A criterion (< 240 col/100 mL) at all sampling sites in 1976, but in 1977 exceeded the old criterion maximum limit at Maxfield Creek and at two sites downstream on the Bogachiel River. During the 1977 sampling, fecal-coliform concentrations averaged about 10 times less than total-coliform concentrations and met the new State Class AA criteria, except at river mile 8.7, just below Mill Creek. The fecal-coliform concentration at that site was 95 col/100 mL; elsewhere, fecal-coliform concentrations ranged from 5 to 30 col/100 mL.

Temperature

The 90-percent probability range of stream temperatures for the Bogachiel River at its mouth is shown in figure 15. Occasional natural exceedence of the State Class AA criterion maximum (16°C) can be expected during the summer.

Dissolved Oxygen

Dissolved-oxygen concentrations can be expected occasionally to be lower than the State Class AA criterion minimum, because water temperatures will naturally exceed 18°C (see fig. 15), the temperature above which DO-saturated water would naturally contain less DO than the 9.5-mg/L State Class AA minimum-DO criterion.

Common Constituents

Proportions of the major chemical constituents in the Bogachiel River are similar to those for the other major tributaries of the Quillayute River (fig. 5). The single Bogachiel River sample was collected during low-streamflow conditions on August 25, 1976. As in the Soleduck River, the proportions of the major chemical constituents in the Bogachiel River probably remain nearly constant despite concentration fluctuations in response to dilution from precipitation or snowmelt.

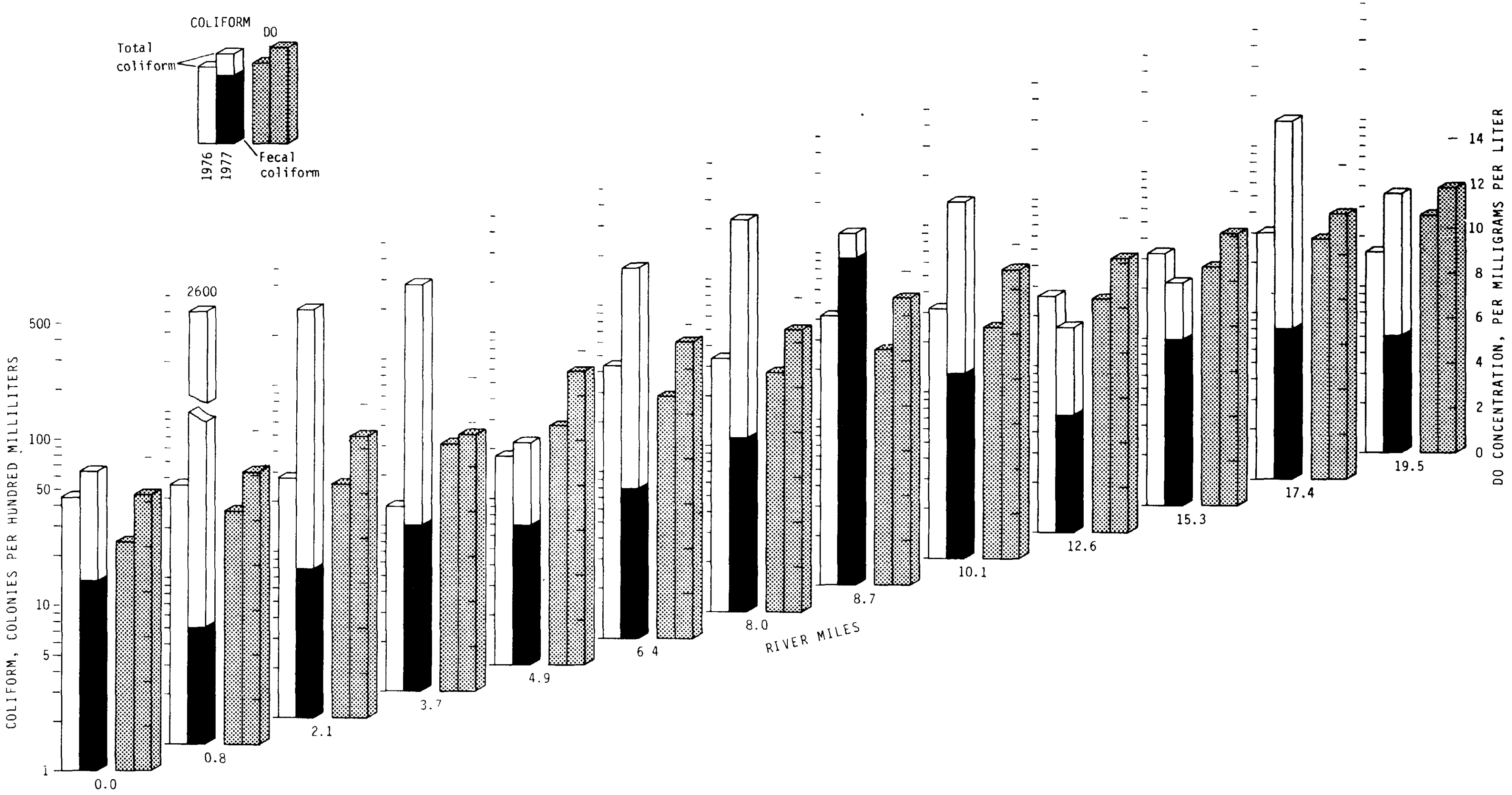


Figure 14.--Distribution of coliform bacteria and dissolved oxygen in the Bogachiel River, August 25, 1976, and October 5, 1977.

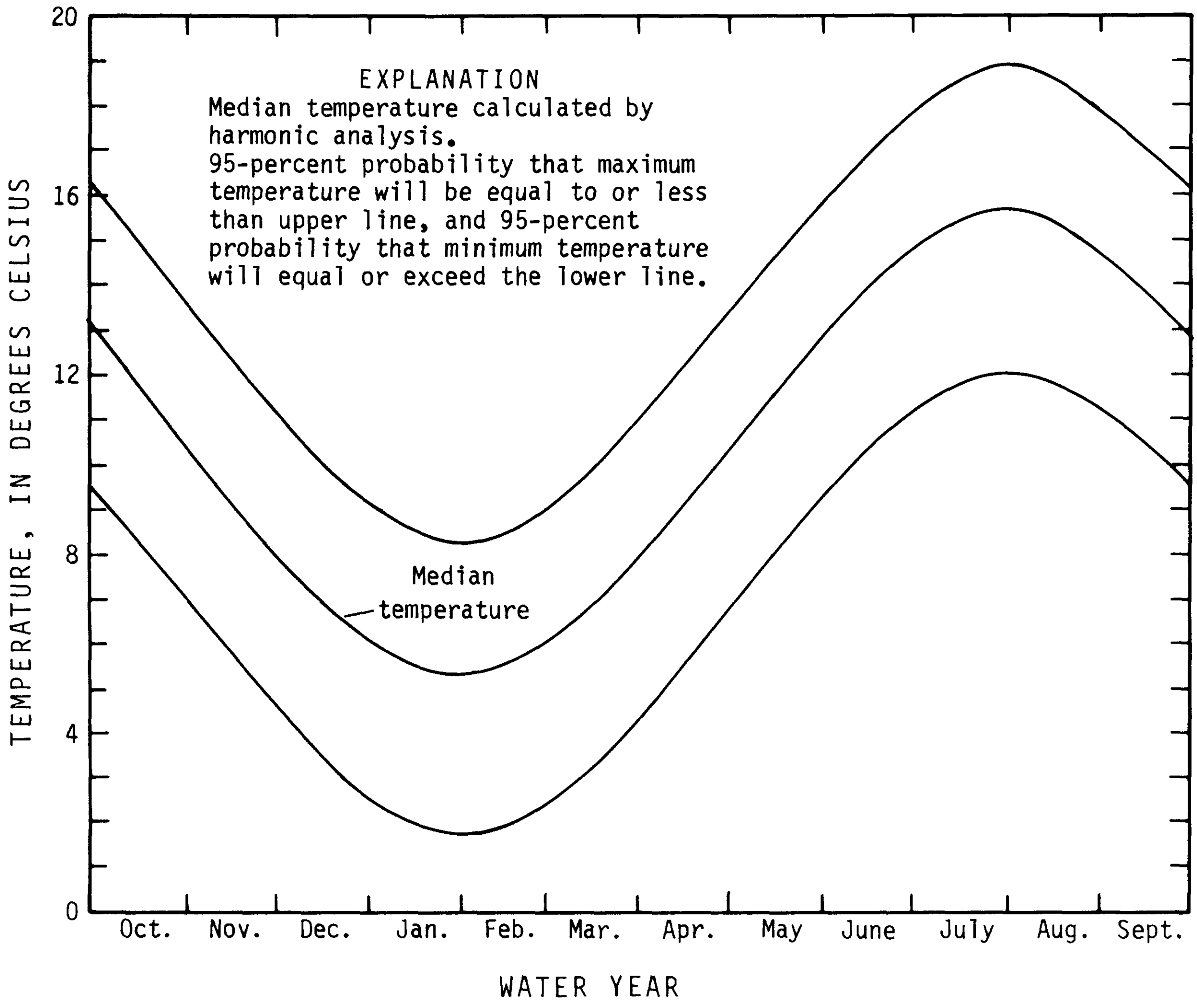


Figure 15.--The 90-percent probability range of stream temperatures for the Bogachiel River at its mouth.

Dickey River

The following discussion is based on data from two water-quality samplings during low streamflow conditions on August 24, 1976, and October 4, 1977, and on intermittent temperature readings taken in conjunction with sediment samplings in 1976 and 1977 by Nelson (1982).

Nutrients

Ammonia concentrations were consistently between 0.03 and 0.07 mg/L throughout the reach sampled, except at two locations during the 1976 sampling (fig. 16). The slightly increased ammonia concentrations observed at the mouth of the West Fork Dickey River and at river mile 6.8 on the main stem are of uncertain origin; there was practically no development in the areas, and the slightly increased ammonia concentrations were not associated with increased bacteria concentrations, as would be likely if the ammonia source were surficial. The probable source was naturally occurring ammonia. Periphyton growth was observed at the mouth of the West Fork Dickey River, but not at the other site. Nitrate concentrations at all sites were very low and there were no apparent patterns.

Phosphate concentrations were generally greater throughout the entire stream reach sampled than in any of the other major tributaries in the basin. The Dickey River is a lowland stream of low stream-channel gradient, whereas the other major tributaries derive much of their water from steeper terrains. Because of the gentle gradient of the lower part of the basin, the Dickey River meanders through boggy areas and, as a result, picks up considerable dissolved organic materials, probably tannins and lignins, which give the water a dark tea-like color. These dissolved organic materials are believed to be important transporters of phosphate, because only about half of the phosphate is in solution as orthophosphate. The other half is either in solution as part of the organic-molecules complex or is strongly sorbed to dissolved organic material. Transport of phosphate by suspended sediment is believed to be unimportant during these low-flow samplings because suspended-sediment concentrations were very low.

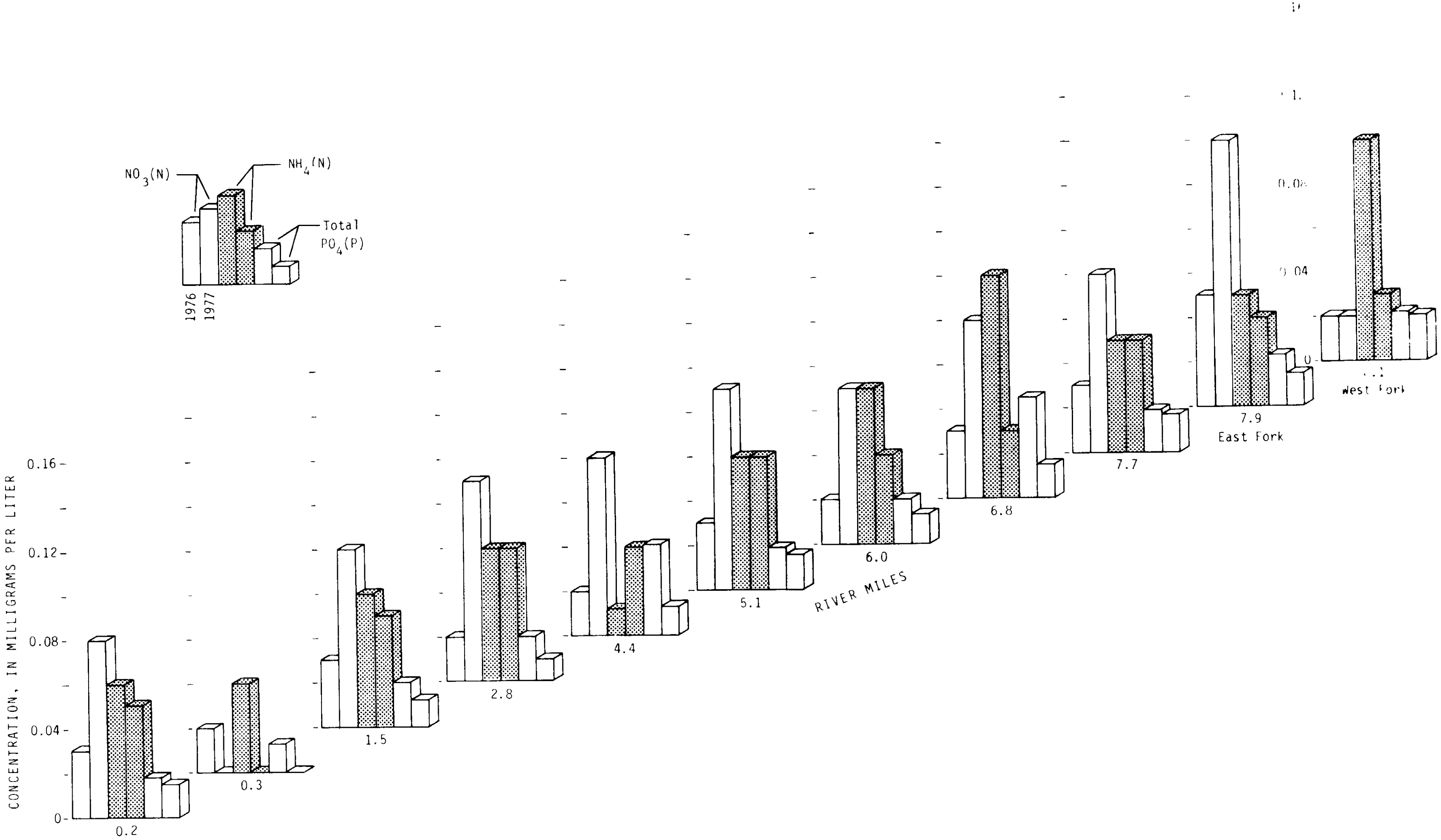


Figure 16.--Distribution of nitrate, ammonia, and total phosphate in the Dickey River, August 24, 1976, and October 4, 1977.

Bacteria

Total-coliform bacteria concentrations (fig. 17) remained within the old State Class A criterion (< 240 col/100 mL) at all sites on August 24, 1976, but exceeded the old criterion maximum limit at 7 of the 12 sites on October 4, 1977. Fecal-coliform concentrations averaged about 10 times less than the total-coliform concentrations, and ranged from 22 to 48 col/100 mL, except in Coal Creek at its mouth (river mile 3.9), which had 86 col/100 mL. All fecal-coliform concentrations except in Coal Creek met the new State Class A criterion.

Temperature

The 90-percent probability range of stream temperatures for the Dickey River at river mile 3.1 is shown in figure 18. Occasional naturally occurring exceedence of the State Class A criterion maximum (18°C) can be expected during the summer.

Dissolved Oxygen

Dissolved-oxygen concentrations (fig. 17) appeared to be within State Class A criteria specifications; DO remained near saturation at low streamflow, and stream temperatures did not appear to exceed the 21°C temperature level at which DO saturated water would naturally have less than the 8.0-mg/L DO the State Class A criterion specifies.

Common Constituents

Proportions of the major chemical constituents in water from all the major tributaries of the Quillayute River system were similar, except for the Dickey River (fig. 5). The single Dickey River sample shown was collected at the Mora Bridge (river mile 0.2) during low-streamflow conditions on August 24, 1976, but unfortunately the river water at this site was partially mixed with saline estuary water; saline water is known to extend a short distance upstream of the bridge on some high tides. Upstream of the estuary, the specific conductance was within a few units of that of the other major tributaries, and the chemical composition of water in the Dickey River was probably also nearly the same as that of the other major tributaries.

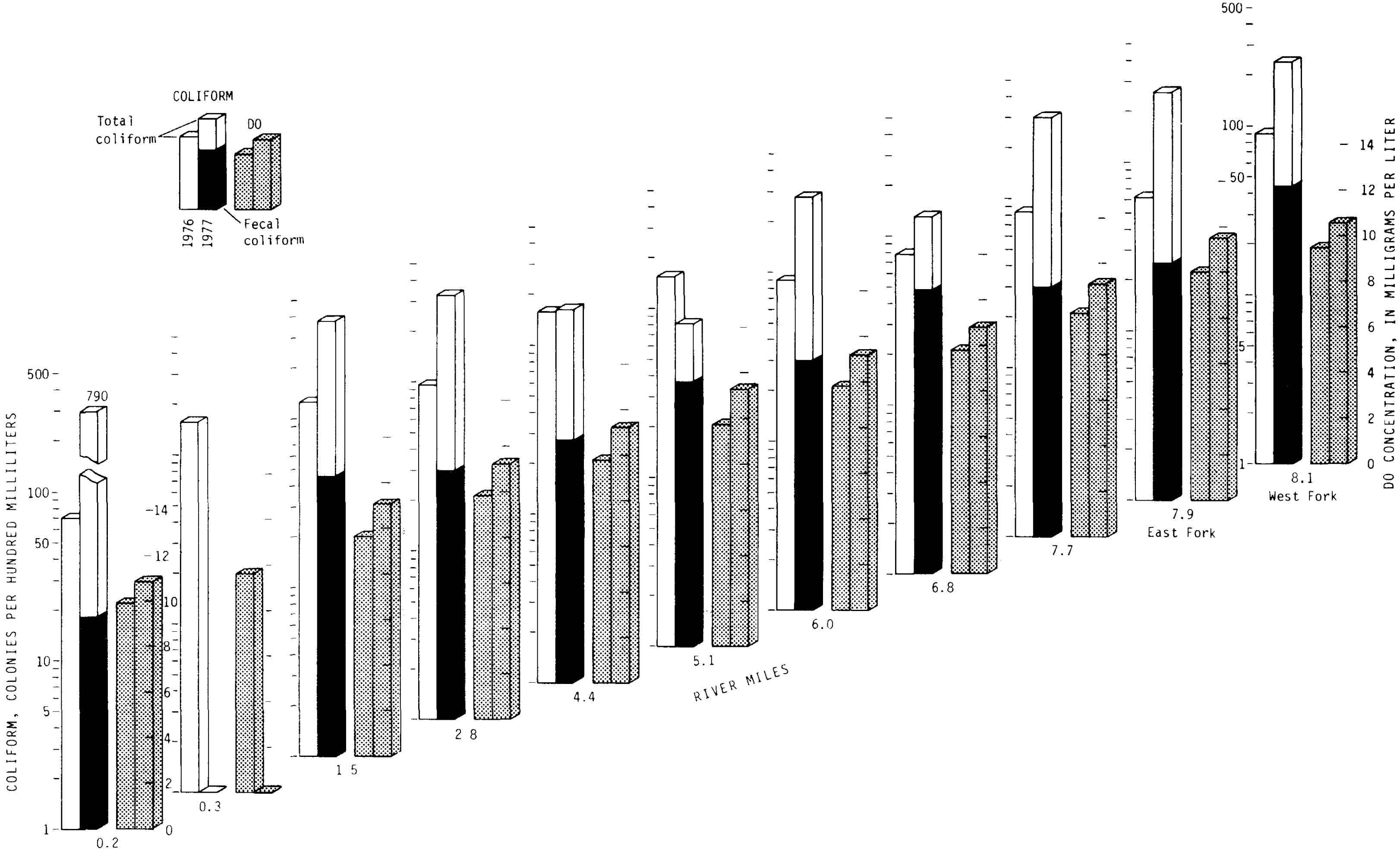


Figure 17.--Distribution of coliform bacteria and dissolved oxygen in the Dickey River, August 24, 1976, and October 4, 1977.

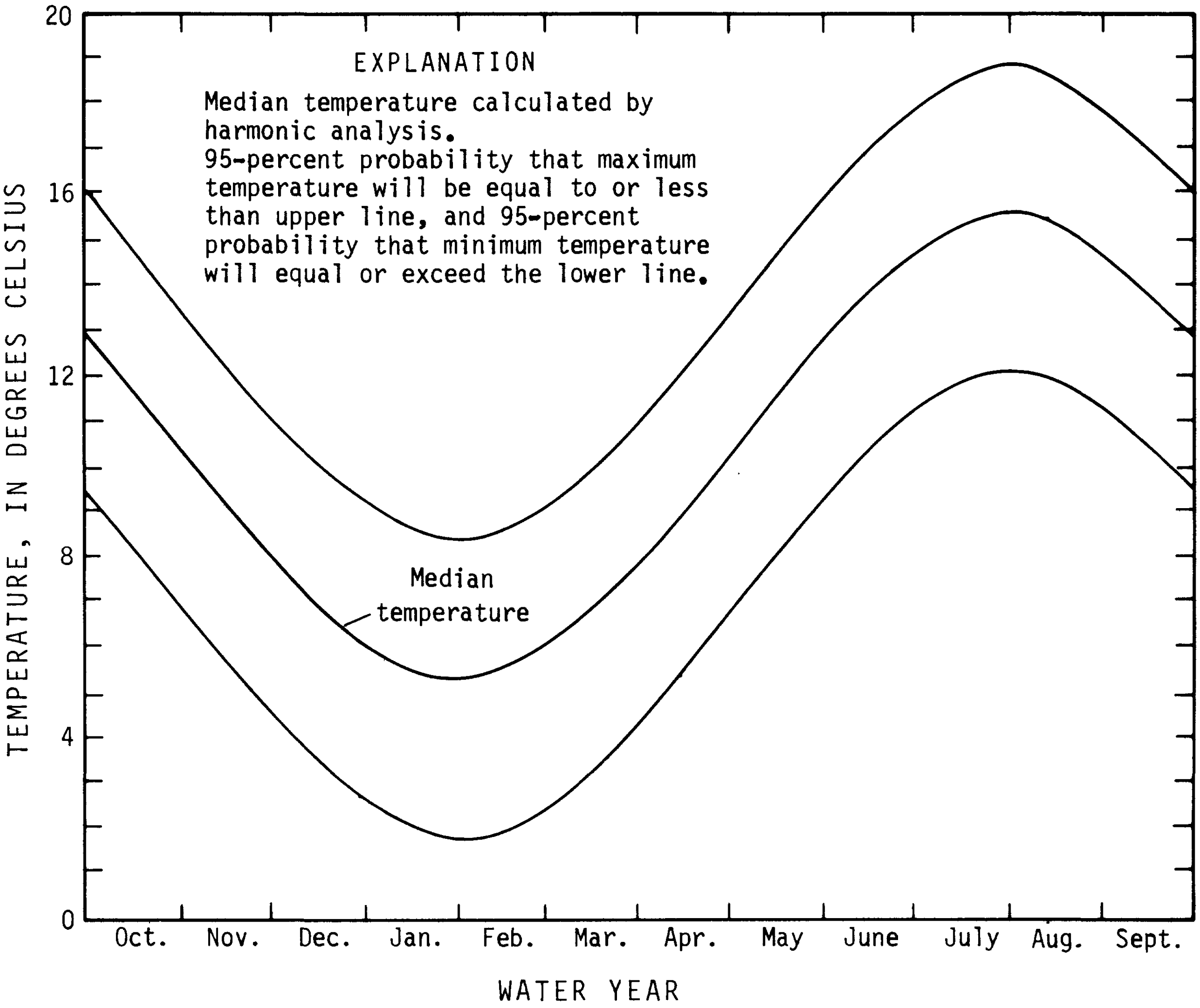


Figure 18.--The 90-percent probability range of stream temperatures for the Dickey River at rivermile 3.1.

Quillayute River

The following discussion is based on data from water-quality samplings of the Quillayute River on August 25, 1976, and October 5, 1977, during low-streamflow conditions.

Nutrients

There were no observable nutrient problems; nitrate, ammonia, and phosphate concentrations were very low (fig. 19). On October 5, 1977, the ammonia concentration at the upper end of the river was slightly higher than elsewhere but the cause was not apparent. Periphyton growth occurred at river miles 5.7 and 3.3, but not at the two lower sites.

Bacteria

On October 5, 1977, total-coliform bacteria concentrations (fig. 20) exceeded the maximum limit of the old State Class AA criterion throughout the entire length of the Quillayute River. Fecal-coliform concentrations, however, were much lower, and ranged from 3 to 9 col/100 mL, indicating that most of the total-coliform bacteria were not associated with a fecal source, but were of soil origin. All fecal-coliform concentrations met the new State criterion.

Temperature

Using the results of harmonic temperature analysis of the Soleduck and Bogachiel Rivers (figs. 8 and 15) as an approximation of stream temperatures in the Quillayute River, it is apparent that the Quillayute River will frequently have summertime water temperatures exceeding the State Class AA criterion maximum of 16°C. However, these high temperatures occur naturally.

Dissolved Oxygen

Dissolved-oxygen concentrations in the Quillayute River (fig. 20) appear to remain near saturation at low streamflow. However, on the basis of occasional naturally occurring water temperatures above 18°C, the temperature above which oxygen-saturated water naturally contains less than the 9.5 mg/L DO necessary to meet the State Class AA criterion, DO will occasionally drop below the minimum limit.

Common Constituents

Proportions of the major chemical constituents in water from the major tributaries of the Quillayute River—excluding the Dickey River, which actually enters the estuary--were all similar (fig. 5); the Quillayute River, therefore, probably had a similar composition. Specific-conductance values measured in the Quillayute River were within a few units of those measured in the tributaries, indicating that concentrations of the major chemical constituents were also probably similar.

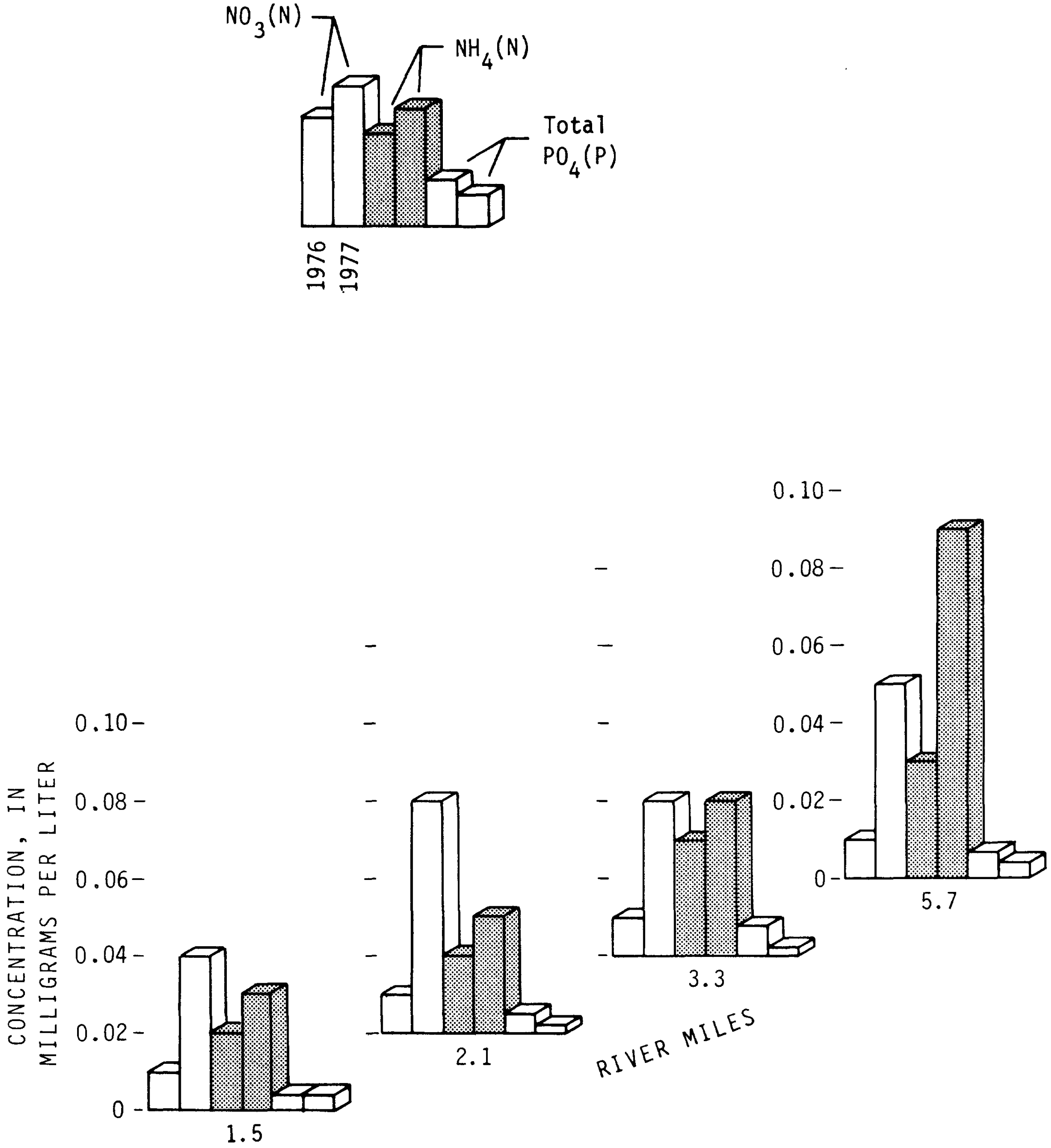


Figure 19.--Distribution of nitrate, ammonia, and total phosphate in the Quillayute River, August 25, 1976, and October 5, 1977.

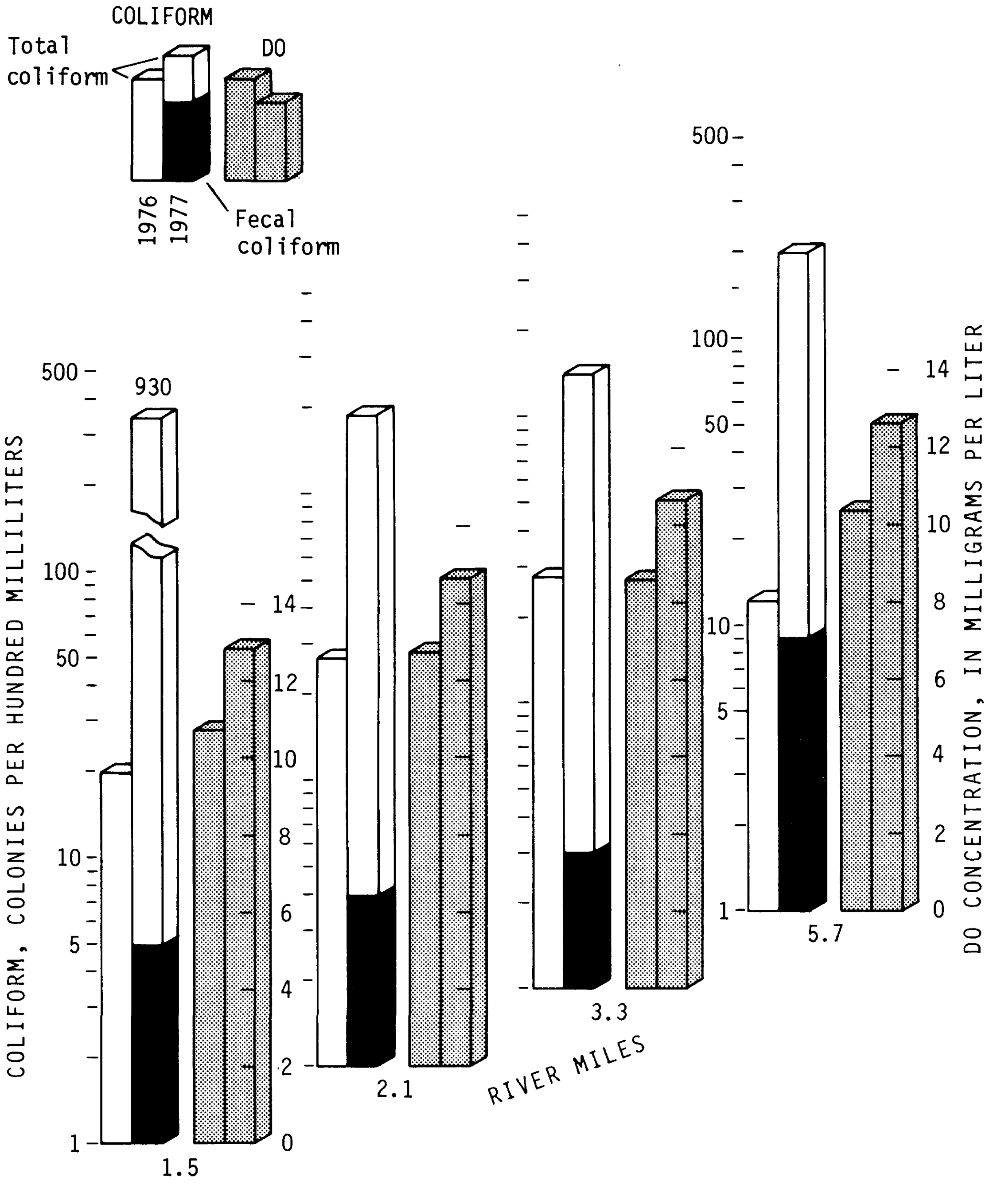


Figure 20.--Distribution of coliform bacteria and dissolved oxygen in the Quillayute River, August 25, 1976, and October 5, 1977.

RIVER BOTTOM MATERIALS

Numerous reports, such as those by Peters (1962), McNeil and Ahnell (1964), and Bjornn (1974), have documented the effect of streambed particle-size distribution on the spawning and embryo survival of trout, steelhead, and salmon. Generally, 10 to 20 percent by volume of sand in the gravel and cobble of a streambed is optimum. Above this percentage, detrimental effects occur, some quite severe. Spawning is inhibited, eggs are suffocated, or embryos may emerge but, being unable to free themselves, die embedded in the sand.

To provide a general qualitative indication of streambed quality, visual estimates of bottom material were made at each sampling site on the rivers (table 6) using criteria provided in table 7. The data can be used to compare general riffle and pool conditions now and at some time in the future, although not on a site-specific basis. Pools and riffles tend to change locations over a period of time, so any future observations should not necessarily be expected to be the same at a given site. Pools and riffles tend to have different streambed compositions; smaller particles settle in the pools because of slower water velocities, but tend to be swept out of the riffles because of higher water velocities.

TABLE 6.--Bottom-material description at selected sites on the Soleduck, Calawah, Bogachiel, Dickey, and Quillayute Rivers

Name	River mile	Regime	Bottom description
Soleduck River	19.0	pool	small and large cobbles, interstices partly filled with coarse sand.
Soleduck River	17.4	riffle	large cobbles, very little sand.
Gunderson Creek	17.3	riffle	small cobbles; clean, very little sand.
Soleduck River	16.1	pool	small cobbles; coarse silt and fine sand on rocks; much leaf litter on bottom.
-do.-	15.2	riffle	large cobbles and 2-3 ft diameter boulders; medium gravel interspersed among larger rocks; periphyton covering.
-do.-	13.9	pool	intermixed coarse sand to medium gravel.
-do.-	12.6	pool	small cobbles; some coarse sand in interstices.
-do.-	11.0	riffle	boulders, 10-15 in. diameter; some coarse sand.
-do.-	9.4	riffle	large cobbles and boulders to 12 in. diameter; some coarse sand.
-do.-	8.3	riffle	large cobbles and boulders to 15 in. diameter; very coarse gravel between larger rocks.
-do.-	6.5	pool	large cobbles and boulders to 12 in. diameter; small cobbles between larger rocks; periphyton covering.
South Fork Calawah River	10.4	pool	small cobbles; periphyton cover; slight covering of coarse silt and fine sand.
North Fork Calawah River	10.2	riffle	small cobbles; very little sand or gravel.

TABLE 6.--Bottom material description at selected sites on the Soleduck, Calawah, Bogachiel, Dickey, and Quillayute Rivers--Continued

Name	River mile	Regime	Bottom description
Calawah River	9.1	riffle	large cobbles with boulders interspersed; very little sand or gravel.
Elk Creek	9.0	riffle	small cobbles with boulders interspersed.
Calawah River	7.5	pool	large cobbles; much fine gravel between the cobbles.
-do-	6.6	pool	very coarse gravel; interstices filled with coarse sand.
-do-	5.1	pool	small cobbles; periphyton cover; very little sand, slight leaf litter.
-do-	3.8	riffle	small cobbles with boulders, 1-3 ft diameter, interspersed.
-do-	2.6	riffle	large cobbles with small cobbles interspersed; a few small boulders; very little sand.
-do-	1.6	riffle	same as preceding; periphyton cover.
-do-	0.0	riffle	same as preceding; some sand.
Bogachiel River	19.5	riffle	boulders and cobbles.
-do-	17.4	pool	cobbles with sand in interstices.
-do-	15.3	riffle	boulders and cobbles.
-do-	12.6	riffle	cobbles.
-do-	10.1	riffle	boulders and cobbles.
-do-	8.7	riffle	boulders and cobbles.
-do-	8.0	riffle	small cobbles; some large cobbles, very little finer material.

TABLE 6.--Bottom material description at selected sites on the Soleduck, Calawah, Bogachiel, Dickey, and Quillayute Rivers--Continued

Name	River mile	Regime	Bottom Description
Bogachiel River	6.4	riffle	small cobbles and very coarse gravel; very little finer material.
-do-	4.9	riffle	small and large cobbles; periphyton cover; very little finer material.
-do-	3.7	riffle	very coarse gravel; very little finer material.
Maxfield Creek	2.7	riffle	very coarse gravel and small cobbles; only a slight amount of sand.
Bogachiel River	2.1	pool	sandstone armor with some coarse sand.
Murphy Creek	1.2	pool	coarse gravel.
Bogachiel River	.8	pool	too deep to see bottom; probably fine sand and silt, as stream is very slow here.
Bogachiel River	0.0	riffle	large cobbles with some small cobbles; very little sand.
West Fork Dickey River	8.1	riffle	small cobbles covered with periphyton, interstices filled with fine sand.
East Fork Dickey River	7.9	riffle	very coarse gravel; interstices filled with fine sand.
Dickey River	7.7	riffle	coarse to very coarse gravel; interstices filled with fine sand.
Dickey River	6.8	pool	fine sand and silt; a few large cobbles and boulders interspersed.
Dickey River	6.0	pool	very fine gravel interspersed among some 2-3 ft diameter boulders, some cobbles.
Dickey River	5.1	pool	coarse gravel nearly completely covered by very fine gravel.

TABLE 6.--Bottom material description at selected sites on the Soleduck, Calawah, Bogachiel, Dickey, and Quillayute Rivers--Continued

Name	River mile	Regime	Bottom description
Colby Creek	5.0	riffle	very coarse gravel and small cobbles; clean, little sand discernible.
Dickey River	4.4	riffle	flat-boulder armored bottom; small cobbles in interstices, clean; little sand discernible.
Coal Creek	3.9	riffle	small cobbles and coarse gravel intermixed.
Dickey River	2.8	pool	medium gravel; interstices filled with coarse sand.
-do-	1.5	pool	coarse to very coarse gravel; interstices filled with coarse sand.
-do-	.3	pool	large cobbles; interstices filled with coarse sand to fine gravel.
Quillayute River	5.7	riffle	small and large cobbles; periphyton cover; very little sand.
-do-	3.3	pool	small cobbles; interstices mostly filled with fine gravel; some periphyton.
-do-	2.1	pool	coarse to very coarse gravel; interstices filled with coarse sand.
-do-	1.5	riffle	large cobbles; very little sand or gravel; periphyton cover.

TABLE 7.--Bottom-material sizes and names, by classes (modified from Lane and others, 1947)

Class name	Class size: Millimeters	Class size: Inches, approximate
Boulders	Greater than 256	Greater than 10
Cobbles:		
Large	256-128	10-5
Small	128-64	5-2½
Gravel:		
Very coarse	64-32	2½-1
Coarse	32-16	1¼-5/8
Medium	16-8.0	5/8-1/3
Fine	8.0-4.0	1/3-1/6
Very fine	4.0-2.0	1/6-1/12
Sand:		
Very coarse	2.0-1.0	1/12-1/25
Coarse	1.0-.50	1/25-1/50
Medium	.50-.25	1/50-1/100
Fine	.25-.125	1/100-1/200
Very fine	.125-.062	1/200-1/400
Silt:		
Coarse	.062-.031	----
Medium	.031-.016	----
Fine	.016-.008	----
Very fine	.008-.004	----
Clay:		
Coarse	.004-.002	----
Medium	.002-.001	----
Fine	.001-.0005	----
Very fine	.0005-.00024	----

LAKES

Historic water-quality data, collected on August 12, 1974, are available for four lakes; two in the Soleduck River basin (Pleasant Lake and Beaver Lake) and two in the Dickey River basin (Dickey Lake and Wentworth Lake).

The data indicate that the lakes were thermally stratified at the time of sampling. This condition leads to lower dissolved-oxygen and greater ammonia concentrations in the colder, lower layer (the hypolimnion) of each lake than in the warmer, upper layer (the epilimnion). Organic matter, such as leaves and dead algae, settle into the lower layer and decompose, reducing the oxygen concentration and increasing the ammonia concentration. Such late summer conditions are typical for western Washington lakes deeper than about 20 feet.

Fecal-coliform bacteria concentrations were low; 5 col/100 mL was the maximum concentration observed, well below the State's new Lake Class criterion (<50 col/100 mL). Interestingly, the maximum concentration was observed on Wentworth Lake, which had no residential development.

In general, concentrations of the plant nutrients nitrogen and phosphorus were moderate. The epilimnions of the lakes had lower levels of ammonia and phosphorus and higher levels of organic nitrogen than the hypolimnions, presumably due to biological uptake of dissolved nutrients by algae in the epilimnion and mineralization in the hypolimnion.

The littoral (near-shore) bottoms of Beaver and Dickey Lakes were covered with muck, and most of their shorelines, as well as that of Wentworth Lake, were covered by emersed aquatic plants. An algal bloom was observed in Beaver Lake. Even though Pleasant Lake received an inflow of industrial cooling water high in nitrogen, the in-lake nitrogen concentration of that lake was the lowest of the four lakes studied.

Bathymetric maps of the four lakes are shown in figure 21, and all physical, cultural, and water-quality data available for the lakes are presented in tables 8-11. A more detailed explanation of the terms used in this discussion and in tables 8-11 can be found in Bortleson and others (1976).

TABLE 8.--Physical, cultural, and water-quality data for Beaver Lake[1]

Latitude 48°6'36", Longitude 124°14'49" T30N-R12W-9
Quillayute River Basin

Physical data		Cultural data	
Drainage area	6.11 mi^2	Residential development	0 pct
Altitude	550 ft		
Lake area	44 acres	Number of nearshore homes	0
Lake volume	840 acre-ft		
Mean depth	19 ft	Land use in drainage basin	
Maximum depth	35 ft		
Shoreline length	1.2 mi	Residential urban	0 pct
Shoreline configuration	1.2	Residential suburban	0 pct
Development of volume	0.55	Agricultural	0 pct
Bottom slope	2.2 pct	Forest or unproductive	99 pct
Basin geology	Sed./Meta.	Lake surface	1 pct
Inflow	Perennial		
Outflow channel	Present	Public boat access to lake	Yes

Water-quality data (in mg/L, unless otherwise indicated)

Date	August 12, 1974	
Time	1340	1345
Depth (ft)	3.	30.
Total nitrate (N)	0.00	0.03
Total nitrite (N)	0.00	0.00
Total ammonia (N)	0.04	0.37
Total organic nitrogen (N)	0.29	0.15
Total phosphorus (P)	0.012	0.024
Total orthophosphate (P)	0.004	0.021
Specific Conductance (umhos)	76	80
Water temperature (oC)	17.3	9.0
Color (platinum-cobalt units)	20	45
Secchi-disc visibility (ft)	9	
Dissolved oxygen	9.3	0.1

Lake shoreline covered by emersed plants	76-100 pct.
Lake surface covered by emersed plants	1-10 pct.

Date	August 12, 1974
Time	1355
Number of fecal coliform samples	3
Fecal coliform, minimum (col/100mL)	<1
Fecal coliform, maximum (col/100mL)	2
Fecal coliform, mean (col/100mL)	1

[1]The lake is fed by a creek which drains a large marsh. Submersed and emersed plants covered most of the shoreline. An algal bloom was observed. Muck covers most of the littoral bottom.

TABLE 9.--Physical, cultural, and water-quality data for Dickey Lake[1]

Latitude 48°5'59", Longitude 124°30'22" T30N-R14W-16
Quillayute River Basin

Physical data		Cultural data	
Drainage area	14.7 mi^2	Residential development	0 pct
Altitude	193 ft		
Lake area	500 acres	Number of nearshore homes	0
Lake volume	13000 acre-ft		
Mean depth	25 ft	Land use in drainage basin	
Maximum depth	45 ft		
Shoreline length	5.0 mi	Residential urban	0 pct
Shoreline configuration	1.6	Residential suburban	0 pct
Development of volume	0.56	Agricultural	0 pct
Bottom slope	0.86 pct	Forest or unproductive	95 pct
Basin geology	Sed./Meta.	Lake surface	5 pct
Inflow	Perennial		
Outflow channel	Present	Public boat access to lake	---

Water-quality data (in mg/L, unless otherwise indicated)

Date	August 12, 1974	
Time	1605	1610
Depth (ft)	3.	33.
Total nitrate (N)	0.00	0.06
Total nitrite (N)	0.00	0.00
Total ammonia (N)	0.05	0.10
Total organic nitrogen (N)	0.32	0.19
Total phosphorus (P)	0.015	0.021
Total orthophosphate (P)	0.006	0.014
Specific Conductance (umhos)	32	33
Water temperature (oC)	20.2	10.8
Color (platinum-cobalt units)	45	65
Secchi-disc visibility (ft)	9	
Dissolved oxygen	8.7	3.0

Lake shoreline covered by emersed plants	76-100 pct.
Lake surface covered by emersed plants	1-10 pct.

Date	August 12, 1974
Time	1615
Number of fecal coliform samples	3
Fecal coliform, minimum (col/100mL)	<1
Fecal coliform, maximum (col/100mL)	2
Fecal coliform, mean (col/100mL)	1

[1]Emersed plants covered most of lake shoreline. The littoral bottom is mostly muck.

TABLE 10.--Physical, cultural, and water-quality data for Pleasant Lake[1]

Latitude 48°3'40", Longitude 124°20'35" T30N-R13W-35
Quillayute River Basin

Physical data		Cultural data	
Drainage area	8.96 mi^2	Residential development	10 pct
Altitude	320 ft		
Lake area	500 acres	Number of nearshore homes	20
Lake volume	16000 acre-ft		
Mean depth	32 ft	Land use in drainage basin	
Maximum depth	50 ft		
Shoreline length	4.9 mi	Residential urban	<1 pct
Shoreline configuration	1.6	Residential suburban	1 pct
Development of volume	0.64	Agricultural	0 pct
Bottom slope	0.95 pct	Forest or unproductive	90 pct
Basin geology	Igneous	Lake surface	9 pct
Inflow	Perennial		
Outflow channel	Present	Public boat access to lake	Yes

Water-quality data (in mg/L, unless otherwise indicated)

Date	August 12, 1974	
Time	1425	1430
Depth (ft)	3.	43.
Total nitrate (N)	0.00	0.03
Total nitrite (N)	0.00	0.00
Total ammonia (N)	0.02	0.16
Total organic nitrogen (N)	0.16	0.06
Total phosphorus (P)	0.009	0.031
Total orthophosphate (P)	0.002	0.031
Specific Conductance (umhos)	40	50
Water temperature (oC)	20.7	10.9
Color (platinum-cobalt units)	0	30
Secchi-disc visibility (ft)	13	
Dissolved oxygen	9.2	1.0

Lake shoreline covered by emersed plants	Little or none
Lake surface covered by emersed plants	None or < 1 pct

Date	August 12, 1974
Time	1430
Number of fecal coliform samples	3
Fecal coliform, minimum (col/100mL)	<1
Fecal coliform, maximum (col/100mL)	1
Fecal coliform, mean (col/100mL)	<1

[1]The lake has many snags and logs. The east side of the lake receives cooling water from a plant that manufactures cedar shingles. The average flow is 0.9 mgd and the average concentration of ammonia and nitrate is 1.7 mg/L. No phosphorus data are available (Dept. of Ecology Wastewater Discharge Master Inventory).

TABLE 11.--Physical, cultural, and water-quality data for Wentworth Lake[1]

Latitude 48°0'43", Longitude 124o32'0" T29N-R14W-20
Quillayute River Basin

Physical data		Cultural data	
Drainage area	0.59 mi^2	Residential development	0 pct
Altitude	80 ft		
Lake area	42 acres	Number of nearshore homes	0
Lake volume	510 acre-ft		
Mean depth	12 ft	Land use in drainage basin	
Maximum depth	21 ft		
Shoreline length	1.1 mi	Residential urban	0 pct
Shoreline configuration	1.2	Residential suburban	0 pct
Development of volume	0.58	Agricultural	0 pct
Bottom slope	1.4 pct	Forest or unproductive	89 pct
Basin geology	Sed./Meta.	Lake surface	11 pct
Inflow	None visible		
Outflow channel	Present	Public boat access to lake	---

Water-quality data (in mg/L, unless otherwise indicated)

Date	August 12, 1974	
Time	1605	1610
Depth (ft)	3	16
Total nitrate (N)	0.00	0.00
Total nitrite (N)	0.00	0.00
Total ammonia (N)	0.04	0.06
Total organic nitrogen (N)	0.31	0.23
Total phosphorus (P)	0.007	0.014
Total orthophosphate (P)	0.004	0.011
Specific Conductance (umhos)	30	35
Water temperature (oC)	21.2	10.6
Color (platinum-cobalt units)	40	45
Secchi-disc visibility (ft)	8	
Dissolved oxygen	8.7	0.6

Lake shoreline covered by emersed plants	76-100 pct.
Lake surface covered by emersed plants	11-25 pct.

Date	August 12, 1974
Time	1615
Number of fecal coliform samples	3
Fecal coliform, minimum (col/100mL)	<1
Fecal coliform, maximum (col/100mL)	5
Fecal coliform, mean (col/100mL)	2

[1]Emersed plants covered most of lake shoreline.

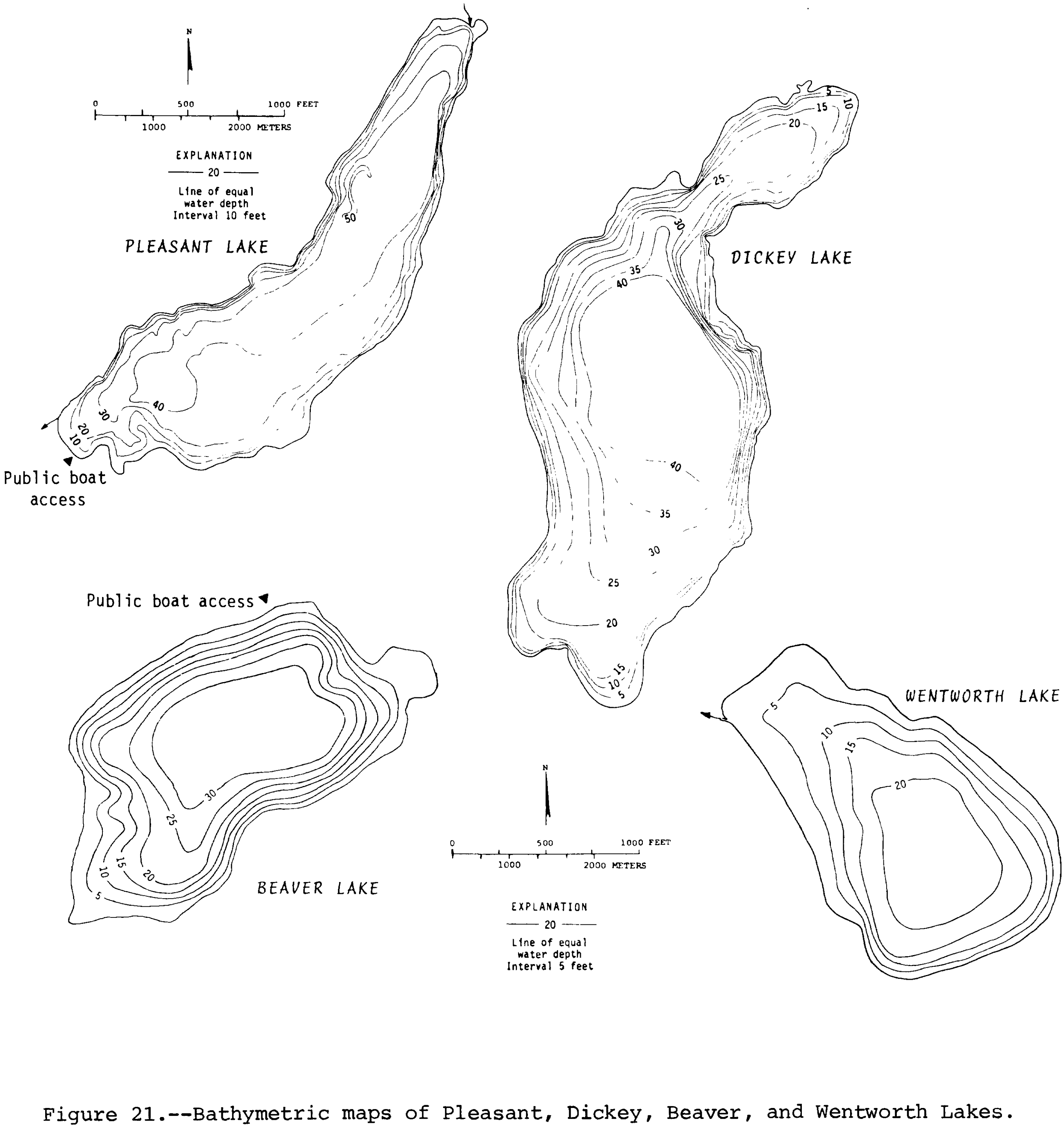


Figure 21.--Bathymetric maps of Pleasant, Dickey, Beaver, and Wentworth Lakes.

THE QUILLAYUTE ESTUARY

Thirteen sites in the Quillayute estuary (fig. 22) were sampled four times for this study. The first was a reconnaissance sampling to determine the general mixing characteristics of the estuary and the general range of concentrations of various constituents. The other three samplings were made to ascertain more closely the quality of water in the estuary and to identify potential problem sources. A tide table and the estimated freshwater discharge for each day of sampling are provided in table 12. All water-quality data collected in the estuary samplings are compiled in table 15, at the end of the report.

Mixing Characteristics

The Quillayute estuary was found to have salt-wedge mixing characteristics; in a typical estuary of this type, the seawater extends upriver under the fresh water for some distance, forming a salt wedge (fig. 23). As the tide rises and falls, the salt wedge advances upriver or recedes downriver, accordingly. The shape of the salt wedge and the extent of its excursions upriver and downriver are largely controlled by the many possible combinations of high or low streamflow, high or low tides, and the magnitude of tide range. The maximum salt-water excursion observed in this study was to the Mora Bridge on the Dickey River and to about 0.1 mi above the Dickey River on the Quillayute River. (See figure 22.)

The fact that the Quillayute estuary is a salt-wedge estuary is important because of the particular mixing characteristics of such estuaries. Because of the general flow directions in the fresh- and saltwater layers of a typical salt-wedge estuary (fig. 23), pollutants introduced into the salt wedge tend to be carried upstream in the estuary to the toe of the wedge. Pollutants introduced into the overlying freshwater layer tend to be carried out to the ocean fairly rapidly. Thus, whether a pollutant is rapidly carried out to sea or spreads upstream in the estuary depends largely upon whether the pollutant first enters the freshwater layer or the salt wedge. A pollutant introduced into one layer, however, can generally also be detected in the other layer--but to a much lesser degree--because of turbulent mixing at the interface between the fresh- and saltwater layers.

Longitudinal diffusion (spreading) of a pollutant is partly controlled by irregularities in the bottom of the estuary, which trap and partly contain the pollutant until it is slowly flushed out. Longitudinal diffusion is obvious in the Quillayute estuary in periods of low streamflow because a natural deep spot near the upper end of the estuary (near site 7 - fig. 22) traps saltwater. Saltwater forced upstream on a particularly high tide can settle in this deep spot (fig. 24) and remain there for several tidal cycles before it is completely removed by mechanical mixing and diffusion into the overlying freshwater. In periods of high streamflow, if saltwater has been able to extend that far upstream (depending on the magnitude of the stream discharge), it may be flushed rapidly out of the deep spot after high tide.

TABLE 12.--Tide table and estimated freshwater discharge into the Quillayute estuary for each day of water-quality sampling
[Water height is in feet above mean lower low tide]

Date	24-hour time (hours minutes)	Water height (feet)	Estimated freshwater discharge (cubic feet per second)
Aug. 11, 1976	0135	8.2	825
	0820	-.8	
	1422	7.7	
	2038	1.0	
Aug. 12, 1976	0217	7.9	825
	0859	.4	
	1454	7.7	
	2120	.9	
Aug. 19, 1976	0215	1.2	1000
	0810	5.5	
	1414	3.0	
	1956	7.4	
Sept. 10, 1976	0158	7.8	950
	0830	.4	
	1411	8.1	
	2053	.4	
Sept. 8, 1977	0333	1.0	1000
	0938	6.1	
	1546	2.9	
	2119	7.4	

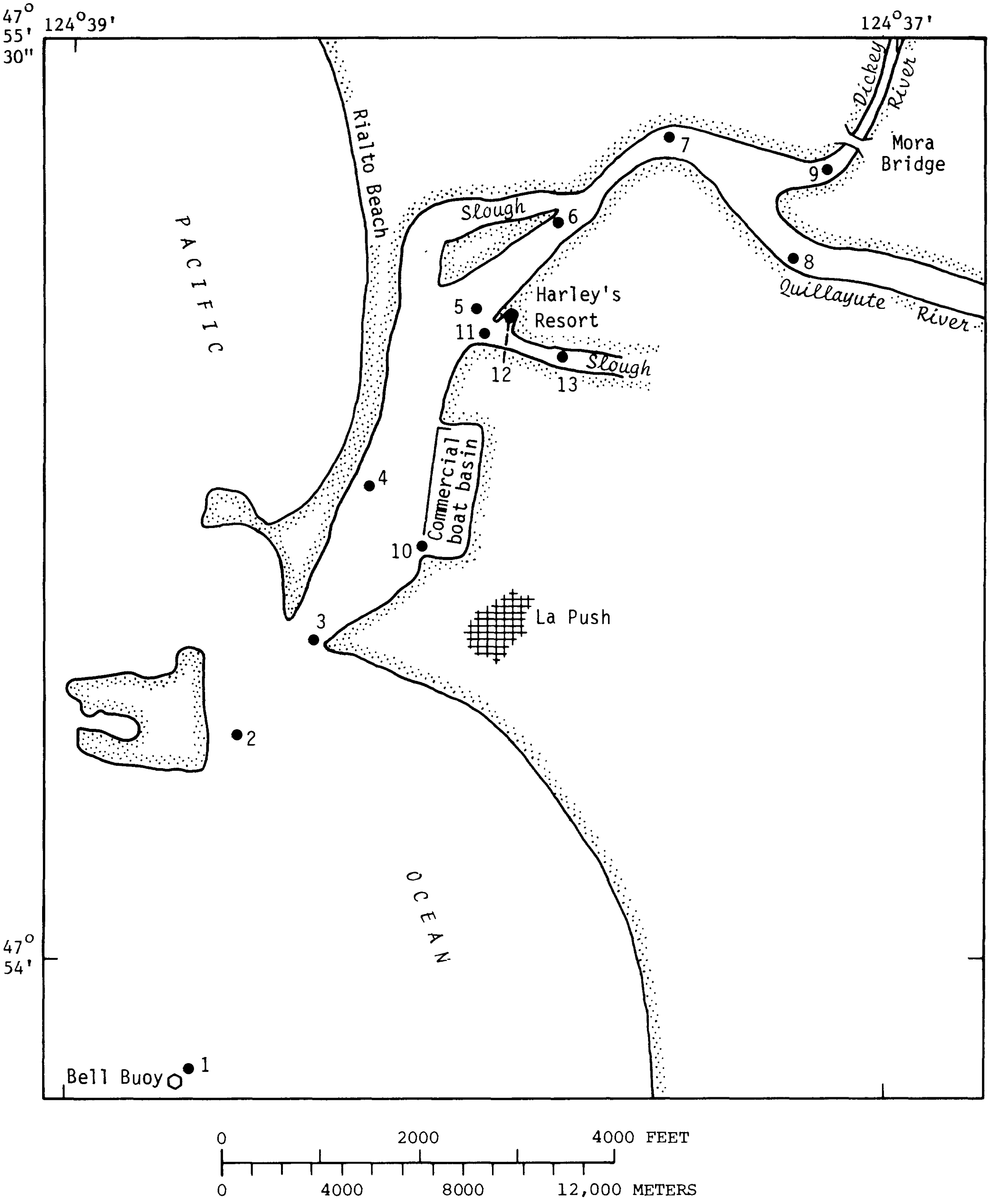


Figure 22.--Quillayute estuary showing sampling sites. (Full site names and locations are given in table 14).

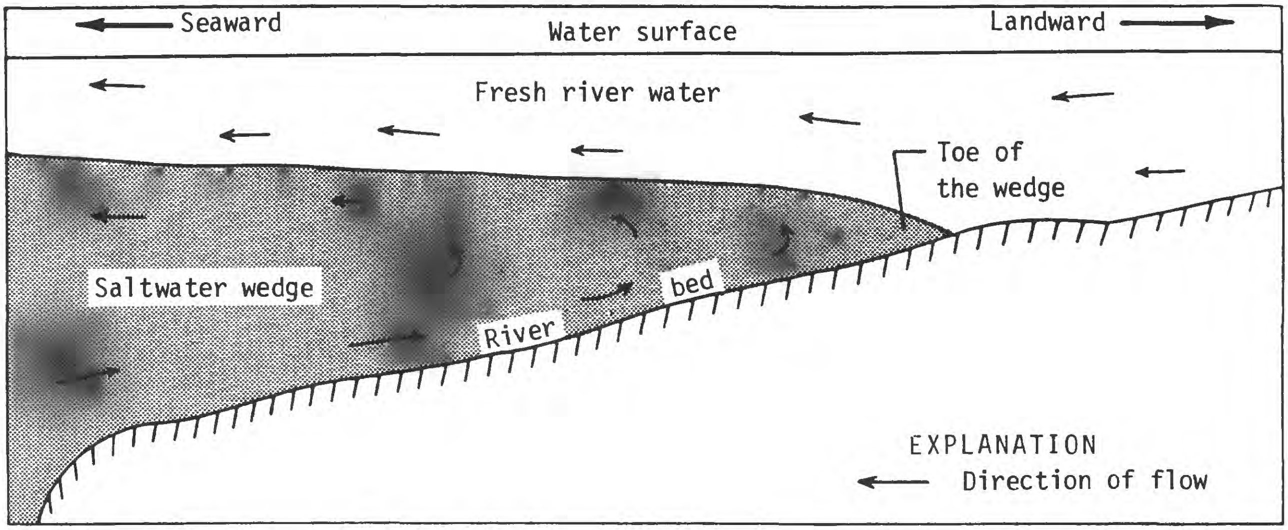


Figure 23.--Distribution of flow in a typical stationary salt wedge.

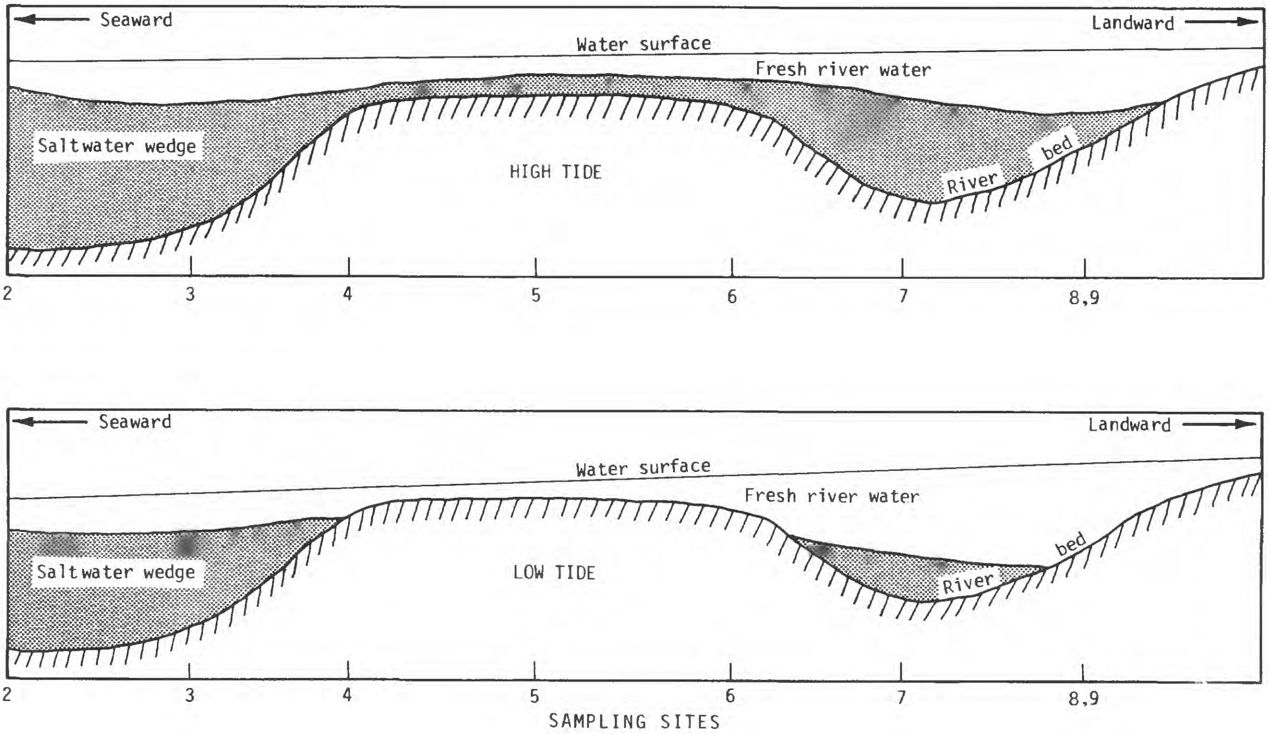


Figure 24.--Distribution of saltwater in the Quillayute estuary under conditions of high and low tide. (See figure 22 for location of sampling sites.)

Dissolved Oxygen

Dissolved-oxygen profiles were determined at several sites on outflowing, low-slack, and inflowing tides on August 19 and September 10, 1976. On both dates, DO concentrations at the more seaward sites on outflowing and low slack tides were generally 6 mg/L or less in the deeper waters. This DO deficit is attributed mostly to upwelling and, possibly to a lesser extent, biodegradation and the decay of organic bottom materials.

Upwelling occurs on the west coast of most continents and is caused by winds displacing the surface layer of water, causing the deeper water to rise, or upwell. Upwelling on the Pacific coastal shelf has been recognized for many years (Hill, 1963; Pearson and Holt, 1960; Sverdrup, 1938; Sverdrup and others, 1961; and Stevenson and Gorsline, 1956). According to Gene Collias, chief scientist on the University of Washington oceanography research vessel "Brown Bear" (oral commun., 1976), late summer occurrence of upwelling is common along the coast of Washington and Oregon.

The association of low DO concentrations with upwelling has also been recognized. Pearson and Holt (1960) attributed low DO concentrations of 3.5 mg/L in Grays Harbor, Wash., to such periodic upwelling, and the latest revision of the State water-use and water-quality criteria (State of Washington, 1977) also recognizes that naturally occurring low DO concentrations are associated with upwelling.

In a detailed exploration of the estuary on September 10, 1976, sloughs and deep spots were examined for possible sources of deoxygenated water, but none was found. A DO concentration of only 3.7 mg/L was observed in the open ocean at a depth of 20 feet. Subsequent observations showed a widespread DO deficit both at the mouth of the estuary and in the ocean itself, tending to support the conclusion that the deficit was indeed caused by upwelling.

A small part of the DO deficit is caused by BOD (biochemical oxygen demand) in the water itself as organic materials are degraded by micro-organisms. This biodegradation (decay) process requires oxygen, which is taken from the water. As a result of the BOD process, DO concentrations in the water may be slightly depleted. The BOD in the water was measured at several sites in the estuary and was found to be low, ranging from 0.2 to 3.4 mg/L on August 19, 1976, and from 0.3 to 1.6 mg/L on September 10, 1976.

An additional, even smaller, part of the DO deficit is caused by oxygen demand from the decaying organic materials at the bottom of some parts of the estuary. The oxygen demand of bottom materials at each of seven sites and the type of bottom material present are shown in table 13. Oxygen demand of bottom material at two of the sites was high enough to affect a thin layer of the immediately overlying water. However, neither area is extensive and dilution volumes are large; therefore, the overall impact on DO concentrations in the overlying water is probably slight. Such bottom materials, however, are not suitable habitat for desirable aquatic organisms.

The high oxygen demand observed in the slough (site 13 - fig. 22) appeared to be naturally occurring. The organic bottom material was identifiable as decomposing aquatic plants and leaves from nearby terrestrial brush.

Coliform Bacteria

Samples of total-coliform bacteria were collected in the study area for outflowing, low slack and inflowing tides on August 19, 1976. On this date, several factors combined to provide an approximation of the most adverse conditions that could be expected, when coliform-bacteria concentrations would be near maximum. This sample collection date was chosen as having 1) the lowest diurnal tide range of the late-summmer tourist season; 2) a near-maximum utilization of the estuary by commercial and sports fishermen; and 3) a low inflow of fresh water from the Dickey and Quillayute Rivers. Fortuitously, a light summer rainstorm also occurred on that date, an event that caused increased bacteria concentrations in the river but no appreciable increase in streamflow. Additionally, sea birds (predominantly gulls), whose bacterial contribution can be significant, were abundant. All these factors combined to produce a situation of near maximal bacterial loading and near minimal dilution by fresh- or seawater.

Total-coliform concentrations were generally lowest in the salt wedge, somewhat higher near the surface of the freshwater, and much higher at the saltwater/freshwater interface (table 14). The settling of bacteria at the saltwater/freshwater interface is similar to that often seen at the thermocline (temperature-stratified interface) of lakes. Both settling phenomena are caused by the density differences between the less dense water at the surface and the more dense water at depth; in the estuary, the bacteria settle through the less dense freshwater to the interface, but do not settle farther. Total-coliform concentrations in water flowing out of the commercial boat basin (sample point 10) and an upstream resort area (sample point 11) were several times greater than in upstream waters. On August 19, 1976, total-coliform bacteria at all sites generally exceeded the old State Class AA criteria's maximum limits (see median concentrations, table 14).

TABLE 13.--Oxygen demand of bottom materials at selected sites in the Quillayute estuary, and a description of the bottom materials

Location[1]	Oxygen demand of bottom materials (mg/kg)[2]	Description		
		Appearance and lithology	Loss on ignition (percent)	Silt or finer (percent)
Site 7	1,400	Fine brown sand, no odor, very little silt, lots of growing seaweed.	3.2	13
Site 11	800	Very fine dark brown sand; faint fishy odor.	2.6	14
Site 12	1,200	Very fine dark brown sand and silt; faint fishy odor.	4.1	29
Site 13	16,000	Black, highly organic muck and debris; odor like cabbage and rotten eggs; many crustacea.	7.8	71
Under bridge in slough by Harley's Resort.	700	Fine brown sand, no odor, very little silt.	2.0	3
In center of commercial boat basin.	1,700	Dark brown to black silt; moderate fishy odor.	5.6	81
Hole about 50 ft below La Push Fish Co. plant.	17,000	Black silt and organic muck; strong fishy odor also odor like sewage, decaying seaweed.	7.6	64

[1]See figure 22 for location of numbered sites.

[2]Calculated from 5-day BOD determination on an appropriate quantity of bottom material (wet weight) in buffered dilution water.

TABLE 14.--Summary of total- and fecal-coliform bacteria concentrations in the Quillayute estuary, August 19 and September 10, 1976
(>, greater than)

Estuary site	Depth (ft)	Bacteria concentrations, colonies per 100 mL					
		Total coliform			Fecal coliform		
		Maximum	Minimum	Median	Maximum	Minimum	Median
				August 19, 1976			
2	1.5	6,000	680	1,900	--	--	--
	6.5	620	70	450		25 (single sample)	
	13	290	170	280	--	--	--
	[1]B-1.5	50	9	30	--	--	--
3	1.5	>1,000	540	>770	370	56	>270
	5.0	2,800	>1,000	1,000	400	110	>220
	10	960	130	340	55	10	32
	B-1.5	69	3	43	11	9	10
4	1.5	800	160	340	--	--	--
	3.3	2,100	150	950	--	--	--
	6.5	550	100	430	--	--	--
	B-1.5	210	45	120	--	--	--
5	1.5	860	49	480	--	--	--
	5.0	870	92	320	--	--	--
	B-1.5	300	50	120	--	--	--
6	1.5	800	97	110	--	--	--
	B-1.5	370	180	200	--	--	--
7	1.5	760	49	130	--	--	--
	B-1.5	200	10	120	--	--	--
8	Mid-depth	720	120	220	--	--	--
10	1.5	5,500 (single sample)			340	280	310
	5.0	12,000 (single sample)			360	320	340
	B-1.5	400 (single sample)			180	37	110
11	1.5	>1,000	>1,000 (two samples)		>450 (two samples)		
	B-1.5	>1,000	>800 (two samples)		>450 (two samples)		
				September 10, 1976			
2	1.5				46	1	24
8	Mid-depth				15	11	13
9	Mid-depth				48	22	35
10	1.5				60	44	43
11	1.5				180	39	84

[1]B-1.5 means 1.5 feet above bottom.

Concentrations of total-coliform bacteria in samples collected on September 10, 1976, and September 8, 1977, were considerably lower than those for August 19, 1976. The last two samplings probably represented conditions nearer the minimum end of the expected bacteria-concentration ranges, because tourism and commercial and sport fishery activity drop off rapidly after the Labor Day weekend. In addition, tidal ranges were greater for the last two samplings. Despite the generally lower concentrations, however, State limits were exceeded at several sites on both dates. Total-coliform median concentration limits were exceeded at sites 3, 4, 9, 10, and 11 on September 10, 1976, and at sites 1, 2, 9, 10, and 11 on September 8, 1977.

Fecal-coliform data (table 14) indicate higher concentrations of coliform bacteria of fecal origin from waters in the vicinity of the boat basin (site 10) and resort areas (site 11) than elsewhere. On August 19, 1976, fecal-coliform concentrations at sites 3, 10, and 11 exceeded the State's new Class AA fecal-coliform criterion limit considerably. On September 10, 1976, the criterion limit was again exceeded at sites 10 and 11. No inflowing river-water samples were collected for comparison in the August sampling; however, in September the inflowing river water was in compliance with the State criterion. The ratio of fecal-coliform to total-coliform bacteria indicates that many of the coliform bacteria are of nonfecal origin and probably originated naturally in the soil.

Ammonia

For estuary samples collected on August 19, 1976, ammonia was the only nitrogen species present in significant concentrations; nitrate ranged from 0.01 to 0.06 mg/L, and nitrite from 0.00 to 0.01 mg/L, as N. The open-ocean (site 1) concentration of ammonia was 0.07 mg/L at a depth of 10 feet; concentrations in the salt wedge ranged from 0.07 to 0.12 mg/L. This corresponds closely with ammonia concentrations at a depth of 13 feet at sites 2 and 3, and indicates that the inflowing seawater was the major source of ammonia in the salt wedge. Ammonia concentrations were virtually the same at sites 10 and 11 as at adjacent estuary sites.

Ammonia profiles at several sites on outflowing, low, and inflowing tides for August 19, 1976, indicate that, in general, near-surface (1.5 feet) samples had lower ammonia concentrations than the deeper samples taken from the underlying salt wedge. At sites 6 and 7, concentrations were lower in the salt wedge than in the overlying freshwater but the reason for this seeming anomaly is not known.

On September 10, 1976, ammonia concentrations, except in the boat basin (site 10), were generally lower than those of August 19, 1976, ranging from 0.02 to 0.08 mg/L. The boat basin had concentrations of 0.16 mg/L at the surface and 0.10 mg/L at mid- and bottom depths at low tide. At high tide, ammonia concentrations in the salt wedge were nearly the same as in the open ocean (site 1).

Other Characteristics

Turbidity in the estuary was extremely low for all samplings, near 0 or 1 JTU (Jackson Turbidity Unit). Under low-streamflow conditions no significant natural turbidity appears to exist in the Quillayute or Dickey Rivers, although the Dickey River was highly colored.

Water temperatures at all estuary sites on August 19, 1976, were nearly uniform, ranging from 13.8° to 14.8°C. On September 10, 1976, temperatures were several degrees warmer in the freshwater than in the open ocean or the salt wedge. The total temperature range on that date was from 8.6°C (in the open ocean—site 1) to 15.5°C (in the Quillayute River—site 8). Temperatures were not taken on September 8, 1977.

Temperatures in the estuary are largely a function of the temperatures of the inflowing freshwater and of the inflowing salt wedge and the degree of mixing that has occurred at a particular point in the cross section. The effects of solar radiation and wind are probably of lesser importance with respect to changes that occur within the short reach—1.8 miles or so—of estuary length. Temperatures of the salt wedge and inflowing freshwater are not measurably influenced by man's activities along the estuary.

SUMMARY

The Quillayute Indian Reservation encompasses about 1,000 acres of land around the mouth of the Quillayute River on the west side of Washington's Olympic Peninsula. The main stem of the river is only about 6 miles long and is formed by the confluence of the Soleduck and Bogachiel Rivers. Large parts of the basin are in Olympic National Park and Olympic National Forest; the remainder, except in and near the small towns of Forks and LaPush, is largely undeveloped timberland.

The climate of the lowland part of the basin is of the West Coast marine type, characterized by warm, dry summers and mild, wet winters.

Water from wells in the basin is generally of the calcium bicarbonate type, although some wells are affected by seawater intrusion and are predominantly of the sodium chloride type. Ground-water quality is generally excellent for most uses, but some wells contained water with iron concentrations high enough to potentially be tasted in beverages and to stain laundered clothes and porcelain fixtures. A comparison of the chemical compositions of ground and surface waters showed a strong similarity over a wide geographic area.

Historical water-quality data were available for selected river sites in the basin. Additional data were collected as part of this study during low-streamflow conditions of 1976 and 1977, and the combined data were then compared to Washington State water-quality criteria.

Water-quality conditions in the major streams were similar. Nutrient concentrations were generally low; all local increases in nutrient concentration were quickly assimilated or diluted downstream. Fecal-coliform bacteria levels generally met State criteria; ratios of total-coliform to fecal-coliform bacteria indicate that most of the coliform bacteria were not associated with fecal sources.

Harmonic analyses showed that stream-water temperatures could occasionally be expected to exceed State criteria; these occasional high temperatures occur naturally and therefore are not considered violations of State criteria. Dissolved-oxygen concentrations during these times of high water temperature can be below established criteria but, because they occur naturally, are not considered violations of State criteria.

Proportions of the major chemical constituents in the rivers of the basin were nearly constant despite concentration fluctuations in response to dilution from precipitation and snowmelt.

The lower reach of the Dickey River differed somewhat from the other major rivers in the basin. Because this reach has a low channel gradient, it meanders through bogs and accumulates considerable dissolved organic material that gives the water a dark tea-like color. Phosphorus concentrations in this reach are relatively high, probably because of transport of phosphorus by the dissolved organic matter.

Historical water-quality data for Beaver, Dickey, Pleasant, and Wentworth Lakes indicate that all four lakes are thermally stratified in summer and contain moderate concentrations of nutrients. The littoral bottoms of Beaver and Dickey Lakes were covered with muck and most of their shorelines, as well as that of Wentworth Lake, were covered by emersed aquatic plants. In addition, an algal bloom was observed in Beaver Lake.

Thirteen sites in the Quillayute estuary were sampled four times as part of this study; the estuary was found to be of the salt-wedge type. Longitudinal diffusion occurred in the estuary during periods of low streamflow because a natural deep spot near the upper end of the estuary traps saltwater.

Dissolved-oxygen concentrations at the more seaward-sampling sites were generally below 6 mg/L in the deeper waters. This DO deficit was attributed primarily to upwelling and, possibly to a lesser extent, biodegradation and the decay of organic bottom materials.

Sampling of the Quillayute estuary for coliform bacteria was accomplished at a time when maximum concentrations could be expected. The data indicated that total-coliform concentrations were generally lowest in the salt wedge, somewhat higher near the surface of the freshwater, and much higher at the saltwater-freshwater interface. Concentrations of fecal-coliform bacteria were highest in the vicinity of a boat basin and resort areas and exceeded State criteria on two occasions.

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TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN

Samples are collected at sites other than gaging stations and partial-record stations to give better areal coverage in a river basin. Such sites are referred to as miscellaneous sites.

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

DATE	TIME	SPECIFIC CONDUCTANCE (MICROMHOS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)
12042400 SOLEDUCK RIVER AT HIGHWAY 101 AT FORKS, WA (LAT 47°59'01" LONG 124°23'48) RIVER MILE 19.0													
AUG , 1976													
26...	0925 (a)	81	11.9	0	0	10.6	225	--	.02	.00	.02	.00	.00
OCT , 1977													
04...	1350 (b)	64	9.1	0	0	12.5	300	5	.10	.00	.04	.00	.00
NOTE.--Mean daily discharge: (a) 450 ft³/s); (b) 280 ft³/s).													
475902124251501 SOLEDUCK RIVER, WA (LAT 47°59'02" LONG 124°25'15") RIVER MILE 17.4													
AUG , 1976													
26...	1010	82	12.0	0	0	10.8	94	--	.02	.00	.02	.01	.00
OCT , 1977													
04...	1430	85	9.0	0	0	12.5	B8200	4	.10	.00	.03	.00	.00
475906124252001 GUNDERSON CREEK AT MOUTH (LAT 47°59'06" LONG 124°25'20") AT SOLEDUCK RIVER MILE 17.3													
AUG , 1976													
26...	1020	62	11.2	25	2	10.6	217	--	.36	.00	.04	.02	.01
OCT , 1977													
04...	1435	73	8.7	5	0	11.2	130	15	.59	.00	.28	.00	.00
475832124260901 SOLEDUCK RIVER, WA (LAT 47°58'32" LONG 124°26'09") RIVER MILE 16.1													
AUG , 1976													
26...	1040	82	12.3	0	0	10.8	54	--	.02	.00	.02	.00	.00
OCT , 1977													
04...	1505	63	9.0	0	0	12.6	8300	5	.12	.00	.08	.00	.00
475752124265001 SOLEDUCK RIVER, WA (LAT 47°57'52" LONG 124°26'50") RIVER MILE 15.2													
AUG , 1976													
26...	1100	83	12.2	0	0	10.8	116	--	.03	.00	.05	.01	.00
OCT , 1977													
04...	1530	63	9.0	0	0	12.6	330	6	.08	.00	.04	.00	.00
12042500 SOLEDUCK RIVER NEAR QUILLAYUTE, WA (LAT 47°57'05" LONG 124°28'00") RIVER MILE 13.9													
AUG , 1976													
26...	1120 (a)	83	12.6	0	0	11.0	118	--	.03	.00	.04	.01	.01
OCT , 1977													
04...	1550 (b)	83	9.1	0	0	12.7	B200	6	.08	.00	.04	.00	.00
NOTE.--Mean daily discharge: (a) 450 ft³/s); (b) 280 ft³/s).													
475640124283901 SOLEDUCK RIVER, WA (LAT 47°56'40" LONG 124°28'39") RIVER MILE 12.6													
AUG , 1976													
26...	1155	83	12.6	0	0	10.9	74	--	.02	.00	.05	.01	.00
OCT , 1977													
04...	1620	81	8.9	0	0	12.7	B180	B2	.08	.00	.04	.00	.00
475623124293301 SOLEDUCK RIVER, WA (LAT 47°56'23" LONG 124°29'33") RIVER MILE 11.0													
AUG , 1976													
26...	1230	83	13.0	0	0	--	88	--	.02	.00	.04	.01	.00
OCT , 1977													
04...	1655	64	9.2	0	0	12.6	150	4	.08	.00	.07	.00	.00
475540124300501 SOLEDUCK RIVER, WA (LAT 47°55'40" LONG 124°30'05") RIVER MILE 9.4													
AUG , 1976													
26...	1305	82	13.4	0	0	10.9	38	--	.02	.00	.03	.01	.00
OCT , 1977													
04...	1730	83	9.2	0	0	12.1	B170	4	.07	.00	.04	.00	.00
475558124311201 SOLEDUCK RIVER, WA (LAT 47°55'58" LONG 124°31'12") RIVER MILE 8.3													
AUG , 1976													
26...	1345	83	--	0	0	10.8	45	--	.01	.01	.05	.01	.00
OCT , 1977													
04...	1755	62	9.1	0	0	12.2	160	3	.07	.00	.04	.00	.00
12042503 SOLEDUCK RIVER AT MOUTH NEAR LA PUSH, WA (LAT 47°54'55", LONG 124°32'27") RIVER MILE 6.5													
OCT , 1977													
04...	1830 (a)	69	9.5	0	0	11.9	2400	87	.06	.00	.04	.00	.00
NOTE.--Mean daily discharge: (a) 280 ft³/s.													

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

DATE	TIME	SPECIFIC CONDUCTANCE (MICROMHOS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)
475230124173701 BOGACHIEL RIVER, WA (LAT 47°52'30" LONG 124°17'37") RIVER MILE 19.5													
AUG , 1976													
25...	0920	79	11.8	0	0	10.6	16	--	.00	.00	.03	.00	.00
OCT , 1977													
05...	1345	80	9.8	0	0	11.8	B36	5	.01	.00	.11	.00	.00
475229124195101 BOGACHIEL RIVER, WA (LAT 47°52'29 LONG 124°19'51") RIVER MILE 17.4													
AUG , 1976													
25...	0940	80	12.4	0	0	10.7	30	--	.00	.01	.04	.01	.01
OCT , 1977													
05...	1410	80	9.8	5	0	11.8	140	8	.02	.00	.09	.00	.00
12042800 BOGACHIEL RIVER NEAR FORKS, WA (LAT 47°53'40" LONG 124°21'19") RIVER MILE 15.3													
AUG , 1976													
25...	0955 (a)	78	12.5	0	1	10.6	33	--	.00	.00	.03	.01	.00
OCT , 1977													
05...	1435 (b)	80	10.4	0	1	12.1	B22	10	.02	.00	.06	.00	.00
NOTE.--Mean daily discharge: (a) 251 ft³/s; (b) 205 ft³/s.													
475417124232001 BOGACHIEL RIVER, WA (LAT 47°54'17" LONG 124°23'20") RIVER MILE 12.6													
AUG , 1976													
25...	1015	80	12.9	5	0	10.4	26	--	.00	.00	.03	.01	.01
OCT , 1977													
05...	1445	62	11.2	5	1	12.2	B17	5	.04	.01	.10	.00	.00
475529124243901 BOGACHIEL RIVER, WA (LAT 47°55'29" LONG 124°24'39) RIVER MILE 10.1													
AUG , 1976													
25...	1030	78	13.2	5	1	10.3	32	--	.01	.00	.11	.01	.01
OCT , 1977													
05...	1510	78	10.9	5	1	12.2	B140	13	.02	.00	.25	.00	.00
475555124262101 BOGACHIEL RIVER, WA (LAT 47°55'55" LONG 124°26'21") RIVER MILE 8.7													
AUG , 1976													
25...	1045	80	13.6	0	0	10.5	42	--	.00	.00	.05	.00	.00
OCT , 1977													
05...	1535	62	10.6	0	1	12.8	B130	94	.01	.01	.02	.06	--
475553124270001 BOGACHIEL RIVER, WA (LAT 47°55'53" LONG 124°27'00") RIVER MILE 8.0													
AUG , 1976													
25...	1410	80	14.4	0	0	10.7	33	--	.00	.00	.05	.09	.09
OCT , 1977													
05...	1250	74	8.6	0	0	12.6	230	11	.06	.00	.01	.00	.00
475530124282001 BOGACHIEL RIVER, WA (LAT 47°55'30" LONG 124°28'20") RIVER MILE 6.4													
AUG , 1976													
25...	1420	79	14.4	0	0	10.8	42	--	.02	.01	.04	.02	.01
OCT , 1977													
05...	1310	79	8.7	0	0	13.2	B170	8	.03	.01	.01	.00	.00
475456124293901 BOGACHIEL RIVER, WA (LAT 47°54'56" LONG 124°29'39) RIVER MILE 4.9													
AUG , 1976													
25...	1430	78	14.4	0	0	10.7	18	--	.03	.00	.02	.01	.00
OCT , 1977													
05...	1335	79	8.8	0	0	13.1	B22	7	.05	.00	.01	.00	.00
475450124302101 BOGACHIEL RIVER, WA (LAT 47°54'50" LONG 124°30'21") RIVER MILE 3.7													
AUG , 1976													
25...	1445	80	14.9	0	0	10.5	13	--	.03	.00	.04	.01	.01
OCT , 1977													
05...	1405	79	9.2	0	0	12.5	220	5	.03	.00	.01	.00	.00
475414124305201 MAXFIELD CREEK AT MOUTH (LAT 47°54'14" LONG 124°30'52") AT BOGACHIEL RIVER MILE 2.7													
AUG , 1976													
25...	1730	73	14.2	25	4	9.6	74	--	.00	.00	.07	.03	[illegible]
OCT , 1977													
05...	1430	52	8.7	20	1	11.4	280	10	.00	.01	.06	.01	.00
475432124313301 BOGACHIEL RIVER, WA (LAT 47°54'32" LONG 124°31'33") RIVER MILE 2.1													
AUG , 1976													
25...	1455	80	15.2	0	0	10.4	28	--	.03	.00	.02	.01	.00
OCT , 1977													
05...	1445	80	9.4	0	0	12.5	290	8	.03	.00	.02	.00	.00

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

475356124321101 MURPHY CREEK AT MOUTH (LAT 47°53'56" LONG 124°32'11) AT BOGACHIEL RIVER MILE 1.2

DATE	TIME	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TEMPER-ATURE (DEG C)	COLOR (PLAT-INUM-COBALT UNITS)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)
AUG , 1976													
25...	1505	57	13.8	50	3	9.8	74	--	.01	.00	.23	.03	.02
OCT , 1977													
05...	1505	55	7.8	50	50	11.4	8600	20	.01	.00	.05	.02	.00

12043015 BOGACHIEL RIVER NEAR LA PUSH, WA (LAT 47°54'11" LONG 124°32'39") RIVER MILE 0.8

DATE	TIME	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TEMPER-ATURE (DEG C)	COLOR (PLAT-INUM-COBALT UNITS)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)
AUG , 1976													
25...	1510 (a)	78	15.0	0	1	10.4	36	--	.00	.00	.03	.01	.01
OCT , 1977													
05...	1520 (b)	81	9.3	0	0	12.1	2600	5	.03	.00	.02	.01	.00

NOTE.--Mean daily discharge: 250 ft^3/s; (b) 205 ft^3/s.

475449124322201 BOGACHIEL RIVER AT MOUTH (LAT 47°54'49" LONG 124°32'22") AT SOLEDUCK RIVER MILE 6.5

DATE	TIME	SAMP-LING DEPTH (FT)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SALIN-ITY (PPT)	TEMPER-ATURE (DEG C)	COLOR (PLAT-INUM COBALT UNITS)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)
AUG , 1976										
12...	1230	1.6	--	.1	9.8	--	--	--	1.8	116
25...	1520	--	79	--	15.1	0	0	10.2	--	44
OCT , 1977										
05...	1535	--	80	--	9.4	5	1	12.3	--	864

DATE	FECAL COLI-FORM .7UM-MF (COL./100 ML)	HARD-NESS (CA,MG) (MG/L)	NON-CAR-BONATE HARD-NESS (MG/L)	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	ALKA-LINITY AS CACO3 (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)
AUG , 1976										
12...	--	--	--	--	--	--	--	--	--	--
25...	--	31	4	9.8	1.5	3.1	.3	32	26	6.2
OCT , 1977										
05...	14	--	--	--	--	--	--	--	--	--

DATE	DIS-SOLVED CHLO-RIDE (CL) (MG/L)	DIS-SOLVED FLUO-RIDE (F) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L)	DIS-SOLVED SOLIDS (TONS PER AC-FT)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)
AUG , 1976										
12...	--	--	--	--	--	--	--	--	--	--
25...	3.1	.1	6.5	46	.06	.00	.00	.03	.01	.00
OCT , 1977										
05...	--	--	--	--	--	.03	.00	.02	.00	.00

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

DATE	TIME	SPECIFIC CONDUCTANCE (MICROMHOS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)
475808124195801 SOUTH FORK CALAWAH RIVER AT MOUTH (LAT 47°58'08" LONG 124°19'58") RIVER MILE 10.4													
AUG , 1976													
24...	1430	68	13.8	0	0	10.5	17	--	.01	.00	.04	.09	.09
OCT , 1977													
06...	1005	60	7.4	0	0	11.7	310	3	.06	.00	.03	.00	.00
475814124195301 NORTH FORK CALAWAH RIVER AT MOUTH (LAT 47°58'14" LONG 124°19'53") AT CALAWAH RIVER MILE 10.2													
AUG , 1976													
24...	1440	64	12.0	0	0	10.7	3	--	.10	.00	.22	.01	.01
OCT , 1977													
06...	1015	60	7.8	0	0	11.5	160	20	.24	.00	.03	.00	.00
475802124212101 CALAWAH RIVER, WA (LAT 47°58'02" LONG 124°21'21") RIVER MILE 9.1													
AUG , 1976													
24...	1520	67	13.6	0	0	10.8	10	--	.03	.00	.04	.01	.00
OCT , 1977													
05...	1040	62	7.6	0	0	12.1	190	4	.09	.00	.03	.00	.00
475759124212401 ELK CREEK AT MOUTH (LAT 47°57'59" LONG 124°21'24") AT CALAWAH RIVER MILE 9.0													
AUG , 1976													
24...	1525	53	11.7	0	0	10.6	50	--	.02	.00	.04	.02	.01
OCT , 1977													
05...	1050	51	8.3	0	0	11.6	B840	5	.08	.00	.03	.01	.00
475808124225301 CALAWAH RIVER, WA (LAT 47°58'08" LONG 124°22'53") RIVER MILE 7.5													
AUG , 1976													
24...	1600	66	13.7	0	0	11.0	5	--	.02	.00	.13	.01	.01
OCT , 1977													
06...	1120	61	7.7	0	0	12.0	240	7	.08	.00	.03	.00	.00
12043000 CALAWAH RIVER NEAR FORKS, WA (LAT 47°57'37" LONG 124°23'30") RIVER MILE 6.6													
AUG , 1976													
24...	1620 (a)	65	13.7	0	0	11.0	8	--	.01	.00	.04	.00	.00
OCT , 1977													
06...	1150 (b)	60	7.9	0	0	12.4	350	84	.08	.00	.04	.00	.00
NOTE.--Mean daily discharge: (a) 170 ft³/s; (b) 185 ft³/s.													
475708124243601 CALAWAH RIVER, WA (LAT 47°57'08" LONG 124°24'36") RIVER MILE 5.1													
AUG , 1976													
24...	1715	65	13.8	0	0	10.8	16	--	.00	.00	.02	.00	.00
OCT , 1977													
06...	1240	67	7.9	0	0	12.4	370	4	.07	.00	.02	.00	.00
475724124251001 CALAWAH RIVER, WA (LAT 47°57'24" LONG 124°25'10") RIVER MILE 3.8													
AUG , 1976													
24...	1810	67	14.1	0	0	10.8	27	--	.02	.00	.06	.01	.01
OCT , 1977													
06...	1325	62	8.0	0	0	12.4	B160	3	.06	.00	.02	.00	.00
475738124261301 CALAWAH RIVER, WA (LAT 47°57'38" LONG 124°26'13") RIVER MILE 2.6													
AUG , 1976													
24...	1850	67	14.1	0	0	10.8	24	--	.02	.00	.15	.00	.00
OCT , 1977													
06...	1355	77	8.1	0	0	12.2	270	10	.05	.01	.04	.00	.00
475650124255501 CALAWAH RIVER, WA (LAT 47°56'50" LONG 124°25'55") RIVER MILE 1.6													
AUG , 1976													
24...	1930	68	14.3	0	0	10.4	8	--	.01	.00	.08	.01	.00
OCT , 1977													
06...	1435	67	8.4	0	0	12.3	B600	9	.05	.01	.03	.00	.00

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

12043003 CALAWAH RIVER AT MOUTH NEAR FORKS, WA (LAT 47°56'04" LONG 124°26'49") AT BOGACHIEL RIVER MILE 8.2

DATE	TIME	MEAN DAILY DIS- CHARGE (CFS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	TEMPER- ATURE (DEG C)	COLOR (PLAT- INUM COBALT UNITS)	TUR- BID- ITY (JTU)	DIS- SOLVED OXYGEN (MG/L)	IMME- DIATE COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM .7UM-MF (COL./ 100 ML)	HARD- NESS (CA+MG) (MG/L)
AUG , 1976										
24...	2000	170	73	14.0	0	0	--	3	--	27
OCT , 1977										
06...	1510	185	68	8.6	0	0	12.1	290	11	--

DATE	NON- CAR- BONATE HARD- NESS (MG/L)	DIS- SOLVED CAL- CIUM (CA) (MG/L)	DIS- SOLVED MAG- NE- SIUM (MG) (MG/L)	DIS- SOLVED SODIUM (NA) (MG/L)	DIS- SOLVED PO- TAS- SIUM (K) (MG/L)	BICAR- BONATE (HCO3) (MG/L)	ALKA- LINITY AS CACO3 (MG/L)	DIS- SOLVED SULFATE (SO4) (MG/L)	DIS- SOLVED CHLO- RIDE (CL) (MG/L)
AUG , 1976									
24...	0	7.9	1.8	3.1	.3	34	28	5.7	2.3
OCT , 1977									
06...	--	--	--	--	--	--	--	--	--

DATE	DIS- SOLVED FLUO- RIDE (F) (MG/L)	DIS- SOLVED SILICA (SIO2) (MG/L)	DIS- SOLVED SOLIDS (SUM OF CONSTI- TUENTS) (MG/L)	DIS- SOLVED SOLIDS (TONS PER AC-FT)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO- GEN (N) (MG/L)	TOTAL PHOS- PHORUS (P) (MG/L)	TOTAL ORTHO PHOS- PHORUS (P) (MG/L)
AUG , 1976									
24...	.1	8.0	46	.06	.03	.00	.02	.00	.00
OCT , 1977									
06...	--	--	--	--	.09	.00	.04	.00	.00

DATE	TIME	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	TEMPER- ATURE (DEG C)	COLOR (PLAT- INUM- COBALT UNITS)	TUR- BID- ITY (JTU)	DIS- SOLVED OXYGEN (MG/L)	IMME- DIATE COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM .7UM-MF (COL./ 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO- GEN (N) (MG/L)	TOTAL PHOS- PHORUS (P) (MG/L)	TOTAL ORTHO PHOS- PHORUS (P) (MG/L)
475916124325501 WEST FORK DICKEY RIVER AT MOUTH (LAT 47°59'16" LONG 124°32'55") RIVER MILE 8.1													
AUG , 1976													
24...	0910	44	13.7	40	1	9.4	90	--	.02	.00	.10	.02	.01
OCT , 1977													
04...	0845	48	8.9	40	1	10.5	240	44	.02	.01	.03	.02	.01
475909124324501 EAST FORK DICKEY RIVER AT MOUTH (LAT 47°59'09" LONG 124°32'45") AT DICKEY RIVER MILE 7.9													
AUG , 1976													
24...	0850	74	12.6	25	1	10.0	62	--	.05	.00	.05	.02	.01
OCT , 1977													
04...	0825	65	7.3	20	1	11.5	260	25	.12	.00	.04	.02	.00
475910124330901 DICKEY RIVER, WA (LAT 47°59'10" LONG 124°33'09") RIVER MILE 7.7													
AUG , 1976													
24...	0920	56	13.5	35	1	9.8	84	--	.03	.00	.05	.02	.01
OCT , 1977													
04...	0905	56	8.0	30	1	11.1	B300	830	.08	.00	.05	.02	.00
475839124332001 DICKEY RIVER, WA (LAT 47°58'39" LONG 124°33'20") RIVER MILE 6.8													
AUG , 1976													
24...	0950	59	13.4	35	1	9.8	78	--	.03	.00	.10	.04	.04
OCT , 1977													
04...	0930	57	8.0	30	1	10.8	B130	48	.08	.00	.03	.02	.01
12043100 DICKEY RIVER NEAR LA PUSH, WA (LAT 47°57'55" LONG 124°32'50") RIVER MILE 6.0													
AUG , 1976													
24...	1005 (a)	57	13.2	35	1	9.8	90	--	.02	.01	.07	.02	.01
OCT , 1977													
04...	1005 (b)	58	7.9	30	1	11.2	280	830	.07	.00	.04	.01	.00

NOTE.--Mean daily discharge: (a) 150 ft^3/s; (b) 104 ft^3/s.

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

DATE	TIME	SPECIFIC CONDUCTANCE (MICROMHOS)	TEMPERATURE (DEG C)	COLOR (PLATINUM-COBALT UNITS)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM .7UM-MF (COL./100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)	TOTAL PHOSPHORUS (P) (MG/L)	TOTAL ORTHO PHOSPHORUS (P) (MG/L)
475724124333201 DICKEY RIVER, WA (LAT 47°57'24" LONG 124°33'32") RIVER MILE 5.1													
AUG , 1976													
24...	1025	58	13.0	35	1	9.7	156	--	.03	.00	.06	.02	.01
OCT , 1977													
04...	1030	58	7.9	30	1	11.2	B82	B37	.09	.00	.06	.02	.01
475720124332801 COLBY CREEK AT MOUTH (LAT 47°57'20" LONG 124°33'28") AT DICKEY RIVER MILE 5.0													
AUG , 1976													
24...	1030	83	11.4	40	2	10.0	74	--	.07	.01	.11	.02	.02
OCT , 1977													
04...	1040	80	6.9	30	1	11.3	B200	B22	.14	.00	.04	.01	.00
475706124335401 DICKEY RIVER, WA (LAT 47°57'06" LONG 124°33'54") RIVER MILE 4.4													
AUG , 1976													
24...	1045	62	13.2	30	1	9.7	155	--	.02	.01	.12	.04	.01
OCT , 1977													
04...	1100	60	7.9	30	1	11.3	B160	B27	.08	.01	.04	.01	.00
475653124343501 COAL CREEK AT MOUTH (LAT 47°56'53" LONG 124°34'35") AT DICKEY RIVER MILE 3.9													
AUG , 1976													
24...	1100	52	12.1	35	6	10.4	180	--	.01	.01	.09	.03	.02
OCT , 1977													
04...	1115	54	7.3	20	2	12.0	430	86	.05	.00	.04	.02	.01
475634124352601 DICKEY RIVER, WA (LAT 47°56'34" LONG 124°35'26") RIVER MILE 2.8													
AUG , 1976													
24...	1125	59	13.4	35	1	9.8	96	--	.02	.01	.06	.02	.01
OCT , 1977													
04...	1145	61	6.0	30	1	11.2	320	B30	.09	.00	.06	.01	.01
475556124361501 DICKEY RIVER, WA (LAT 47°55'56" LONG 124°36'15") RIVER MILE 1.5													
AUG , 1976													
24...	1150	59	13.1	35	1	9.6	126	--	.03	.00	.06	.02	.01
OCT , 1977													
04...	1215	61	8.3	30	1	11.1	380	46	.08	.01	.05	.01	.00
475526124365801 DICKEY RIVER, WA (LAT 47°55'26" LONG 124°36'58") RIVER MILE 0.3													
AUG , 1976													
25...	1610	61	14.8	30	1	9.6	158	--	.02	.00	.04	.01	.01
SEP , 1977													
08...	0827	79	--	--	--	9.4	B700	--	--	--	--	--	--

475518124370501 DICKEY RIVER AT MORA BRIDGE, AT MOUTH (LAT 47°55'18" LONG 124°37'05") RIVER MILE 0.2

DATE	TIME	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	TEMPERATURE (DEG C)	COLOR (PLATINUM COBALT UNITS)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM .7UM-MF (COL./100 ML)	HARDNESS (CA,MG) (MG/L)
AUG , 1976										
24...	1220	--	236	14.6	35	1	9.9	70	--	41
SEP , 1977										
08...	0700	--	107	--	--	--	--	60	--	--
08...	0832	1.0	72	--	--	--	9.3	670	--	--
08...	0833	8.0	73	--	--	--	9.3	210	--	--
08...	1015	--	105	--	--	--	--	380	--	--
08...	1135	--	154	--	--	--	--	B17	--	--
08...	1315	--	69	--	--	--	--	B25	--	--
08...	1420	--	73	--	--	--	9.7	80	--	--
08...	1545	--	120	--	--	--	--	B25	--	--
08...	1715	--	72	--	--	--	--	31	--	--
08...	1900	--	74	--	--	--	--	54	--	--
OCT										
04...	1250	--	71	7.9	30	1	10.8	790	818	--

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

475518124370501 DICKEY RIVER AT MORA BRIDGE, AT MOUTH (LAT 47°55'18" LONG 124°37'05") RIVER MILE 0.2 (CONT.)

DATE	NON-CAR-BONATE HARD-NESS (MG/L)	DIS-SOLVED CAL-CIUM (CA) (MG/L)	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L)	DIS-SOLVED SODIUM (NA) (MG/L)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L)	BICAR-BONATE (HCO3) (MG/L)	ALKA-LINITY AS CACO3 (MG/L)	DIS-SOLVED SULFATE (SO4) (MG/L)	DIS-SOLVED CHLO-RIDE (CL) (MG/L)
AUG , 1976									
24...	21	7.2	5.5	44	2.1	24	20	14	79

DATE	DIS-SOLVED FLUO-RIDE (F) (MG/L)	DIS-SOLVED SILICA (SIO2) (MG/L)	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L)	DIS-SOLVED SOLIDS (TONS PER AC-FT)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)
AUG , 1976									
24...	.1	6.3	170	.23	.03	.00	.06	.02	.01
OCT , 1977									
04...	--	--	--	--	.08	.01	.05	.02	.01

DATE	TIME	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	TEMPER-ATURE (DEG C)	COLOR (PLAT-INUM-COBALT UNITS)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM .7UM-MF (COL./ 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)
475435124332101 QUILLAYUTE RIVER, WA (LAT 47°54'35" LONG 124°33'21") RIVER MILE 5.7													
AUG , 1976													
25...	1705	80	15.5	0	0	10.3	12	--	.01	.00	.03	.01	.00
OCT , 1977													
05...	1555	77	9.8	0	0	12.6	B200	9	.05	.00	.09	.00	.00
475443124345401 QUILLAYUTE RIVER, WA (LAT 47°54'43" LONG 124°34'54") RIVER MILE 3.3													
AUG , 1976													
25...	1630	80	15.2	0	0	10.6	27	--	.01	.00	.03	.01	.00
OCT , 1977													
05...	1615	82	10.0	0	0	12.6	140	3	.04	.00	.04	.00	.00
475453124360901 QUILLAYUTE RIVER AT JAMES PARK, WA (LAT 47°54'53" LONG 124°36'09) RIVER MILE 2.1													
AUG , 1976													
25...	1620	80	15.2	0	0	10.7	27	--	.01	.00	.02	.01	.00
OCT , 1977													
05...	1635	77	10.0	0	0	12.6	B190	4	.06	.00	.03	.00	.00

475508124370801 QUILLAYUTE RIVER, WA (LAT 47°55'08" LONG 124°37'08") RIVER MILE 1.5

DATE	TIME	SAMP-LING DEPTH (FT)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	SALIN-ITY (PPT)	TEMPER-ATURE (DEG C)	COLOR (PLAT-INUM COBALT UNITS)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)
AUG , 1976									
25...	1600	--	82	--	15.2	0	0	10.7	--
SEP									
10...	0755	.8	--	.2	12.4	--	--	9.5	1.0
10...	1345	1.6	--	.1	15.5	--	--	11.3	--
SEP , 1977									
08...	0710	--	85	--	--	--	--	--	--
08...	0850	--	79	--	--	--	--	10.2	--
08...	1030	--	80	--	--	--	--	--	--
08...	1145	--	85	--	--	--	--	--	--
08...	1325	--	79	--	--	--	--	--	--
08...	1435	--	81	--	--	--	--	11.2	--
08...	1605	--	85	--	--	--	--	--	--
08...	1725	--	81	--	--	--	--	--	--
08...	1855	--	82	--	--	--	--	--	--
OCT									
05...	1655	--	78	--	10.8	0	0	12.8	--

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO OCTOBER 1977

475508124370801 QUILLAYUTE RIVER, WA (LAT 47°55'08" LONG 124°38'08") RIVER MILE 1.5 (CONT.)

DATE	IMME- DIATE COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM .7UM-MF (COL./ 100 ML)	STREP- TOCOCCI (COL- ONIES PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO- GEN (N) (MG/L)	TOTAL PHOS- PHORUS (P) (MG/L)	TOTAL ORTHO PHOS- PHORUS (P) (MG/L)
AUG , 1976									
25...	20	--	--	--	.01	.00	.02	.00	.00
SEP									
10...	65	15	--	10	--	--	.03	--	--
10...	42	11	--	1	--	--	.02	--	--
SEP , 1977									
08...	B78	--	--	--	--	--	--	--	--
08...	2900	--	--	--	--	--	--	--	--
08...	420	--	--	--	--	--	--	--	--
08...	B8	--	--	--	--	--	--	--	--
08...	B2	--	--	--	--	--	--	--	--
08...	54	--	--	--	--	--	--	--	--
08...	82	--	--	--	--	--	--	--	--
08...	88	--	--	--	--	--	--	--	--
08...	40	--	--	--	--	--	--	--	--
OCT									
05...	B930	--	5	--	.04	.00	.03	.00	.00

475512124371901 QUILLAYUTE ESTUARY, WA (LAT 47°55'12" LONG 124°37'19") RIVER MILE 1.4 SITE 8

DATE	TIME	SAMP- LING DEPTH (FT)	SALIN- ITY (PPT)	TEMPER- ATURE (DEG C)	TUR- BID- ITY (JTU)	DIS- SOLVED OXYGEN (MG/L)	BIO- CHEM- ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME- DIATE COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO- GEN (N) (MG/L)
AUG , 1976												
11...	1930	1.6	.3	17.0	--	--	--	--	--	--	--	--
12...	0905	1.6	.4	15.2	--	9.6	--	76	--	--	--	--
19...	0840	4.9	.1	14.0	0	10.4	.7	--	--	.02	.00	.01
19...	1030	8.2	.1	--	0	9.6	--	B720	--	.02	.00	.02
19...	1250	8.2	.1	--	0	10.1	--	290	--	.02	.00	.01
19...	1300	8.2	.1	--	0	10.2	.9	140	58	.02	.00	.01
19...	1440	8.2	.1	14.0	0	8.8	1.3	120	--	.02	.00	.00
19...	1720	8.2	.1	14.0	0	10.5	--	150	--	.02	.00	.02
19...	2015	8.2	.1	14.0	1	10.0	1.0	480	--	.02	.00	.09

B Results based upon colony counts outside the ideal range.

475517124371401 (LAT 47°55'17" LONG 124°37'14")
QUILLAYUTE ESTUARY, WA RIVER MILE 1.3 AND AT DICKEY RIVER MILE 0.1 SITE 9

DATE	TIME	SAMP- LING DEPTH (FT)	SALIN- ITY (PPT)	TEMPER- ATURE (DEG C)	DIS- SOLVED OXYGEN (MG/L)	BIO- CHEM- ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME- DIATE COLI- FORM (COL. PER 100 ML)	FECAL COLI- FORM (COL. PER 100 ML)	STREP- TOCOCCI (COL- ONIES PER 100 ML)	TOTAL AMMONIA NITRO- GEN (N) (MG/L)
SEP , 1976										
10...	0810	.5	1.4	11.8	8.9	1.4	42	48	24	.03
10...	1030	1.6	.2	12.7	9.3	--	88	--	--	.03
10...	1400	1.6	.2	15.0	10.6	--	B800	22	2	.02

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1976

475520124373201 QUILLAYUTE ESTUARY, WA (LAT 47°55'20" LONG 124°37'32") RIVER MILE 1.1 SITE 7

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976											
11...	1910	1.6	3.0	16.9	--	--	--	--	--	--	--
11...	1915	3.3	2.8	16.5	--	--	--	--	--	--	--
11...	1919	6.6	3.3	16.3	--	--	--	--	--	--	--
11...	1924	9.8	30	11.1	--	--	--	--	--	--	--
11...	1927	13	31	10.6	--	--	--	--	--	--	--
12...	0910	1.6	.8	14.7	--	9.5	1.2	90	--	--	--
12...	0912	3.3	.9	14.7	--	--	--	--	--	--	--
12...	0915	6.6	1.4	14.2	--	--	--	--	--	--	--
12...	0919	9.8	30	10.0	--	--	--	--	--	--	--
12...	0921	13	31	10.2	--	--	--	--	--	--	--
12...	0923	16	31	10.5	--	7.2	1.5	45	--	--	--
19...	0820	1.6	.1	13.8	0	8.5	1.1	--	.02	.00	.03
19...	0825	21	24	--	1	7.1	.9	--	.02	.01	.09
19...	1015	1.6	.1	--	1	9.1	--	B760	.03	.00	.02
19...	1020	20	24	--	1	7.7	--	200	.04	.00	.11
19...	1225	1.6	.2	14.1	1	9.0	--	B130	.02	.00	.02
19...	1235	19	28	14.2	1	7.3	--	170	.03	.01	.10
19...	1430	1.6	.1	14.0	1	8.8	.8	49	.02	.00	.03
19...	1440	18	5.1	14.0	1	7.6	--	40	.02	.01	.06
19...	1700	1.6	.7	14.0	0	10.5	--	150	.02	.00	.02
19...	1715	21	23	14.2	1	7.4	--	116	.03	.00	.12
19...	1950	1.6	.1	14.0	0	10.2	--	B70	.02	.00	.06
19...	2000	23	25	14.2	1	7.0	1.4	120	.03	.00	.03
SEP											
10...	0825	1.6	.3	12.2	--	9.6	1.0	38	--	--	.02
10...	0835	16	25	--	--	5.6	1.2	4	--	--	.07
10...	1415	1.6	.4	14.7	--	11.1	--	35	--	--	.02
10...	1425	23	29	10.1	--	5.9	--	12	--	--	.05

B Results based upon colony counts outside the ideal range.

475511124374901 QUILLAYUTE ESTUARY, WA (LAT 47°55'11" LONG 124°37'49") RIVER MILE 0.9 SITE 6

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976											
11...	1904	1.6	2.0	15.8	--	--	--	--	--	--	--
11...	1907	3.3	8.2	14.8	--	--	--	--	--	--	--
19...	0805	1.6	.7	13.8	1	8.9	1.0	--	.02	.00	.12
19...	0810	10	24	13.8	1	7.4	1.7	--	.04	.00	.09
19...	1000	1.6	.4	--	1	9.4	--	B800	.02	.00	.02
19...	1005	9.0	24	--	1	7.5	--	200	.03	.00	.08
19...	1205	1.6	1.3	14.0	1	8.9	--	B120	.01	.01	.04
19...	1215	9.0	16	14.0	1	9.4	--	250	.03	.00	.09
19...	1405	1.6	.7	14.0	1	9.6	.9	97	.02	.00	.02
19...	1410	9.0	4.4	14.0	1	10.6	.9	180	.02	.00	.04
19...	1640	1.6	.3	14.2	1	10.4	--	110	.02	.00	.03
19...	1650	11	11	14.3	1	9.0	--	196	.01	.01	.05
19...	1930	1.6	.2	14.0	1	10.2	1.1	102	.02	.00	.10
19...	1940	12	20	14.3	1	7.5	.9	370	.02	.00	.01
SEP											
10...	0845	1.6	1.1	12.4	--	9.6	--	31	--	--	.03
10...	0855	6.6	4.4	12.2	--	8.8	--	23	--	--	.04
10...	1430	1.6	.5	15.0	--	11.0	--	16	--	--	.03
10...	1435	13	29	10.6	--	6.3	--	19	--	--	.04

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1976

475503124380001 QUILLAYUTE ESTUARY, WA (LAT 47°55'03" LONG 124°38'00") RIVER MILE 0.6 SITE 5

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976											
11...	1850	1.6	3.3	15.7	--	--	--	--	--	--	--
11...	1853	3.3	6.1	15.6	--	--	--	--	--	--	--
11...	1857	6.6	27	12.2	--	--	--	--	--	--	--
11...	1900	8.2	31	11.0	--	--	--	--	--	--	--
19...	0825	1.6	2.2	14.3	1	8.4	.4	860	.02	.00	.07
19...	0830	4.9	21	14.5	1	8.5	1.7	B380	.03	.00	.04
19...	0840	7.5	25	14.5	1	8.3	2.0	120	.03	.00	.10
19...	1030	1.6	2.4	14.3	0	9.1	--	470	.02	.00	.04
19...	1040	4.9	11	14.5	1	8.7	--	--	.03	.00	.23
19...	1045	7.5	23	14.5	1	8.0	--	--	.04	.00	.09
19...	1305	1.6	1.4	14.1	1	9.7	--	500	.02	.00	.06
19...	1310	4.9	1.9	14.1	1	9.7	--	92	.02	.00	.08
19...	1315	5.9	12	14.2	1	7.7	--	120	.03	.00	.08
19...	1510	1.6	.8	14.0	1	9.8	--	49	.02	.00	.02
19...	1515	4.9	9.6	14.1	1	9.8	1.1	260	.02	.00	.01
19...	1520	6.6	22	--	1	6.5	1.5	850	.01	.01	.07
19...	1720	1.6	.7	14.1	1	10.2	--	540	.02	.00	.02
19...	1725	4.9	2.6	14.2	1	9.8	--	B870	.02	.00	.03
19...	1730	8.2	23	14.5	1	7.6	--	300	.03	.00	.10
19...	2030	1.6	.2	14.4	0	10.2	.7	370	.02	.00	.03
19...	2035	4.9	5.0	14.4	1	9.1	--	720	.03	.00	.07
19...	2040	10	24	14.5	1	8.6	1.6	100	.04	.00	.11
SEP											
10...	0915	1.6	1.4	12.8	--	9.6	1.1	4	--	--	.03
10...	0925	6.6	8.8	12.0	--	9.5	1.4	110	--	--	.07
10...	1445	1.6	.4	15.2	--	11.0	--	35	--	--	.02
10...	1455	13	30	11.2	--	5.9	--	31	--	--	.04

B Results based upon colony counts outside the ideal range.

475453124374701 (LAT 47°54'53" LONG 124°37'47")
SLOUGH BEHIND HARLEY'S RESORT AT LA PUSH, WA AT QUILLAYUTE RIVER MILE 0.5 SITE HRS

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	STREPTOCOCCI (COLONIES PER 100 ML)	TOTAL AMMONIA NITROGEN (N) (MG/L)
SEP , 1976									
10...	1100	1.6	--	--	--	230	--	--	--
10...	1115	1.6	5.0	12.8	8.8	300	140	11	.06
10...	1640	1.6	--	--	--	420	--	--	--

475445124380601 (LAT 47°54'45" LONG 124°38'06")
HARLEY'S RESORT INNER BOAT BASIN LA PUSH, WA AT QUILLAYUTE RIVER MILE 0.5 SITE IB

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	DISSOLVED OXYGEN (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	STREPTOCOCCI (COLONIES PER 100 ML)	TOTAL AMMONIA NITROGEN (N) (MG/L)
SEP , 1976								
10...	1155	1.6	--	--	2300	130	46	--
10...	1705	1.6	13	8.3	560	36	116	.08
10...	1706	15	--	4.0	--	--	--	--

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1977

475456124380401 (LAT 47°54'56" LONG 124°38'04")
MOUTH OF HARLEY'S RESORT BOAT BASIN LA PUSH, WA AT QUILLAYUTE RIVER MILE 0.5 SITE HR

DATE	TIME	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
AUG , 1976							
19...	1055	1.6	--	2.5	--	1	8.3
19...	1100	4.2	--	7.3	--	1	7.5
19...	1340	1.6	--	2.1	14.2	1	9.0
19...	1350	3.2	--	2.1	14.2	1	8.7
SEP							
10...	0925	1.6	--	3.4	12.8	--	9.0
10...	0942	3.3	--	4.1	12.7	--	8.4
10...	1050	--	--	--	--	--	--
10...	1505	1.6	--	5.1	14.8	--	--
10...	1513	8.2	--	29	10.3	--	5.7
10...	1722	1.6	--	--	--	--	--
SEP , 1977							
08...	0720	1.0	2200	--	--	--	--
08...	0721	--	40500	--	--	--	--
08...	0900	1.0	1320	--	--	--	9.2
08...	0901	--	43500	--	--	--	7.3
08...	1045	1.0	1460	--	--	--	--
08...	1046	--	45500	--	--	--	--
08...	1200	1.0	1620	--	--	--	--
08...	1201	--	42500	--	--	--	--
08...	1335	1.0	2300	--	--	--	--
08...	1336	--	15100	--	--	--	--
08...	1445	1.0	1460	--	--	--	11.0
08...	1446	--	2260	--	--	--	9.4
08...	1615	1.0	1090	--	--	--	--
08...	1616	--	2890	--	--	--	--
08...	1740	1.0	1310	--	--	--	--
08...	1741	--	18500	--	--	--	--
08...	1905	1.0	1630	--	--	--	--
08...	1906	--	41500	--	--	--	--

DATE	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	STREPTOCOCCI (COLONIES PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976							
19...	1.5	>1000	>450	--	.03	.00	.06
19...	3.9	>1000	--	--	.02	.01	.12
19...	1.0	>1000	>450	--	.01	.01	.04
19...	.9	>800	>450	--	.01	.01	.03
SEP							
10...	1.1	140	39	10	--	--	.04
10...	1.1	9	--	--	--	--	.05
10...	--	89	42	13	--	--	--
10...	--	730	84	64	--	--	.05
10...	1.0	27	--	--	--	--	.05
10...	--	1100	180	108	--	--	--
SEP , 1977							
08...	--	B700	--	--	--	--	--
08...	--	B300	--	--	--	--	--
08...	--	B1400	--	--	--	--	--
08...	--	220	--	--	--	--	--
08...	--	1100	--	--	--	--	--
08...	--	260	--	--	--	--	--
08...	--	62	--	--	--	--	--
08...	--	B39	--	--	--	--	--
08...	--	60	--	--	--	--	--
08...	--	B22	--	--	--	--	--
08...	--	B160	--	--	--	--	--
08...	--	570	--	--	--	--	--
08...	--	<2	--	--	--	--	--
08...	--	B3	--	--	--	--	--
08...	--	<2	--	--	--	--	--
08...	--	160	--	--	--	--	--
08...	--	B3	--	--	--	--	--
08...	--	B3	--	--	--	--	--

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

475447124381501 QUILLAYUTE ESTUARY, WA (LAT 47°54'47" LONG 124°38'15") RIVER MILE 0.3 SITE 4

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976											
11...	1835	1.6	2.8	16.0	--	--	--	--	--	--	--
11...	1838	3.3	7.5	15.2	--	--	--	--	--	--	--
11...	1842	9.8	26	10.9	--	--	--	--	--	--	--
11...	1845	6.6	31	11.9	--	--	--	--	--	--	--
12...	1010	1.6	2.8	14.6	--	--	1.4	>560	--	--	--
12...	1012	3.3	5.1	14.3	--	--	--	--	--	--	--
12...	1015	6.6	24	11.8	--	--	1.7	>600	--	--	--
19...	0800	1.6	.9	14.2	1	8.8	.2	B800	.02	.00	.01
19...	0805	3.3	13	14.5	1	8.6	1.5	2100	.01	.01	.01
19...	0810	6.6	25	14.6	1	8.9	1.0	B100	.03	.00	.08
19...	0815	15	26	14.6	1	8.5	1.3	B45	.03	.00	.10
19...	1000	1.6	1.5	14.2	0	9.0	1.3	--	.02	.00	.02
19...	1005	3.3	2.4	14.3	1	9.0	--	--	.02	.00	.03
19...	1015	6.6	24	14.7	1	8.3	--	--	.04	.00	.11
19...	1020	12	26	14.6	1	8.5	1.3	B50	.04	.00	.08
19...	1240	1.6	1.9	14.2	1	9.3	.6	450	.02	.00	.03
19...	1245	3.3	1.9	14.2	1	9.1	--	B800	.02	.00	.02
19...	1250	6.6	16	14.2	1	7.7	--	410	.03	.00	.10
19...	1255	16	24	14.4	1	7.9	1.0	150	.02	.01	.09
19...	1450	1.6	1.6	14.1	1	9.7	2.0	B160	.02	.00	.01
19...	1455	3.3	1.4	14.1	1	9.9	1.4	150	.02	.00	.02
19...	1500	6.6	7.1	14.3	1	6.9	3.0	B180	.03	.00	.06
19...	1505	16	24	14.5	1	5.6	1.5	210	.03	.01	.08
19...	1700	1.6	1.6	14.1	1	9.9	--	B180	.01	.01	.03
19...	1705	3.3	2.0	14.1	1	9.8	--	1100	.02	.00	.03
19...	1710	6.6	20	14.3	2	8.4	--	540	.04	.00	.09
19...	1715	14	25	14.4	1	7.8	--	B170	.03	.01	.10
19...	2010	1.6	.7	14.4	1	10.2	1.1	220	.02	.00	.02
19...	2015	3.3	.7	14.1	1	10.1	1.5	650	.02	.00	.02
19...	2020	6.6	8.9	14.3	1	9.4	1.6	550	.03	.00	.05
19...	2025	14	25	14.4	1	8.0	1.4	B82	.05	.00	.10
SEP , 1976											
10...	0920	1.6	2.2	12.6	--	9.3	1.4	46	--	--	.04
10...	0922	6.6	7.1	12.2	--	8.3	--	B5	--	--	.06
10...	0925	9.8	22	11.2	--	6.3	.6	69	--	--	.07
10...	1457	1.6	4.7	14.3	--	9.0	.3	B300	--	--	.04
10...	1500	6.6	27	11.4	--	8.9	--	46	--	--	.04
10...	1503	15	28	9.7	--	7.0	.5	4	--	--	.05

B Results based upon colony counts outside the ideal range.

475438124381201 (LAT 47°54'38" LONG 124°38'12")
MOUTH OF COMMERCIAL BOAT BASIN LA PUSH, WA AT QUILLAYUTE RIVER MILE 0.2 SITE BB

DATE	TIME	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
AUG , 1976							
12...	1000	1.6	--	8.6	14.3	--	8.6
12...	1002	3.3	--	11	14.0	--	--
12...	1004	6.6	--	26	11.7	--	--
12...	1005	13	--	30	10.3	--	5.2
19...	1040	1.6	--	7.0	14.4	1	8.9
19...	1045	4.9	--	9.3	14.5	1	8.9
19...	1050	19	--	26	14.4	1	8.1
19...	1240	1.6	--	4.0	14.2	1	9.0
19...	1245	4.9	--	7.2	14.3	1	8.8
19...	1250	18	--	22	14.4	2	7.6
SEP							
10...	0903	1.6	--	8.0	12.3	--	8.3
10...	0905	4.9	--	12	12.2	--	8.1
10...	0907	16	--	28	10.2	--	4.9
10...	1130	1.6	--	16	12.6	--	7.4
10...	1445	1.6	--	10	13.7	--	7.9
10...	1447	4.9	--	13	13.2	--	8.3
10...	1449	23	--	26	9.4	--	4.1
10...	1655	1.6	--	10	--	--	8.8
10...	1700	20	--	30	--	--	4.1
SEP , 1977							
08...	0727	1.0	3800	--	--	--	--
08...	0728	--	46500	--	--	--	--
08...	0910	1.0	2750	--	--	--	9.1
08...	0911	--	45500	--	--	--	6.7
08...	1050	1.0	2860	--	--	--	--
08...	1051	--	45500	--	--	--	--
08...	1210	1.0	3000	--	--	--	--
08...	1211	--	45500	--	--	--	--
08...	1342	1.0	2700	--	--	--	--
08...	1343	--	45500	--	--	--	--
08...	1455	1.0	3000	--	--	--	10.4
08...	1456	--	43500	--	--	--	6.6
08...	1625	1.0	2670	--	--	--	--
08...	1626	--	47500	--	--	--	--
08...	1745	1.0	2930	--	--	--	--
08...	1746	--	45500	--	--	--	--
08...	1915	1.0	1430	--	--	--	--
08...	1916	--	47500	--	--	--	--

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1977

475438124381201 (LAT 47°54'38" LONG 124°38'12")
MOUTH OF COMMERCIAL BOAT BASIN LA PUSH, WA AT QUILLAYUTE RIVER MILE 0.2 (CONT). SITE BB (CONT.)

DATE	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)
AUG , 1976							
12...	1.1	>800	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	1.4	224	--	--	--	--	--
19...	1.3	--	280	--	.02	.00	.04
19...	.5	--	360	--	.02	.00	.08
19...	1.2	--	37	--	.06	.00	.10
19...	1.0	5500	340	--	.02	.00	.06
19...	1.0	B12000	>320	--	.02	.00	.09
19...	1.7	B400	180	--	.04	.01	.16
SEP							
10...	1.1	170	92	54	--	--	.16
10...	--	99	--	--	--	--	.10
10...	.8	240	--	--	--	--	.10
10...	--	730	160	60	--	--	.10
10...	1.2	340	37	44	--	--	.07
10...	--	250	--	--	--	--	.06
10...	1.3	270	--	--	--	--	.06
10...	--	5300	--	--	--	--	.12
10...	--	290	--	--	--	--	.09
SEP , 1977							
08...	--	440	--	--	--	--	--
08...	--	B140	--	--	--	--	--
08...	--	650	--	--	--	--	--
08...	--	300	--	--	--	--	--
08...	--	540	--	--	--	--	--
08...	--	817	--	--	--	--	--
08...	--	240	--	--	--	--	--
08...	--	88	--	--	--	--	--
08...	--	42	--	--	--	--	--
08...	--	3300	--	--	--	--	--
08...	--	B1300	--	--	--	--	--
08...	--	770	--	--	--	--	--
08...	--	82	--	--	--	--	--
08...	--	210	--	--	--	--	--
08...	--	116	--	--	--	--	--
08...	--	B36	--	--	--	--	--
08...	--	146	--	--	--	--	--
08...	--	817	--	--	--	--	--

475434124381801 (LAT 47°54'34" LONG 124°38'18")
QUILLAYUTE ESTUARY, WA RIVER MILE 0.1, AT SITE OF FIRST QUARTILE FROM LEFT BANK SITE 3

DATE	TIME	SAMP-LING DEPTH (FT)	SALIN-ITY (PPT)	TEMPER-ATURE (DEG C)	TUR-BID-ITY (JTU)	DIS-SOLVED OXYGEN (MG/L)	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)
AUG , 1976												
11...	1815	1.6	5.0	15.6	--	--	--	--	--	--	--	--
11...	1818	3.3	7.2	15.2	--	--	--	--	--	--	--	--
11...	1822	6.6	21	13.2	--	--	--	--	--	--	--	--
11...	1825	13	30	10.7	--	--	--	--	--	--	--	--
11...	1828	9.8	29	11.0	--	--	--	--	--	--	--	--
11...	1832	16	30	10.8	--	--	--	--	--	--	--	--
19...	0840	1.6	1.7	14.2	1	9.3	1.1	730	56	.02	.00	.01
19...	0845	4.9	6.9	14.5	1	8.4	1.3	B1000	--	.02	.00	.02
19...	0850	9.8	20	14.6	1	7.2	1.6	B340	--	.04	.00	.05
19...	0855	21	25	14.6	1	8.4	.8	9	--	.05	.00	.09
19...	1015	1.6	2.0	14.4	1	8.7	--	B960	--	.02	.00	.02
19...	1020	4.9	4.1	14.4	1	8.7	--	--	--	.02	.00	.03
19...	1025	9.8	21	14.4	1	5.4	--	--	--	.04	.00	.09
19...	1030	16	25	14.4	1	5.2	--	--	--	.03	.01	.09
19...	1430	1.6	3.4	14.2	1	9.1	1.3	540	>270	.03	.00	.02
19...	1435	4.9	5.6	14.2	1	8.0	1.0	B2800	400	.02	.01	.03
19...	1440	9.8	23	14.4	1	5.6	3.4	340	55	.02	.01	.10
19...	1445	25	25	14.3	1	5.4	.4	43	11	.03	.01	.10
19...	1640	1.6	4.4	14.2	1	9.8	--	--	370	.01	.01	.04
19...	1645	4.9	16	14.2	2	8.6	--	>1000	106	.03	.00	.09
19...	1650	9.8	24	14.4	1	8.5	--	130	10	.04	.00	.10
19...	1655	23	25	14.4	2	7.7	--	69	9	.05	.00	.08
19...	2000	1.6	3.1	14.3	1	10.2	1.6	>1000	--	.02	.00	.03
19...	2005	4.9	6.0	14.3	1	10.1	1.1	>1000	>220	.03	.00	.06
19...	2010	9.8	22	14.5	1	9.4	--	B960	--	.04	.00	.10
19...	2015	26	25	14.4	1	8.0	.6	860	--	.05	.00	.11
SEP , 1976												
10...	0840	1.6	4.3	12.2	--	8.7	1.5	19	--	--	--	.05
10...	0843	4.9	8.9	12.0	--	8.0	--	31	--	--	--	.05
10...	0845	9.8	27	10.5	--	5.6	--	100	--	--	--	.08
10...	0850	22	30	8.8	--	3.8	1.1	8	--	--	--	.06
10...	1425	1.6	2.3	14.7	--	10.2	1.0	360	--	--	--	.04
10...	1427	4.9	25	12.5	--	6.9	--	230	--	--	--	.05
10...	1430	9.8	27	10.1	--	6.9	--	46	--	--	--	.06
10...	1432	31	28	9.6	--	5.4	.8	B	--	--	--	.05

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA AUGUST 1976

QUARTILE RUN, QUILLAYUTE ESTUARY, WA (LAT 47°54'34" LONG 124°38'18") AT RIVER MILE 0.1

475434124381802 FIRST QUARTILE FROM LEFT BANK

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976												
19...	1220	1.6	2.4	14.1	1	9.3	1.5	100	110	.02	.00	.03
19...	1225	4.9	8.5	14.3	1	8.6	1.1	>800	120	.02	.00	.06
19...	1230	9.8	27	14.4	1	7.9	1.2	192	17	.04	.01	.08
19...	1235	20	26	14.4	1	7.9	1.6	100	9	.05	.00	.12

475434124381803 SECOND QUARTILE FROM LEFT BANK

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976												
19...	1215	1.6	4.6	14.2	1	9.0	1.6	B600	90	.02	.00	.04

475434124381804 THIRD QUARTILE FROM LEFT BANK

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976												
19...	1210	1.6	3.2	14.1	1	9.3	1.1	B560	78	.02	.00	.03

475434124381805 FOURTH QUARTILE FROM LEFT BANK

DATE	TIME	SAMPLING DEPTH (FT)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976												
19...	1205	1.6	2.3	14.1	1	9.2	.8	200	95	.02	.00	.02

B Results based upon colony counts outside the ideal range.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1977

475419124383401 (LAT 47°54'19" LONG 124°38'34")
QUILLAYUTE ESTUARY AT SOUTH END OF JAMES ISLAND, WA 0.2 MI OFFSHORE FROM QUILLAYUTE RIVER MILE 0.0 SITE 2

DATE	TIME	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	SALINITY (PPT)	* TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)	*MEAN DAILY DISCHARGE (CFS)
AUG , 1976								
11...	1800	1.6	--	6.6	15.3	--	--	825
11...	1805	6.6	--	20	13.6	--	--	--
11...	1807	13	--	30	11.0	--	--	--
11...	1810	23	--	31	9.3	--	--	--
12...	1030	1.6	--	6.7	13.7	--	8.1	825
12...	1032	3.3	--	31	10.4	--	--	--
12...	1033	6.6	--	32	9.4	--	--	--
12...	1035	9.8	--	32	--	--	--	--
12...	1037	13	--	32	9.1	--	--	--
12...	1040	16	--	32	9.1	--	5.3	--
19...	0900	1.6	--	2.8	14.5	1	8.8	1,000
19...	0905	6.6	--	20	14.6	1	8.3	--
19...	0910	13	--	26	14.6	0	8.4	--
19...	0915	26	--	26	14.5	2	7.8	--
19...	1045	1.6	--	2.0	14.8	0	9.0	--
19...	1050	6.6	--	3.2	--	1	8.1	--
19...	1055	13	--	23	--	1	7.3	--
19...	1100	20	--	25	--	3	5.3	--
19...	1410	1.6	--	3.7	14.0	1	9.6	--
19...	1415	28	--	26	14.0	2	6.0	--
19...	1420	6.6	--	9.3	14.0	1	8.9	--
19...	1425	13	--	24	14.2	1	6.3	--
19...	1935	1.6	--	5.7	14.3	1	8.8	--
19...	1940	6.6	--	22	14.3	1	8.7	--
19...	1945	13	--	24	14.4	1	8.5	--
19...	1950	31	--	25	14.4	2	8.3	--
SEP								
10...	0815	1.6	--	5.4	12.2	--	8.7	950
10...	0820	6.6	--	24	9.8	--	5.7	--
10...	0822	13	--	29	9.3	--	4.5	--
10...	0830	22	--	30	8.5	--	3.2	--
10...	1403	1.6	--	23	12.0	--	7.6	--
10...	1405	6.6	--	27	11.8	--	6.9	--
10...	1407	13	--	27	11.0	--	7.0	--
10...	1410	31	--	27	10.3	--	6.6	--
SEP , 1977								
08...	0735	1.0	14000	--	--	--	--	1,000
08...	0736	--	49500	--	--	--	--	--
08...	0920	1.0	7500	--	--	--	9.1	--
08...	0921	--	47500	--	--	--	5.9	--
08...	1100	1.0	25500	--	--	--	--	--

* Estimated mean daily freshwater discharge to the Quillayute Estuary.

TABLE 15.--WATER-QUALITY DATA FOR MISCELLANEOUS SAMPLING SITES IN THE QUILLAYUTE RIVER BASIN--CONTINUED

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1977

475419124383401 (LAT 47°54'19" LONG 124°38'34")

QUILLAYUTE ESTUARY AT SOUTH END OF JAMES ISLAND, WA 0.2 MI OFFSHORE FROM QUILLAYUTE RIVER MILE 0.0 (CONT). SITE 2 (CONT)

DATE	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM (COL. PER 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)
AUG , 1976							
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
12...	1.5	>300	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	1.2	4	--	--	--	--	--
19...	1.0	2300	--	--	.02	.00	.09
19...	1.2	390	25	--	.04	.00	.04
19...	--	--	--	--	.04	.01	.12
19...	--	9	--	--	.05	.00	.10
19...	1.1	--	--	--	.02	.00	.03
19...	--	--	--	--	.02	.00	.03
19...	--	290	--	--	.05	.00	.08
19...	--	--	--	--	.04	.00	.12
19...	1.2	680	--	--	.02	.00	.02
19...	--	--	--	--	.03	.01	.10
19...	1.6	620	--	--	.02	.01	.04
19...	1.0	270	--	--	.03	.01	.10
19...	1.3	6000	--	--	.02	.00	.08
19...	1.2	870	--	--	.05	.00	.09
19...	--	B170	--	--	.05	.00	.07
19...	1.3	B50	--	--	.04	.01	.08
SEP							
10...	1.6	69	46	26	--	--	.04
10...	--	35	--	--	--	--	.07
10...	--	15	--	--	--	--	.05
10...	1.4	4	--	--	--	--	.05
10...	1.1	27	1	3	--	--	.08
10...	--	4	--	--	--	--	.04
10...	--	4	--	--	--	--	.03
10...	.9	<1	--	--	--	--	.03
SEP , 1977							
08...	--	B1100	--	--	--	--	--
08...	--	B25	--	--	--	--	--
08...	--	B1200	--	--	--	--	--
08...	--	<3	--	--	--	--	--
08...	--	550	--	--	--	--	--

DATE	TIME	SAMP-LING DEPTH (FT)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	DIS-SOLVED OXYGEN (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)
SEP , 1977					
08...	1101	--	49500	--	9
08...	1220	1.0	5500	--	B18
08...	1221	--	49500	--	<9
08...	1350	1.0	17000	--	114
08...	1351	--	47500	--	B8
08...	1505	1.0	10000	10.6	B21
08...	1506	--	45500	7.0	B11
08...	1640	1.0	4000	--	B13
08...	1641	--	44500	--	B2
08...	1755	1.0	5000	--	B33
08...	1756	--	45500	--	B6
08...	1920	1.0	13500	--	152
08...	1921	--	47500	--	100

B Results based upon colony counts outside the ideal range.

WATER QUALITY DATA, AUGUST 1976 TO SEPTEMBER 1977

475350124384001 (LAT 47°53'50" LONG 124°38'40")
PACIFIC OCEAN 0.8 MI OFFSHORE FROM RIVER MILE 0.0 ON QUILLAYUTE ESTUARY SITE 1

DATE	TIME	SAMPLING DEPTH (FT)	SPECIFIC CONDUCTANCE (MICROMHOS)	SALINITY (PPT)	TEMPERATURE (DEG C)	TURBIDITY (JTU)	DISSOLVED OXYGEN (MG/L)
AUG , 1976							
11...	1745	1.6	--	25	12.2	--	--
11...	1747	9.8	--	31	11.0	--	--
11...	1750	20	--	31	9.6	--	--
11...	1752	33	--	32	9.6	--	--
12...	1042	1.6	--	28	10.9	--	--
12...	1045	3.3	--	31	10.5	--	--
12...	1047	6.6	--	32	9.0	--	--
12...	1048	9.8	--	32	8.9	--	--
12...	1050	16	--	32	8.0	--	--
12...	1052	33	--	33	8.3	--	--
19...	0915	9.8	--	25	14.1	1	8.6
SEP							
10...	0805	1.6	--	23	10.3	--	6.7
10...	0810	20	--	30	8.6	--	3.7
10...	1347	1.6	--	28	12.4	--	7.2
10...	1350	20	--	29	10.8	--	6.5
SEP , 1977							
08...	0930	1.0	44600	--	--	--	8.6
08...	0931	33	46500	--	--	--	6.6
08...	0932	66	43500	--	--	--	5.2
08...	1810	1.0	44500	--	--	--	--
08...	1811	33	48500	--	--	--	--
08...	1812	66	49500	--	--	--	--

DATE	BIOCHEMICAL OXYGEN DEMAND 5 DAY (MG/L)	IMMEDIATE COLIFORM (COL. PER 100 ML)	FECAL COLIFORM (COL. PER 100 ML)	STREPTOCOCCI (COLONIES PER 100 ML)	TOTAL NITRATE (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL AMMONIA NITROGEN (N) (MG/L)
AUG , 1976							
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
11...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	1.0	10	--	--	--	--	--
12...	--	--	--	--	--	--	--
12...	--	--	--	--	--	--	--
19...	1.1	--	1	--	.05	.00	.07
SEP							
10...	1.5	35	10	100	--	--	--
10...	1.4	12	<1	1	--	--	.04
10...	.8	<1	2	<1	--	--	.05
10...	.7	<1	2	71	--	--	.06
SEP , 1977							
08...	--	B140	--	--	--	--	--
08...	--	B2	--	--	--	--	--
08...	--	<100	--	--	--	--	--
08...	--	<2	--	--	--	--	--
08...	--	<3	--	--	--	--	--
08...	--	<9	--	--	--	--	--

B Results based upon colony counts outside the ideal range.

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1960 - June 1970.

DATE	TIME	DIS-CHARGE (CFS) (00060)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE (DEG C) (00010)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	TUR-BID-ITY (JTU) (00070)	DIS-SOLVED OXYGEN (MG/L) (00300)	COM-PLETE COLI-FORM (MPN) (31507)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)
JUL , 1960												
18...	--	286	80	7.8	16.5	0	--	9.4	0	34	2	11
AUG												
02...	--	171	89	7.8	--	5	--	9.8	36	39	5	14
SEP												
07...	--	154	91	7.7	10.5	5	--	10.8	0	38	4	13
OCT												
05...	--	83	102	7.9	12.0	5	--	10.6	0	43	4	15
NOV												
04...	--	501	73	7.7	6.1	5	--	12.3	0	31	3	10
DEC												
06...	--	447	77	7.5	3.4	5	--	13.2	0	34	4	12
JAN , 1961												
05...	--	2170	56	7.5	4.8	10	--	--	0	23	2	8.0
FEB												
02...	--	2700	47	7.3	5.1	10	--	11.7	0	19	0	7.5
MAR												
02...	--	1250	59	7.4	3.7	5	--	12.9	0	24	1	8.0
APR												
04...	--	855	64	7.3	6.0	5	--	--	0	28	3	9.0
MAY												
01...	--	802	66	7.4	8.0	5	--	11.4	0	28	2	9.5
JUN												
01...	--	652	70	7.6	11.0	5	--	10.9	0	30	2	10
JUL												
17...	--	222	82	7.6	18.8	0	--	9.2	36	35	3	12
AUG												
01...	--	140	91	7.6	18.6	0	--	9.7	0	41	6	14
SEP												
05...	--	140	90	7.6	15.0	5	--	10.2	91	39	5	13
NOV												
01...	1700	630	69	7.1	6.1	5	0	12.1	36	29	3	10
FEB , 1962												
14...	1315	420	77	7.4	6.0	5	0	12.0	<23	32	3	11
MAY												
14...	1130	428	82	7.6	6.7	5	0	11.7	360	34	3	11
AUG												
14...	1410	140	94	7.5	15.0	5	0	10.2	36	41	5	15
DEC												
13...	1305	1000	69	7.0	6.1	5	0	13.7	73	29	3	10
JUL , 1963												
17...	1650	382	75	7.5	16.7	0	0	10.7	<23	33	4	11

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1960 - June 1970.

DATE	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L) (00935)	BICAR-BONATE (HCO3) (MG/L) (00440)	CAR-BONATE (CO3) (MG/L) (00445)	ALKA-LINITY AS CACO3 (MG/L) (00410)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) (70300)
JUL , 1960												
18...	1.7	1.8	10	.2	39	0	32	1.0	6.4	.0	5.0	51
AUG												
02...	1.0	2.2	11	.6	42	0	34	1.2	8.0	.1	5.1	55
SEP												
07...	1.5	2.7	13	.3	42	0	34	1.2	7.6	.1	5.2	52
OCT												
05...	1.4	2.7	12	.5	47	0	39	1.5	9.8	.2	5.6	58
NOV												
04...	1.5	1.9	12	.0	34	0	28	1.5	5.8	.0	5.4	47
DEC												
06...	.9	1.9	11	.0	37	0	30	1.5	5.8	.1	5.9	51
JAN , 1961												
05...	.7	1.6	13	.0	26	0	21	1.2	3.8	.1	5.0	37
FEB												
02...	.1	1.4	14	.1	23	0	19	1.2	2.8	.1	4.7	31
MAR												
02...	1.0	1.9	15	.0	28	0	23	1.2	4.0	.1	5.7	39
APR												
04...	1.2	2.2	14	.7	31	0	25	1.0	5.2	.1	5.0	44
MAY												
01...	1.0	1.8	12	.2	32	0	26	1.2	5.6	.1	4.9	40
JUN												
01...	1.2	1.6	10	.3	34	0	28	1.0	6.2	.1	5.1	42
JUL												
17...	1.2	2.0	11	.2	39	0	32	1.0	6.8	.1	5.4	51
AUG												
01...	1.4	2.3	11	.2	43	0	35	1.0	8.4	.1	5.1	58
SEP												
05...	1.5	2.6	13	.5	42	0	34	1.2	8.4	.1	5.1	54
NOV												
01...	.9	1.9	12	.3	32	0	26	1.0	5.2	.1	5.4	46
FEB , 1962												
14...	1.2	2.3	13	.3	36	0	30	1.5	6.0	.1	5.8	51
MAY												
14 ..	1.6	2.2	12	.4	38	0	31	1.0	6.8	.0	5.9	53
AUG												
14...	.8	2.4	11	.3	44	0	36	1.2	8.2	.1	5.8	56
DEC												
13...	1.0	2.2	14	.2	32	0	26	1.8	6.4	.1	5.3	45
JUN , 1963												
17...	1.3	1.6	10	.2	36	0	30	.8	5.4	.1	4.2	46

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1969 - June 1970.

DATE	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	TOTAL NITRATE (N) (MG/L) (00620)	DIS-SOLVED ORTHO. PHOS-PHORUS (P) (MG/L) (00671)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CHRO-MIUM (CR) (UG/L) (01030)	HEXA-VALENT CHRO-MIUM (CR6) (UG/L) (01032)	DIS-SOLVED COPPER (CU) (UG/L) (01040)	TOTAL IRON (FE) (UG/L) (01045)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)
JUL , 1960											
18...	46	39.4	.00	.00	--	--	--	--	--	10	--
AUG											
02...	53	25.4	.00	.00	--	--	--	--	--	10	--
SEP											
07...	52	21.6	.02	.00	0	0	10	--	0	40	--
OCT											
05...	60	13.0	.00	.01	--	--	--	--	--	20	--
NOV											
04...	43	63.6	.02	.00	--	--	--	--	--	30	--
DEC											
06...	46	61.6	.02	.00	--	--	--	--	--	30	--
JAN , 1961											
05...	33	217	.07	.00	0	0	40	--	90	140	--
FEB											
02...	29	226	.05	.01	--	--	--	--	--	450	--
MAR											
02...	36	132	.02	.00	--	--	--	--	--	60	--
APR											
04...	40	102	.02	.00	--	--	--	--	--	10	--
MAY											
01...	40	86.6	.00	.00	--	--	--	--	--	40	--
JUN											
01...	42	73.9	.00	.00	--	--	--	--	--	20	--
JUL											
17...	48	30.6	.02	.00	--	--	--	--	--	10	--
AUG											
01...	54	21.9	.00	.00	--	--	--	--	--	20	--
SEP											
05...	53	20.4	.02	.00	--	--	--	--	--	0	--
NOV											
01...	41	78.2	.00	.00	0	0	0	0	40	0	<50
FEB , 1962											
14...	46	57.8	.00	.01	--	--	--	--	--	10	--
MAY											
14...	48	61.2	.02	.00	0	0	0	0	0	30	<50
AUG											
14...	55	21.2	.00	.00	--	--	--	--	--	0	--
DEC											
13...	43	121	.02	.00	0	0	0	0	0	40	<50
JUN , 1963											
17...	42	47.4	.00	.00	0	0	0	0	10	0	<50

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1960 - June 1970.

DATE	TIME	DIS-CHARGE (CFS) (00060)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS) (00095)	PH (UNITS) (00400)	TEMPER-ATURE (DEG C) (00010)	COLOR (PLAT-INUM-COBALT UNITS) (00080)	TUR-BID-ITY (JTU) (00070)	DIS-SOLVED OXYGEN (MG/L) (00300)	COM-PLETE COLI-FORM (MPN) (31507)	HARD-NESS (CA,MG) (MG/L) (00900)	NON-CAR-BONATE HARD-NESS (MG/L) (00902)	DIS-SOLVED CAL-CIUM (CA) (MG/L) (00915)
DEC , 1963												
23...	1145	5080	38	7.0	6.7	15	35	12.0	<23	16	0	5.0
JUN , 1964												
15...	1430	456	60	7.5	8.9	5	0	11.6	<23	27	2	9.0
DEC												
14...	1515	--	76	7.5	3.8	5	0	11.7	30	32	3	11
JUN , 1965												
02...	1600	--	72	7.5	12.4	0	0	11.3	<23	30	2	10
FEB , 1966												
07...	1440	--	70	7.4	5.0	5	--	11.8	30	28	2	9.2
AUG												
02...	0820	--	82	7.0	12.4	0	--	10.8	36	36	4	12
MAY , 1967												
18...	0825	--	68	7.7	7.2	5	--	--	--	28	0	8.8
OCT												
18...	1330	--	69	7.5	11.0	5	--	--	--	28	1	8.8
APR , 1968												
18...	1415	--	67	7.5	8.0	5	--	--	--	26	0	7.9
NOV												
13...	1500	--	62	7.1	--	5	--	--	--	26	0	7.9
SEP , 1969												
09...	1700	--	95	7.2	--	0	--	--	--	39	1	12
JUN , 1970												
09...	--	--	73	7.2	8.5	0	--	--	--	30	2	10

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1960 - June 1970.

DATE	DIS-SOLVED MAG-NE-SIUM (MG) (MG/L) (00925)	DIS-SOLVED SODIUM (NA) (MG/L) (00930)	PERCENT SODIUM (00932)	DIS-SOLVED PO-TAS-SIUM (K) (MG/L) (00935)	BICAR-BONATE (HCO3) (MG/L) (00440)	CAR-BONATE (CO3) (MG/L) (00445)	ALKA-LINITY AS CACO3 (MG/L) (00410)	DIS-SOLVED CHLO-RIDE (CL) (MG/L) (00940)	DIS-SOLVED SULFATE (SO4) (MG/L) (00945)	DIS-SOLVED FLUO-RIDE (F) (MG/L) (00950)	DIS-SOLVED SILICA (SIO2) (MG/L) (00955)	DIS-SOLVED SOLIDS (RESI-DUE AT 180 C) (MG/L) (70300)
DEC , 1963												
23...	.8	1.8	20	.3	18	0	15	1.0	3.2	.1	3.5	27
JUN , 1964												
15...	1.0	1.7	12	.3	30	0	25	1.2	4.8	.1	4.3	39
DEC												
14...	1.2	2.3	13	.3	36	0	30	1.2	6.4	.1	5.4	47
JUN , 1965												
02...	1.4	2.0	12	.4	35	0	29	1.0	6.2	.1	5.4	43
FEB , 1966												
07...	1.2	2.0	13	.2	32	0	26	1.5	5.2	.1	5.3	41
AUG												
02...	1.5	2.0	11	.3	39	0	32	1.5	6.4	.1	4.7	44
MAY , 1967												
18...	1.3	2.0	14	.3	33	0	27	1.5	4.4	.1	8.0	41
OCT												
18...	1.4	2.8	18	.2	33	0	27	1.5	5.0	.1	7.3	43
APR , 1968												
18...	1.5	3.0	20	.1	33	0	27	1.5	3.8	.1	7.7	42
NOV												
13...	1.6	2.8	19	.3	32	0	26	1.4	4.0	.1	6.6	44
SEP , 1969												
09...	2.1	3.6	17	.4	46	0	38	1.8	5.2	.1	9.5	58
JUN , 1970												
09...	1.2	1.9	12	.3	35	0	29	.7	5.8	.1	4.5	41

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 1 -- Station 12042000 - Soleduck River near Beaver, Washington (at rivermile 44.9). Period of record: July 1960 - June 1970

DATE	DIS-SOLVED SOLIDS (SUM OF CONSTI-TUENTS) (MG/L) (70301)	DIS-SOLVED SOLIDS (TONS PER DAY) (70302)	TOTAL NITRATE (N) (MG/L) (00620)	DIS-SOLVED ORTHO. PHOS-PHORUS (P) (MG/L) (00671)	DIS-SOLVED ARSENIC (AS) (UG/L) (01000)	DIS-SOLVED BORON (B) (UG/L) (01020)	DIS-SOLVED CHRO-MIUM (CR) (UG/L) (01030)	HEXA-VALENT CHRO-MIUM (CR6) (UG/L) (01032)	DIS-SOLVED COPPER (CU) (UG/L) (01040)	TOTAL IRON (FE) (UG/L) (01045)	DIS-SOLVED ZINC (ZN) (UG/L) (01090)
DEC , 1963											
23...	25	370	.07	.00	0	0	10	10	90	630	<50
JUN , 1964											
15...	37	48.0	.05	.01	0	10	0	0	0	40	<50
DEC											
14...	46	--	.05	--	0	20	0	0	10	30	<50
JUN , 1965											
02...	44	--	.07	--	0	10	0	0	20	20	<50
FEB , 1966											
07...	41	--	.02	--	0	30	0	0	10	--	<50
AUG											
02...	48	--	.02	--	0	10	0	0	20	--	0
MAY , 1967											
18...	43	--	.02	--	0	40	0	0	0	--	20
OCT											
18...	43	--	.11	--	0	0	0	0	0	--	0
APR , 1968											
18...	42	--	.05	--	--	--	--	--	--	--	--
NOV											
13...	40	--	.14	--	--	20	0	0	0	--	0
SEP , 1969											
09...	57	--	.07	--	--	--	0	0	0	--	0
JUN , 1970											
09...	42	--	.02	--	--	--	--	--	--	--	--

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 2 -- Station 12042300 - Soleduck River near Forks, Washington (at rivermile 23.4). Period of record: October 1971 - September 1974.

DATE	TIME	INSTANTANEOUS DISCHARGE (CFS) (00061)	SPECIFIC CONDUCTANCE (MICROMHOS) (00095)	PH (UNITS) (00400)	TEMPERATURE (DEG C) (00010)	COLOR (PLATINUM-COBALT UNITS) (00080)	TURBIDITY (JTU) (00070)	DISSOLVED OXYGEN (MG/L) (00300)	IMMEDIATE COLIFORM (COL. PER 100 ML) (31501)
OCT , 1971									
27...	0950	--	66	7.2	4.4	--	--	12.6	130
DEC									
14...	1110	2150	67	7.1	5.3	40	2	12.5	350
FEB , 1972									
08...	1115	1720	64	7.5	5.3	26	4	12.9	100
APR									
11...	1115	1500	67	7.5	5.4	9	2	12.5	75
JUN									
13...	1115	863	86	7.4	9.6	6	1	11.7	225
AUG									
08...	1100	401	98	7.8	16.8	5	1	9.8	120
NOV									
29...	1130	--	67	7.6	4.7	0	3	12.9	80
JAN , 1973									
16...	1050	--	48	7.1	5.5	55	45	12.4	160
MAR									
13...	1100	--	94	7.0	6.6	19	3	12.9	100
MAY									
30...	1015	--	78	7.6	10.6	23	1	11.1	75
JUL									
17...	1040	--	99	7.8	15.7	5	1	9.7	100
SEP									
25...	1120	--	100	7.8	12.0	18	1	11.1	540
NOV									
13...	1100	--	61	7.4	6.0	29	8	12.1	440
JAN , 1974									
23...	1110	--	66	7.4	6.0	17	15	12.8	270
MAR									
19...	1100	--	67	7.4	5.8	10	7	13.0	120
MAY									
15...	1120	--	77	7.5	7.0	16	5	13.0	260
JUL									
23...	1045	--	76	7.7	11.6	11	2	11.4	650
SEP									
17...	1050	--	94	7.5	12.7	14	2	11.1	660

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued

Site 2 -- Station 12042300 - Soleduck River near Forks, Washington (at rivermile 23.4). Period of record: October 1971 - September 1974.

DATE	HARDNESS (CA,MG) (MG/L) (00900)	NON-CARBONATE HARDNESS (MG/L) (00902)	DISSOLVED CALCIUM (CA) (MG/L) (00915)	DISSOLVED MAGNESIUM (MG) (MG/L) (00925)	DISSOLVED SODIUM (NA) (MG/L) (00930)	PERCENT SODIUM (00932)	DISSOLVED POTASSIUM (K) (MG/L) (00935)	BICARBONATE (HCO3) (MG/L) (00440)	CARBONATE (CO3) (MG/L) (00445)
OCT , 1971									
27...	26	0	9.0	.8	1.8	13	.4	33	0
DEC									
14...	24	0	7.5	1.4	3.0	21	.3	30	0
FEB , 1972									
08...	25	0	7.9	1.3	2.9	20	.3	30	0
APR									
11...	26	0	8.4	1.3	3.2	21	.4	32	0
JUN									
13...	31	1	10	1.4	2.3	14	.2	36	0
AUG									
08...	34	0	11	1.7	2.4	13	.2	42	0
NOV									
29...	31	1	9.7	1.6	3.2	18	.5	36	0
JAN , 1973									
16...	16	0	5.1	.9	2.3	23	.6	24	0
MAR									
13...	28	4	8.8	1.5	3.0	18	1.9	30	0
MAY									
30...	31	0	10	1.5	2.4	14	.3	38	0
JUL									
17...	37	0	12	1.7	3.0	15	.4	47	0
SEP									
25...	37	0	12	1.8	3.6	17	.3	48	0
NOV									
13...	--	--	--	--	--	--	--	--	--
JAN , 1974									
23...	--	--	--	--	--	--	--	--	--
MAR									
19...	--	--	--	--	--	--	--	--	--
MAY									
15...	--	--	--	--	--	--	--	--	--
JUL									
23...	--	--	--	--	--	--	--	--	--
SEP									
17...	--	--	--	--	--	--	--	--	--

TABLE 16.--Water-quality data for period of record at historic sites 1 and 2 on the Soleduck River--continued.

Site 2 -- Station 12042300 - Soleduck River near Forks, Washington (at rivermile 23.4). Period of record: October 1971 - September 1974.

DATE	ALKALINITY AS CACO3 (MG/L) (00410)	DISSOLVED CHLORIDE (CL) (MG/L) (00940)	DISSOLVED SULFATE (SO4) (MG/L) (00945)	TOTAL NITRITE (N) (MG/L) (00615)	TOTAL NITRITE PLUS NITRATE (N) (MG/L) (00630)	TOTAL AMMONIA NITROGEN (N) (MG/L) (00610)	TOTAL KJELDAHL NITROGEN (N) (MG/L) (00625)	TOTAL PHOSPHORUS (P) (MG/L) (00665)	DISSOLVED ORTHO. PHOSPHORUS (P) (MG/L) (00671)
OCT , 1971									
27...	27	1.3	--	--	--	--	--	--	--
DEC									
14...	25	2.7	--	.00	.26	.01	.04	.01	.00
FEB , 1972									
08...	25	2.4	--	.00	.06	.04	.13	.01	.01
APR									
11...	26	2.2	--	.01	.02	.16	.22	.05	.05
JUN									
13...	30	2.6	--	.00	.04	.03	.14	.01	.00
AUG									
08...	34	1.5	--	.00	.02	.02	.08	.00	.00
NOV									
29...	30	2.4	5.9	.00	.22	.09	--	.01	.00
JAN , 1973									
16...	20	2.2	3.1	.01	.18	.18	--	.11	.00
MAR									
13...	25	2.7	12	.00	.15	.11	--	.00	.00
MAY									
30...	31	1.7	5.6	.00	.06	.03	--	.00	.00
JUL									
17...	39	2.1	5.9	.01	.06	.02	--	.00	.00
SEP									
25...	39	2.3	5.2	.00	.08	.01	--	.00	.00
NOV									
13...	--	--	--	--	.23	.07	--	.02	.00
JAN , 1974									
23...	--	--	--	--	.15	.05	--	.02	.00
MAR									
19...	--	--	--	--	.20	.07	--	.02	.00
MAY									
15...	--	--	--	--	.04	.11	--	.01	.00
JUL									
23...	--	--	--	--	.03	.07	--	.01	.00
SEP									
17...	--	--	--	--	.06	.05	--	.01	.00