RECLAMATION

Managing Water in the West

Watershed Conditions and Seasonal Variability for Select Streams within WRIA 20, Olympic Peninsula, Washington

Washington Investigations Project
Pacific Northwest Region

Draft

U.S. Department of the Interior
Bureau of Reclamation
Technical Services Center
Denver, Colorado

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Cover Photo: Rialto Beach, where the Quillayute River outflows into the Pacific Ocean. Photo date: May 9, 1997. Provided by the Washington Department of Ecology, Shoreline Aerial Photos. Retrieved August 11, 2005 from http://apps.ecy.wa.gov/shorephotos/scripts/bigphoto.asp?id=CLA0616

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Washington Investigations Project
Pacific Northwest Region

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Introduction

In recent years, increased use of ground and surface water within watersheds of the State of Washington has created concern that insufficient flows will remain for anadromous fish and other uses. In response to this concern, the Washington State Legislature passed the Watershed Management Act of 1998 (ESHB 2514), which provides funding for local watershed planning and delegates the planning to the local level. As a part of this planning, stakeholders within each of the 62 state defined Water Resources Inventory Areas, known as WRIAs, will assess the status of water resources within their WRIA and determine if water is available for allocation. Such assessments will be completed through hydrologic analysis.

This report presents the results of an initial hydrologic analysis and assessment for WRIA 20, which is inclusive of the watersheds embraced by the Hoh River on the south, the Soleduck River on the west, and the Wa'atch River on the north. This area also contains the stream systems of the Quillayute River and Lake Ozette. This assessment was completed for the WRIA 20 local watershed management group made up of stakeholders in the management area.

This report provides a comprehensive appraisal level overview of watershed conditions within WRIA 20, wherein characteristics are defined for the contributing drainage of selected streams. Of principal importance, the indicated range of flow variability and volumetric discharge at specified locations along the stream is presented for each selected stream. Flow variability and volumetric discharge were calculated for both gaged and ungaged watersheds.

Incidental streamflow measurements collected in the future will help to evaluate changes in stream conditions that affect stream baseflow, or discharges above stream baseflow. This report provides a starting point from which the water resources picture of WRIA 20 may be examined.

Preparation of this report was accomplished using easily accessed information, and reasonably simple methods and procedures. A detailed description of the methods used is provided in Appendix 1. Watershed assessments were developed from 7.5 minute, 1:24000 scale topographic sheets that are provided in Digital Raster Graphic (DRG) form by the U. S. Geological Survey. The map overlays included with this report, were developed using interpretive techniques to delineate subwatershed areas, based on factors that defined watershed characteristics such as elevation, integration of the drainage network, and valley/streamcourse characteristics. Watershed drainage areas were determined using a Geographic Information System (GIS).

Field data, in the form of precipitation histories and streamflow histories, were obtained from sources documented in this report. These data are available from the U. S. Geological Survey and the National Oceanographic and Atmospheric Administration. Some of the data used in this report was provided on compact disk published by Hydrosphere, Boulder, Colorado. Statistical techniques used to evaluate these data, are well documented in the literature. Results similar to those developed for this report can be achieved using the tools available in spreadsheet software, such as Excel. However, some of the numerical and statistical techniques used in this report were specifically tailored for this effort.

Acknowledgements –
Several people were influential to the development of this report and the underlying data. Thomas Perry engendered enormous creativity in the development of unique methodologies. Joseph Lyons provided endless attention and an enormous ability to be decisive and comprehend complex hydrology. Jeff Shellberg of the Makah Indian Tribe provided a critical assessment of Reclamation efforts, as well as invaluable data collection. Thomas Bellinger provided a keen eye in the peer review process. James Jorgensen of the Hoh Indian Tribe, Ed Chadd of the Streamkeepers of Clallam County, and Patrick McNeil of Region 6 of the U.S. Forest Service provided data upon the slightest request. Valerie Streeter continued the excellent working relationship between Reclamation and the State of Washington that Cynthia Nelson began several years ago in WRIA 18. Finally, Dave Nelson provided the vision and continued support to make this assessment a reality.

Study Area

The study area encompasses the majority of WRIA 20 on the Olympic Peninsula of the State of Washington. Watershed boundaries defining WRIA 20 are those inclusively encompassing the watersheds of the Hoh River, Quillayute River, Ozette River, and the Sooes River. The Wa'atch River watershed is also within WRIA 20, but was not included in this study.

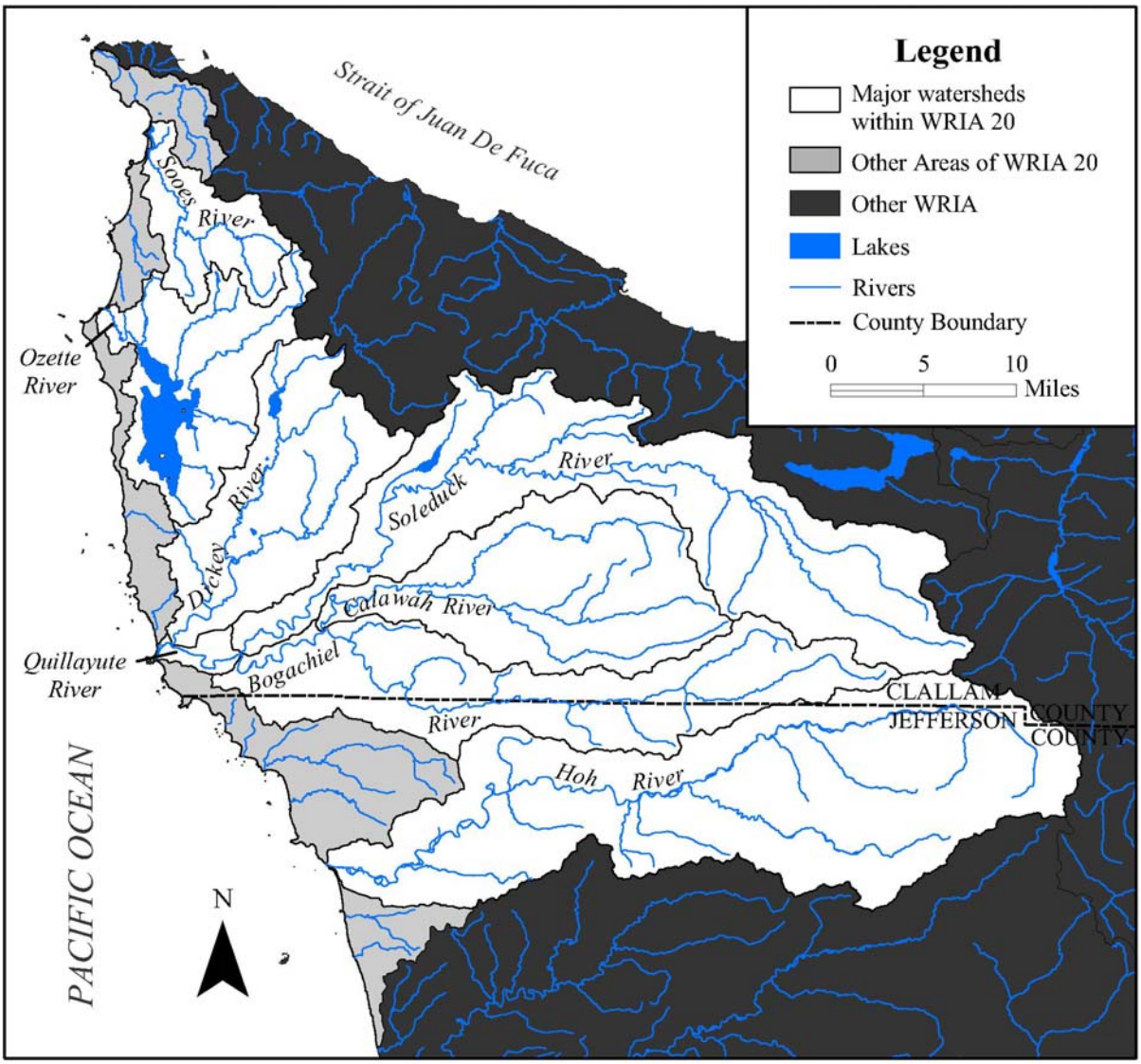

Figure 1. Map of WRIA 20.

Watershed Conditions and Flow Evaluations

Streamflow histories were developed and evaluated for variability at select locations along individual streamcourses, as shown in Figure 2 below. These locations were chosen by the WRIA 20 planning group, including members of the initiating governments, in conjunction with employees of Golder Associates in Seattle, who were asked to develop the WRIA 20 planning report. The results of these evaluations are presented in the following section.

Streamflow variability was evaluated from the monthly flow records between October 1961 and September 1999. Streamflow histories were developed at more than one particular location along each stream so that downstream changes in the character of flow could be observed. The methodology employed to estimate a complete streamflow history for each location and then evaluate the recurrence interval of each level of streamflow is described in Appendix 1. In general, extended streamflow histories between October 1961 and September 1999 were developed at gaging station locations using regression techniques. Flow histories were developed for ungaged evaluation sites using the watershed characteristics method or a modified drainage-area method. Streamflow data compiled and used in these evaluations are assumed to represent natural watershed conditions. The resulting natural flows were assumed to not be adversely impacted by development within the watershed for which the evaluation is being completed. Accommodations for changes in watershed conditions were not indicated for this appraisal level assessment. Basin-specific information used to develop these data is included in the following section, and this information is supplemental to the methodology description in Appendix 1.

The following discussion of watershed characteristics and streamflow variability is organized into specific WRIA 20 subwatersheds. For each watershed, conditions evident from aerial photography and topographic maps are described. The discussion begins with the Hoh watershed and proceeds in a northern direction up the west coast of the Olympic Peninsula. Because all gaging station records used are tabulated as water year records, the evaluation results are given in the water year format from October through September.

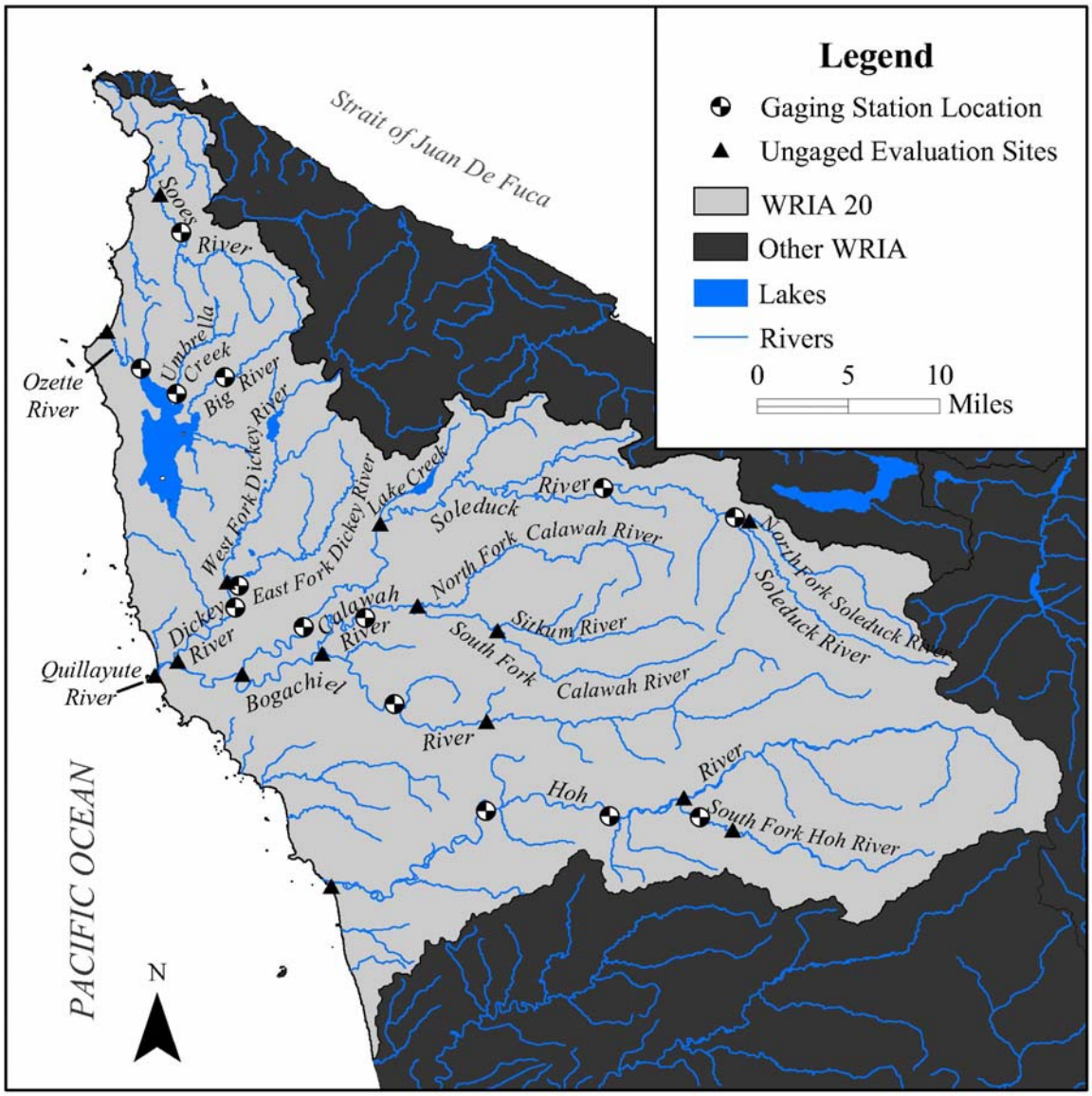

Figure 2. Select gaged and ungaged sites where streamflow was evaluated within WRIA 20.

Hoh River watershed

The Hoh River watershed is the most southern located watershed within WRIA 20, as seen in Figure 3 below. The Queets River watershed of WRIA 21 is adjacent to the south, while the Elwah River watershed of WRIA 18 is located to the east. The large Quillayute River watershed of WRIA 20 is located to the north.

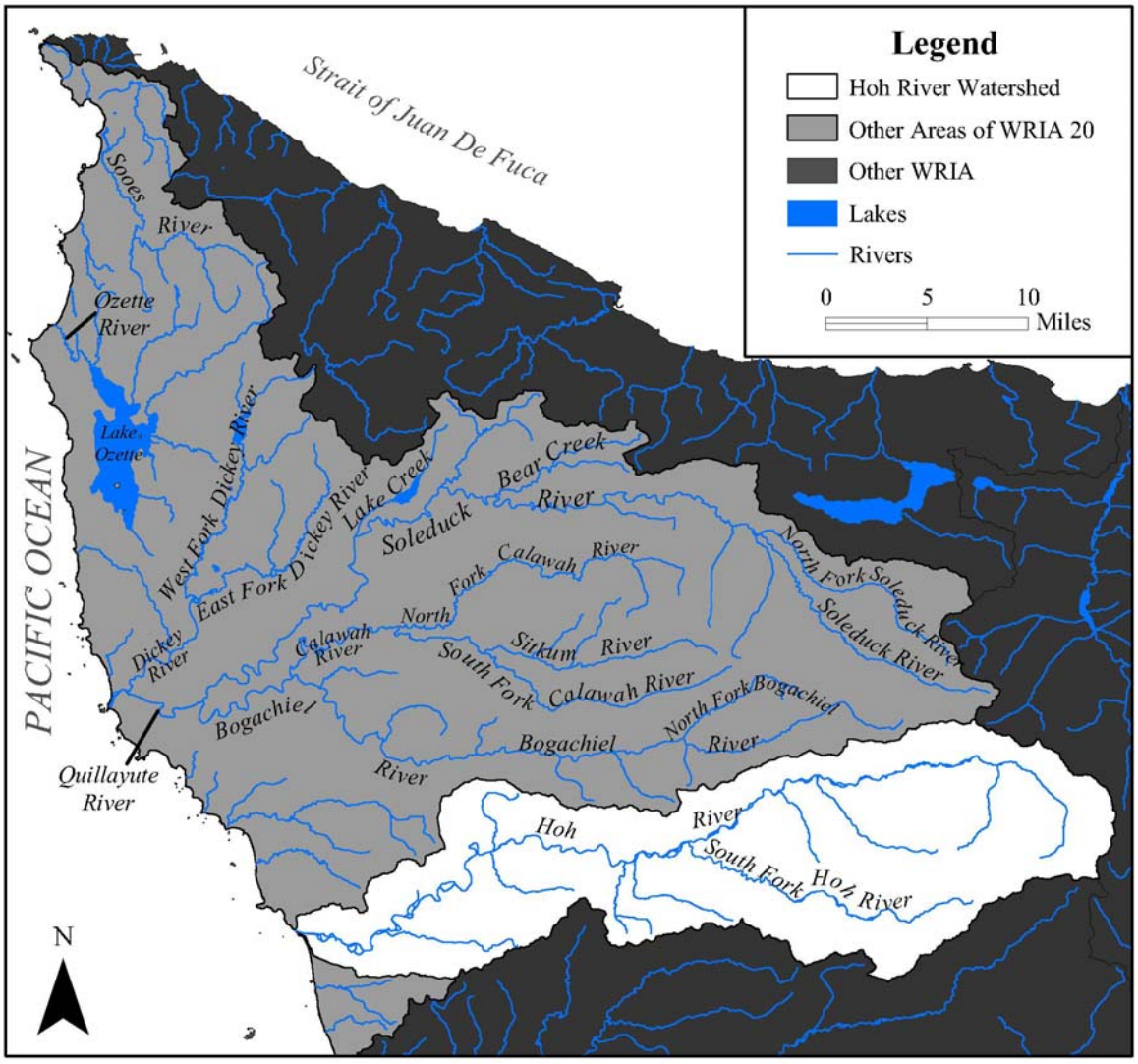

Figure 3. Location map of Hoh River watershed within WRIA 20.

The Hoh River flows from east to west and outlets directly into the Pacific Ocean. Average annual precipitation varies significantly, with over 240 inches of precipitation along the ridge above Humes and Hoh Glaciers, down to 93 inches near the outlet. The entire watershed covers approximately 298 square-miles in area, and a large portion of the watershed is administered within the Olympic National Park and has therefore not been altered by timber harvesting practices. Figure 4 below illustrates the extent of the national park within the Hoh River watershed as well as the extent of other land administration categories.

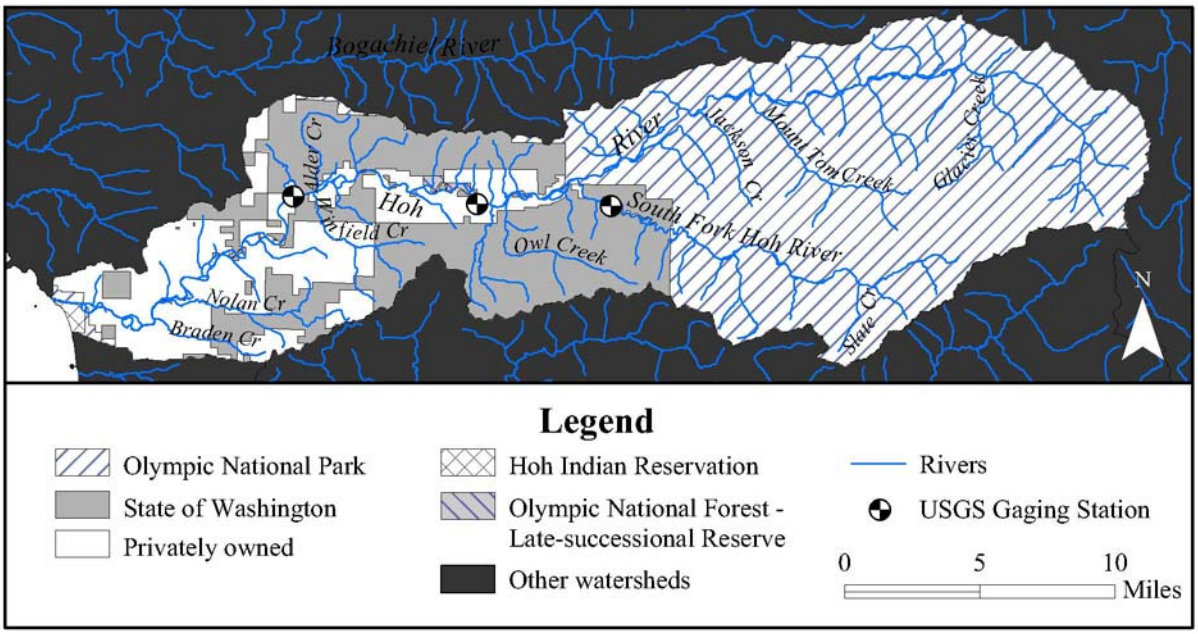

Figure 4. Land administration within the Hoh River watershed.

Table 1 below summarizes the areal extent of each administration category and the percent of the entire watershed that is administered by each category.

Table 1. Land administration areas within the Hoh River watershed.

Land Administration	Area* (sq. mi.)	Percent of Total Area*
Olympic National Park	171.7	57.6
Late-successional/Riparian Reserves (USFS)	0.64	0.22
State of Washington	72.6	24.4
Hoh Indian Reservation	0.63	0.21
Privately owned	52.5	17.6
Total Area	298.2	100

* = The sum of the areas will not equal the total due to rounding.

Only a small portion of the remaining watershed may have been affected by implementation of the President's Northwest Forest Plan of 1994 by the USDA Forest Service. In this plan, Forest Service and some state and private in-holding lands outside of wilderness areas have been assigned specific management designations. The only wilderness areas within the Hoh River watershed are located within the Olympic National Park, which covers over half of the watershed. Only a small area of the watershed between River Mile (RM) 23 and 26 is managed by the Forest Service, all of which has been designated as Late-successional Reserve (LSR). This area measures approximately 0.64 square-miles and is "managed to protect and enhance old-growth forests and habitat conditions for species dependent upon old-growth within a system of well-distributed large blocks of forest (ONRC, [no date])." Also, 0.25 square miles of the LSR area has been designated as a Riparian Reserve, where the land is "managed to provide high quality water supply, habitat for salmonids, and dispersal habitat for spotted owls and other wildlife (ONRC, [no date])."

The Hoh River watershed was delineated into specific watershed characteristic zones in order to evaluate streamflow variability. The extent of these delineations are illustrated in Figure 5 below and summarized in Table 2 below. The headwater areas are dominated by highland watershed characteristics, especially in the Hoh River above the South Fork Hoh River. These areas contribute to streamflow more directly during the spring due to snowmelt. Lower elevation areas that area characterized as upland or lowland subwatersheds contribute more directly to flow during the winter, since snow melts occurs more rapidly in these areas. A more accurate description of these watershed characteristic types can be found in Appendix 1.

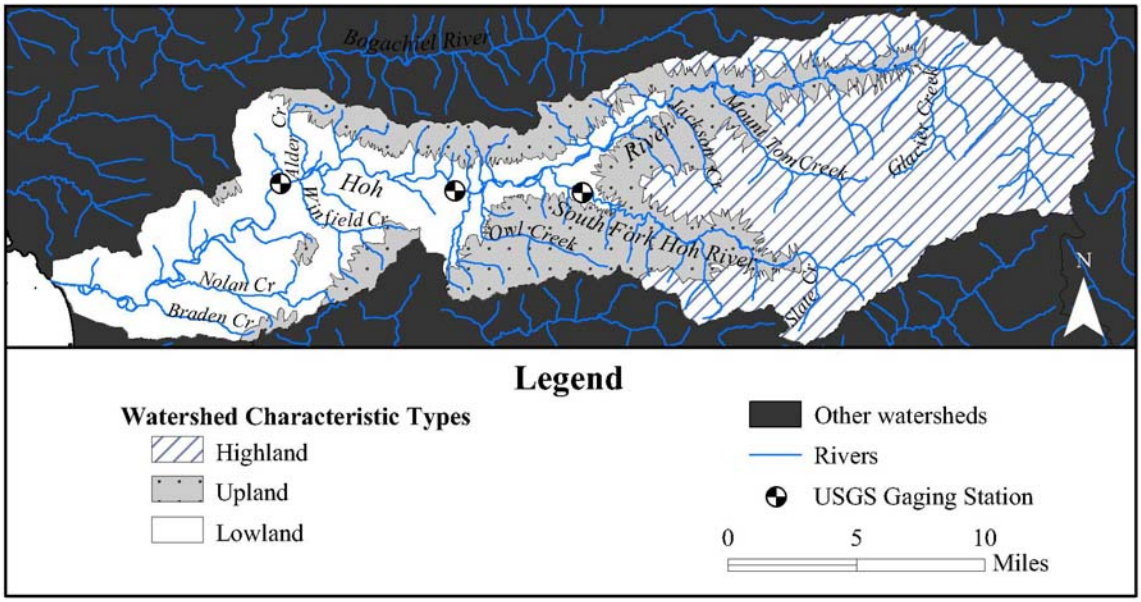

Figure 5. Watershed characteristic types within the Hoh River watershed.

Table 2. Watershed characteristics of areas within the Hoh River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	124.30	41.7
Upland	78.26	26.2
Upland, *but ineffective*	3.74	1.3
Lowland	72.65	24.4
Lowland, *but ineffective*	19.22	6.4
Total Area	298.17	100

As indicated in Table 2 above, some areas of the Hoh River watershed were considered ineffective towards streamflow. Areas of large flat valleys were considered partially ineffective in regards to direct surface runoff, as some precipitation that falls on these flat areas will sink into the subsurface aquifers and not be directly measurable at the next downstream gage. Although these flows may once again become surficial further downstream, areas that function in this manner need to be identified in order to evaluate streamflow variability at ungaged locations. Additionally, these areas do not have definite boundaries, as some areas identified as "upland" or "lowland" were considered only partially effective. For example, a large portion of Hoh River ineffective areas are located in the South Fork Hoh River watershed along the flat valley bottom called "Big Flat." This area stretches between RM 3 and RM 11. Thus, this large area is separated into relative effective and ineffective portions for inclusion in Table 2.

Streamflow Evaluations of the Hoh River

Streamflow information was compiled from three USGS gaging station records within the Hoh River watershed in order to evaluate streamflow at several locations. From upstream to downstream, these gages are:

- USGS Station Number 12040900 South Fork Hoh River near Forks, WA
- USGS Station Number 12041000 Hoh River near Forks, WA
- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA

The most downstream gage at U.S. Highway 101 (gage 12041200) has a complete period of record during the relevant flow history from October 1961 to September 1999. Regression techniques were used to extend the other gags records based on the complete flow history recorded at Highway 101.

Streamflow was evaluated at several locations within the Hoh River watershed. These sites are indicated in Figure 6 below. Gage markers indicate locations

where USGS gaged data was available. Ungaged locations where streamflow was evaluated are designated by a black triangle.

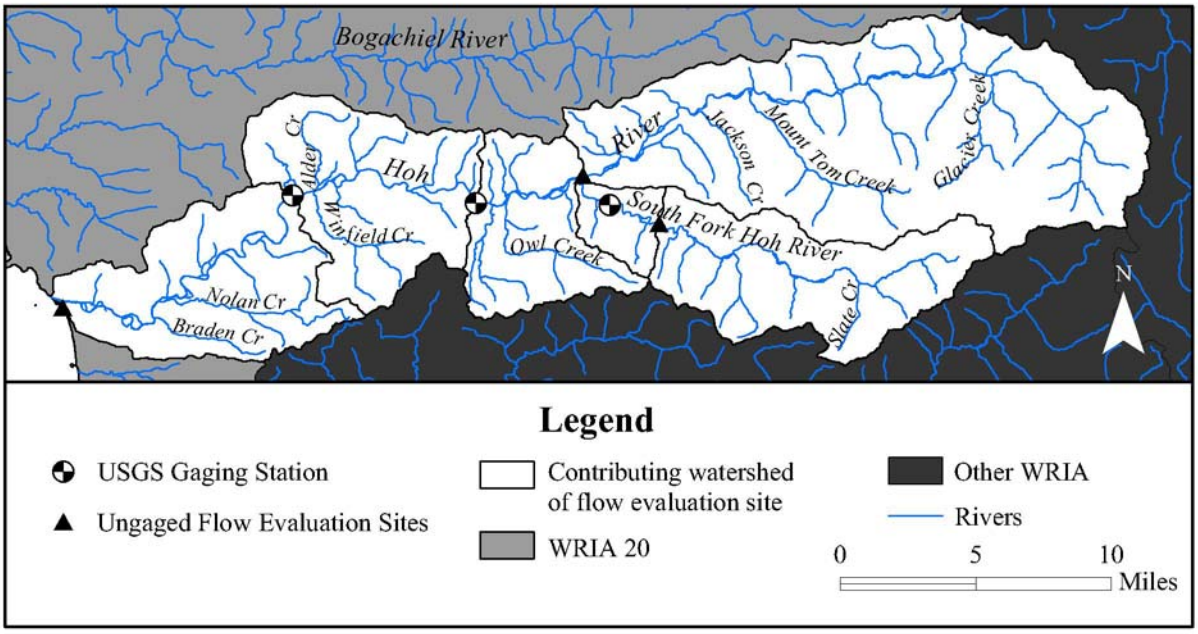

Figure 6. Flow evaluation sites and contributing watersheds within the Hoh River watershed.

Natural streamflow estimates used in this assessment were computed using the watershed characteristics method. Watershed characteristic information was required for each contributing subwatershed in order to evaluate streamflow at ungaged locations. Each subwatershed illustrated in Figure 6 is separated into watershed characteristic types in Table 3 below. To fully characterize the streamflow at a specific location, all upstream areas should be summed together. For example, the column entitled "Hoh River at Outlet" in Table 3 only describes the characteristics of the subwatersheds below Highway 101 and upstream of the outlet. This separation was necessary for developing streamflow estimates by the watershed characteristics method, but to accurately depict the entire Hoh River watershed above the outlet, all of the columns should be added together. This type of summary table for the entire watershed was presented in Table 2. The corresponding average annual precipitation numbers for each subwatershed that were used with the watershed characteristics method of gage transference are presented in Table 4.

Table 3. Watershed characteristics within each portion of the Hoh River watershed.

Watershed Characteristic Types	South Fork Hoh River at outlet of Rainforest WAU	South Fork Hoh River at outlet	Hoh River above South Fork Hoh River	Hoh River at USGS gage # 12041000 - Hoh River nr Forks	Hoh River at USGS gage # 12041200 - Hoh River at Hwy 101	Hoh River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	32.2	-	92.1	-	-	-
Upland	9.56	5.77	28.0	19.5	12.9	2.6
Upland-*ineffective*	3.73	-	-	-	-	-
Lowland	-	1.81	2.3	6.34	25.8	36.4
Lowland-*ineffective*	-	0.59	3.0	2.35	6.95	6.29
Entire area	45.5	8.16	125.5	28.2	45.6	45.3

Table 4. Average Annual Precipitation for each portion of the Hoh River watershed.

Watershed Characteristic Types	South Fork Hoh River at River Mile 3.6	South Fork Hoh River at outlet	Hoh River above South Fork Hoh River	Hoh River at USGS gage # 12041000 - Hoh River nr Forks	Hoh River at USGS gage # 12041200 - Hoh River at Hwy 101	Hoh River at Outlet
	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)	Average Annual Precip (in)
Highland	199.5	-	180.6	-	-	-
Upland	175.1	148.6	150.2	139.6	130.7	118.4
Upland-*ineffective*	175.1	-	-	-	-	-
Lowland	-	140.8	140.2	133.0	124.5	111.0
Lowland-*ineffective*	-	140.0	146.9	134.1	124.2	110.1
Entire area	192.4	153.5	172.3	137.6	126.2	111.3

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is presented in approximate average monthly flow in cubic feet per second (cfs) and is summarized in corresponding tables. These values are estimated from how frequent a monthly total flow occurred in the period between October 1960 and September 1999. Although most other WRIA 20 streamflow evaluations were only completed back to October 1961, sufficient streamflow data was available from the Hoh river gages to develop streamflow estimates back to October 1960.

South Fork Hoh River at River Mile 3.6 (the outlet of Rainforest WAU) –

Streamflow in the South Fork Hoh River was measured at USGS gage # 12040900 for 5 years between July 1985 and October 1989. These data were collected at RM 1.5 and were extended using regression techniques against the USGS gage on the Hoh River at Highway 101. Streamflow at RM 3.6 was estimated using the watershed characteristics method and the period of record extended between October 1960 and September 1999 (water years 1961 to 1999). This estimated streamflow record is presented in Appendix 3.

Streamflow in the South Fork Hoh River shows a bi-modal distribution, with monthly average streamflow peaking typically in the month of November and again in June due to snowmelt runoff. During the late summer and early fall, flow in the South Fork Hoh River recedes to minimum or base flow. This minimum flow season extends into September. The months between November and February exhibit the greatest indicated variation in streamflow.

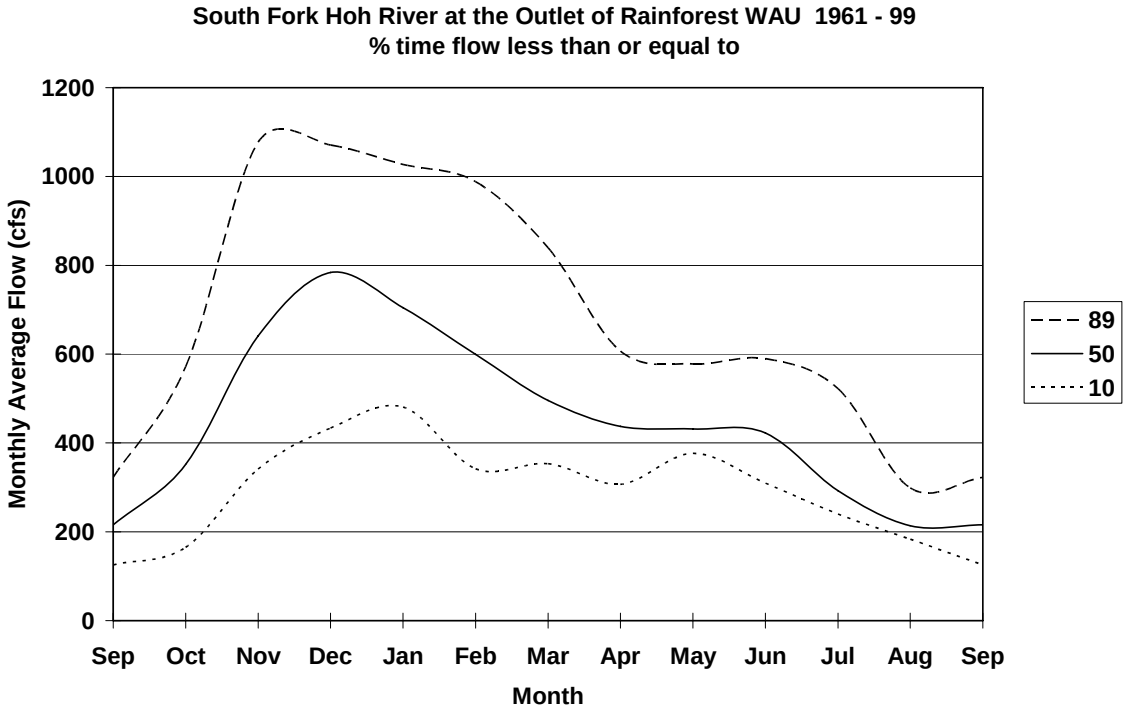

Table 5. Percent of time that average monthly streamflow (cfs) would be less than or equal to the value for each month in the South Fork Hoh River at RM 3.6.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	571	1077	1071	1027	988	839	607	578	590	522	299	323
50	352	641	784	705	600	496	437	431	423	293	214	216
10	165	341	433	481	342	354	307	377	309	240	183	125

South Fork Hoh River at the Outlet –

The gaged streamflow data collected by the USGS on the South Fork Hoh River was again used to evaluate streamflow at the outlet through the watershed characteristics method. This estimated streamflow record was generated between October 1960 and September 1999 and is included in Appendix 3.

Streamflow at the outlet of the South Fork Hoh River exhibits similar characteristics to the flow described at RM 3.6. The primary differences between these sites are an increase in overall flow, even at low flow times, and greater variability in the winter months. This additional variability is expected, since the additional 8.2 square-miles area contributing to streamflow between RM 3.6 and the outlet are characterized as upland and lowland subwatershed areas, where the snowpack is not sustained for a long period of time.

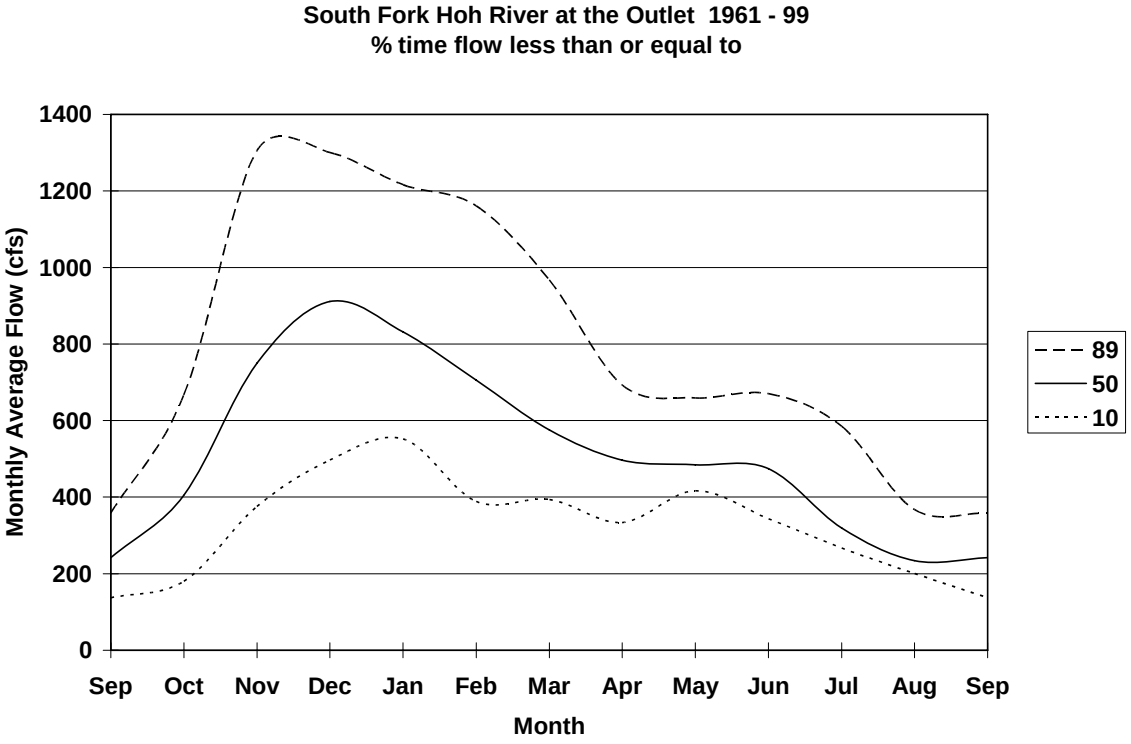

Table 6. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the outlet of the South Fork Hoh River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	667	1305	1300	1216	1161	967	693	659	670	585	367	358
50	406	750	911	832	706	575	497	485	474	319	234	242
10	180	376	496	552	388	394	334	417	343	267	200	137

Hoh River above the South Fork Hoh River confluence –

Streamflow of the Hoh River above the South Fork confluence was generated using the watershed characteristics method. The extended flow history for USGS gaging station number 12041000, Hoh River near Forks, accounted for the flow in both the South Fork and mainstem branches of the Hoh River. The Hoh River above the South Fork confluence was generated by subtracting out all other water contributing to this gage. Thus, streamflow generated by the mainstem Hoh River between the South Fork confluence and the gage was estimated using the watershed characteristics method and subtracted from the Hoh River gage number 12041000, along with streamflow estimated at the outlet of the South Fork Hoh River. This estimated record was also generated between October 1960 and September 1999 and can be found in Appendix 3. The months between November and February exhibit the greatest indicated variation in streamflow. During the late summer and into the fall, flow in the Hoh River recedes to minimum flow. This minimum flow season is indicated to extend into September.

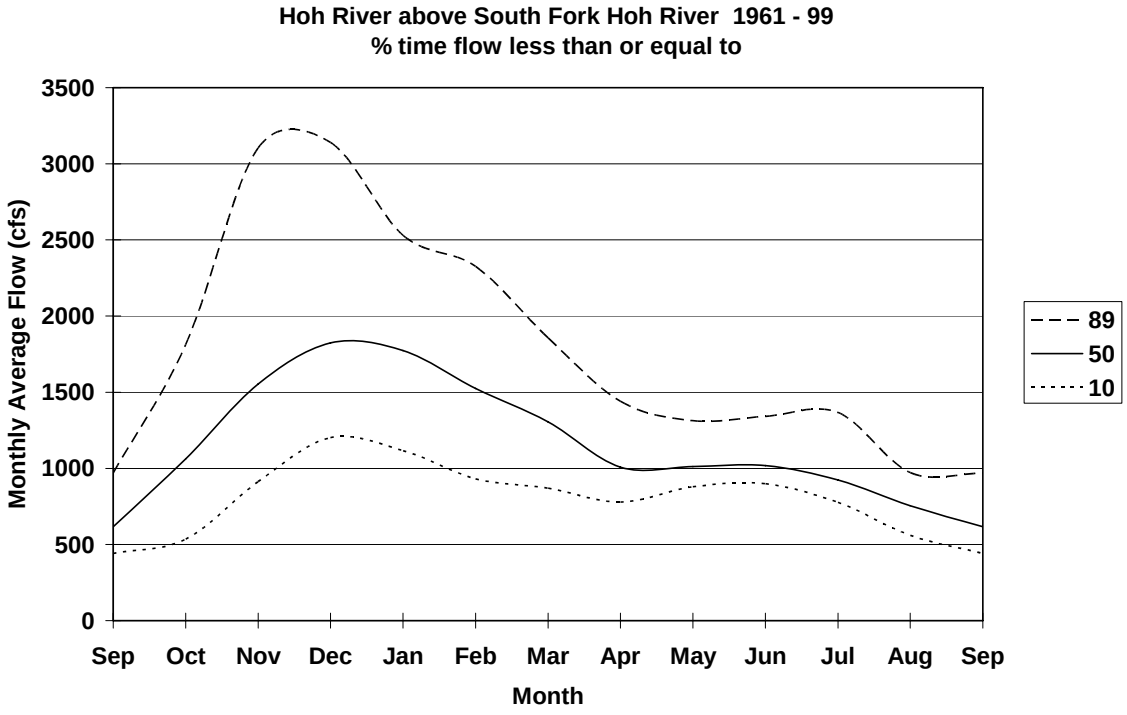

Table 7. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River above the outlet of the South Fork Hoh River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1812	3105	3140	2530	2326	1858	1440	1313	1342	1366	972	969
50	1063	1555	1824	1775	1525	1305	1008	1012	1019	924	755	616
10	535	913	1202	1116	932	870	778	878	899	775	560	441

Hoh River near Forks (at USGS Gage 12041000) –

Streamflow information was collected at RM 25.6 of the Hoh River by the USGS between August 1926 and September 1964. This gaged streamflow record was extended using regression techniques against the streamflow record from USGS gage 12041200, Hoh River at Highway 101. Several regression equations were used to estimate streamflow more accurately at high, medium, or low flow periods. This estimated record was also generated between October 1960 and September 1999 and can be found in Appendix 3.

Streamflow in the Hoh River is characterized by a bi-modal distribution, with monthly average streamflow peaking typically in the late fall or winter and again in the spring due to snowmelt runoff. The months between November and February exhibit the greatest indicated variation in streamflow. Streamflow in the Hoh River recedes to minimum flow during the late summer and into the fall. This minimum flow season is indicated to extend into September.

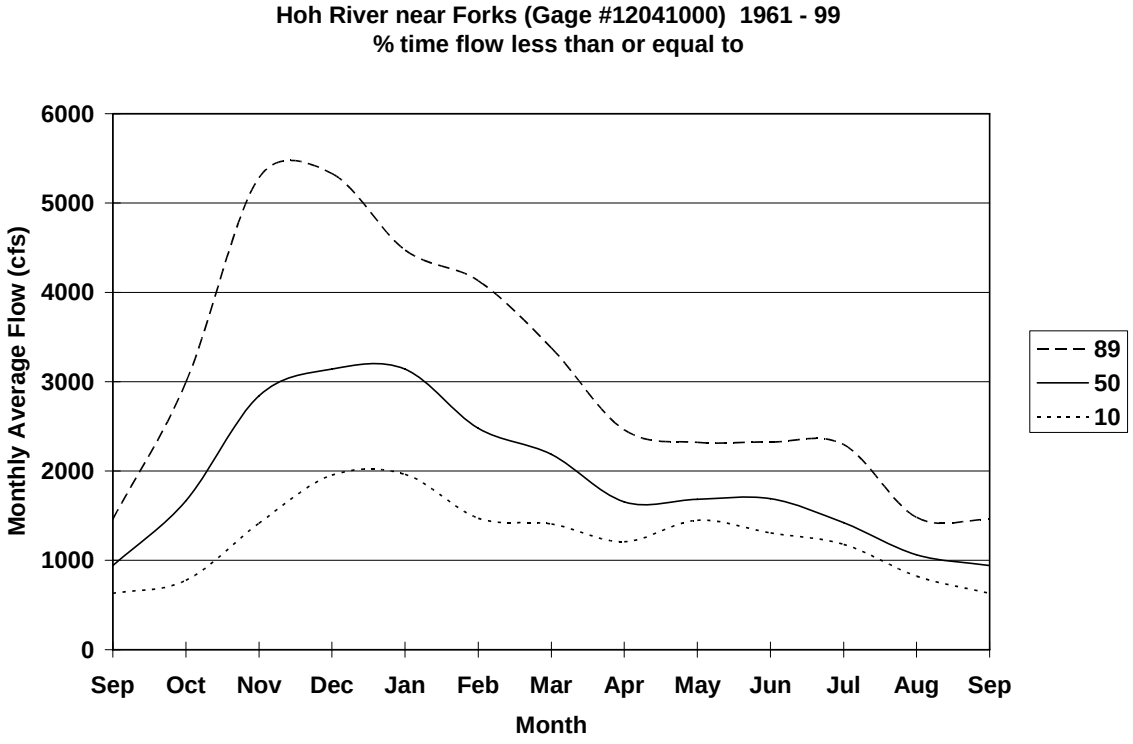

Table 8. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River near Forks.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	2990	5282	5329	4473	4130	3379	2460	2320	2324	2296	1480	1458
50	1668	2840	3139	3140	2479	2186	1654	1684	1691	1420	1063	940
10	773	1415	1954	1961	1471	1407	1209	1448	1306	1179	822	631

Hoh River at U.S. Highway 101 (at USGS Gage 12041200) –

As stated previously, a complete period of record was available for the Hoh River at the Highway 101 bridge. The USGS gaging station at this location began operation in October 1960 and is still in operation today. The data used to evaluate streamflow variability at this location were derived from these gaged data. The streamflow evaluation was limited to data recorded between October 1960 and September 1999, which can be found in Appendix 3.

Streamflow in the Hoh River at the Highway 101 bridge illustrates highly similar characteristics to the USGS gaged location at RM 25.6. The only changes exhibited at this location were an increase in streamflow totals and greater variability, especially in the winter. Again, the months between November and February exhibit the greatest indicated variation in streamflow. Hoh River streamflow recedes to minimum flow during the late summer and into the fall. This minimum flow season is observed to extend into September.

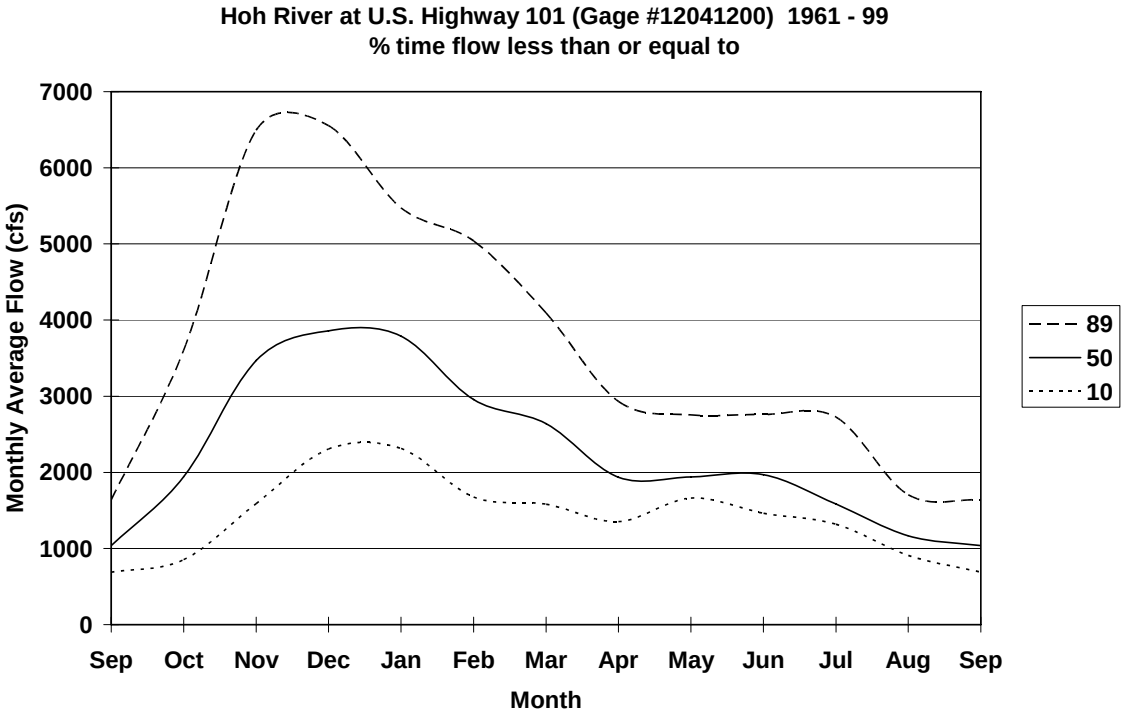

Table 9. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River at U.S. Hwy 101.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	3601	6493	6553	5472	5039	4092	2932	2755	2761	2725	1703	1639
50	1942	3470	3860	3790	2957	2641	1935	1940	1970	1585	1167	1038
10	852	1589	2304	2314	1675	1580	1352	1662	1464	1318	907	688

Hoh River at the Outlet –

Streamflow of the Hoh River at the outlet into the Pacific Ocean was estimated using the watershed characteristics method. Since a complete period of record was available at the USGS gage 12041200, Hoh River at U.S. Highway 101, only the additional streamflow below Highway 101 needed to be estimated using the differences between the Highway 101 and the Forks gage (USGS gage 12041000). The streamflow gains between those two gages were rescaled based on the watershed characteristics method to estimate the streamflow generated by remaining contributing area below Highway 101 and added to recorded streamflow at Highway 101 to represent expected monthly total streamflow at the outlet into the Pacific Ocean. Unlike other WRIA 20 rivers, incidental streamflow measurements of the Hoh River at or near the outlet were not available for use in calibrating these estimates. The only changes exhibited at this location from the Highway 101 location are an increase in streamflow totals and greater variability, especially in the winter months when the intermediary lands contribute directly to streamflow.

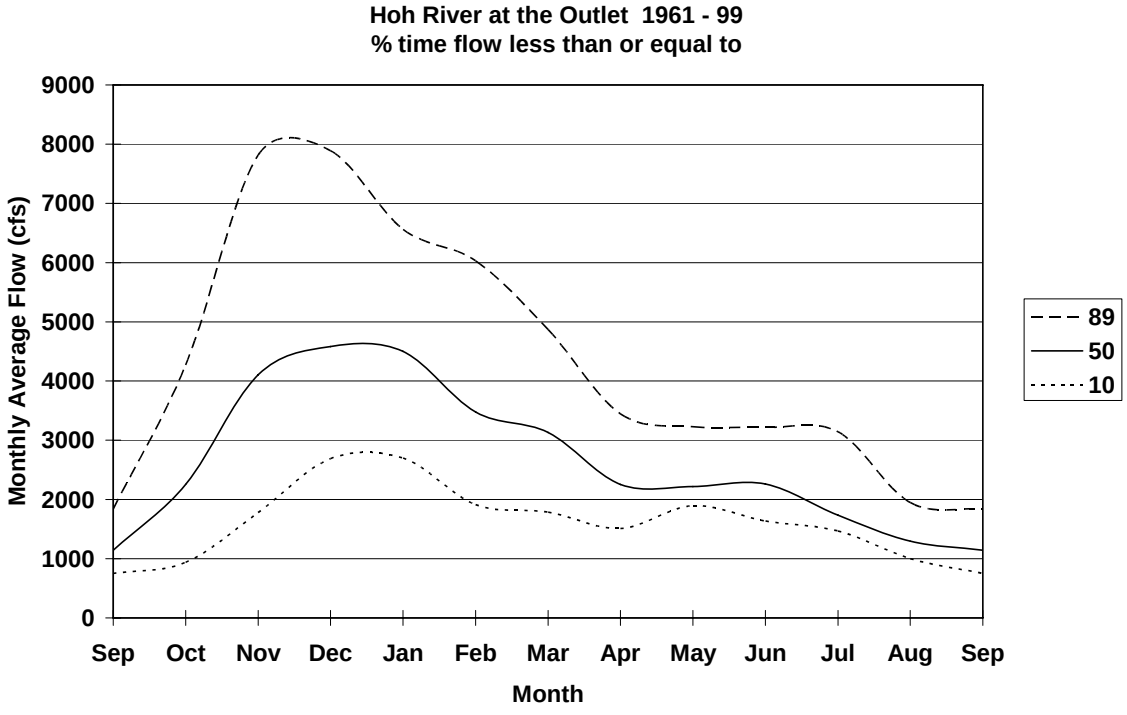

Table 10. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	4268	7813	7886	6561	6030	4869	3447	3230	3220	3141	1947	1836
50	2257	4107	4584	4499	3477	3133	2254	2219	2260	1732	1295	1146
10	937	1779	2687	2698	1911	1784	1509	1896	1636	1469	1001	750

Quillayute River watershed

The Quillayute River is a major stream drainage on the western edge of the Olympic Mountains that drains into the Pacific Ocean. The location of the Quillayute River watershed is illustrated in Figure 7. As illustrated, the Hoh River watershed lies adjacent to the south, while the northern edge is bounded by watersheds in WRIA 19 that flow north into the Strait of Juan De Fuca.

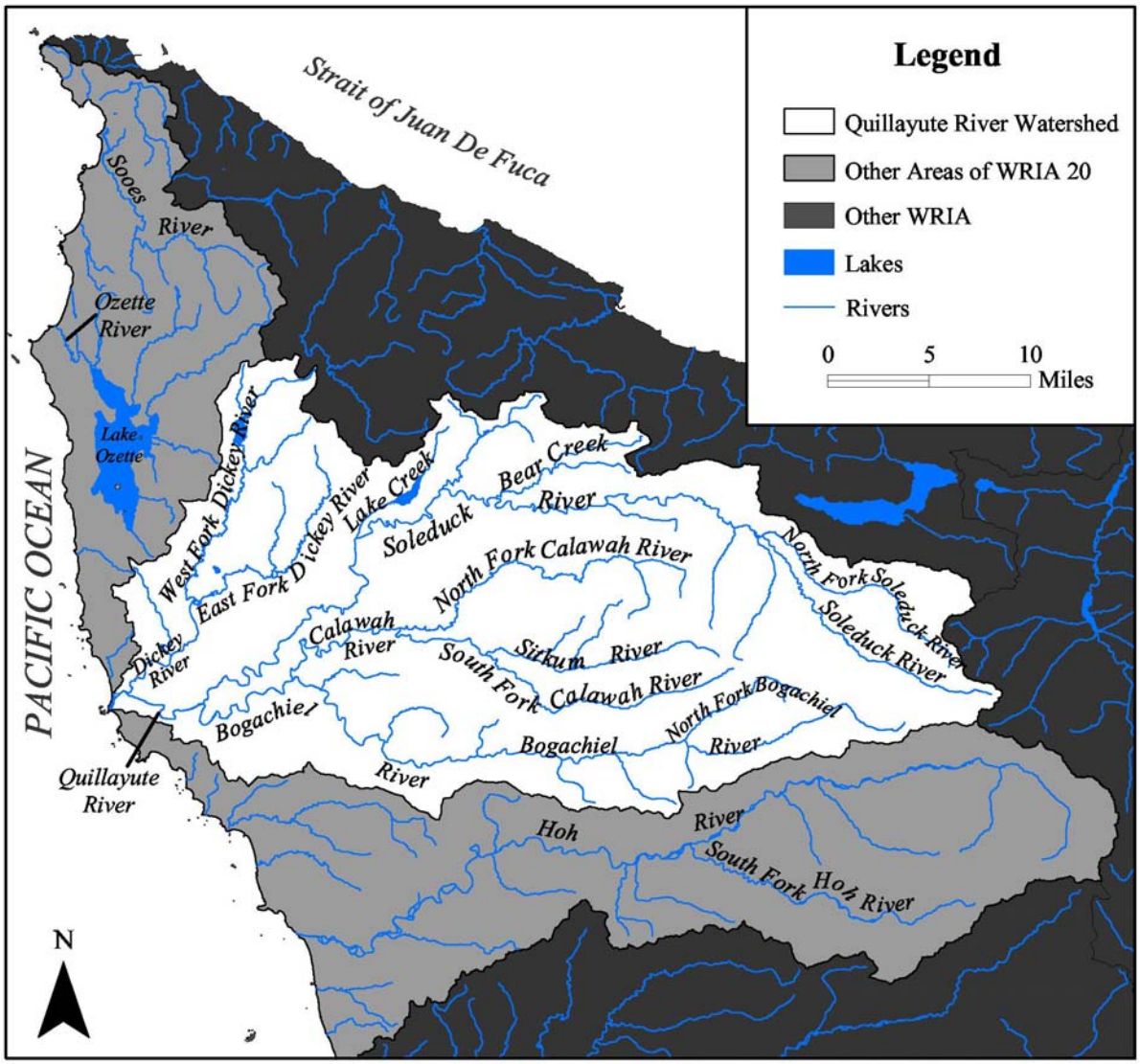

Figure 7. Location of Quillayute River watershed within WRIA 20.

Several tributaries contribute to the flow of the Quillayute River. Two major drainages, the Soleduck and Bogachiel Rivers, join to create the most upstream portion of the Quillayute River about 6.5 miles upstream of the coast. The last large drainage to join the Quillayute at 1 mile upstream of the outlet is the Dickey River.

Natural streamflow records were developed at each major confluence illustrated in Figure 8 below. Specifically, streamflow frequency distributions were developed for major tributaries within the Dickey River, Soleduck River, Calawah River, and Bogachiel River watersheds. Each of these watersheds will be discussed separately herein, and the specific locations where streamflow was evaluated are described in regards to each major subwatershed. Streamflow estimates for the Quillayute River will then be described to complete the entire Quillayute River watershed.

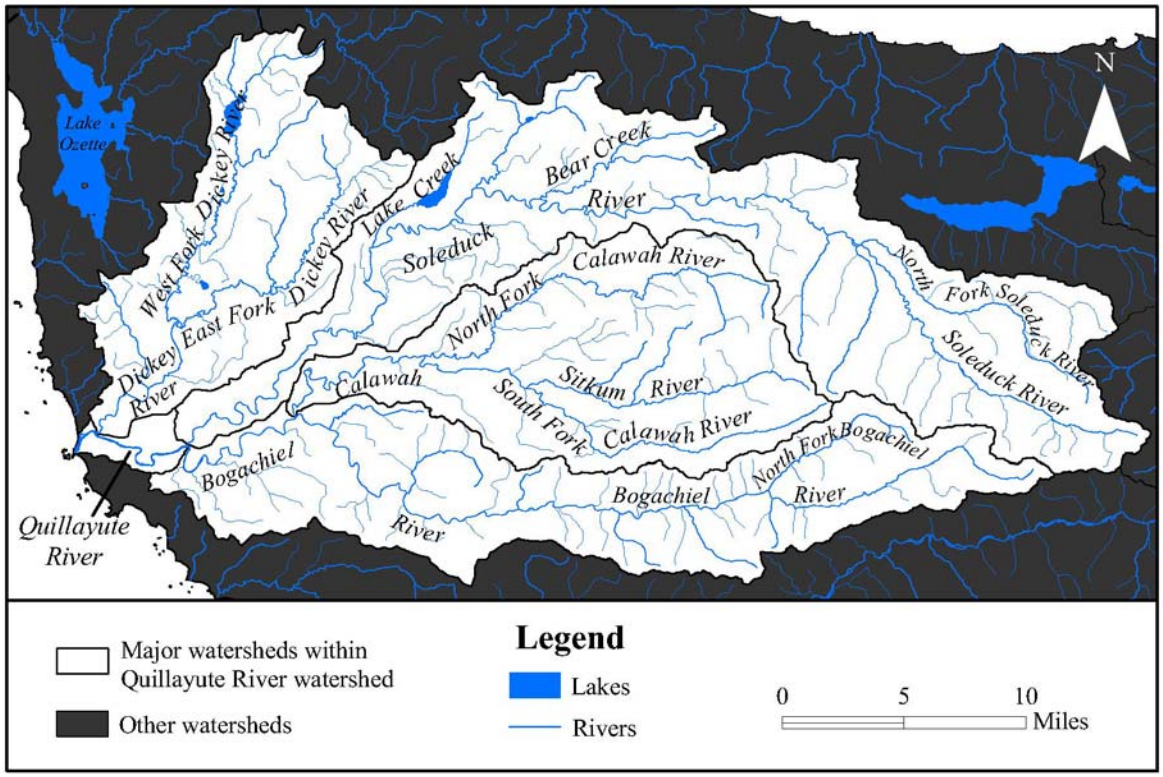

Figure 8. Major watersheds within the Quillayute River watershed.

Bogachiel River watershed –

The Bogachiel River watershed composes over 24 percent of the Quillayute River watershed, covering approximately 152.6 square-miles in drainage area. The confluence of the Soleduck River and the Bogachiel River marks the beginning of the Quillayute River, which is only about 6.5 miles upstream for the coast. Precipitation varies between 150 inches annually on the southern rim about 1.5 miles west of Green Peak down to 82 inches annually at the western most watershed edge. Elevation extends up to 5474 feet above sea level on Bogachiel Peak and drops to about 30 feet at the confluence with the Soleduck River.

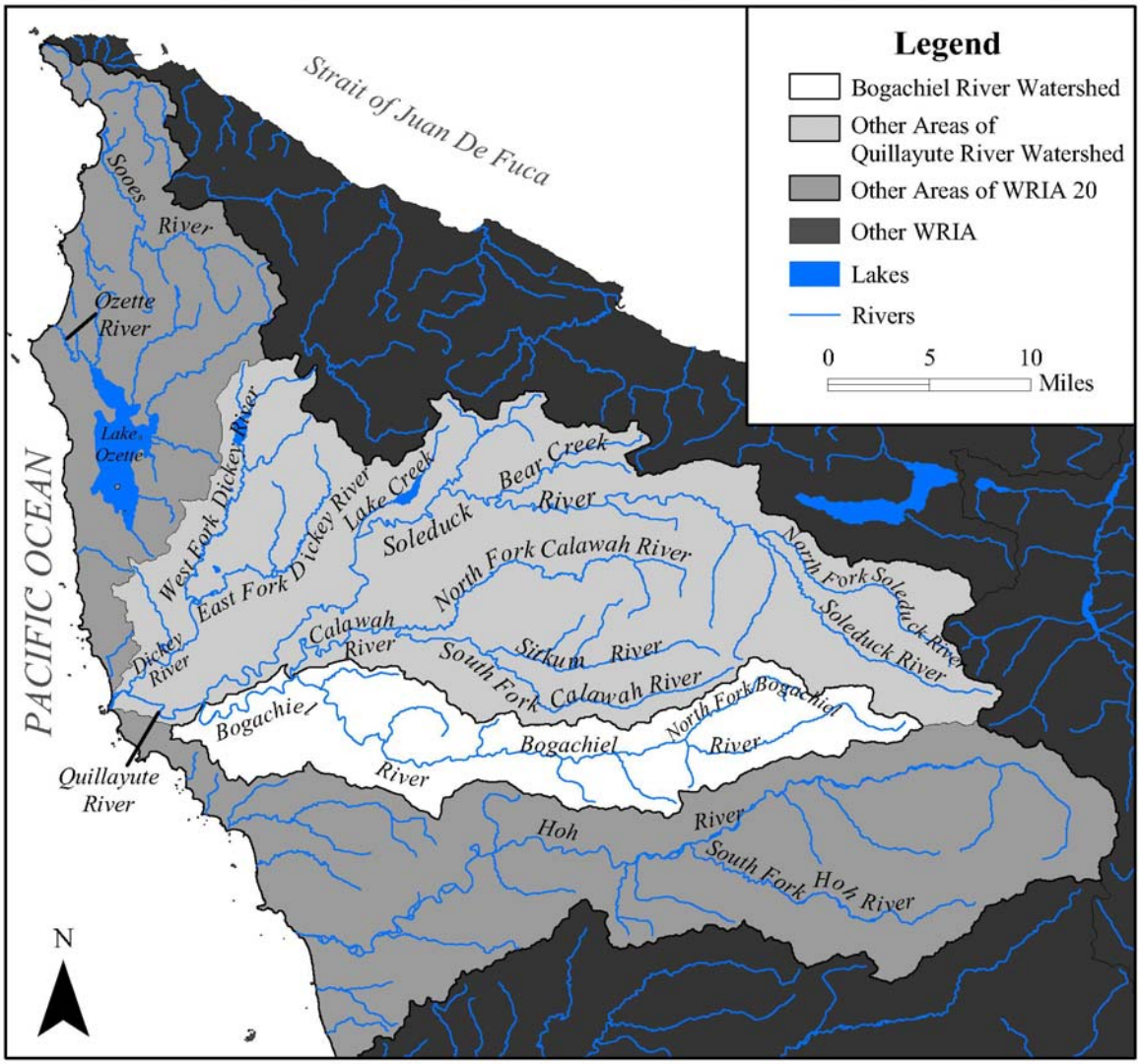

Figure 9. Location of Bogachiel River watershed within WRIA 20.

The Bogachiel River watershed includes a portion of the Olympic National Park, as illustrated in Figure 10 below. The Bogachiel River watershed also contains significant areas of state administered and privately owned lands. A summary of these totals can be found in Table 11.

Table 11. Land Administration within the Bogachiel River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	81.7	53.5
Late-successional Reserves (USFS)	9.0	5.9
State of Washington	29.2	19.1
Privately owned	32.7	21.5
Total Area	152.6	100

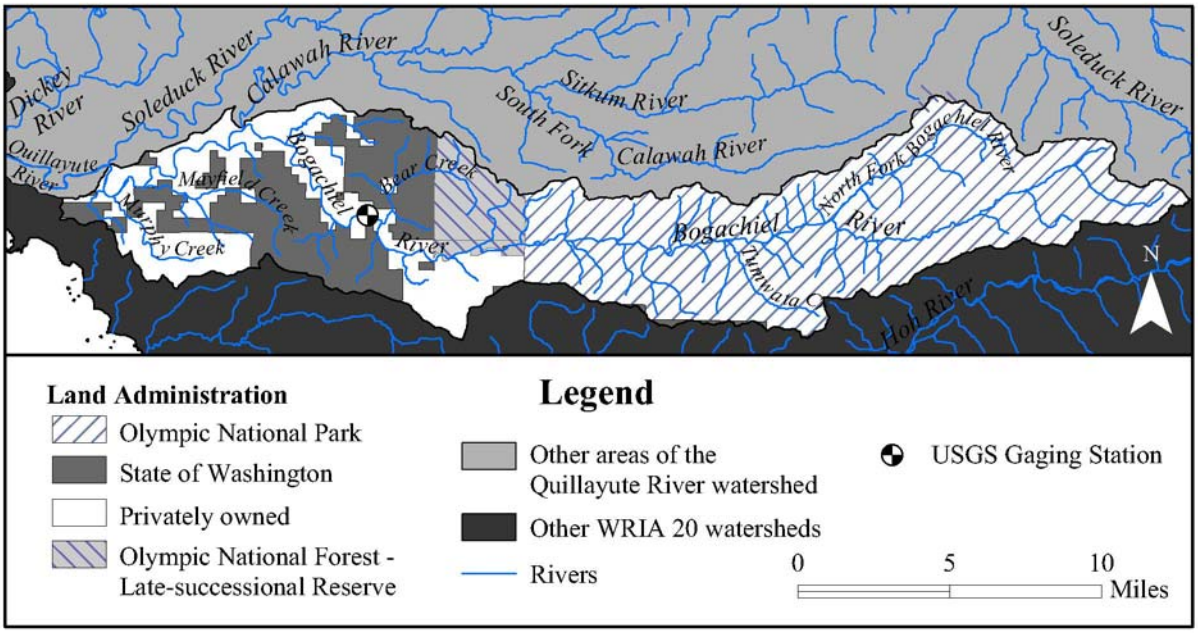

Figure 10. Land Administration within the Bogachiel River watershed.

The majority of area above the USGS gaging station 12042800 likely represents old-growth conditions, since 82 percent of the upstream area is either part of the Olympic National Park or is managed as LSR by the USDA Forest Service through the Northwest Forest Plan. In fact, the majority of the LSR in the Bogachiel River watershed was included in a Forest Service analysis of timber age class, and the resultant GIS coverage provided the information provided in Table 12 (ONF, 2000). This information identifies that about 89 percent of the Late-successional Reserve area characterized (85 percent of LSR area in Bogachiel River watershed) yields timber that are over 80 years old. As such, the

Bogachiel gage was considered to represent undepleted or natural streamflow conditions.

Table 12. Age class descriptions of part of the timber located in the Late-successional Reserve area within the Bogachiel River watershed.

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	0.85	11.2
21 - 40 years	0.01	0.1
81 - 160 years	3.04	39.9
over 160 years	3.72	48.8
Total Area	7.63	100

The Bogachiel River watershed is dominated by upland and lowland areas, which contribute more directly to streamflow in the winter months. The headwater area is characterized by highland subwatershed, where snowmelt contributes a large portion of streamflow in the spring runoff months, as well as during the winter precipitation maximum. The areas of each watershed characteristic type are illustrated in Figure 11 below, and a summary of these areas can be found in Table 13.

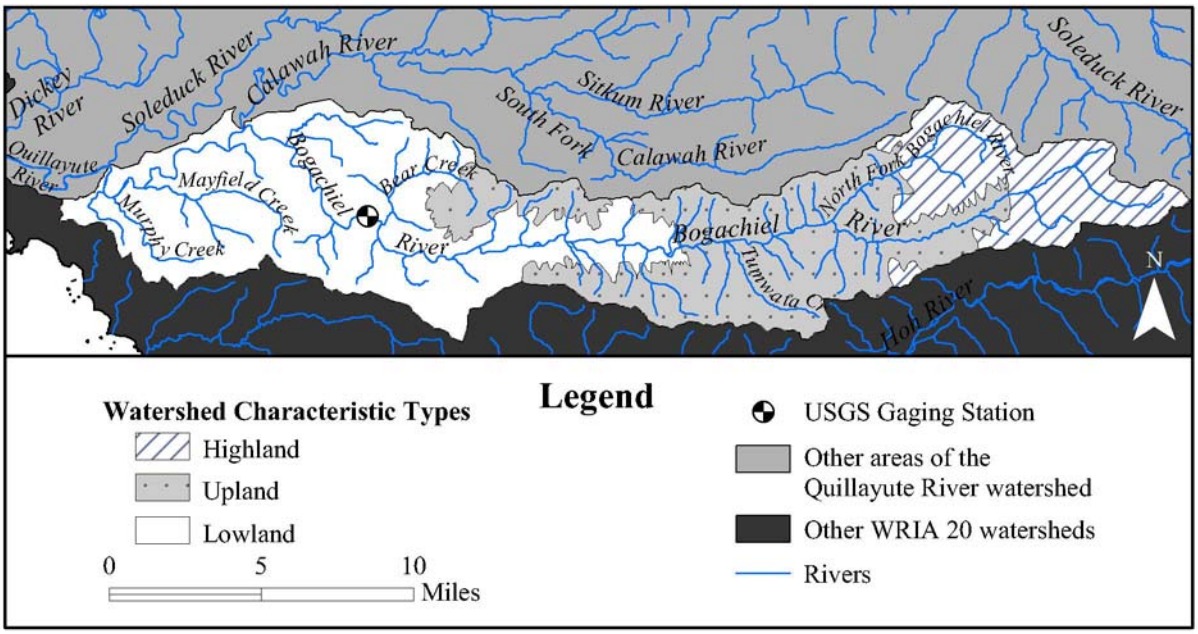

Figure 11. Watershed characteristics of areas within the Bogachiel River watershed.

Table 13. Watershed characteristics of the Bogachiel River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	26.2	17.2
Upland	52.0	34.1
Lowland	61.3	40.2
Lowland, *but ineffective*	13.1	8.6
Total Area	152.6	100

Streamflow Evaluations of the Bogachiel River

The primary source of Bogachiel River streamflow information was from the USGS gaging station 12042800, Bogachiel River near Forks, WA. This gage collected streamflow information between April 1975 and September 1980. An extended streamflow record was created for this gage using regression techniques against two nearby streamflow gages that had overlapping periods of record with the Bogachiel River gage. These gages are:

- USGS Station Number 12043000 Calawah River near Forks, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

Regressions against these gages were completed using all monthly total values in the same regression equation, whereas regression equations based on each month were developed for gages that had a greater number of months that overlapped with a nearby gage. Although these gages exhibited excellent similarities to the Bogachiel River gage (R^2 values of 0.984 and 0.969 respectively), streamflow information was not collected at any of these gages for several months in the desired period of record between October 1961 and September 1999. For these remaining 33 months, which represents approximately 7 percent of the entire period of record, monthly total streamflow was estimated for the Bogachiel River gage from an extended period of record developed for USGS gaging station 12043300, Hoko River near Sekiu, WA. This Hoko River gage was extended using local precipitation data from stations in Sappho, Clallam Bay, Forks, and Neah Bay.

Streamflow was estimated for several ungaged locations in the Bogachiel River watershed. All of these sites were located downstream of the Olympic National Park and are illustrated in Figure 12.

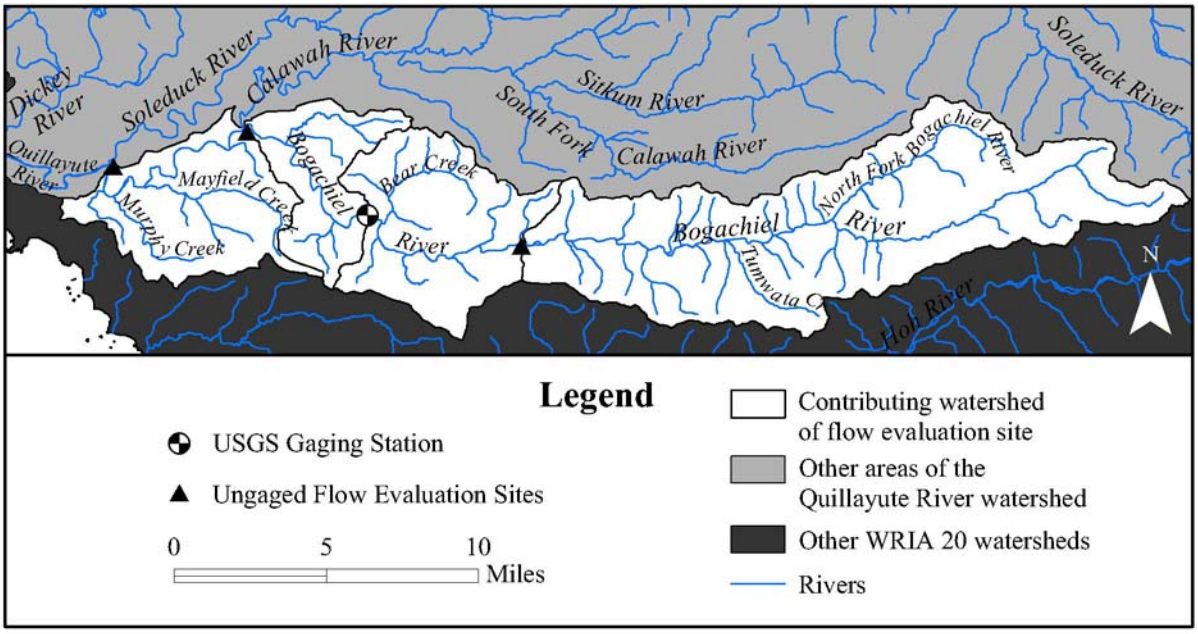

Figure 12. Flow evaluation sites within the Bogachiel River watershed.

Streamflow was estimated at the ungaged sites by the watershed characteristics method. As such, watershed characteristic information was needed for each contributing watershed. A summary of the areas within each watershed characteristic type designated by contributing watershed, as described in Table 14. Also, the average annual precipitation values used to weight streamflow in the watershed characteristics method are summarized in Table 15.

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table for each evaluation site. These values are estimated from how frequent a monthly total flow occurred in the period between October 1961 and September 1999.

Table 14. Watershed characteristics within each portion of the Bogachiel River watershed.

Watershed Characteristic Types	Bogachiel River at exit of Upper Bogachiel WAU	Bogachiel River at USGS gage# 12042800 - Bogachiel River nr Forks, WA	Bogachiel River above the Calawah River confluence	Bogachiel River at outlet at Soleduck River confluence
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	26.2	-	-	-
Upland	46.5	5.56	-	-
Lowland	4.99	23.7	11.9	20.7
Lowland-*ineffective*	3.33	0.46	4.30	4.97
Entire area	81.0	29.7	16.2	25.7

Table 15. Average annual precipitation of each portion of the Bogachiel River watershed.

Watershed Characteristic Types	Bogachiel River at exit of Upper Bogachiel WAU	Bogachiel River at USGS gage # 12042800 - Bogachiel River nr Forks, WA	Bogachiel River above the Calawah River confluence	Bogachiel River at outlet at Soleduck River confluence
	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)
Highland	130.2	-	-	-
Upland	131.3	123.4	-	-
Lowland	128.4	120.5	112.2	97.0
Lowland-*ineffective*	128.4	115.6	108.6	92.7
Entire area	130.6	120.9	111.3	96.1

Bogachiel River at River Mile 22.0 (outlet of Upper Bogachiel WAU) –

The most upstream flow evaluation site was chosen based on the most downstream end of the Washington Department of Transportation's Watershed Administrative Unit (WAU) called the Upper Bogachiel WAU, which is located at RM 22.0. The watershed characteristics method was used to estimate streamflow at this location based on the extended streamflow record created for the USGS gaging station 12042800, Bogachiel River near Forks. The monthly time series for this location can be found in Appendix 3.

Streamflow in the Bogachiel River exhibits the greatest indicated variation in streamflow between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

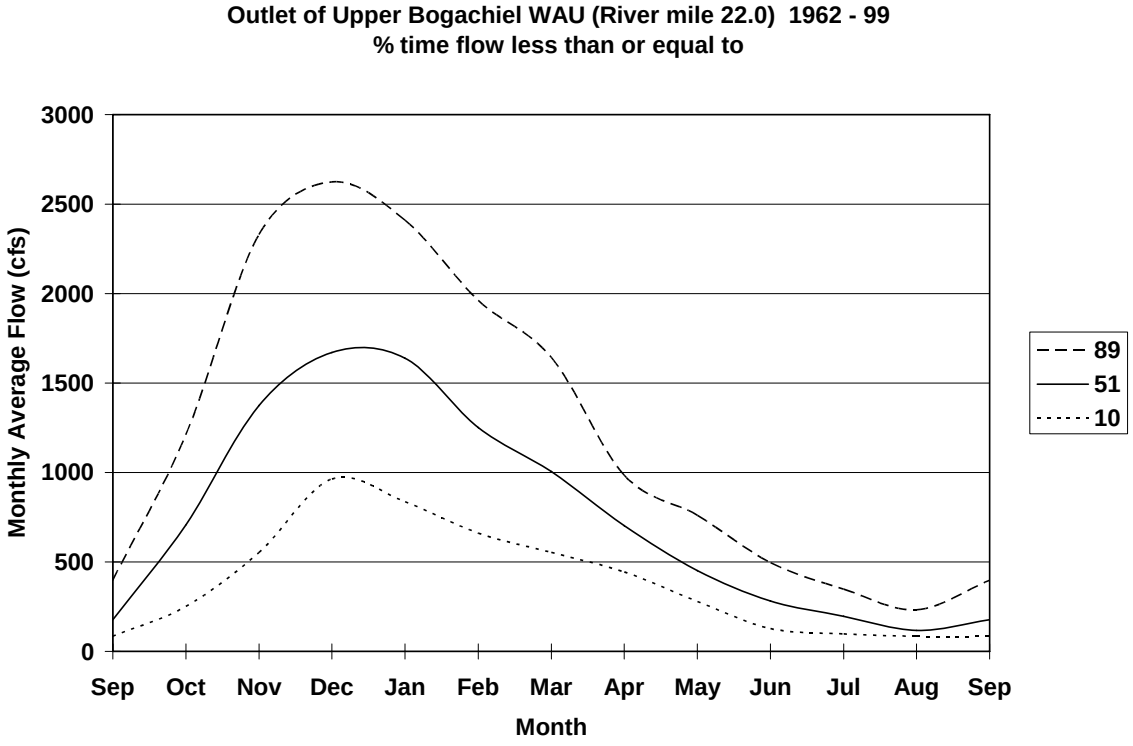

Table 16. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month in the Bogachiel River at River Mile 22.0

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1211	2329	2624	2409	1962	1644	984	761	496	348	233	398
51	708	1375	1670	1638	1252	1005	704	452	282	196	118	177
10	252	553	963	836	661	554	445	279	128	98	84	85

Bogachiel River near Forks (at USGS Gage 12042800) –

As described earlier, an extended period of record was generated for the Bogachiel River at USGS gage 12042800, located where U.S. Highway 101 crosses the Bogachiel River. This extended record was generated using regression techniques against other nearby streamflow gages. See the beginning of "Streamflow Evaluations for the Bogachiel River" for more information. The extended period of record can be found in Appendix 3.

The following graph illustrates the percentage of time that average monthly flow in Bogachiel River at the specified location was less than or equal to an indicated level of flow. Streamflow in the Bogachiel River exhibits the greatest indicated variation in streamflow between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

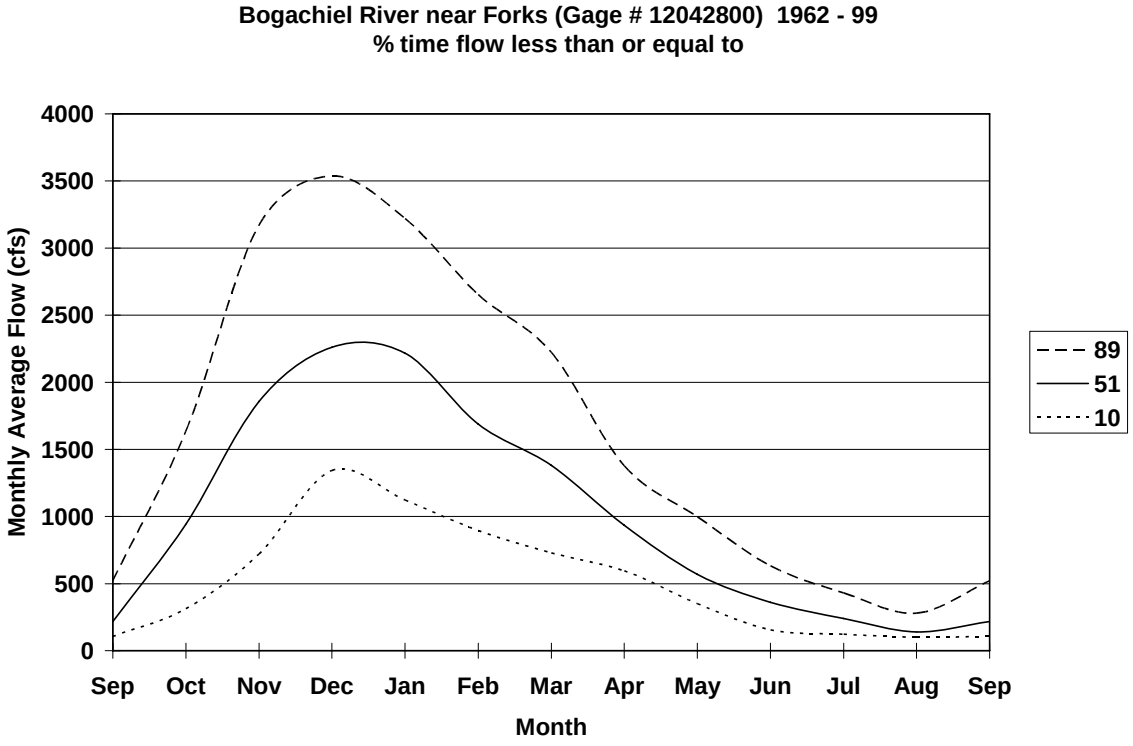

Table 17. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River near Forks.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1633	3170	3537	3220	2654	2224	1378	997	631	431	281	520
51	945	1857	2261	2217	1689	1381	936	569	361	240	140	218
10	313	721	1342	1122	896	730	595	350	155	123	100	106

Bogachiel River above the Calawah River confluence –

The Calawah River outflows into the Bogachiel River at RM 8.2. Streamflow was estimated for the Bogachiel River above this confluence through applying the watershed characteristics method to streamflow information from USGS gage 12042800, and low flow months were calibrated using streamflow measurements collected by the Streamkeepers of Clallam County in the summer and fall of 2002. The extended period of record can be found in Appendix 3.

The greatest variation in streamflow of the Bogachiel River is exhibited between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

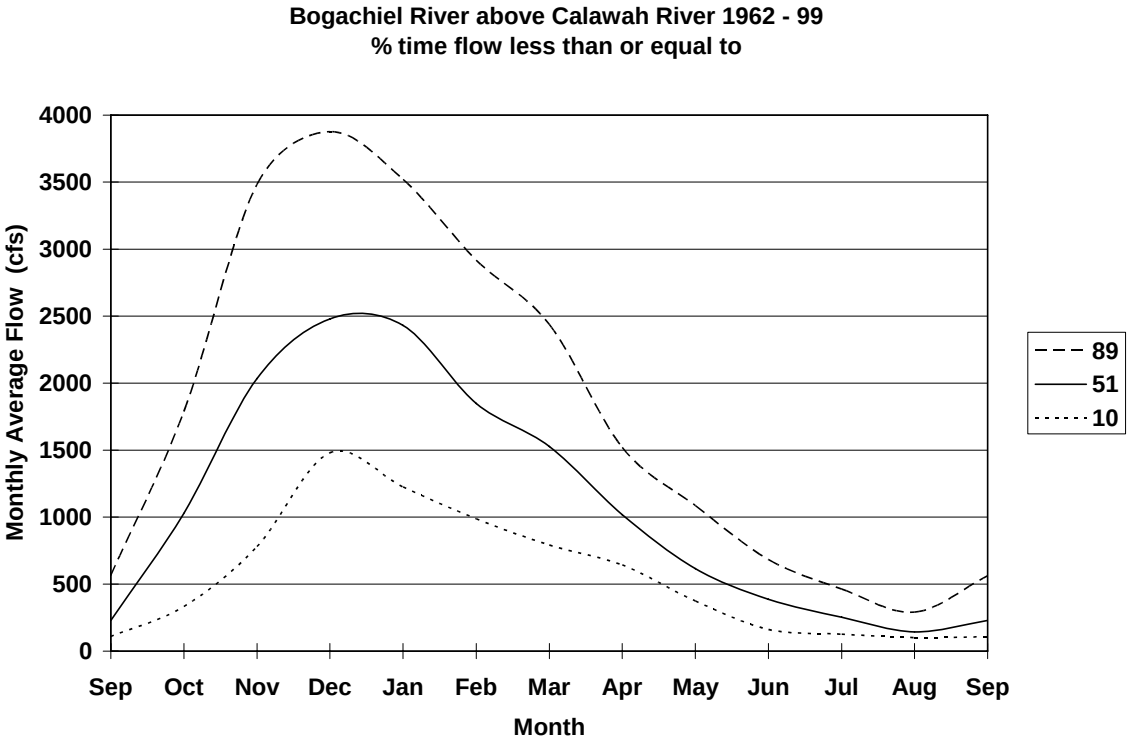

Table 18. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River above the Calawah River confluence.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1788	3482	3877	3521	2917	2438	1520	1086	683	462	291	562
51	1029	2035	2480	2430	1849	1527	1018	615	387	252	143	229
10	331	779	1481	1225	986	791	642	372	161	127	101	108

Bogachiel River at the Outlet –

The outlet of the Bogachiel River marks the beginning of the Quillayute River when combined with the Soleduck River, since the confluence of the Bogachiel and Soleduck Rivers marks the upstream extent of the Quillayute River. Streamflow was estimated for the Bogachiel River at the outlet through applying the watershed characteristics method to streamflow information from USGS gage 12042800, and low flow months were calibrated using streamflow measurements collected by the Streamkeepers of Clallam County in the summer and fall of 2002. The extended period of record can be found in Appendix 3.

The greatest variation in streamflow of the Bogachiel River is exhibited between the months of November and February. During the late summer and into the fall, flow in the Bogachiel River recedes to minimum flow. This minimum flow season is indicated to extend into September.

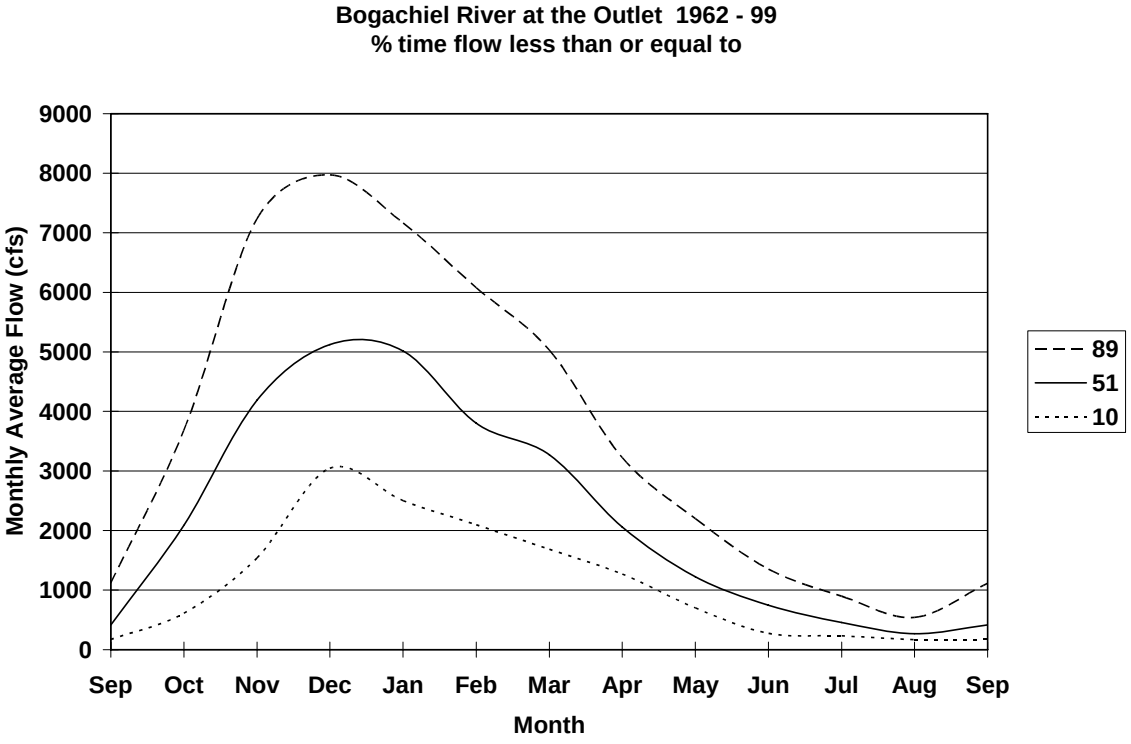

Table 19. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the Bogachiel River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	3678	7234	7972	7165	6079	5031	3225	2200	1351	896	541	1112
51	2090	4192	5122	5017	3804	3273	2057	1224	747	455	266	413
10	611	1537	3045	2503	2098	1684	1266	697	274	233	168	172

Calawah River watershed –

The Calawah River is a large tributary to the Bogachiel River, with the outlet located just downstream of Forks near Bogachiel river mile 8. The Soleduck River watershed confines the Calawah watershed on the north, east, and west, and the Bogachiel River watershed lies adjacent to the south. Figure 13 illustrates the location of the Calawah River watershed within WRIA 20 and the Quillayute River watershed.

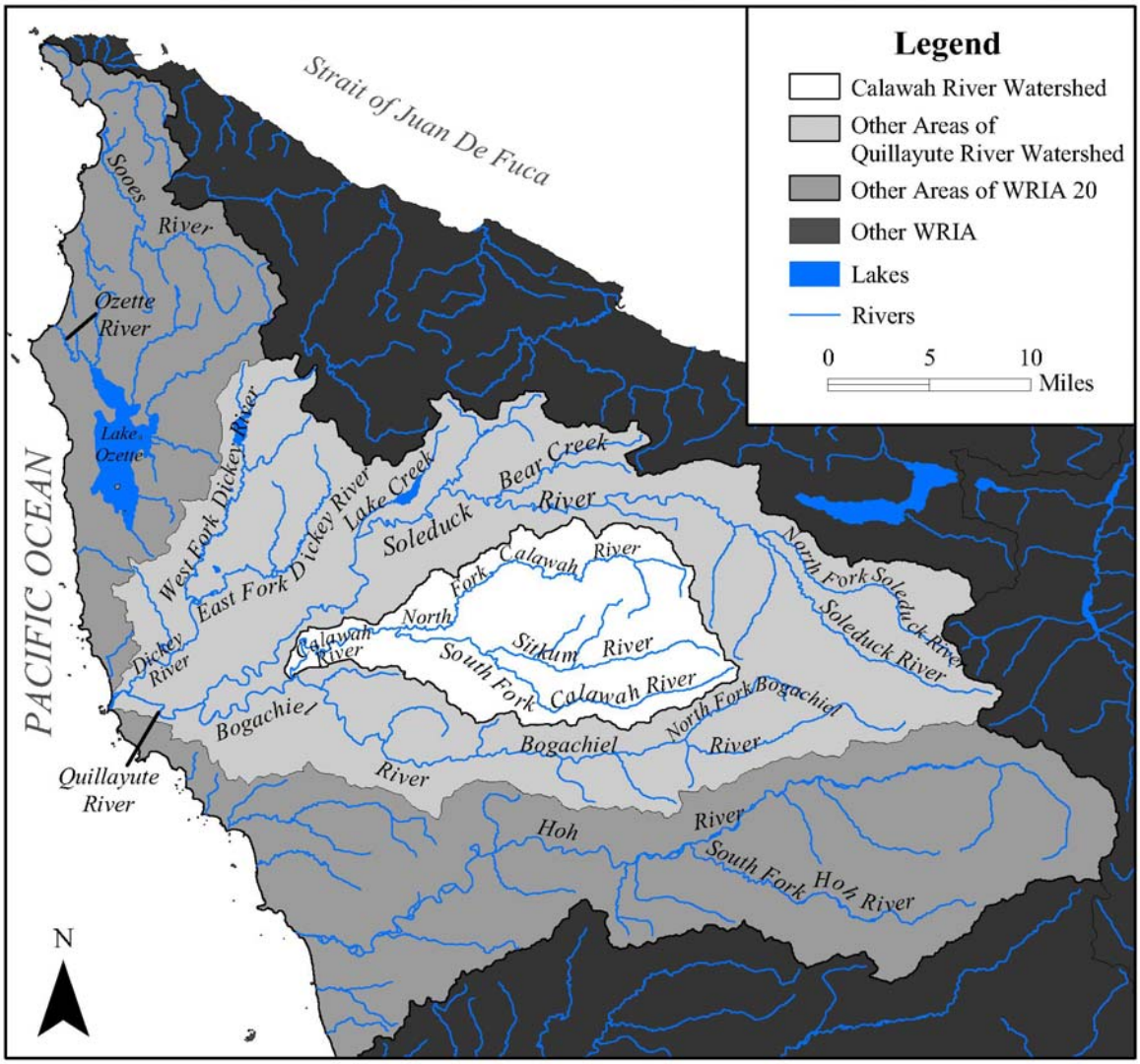

Figure 13. Location of Calawah River watershed.

The Calawah River watershed covers approximately 136 square-miles. Elevations range from less than 100 ft at the mouth to over 3400 ft. Precipitation is extremely high over the entire watershed with average precipitation ranging from 95 inches to over 125 inches annually. Precipitation levels are the lowest

along the northeastern boundary near Bigler Mountain and Grindstone Pass and highest along southwestern border near Elk Ridge. The movement of weather patterns through the area is anticipated to be from the southwest towards the northeast, thus the indicated areas of high and low precipitation are expected.

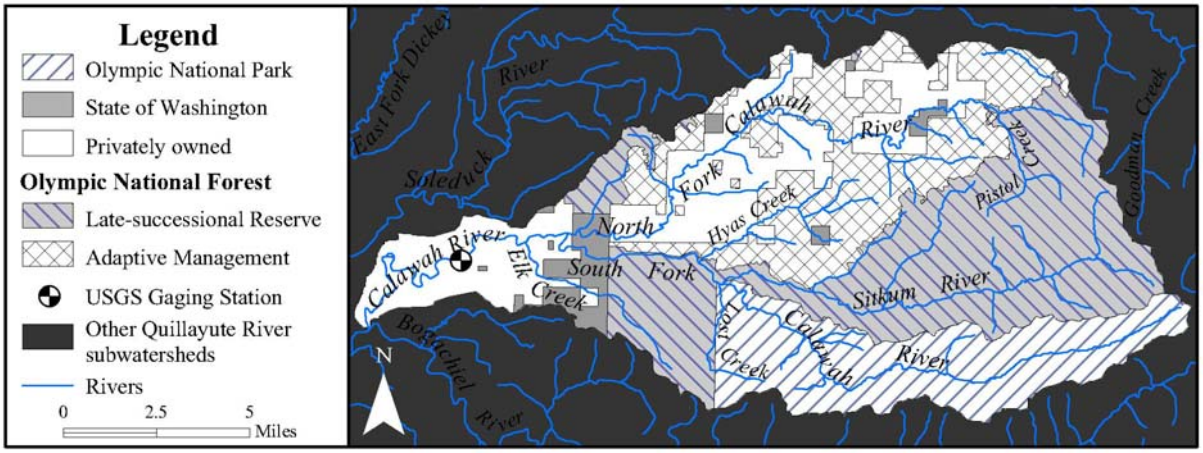

Figure 14. Land Administration within the Calawah River watershed.

The Calawah River is separated into a north and south fork about 10 miles upstream of the watershed mouth. The largest tributary within the Calawah River drainage beyond these two forks is the Sitkum River. The Calawah River headwaters begin in the Olympic National Forest and the Olympic National Park and flow west. Table 20 summarizes the land ownership within the entire Calawah River watershed.

Table 20. Land Administration within the Calawah River watershed.

Land Owner/Administrator	Area (sq. mi.)	Percent of Total Area
Olympic National Park	25.9	19.0
Late-successional Reserve (USFS)	48.6	35.7
Adaptive Management (USFS)	27.7	20.4
State of Washington	4.7	3.5
Privately owned	29.1	21.4
Total Area	136.1	100

The areas managed by the USDA Forest Service are subject to the President's Northwest Forest Plan of 1994. In this plan, Forest Service and some state and private in-holding lands have been assigned specific management designations, if outside of a wilderness area. No wilderness areas exist within the Calawah River watershed, other than the land within the Olympic National Park, which covers less than one-quarter of the watershed. Over one-third of the entire watershed has been designated Late-successional Reserve through the Northwest Forest Plan,

where the goal is to maintain or develop 'old-growth-like' conditions. The remaining Forest Service lands, which total about another 20 percent of the watershed, have been designated an Adaptive Management area where the land is managed to provide both ecological and economic benefits. Private entities manage almost one-quarter of the watershed, mainly near Forks.

Over the last 100 years, timber removal has occurred over the majority of the watershed. Today, the majority of the Calawah River watershed is forested. The majority of land within the Calawah River drainage above the North Fork and South Fork confluence was inventoried during a Forest Service analysis of timber age class, and the resultant GIS coverage provided the information provided in Table 21 (ONF, 2000). This inventory assessed timber age classes in the areas managed by the Forest Service and the State of Washington above the North Fork and South Fork Calawah River confluence. Old-growth conditions can also be found in the Olympic National Park to the south of the Sitkum River drainage, which was not included in the age class inventory by the Forest Service. If we assume the timber within the Olympic National Park are at least over 81 years old, then timber over 81 years of age covers at least 62.4 square-miles or 52 percent of the entire area above the North Fork and South Fork Calawah River confluence, which measures 120.2 square-miles in area. Also, the amount of timber that is over 41 years of age covers at least 102.9 square miles or 85.6 percent of the entire area above the North Fork and South Fork Calawah River confluence. Keep in mind that some privately owned areas above this confluence were not included in this timber inventory, so there is the potential for each age group classes to increase if any old timber exists on these private lands.

Table 21. Age class descriptions of part of the timber located above the North Fork and South Fork Confluence within the Calawah River watershed.

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	7.05	7.4
21 - 40 years	11.8	12.3
41 - 60 years	38.9	40.5
61 - 80 years	1.62	1.7
81 - 160 years	3.44	3.6
over 160 years	33.1	34.5
Total Area	95.9	100

The Calawah River USGS gage is located approximately 3.6 river miles downstream of the North Fork and South Fork Calawah River confluence. Although we know little about the additional privately owned and state managed lands between this confluence and the gage location, the 102.7 square-miles of timber that have been identified as older than 41 years of age still represent a significant portion, or 78 percent, of the 131.1 square miles contributing to

streamflow at the gaged location. The USGS also indicated that no diversions occur upstream of the gage in their gage summary. As such, the USGS gaging station 12043000 was considered to represent undepleted or natural streamflow conditions in the Calawah River.

Both the Sitkum and the South Fork Calawah subwatersheds contain the highest elevation headwaters, particularly Pine Mountain within the South Fork drainage. These higher elevation subwatersheds have ridges that exceed 3400 ft, and several subwatershed areas that span areas entirely above 2500 ft are characterized as highland subwatersheds. These subwatersheds typically experience higher snowfall accumulations that remain into the spring and summer months. At elevations below 2500 ft, winter snow accumulation may not remain for many months; rather snowmelt occurs within a week or so of accumulation.

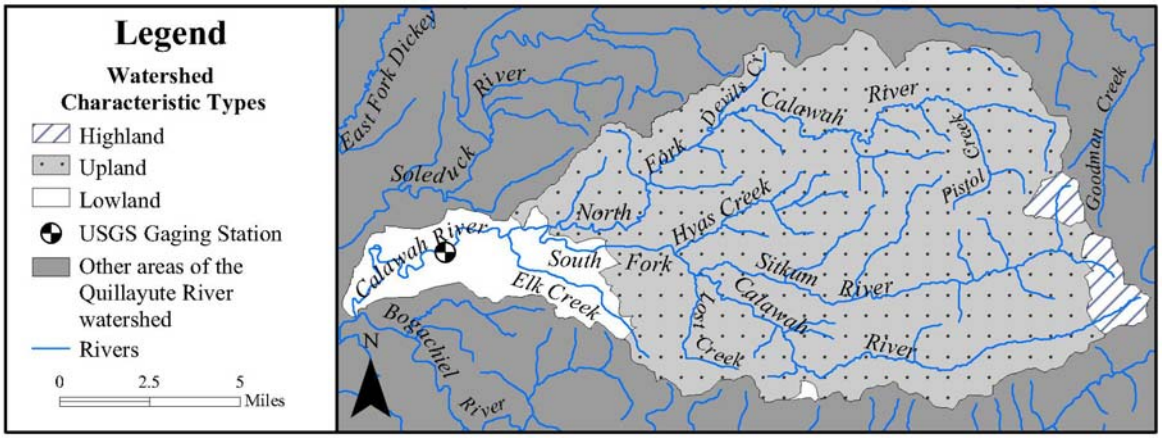

Figure 15. Watershed Characteristics of the Calawah River watershed.

The flow of the Calawah River is fed by subwatershed areas that exhibit specific characteristics, as shown in Figure 15. The highland subwatersheds are located at the headwaters of the Calawah River. These areas are characterized by the snowmelt runoff that lasts until late summer, but only a small portion of the entire watershed, less than four percent, exhibits these characteristics as seen in Table 22 below. The largest subwatershed type contributing to flow in the Calawah River is a large upland subwatershed. These areas correspond to those below 2500 ft, which experience only short term snow accumulation. Upland subwatersheds tend to cause an increase in streamflow during the winter-season precipitation months due to snowmelt runoff. Almost 90 percent of the entire watershed is characterized as upland subwatershed, but over five percent of that area is ineffective due to flat slopes. In these areas, recharge to surficial aquifers is likely to occur and minimal runoff from these areas contributes to streamflow. Two specific areas adjacent to the North Fork Calawah River are considered upland yet ineffective towards streamflow, the Cooper Ranch Valley and areas south of Bonidu Creek. The lowest elevation areas are characterized as lowland subwatersheds. Lowland areas contribute to streamflow in a similar fashion as

the upland areas by providing additional streamflow during winter precipitation months. These areas also usually allow summer streamflow to recharge surficial aquifers, thereby reducing streamflow. Several lowland areas within the Calawah River watershed are considered ineffective areas. The majority of lowland areas are considered to produce insignificant additional streamflow under natural conditions, since the land in these areas is extremely flat, particularly near Forks. Also, these areas are not considered to reduce summer streamflow significantly, particularly those that are not located adjacent to the stream channel.

Table 22. Watershed Characteristics of Areas within the Calawah River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	4.7	3.4
Upland	107.7	79.2
Upland, *but ineffective*	8.0	5.9
Lowland	7.0	5.1
Lowland, *but ineffective*	8.7	6.4
Total Area	136.1	100

Streamflow Evaluations of the Calawah River

A USGS gaging station 12043000 is located on the Calawah River at RM 6.5, where Highway 101 crosses the river near Forks. The effects of land management activities on this gage is considered to be minimal under current conditions for the reasons discussed previously. Daily gaged streamflow records are available for this gage intermittently between January 1976 and September 1983 and continuously starting in March 1984. This gage is still in operation.

The available gaged streamflow records between 1976 and 2000 were extended to create an complete period of record between October 1961 and September 2000. An extended streamflow record was created for this gage using regression techniques against two nearby streamflow gages that had overlapping periods of record with the Calawah River gage. These gages are:

- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

As described previously for the Bogachiel River, regressions against these gages were completed using all monthly total values in the same regression equation, whereas regression equations based on each month were developed for gages with a greater number of coincidental months. These equations exhibited excellent similarities to the Calawah River gage (R^2 values of 0.984 against the Bogachiel

River gage and 0.972 against the Dickey River gage), streamflow information was not collected at any of these gages for several months in the desired period of record between October 1961 and September 1999. For these remaining 69 months, which represents approximately 15 percent of the entire period of record, monthly total streamflow was estimated for the Calawah River gage from an extended period of record developed for USGS gaging station 12043300, Hoko River near Sekiu, WA. This Hoko River gage was extended using total monthly precipitation values from precipitation stations in Sappho, Clallam Bay, Forks, and Neah Bay.

Streamflow for the Calawah River and its tributaries was estimated and evaluated at 4 primary locations within the watershed. The three largest subwatersheds within the Calawah River drainage are the North Fork Calawah River, the South Fork Calawah River, and the Sitkum River. A complete period of record between October 1961 and September 1999 was developed immediately above the confluences between these subwatersheds. These locations can be seen in Figure 16 below. The streamflow below these confluences can be considered equal to the sum of the two contributing streams.

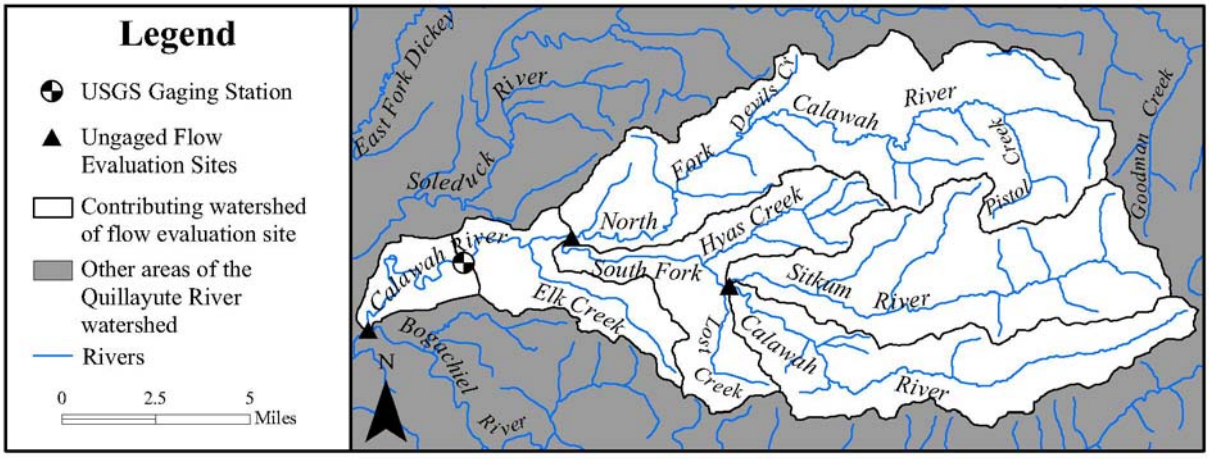

Figure 16. Locations within the Calawah River watershed where natural flows were developed.

Streamflow was estimated at ungaged locations using the watershed characteristics method, which is described in Appendix 1. Representative type-watershed flow histories were generated for highland, upland, and lowland areas through by comparing streamflow records and watershed characteristics for the contributing watershed above the USGS gaging station 12042800 Bogachiel River near Forks, WA. The watershed characteristic information for the Calawah River watershed is provided below. Table 23 and Table 24 summarize the area and average annual precipitation values used in the watershed characteristics method to develop streamflow estimates for each Calawah River subwatershed.

Table 23. Watershed characteristics within each portion of the Calawah River watershed.

Watershed Characteristic Types	South Fork Calawah River above Sitkum River confluence	Sitkum River above South Fork Calawah River confluence	South Fork Calawah River above NF Calawah River confluence	North Fork Calawah River above SF Calawah River confluence	Calawah River at gage # 12043000 - Calawah River nr Forks	Calawah River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	1.58	3.09	-	-	-	-
Upland	21.6	27.8	16.5	39.8	2.09	-
Upland-*ineffective*	-	-	0.013	7.98	-	-
Lowland	-	-	1.13	-	4.63	1.23
Lowland-*ineffective*	0.24	-	0.57	-	4.18	3.70
Entire area	23.4	30.8	18.2	47.8	10.9	4.93

Table 24. Average annual precipitation for each portion of the Calawah River watershed.

Watershed Characteristic Types	South Fork Calawah River above Sitkum River confluence	Sitkum River above South Fork Calawah River confluence	South Fork Calawah River above NF Calawah River confluence	North Fork Calawah River above SF Calawah River confluence	Calawah River at gage # 12043000 - Calawah River nr Forks	Calawah River at Outlet
	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)
Highland	121.3	111.9	-	-	-	-
Upland	119.4	114.8	122.7	112.3	123.5	-
Upland-*ineffective*	-	-	124.3	104.0	-	-
Lowland	-	-	122.2	-	120.3	104.0
Lowland-*ineffective*	122.5	-	122.2	-	114.8	104.0
Entire area	119.5	114.5	122.7	110.9	118.8	104.0

The evaluation of streamflow at each location is described below. The following section describes and illustrates the expected range in streamflow variation for each location in average monthly streamflow in cubic feet per second (cfs).

South Fork Calawah River above Sitkum River –

The South Fork Calawah River is separated from the Sitkum River by Rugged Ridge. This area above Sitkum River includes flow developed in highland and upland subwatershed areas, which begins along the western flanks of Pine Mountain. The drainage area of the South Fork Calawah River above this confluence measures 23.4 square-miles, of which seven percent is highland subwatershed and 92 percent is upland subwatershed. The remaining one percent is the area associated with Indian Pass, located along the southern watershed boundary, and is considered typical of lowland subwatersheds, but ineffective toward streamflow due the slope of land.

Seasonal maxima in streamflow are clearly shown for the winter season precipitation maximum. During the late summer and into the fall, flow in the South Fork Calawah River recedes to minimum flow. This minimum flow season is indicated to extend into September. The months between November and February exhibit the greatest indicated variation in streamflow.

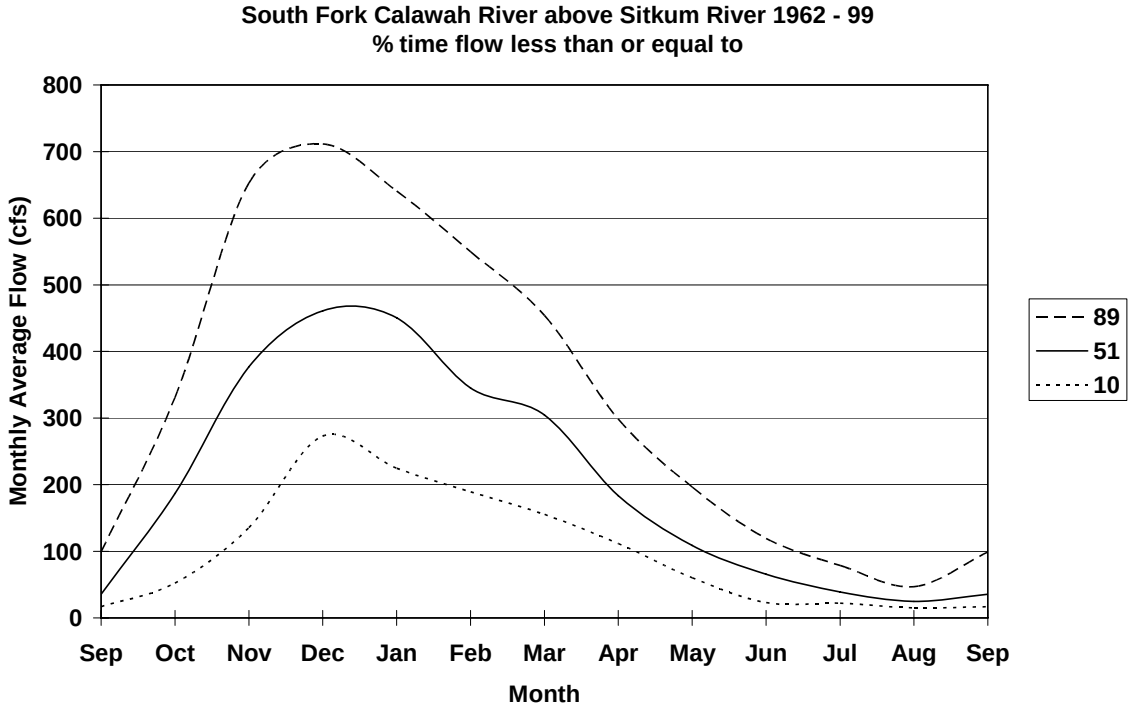

Table 25. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the SF Calawah River above the Sitkum River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	331	653	711	641	550	454	298	196	119	79	47	99
51	187	377	461	451	345	304	183	109	66	39	25	35
10	52	136	273	224	189	155	112	60	23	22	15	17

Sitkum River at the Outlet –

The Sitkum River is located to the north of the South Fork Calawah River drainage and south of the North Fork Calawah drainage. Streamflow at the outlet is comprised of several subwatersheds, North Fork Sitkum River, Rainbow Creek, and the Upper Sitkum River. These areas and the intermediary catchments measure almost 31 square-miles in area. Of this entire area, only 10 percent is characterized as highland subwatershed, while 90 percent is typical upland subwatershed. The entire Sitkum River watershed contributes directly to streamflow through runoff, thus there are no ineffective areas.

Winter-season precipitation dominates the Sitkum River hydrograph, as seen in the illustrated range of flow below. The large increase of streamflow during the winter months relates to snow accumulation that lasts only about a week or so before melting. This range in flow is similar to that of the South Fork Calawah River, but has greater variation in winter due to a larger contributing drainage area. The months noted with the largest variation in streamflow are between November and January.

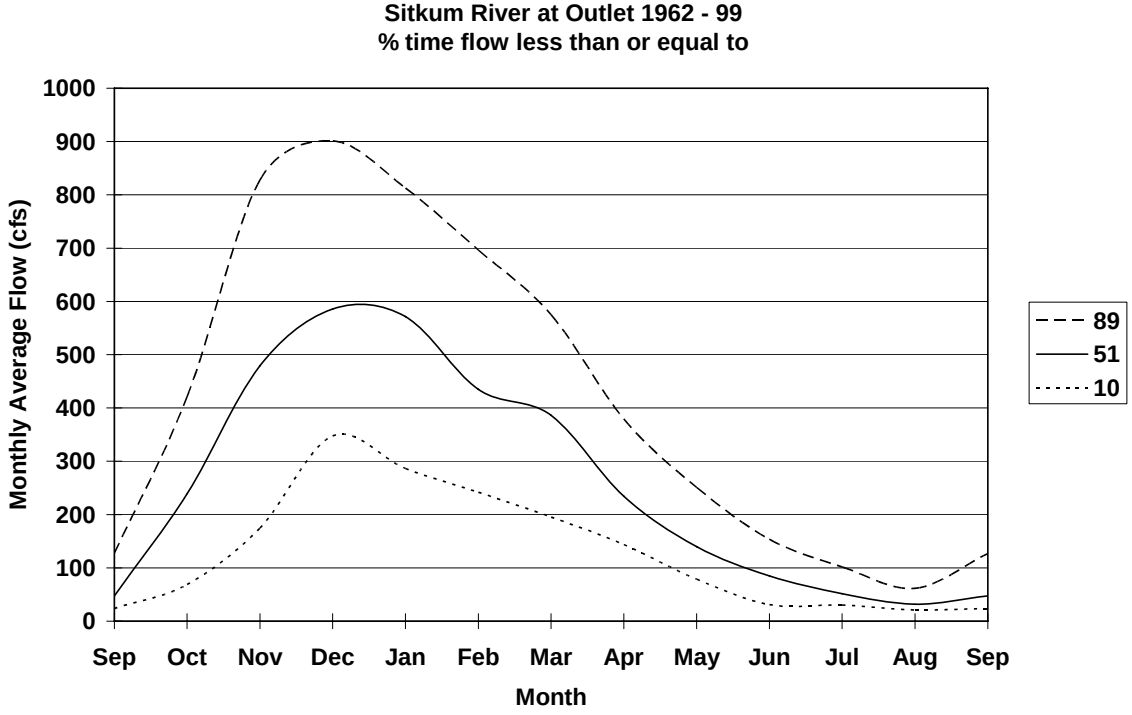

Table 26. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month in the Sitkum River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	421	828	901	813	696	575	380	251	153	102	62	127
51	239	479	586	572	435	386	234	140	85	52	32	48
10	69	175	348	286	242	195	144	79	31	30	21	24

South Fork Calawah River at the Outlet –

Two significant tributaries contribute to flow in the South Fork Calawah River below the Sitkum River confluence. Lost Creek joins the main stream channel just a few hundred feet downstream of the Sitkum River, and the Hyas Creek confluence is located less than a mile downstream of there. At the outlet, the entire contributing area of the South Fork Calawah River is 72.4 square-miles. Lost Creek and Hyas Creek are both entirely typical of upland subwatershed areas, as well are most intermediary areas. The furthest downstream stretch of the river, mainly west of Klahanie Campground, is considered lowland subwatershed. Within this area, land slopes decrease and a small area is ineffective toward streamflow. Only slightly over one percent of the entire watershed is considered ineffective toward runoff.

The greatest variation in South Fork Calawah streamflow occurs in the winter, specifically between November and February, as is expected of the upland subwatersheds that dominate the drainage area. Streamflow decreases down to minimum baseflow levels in August and September.

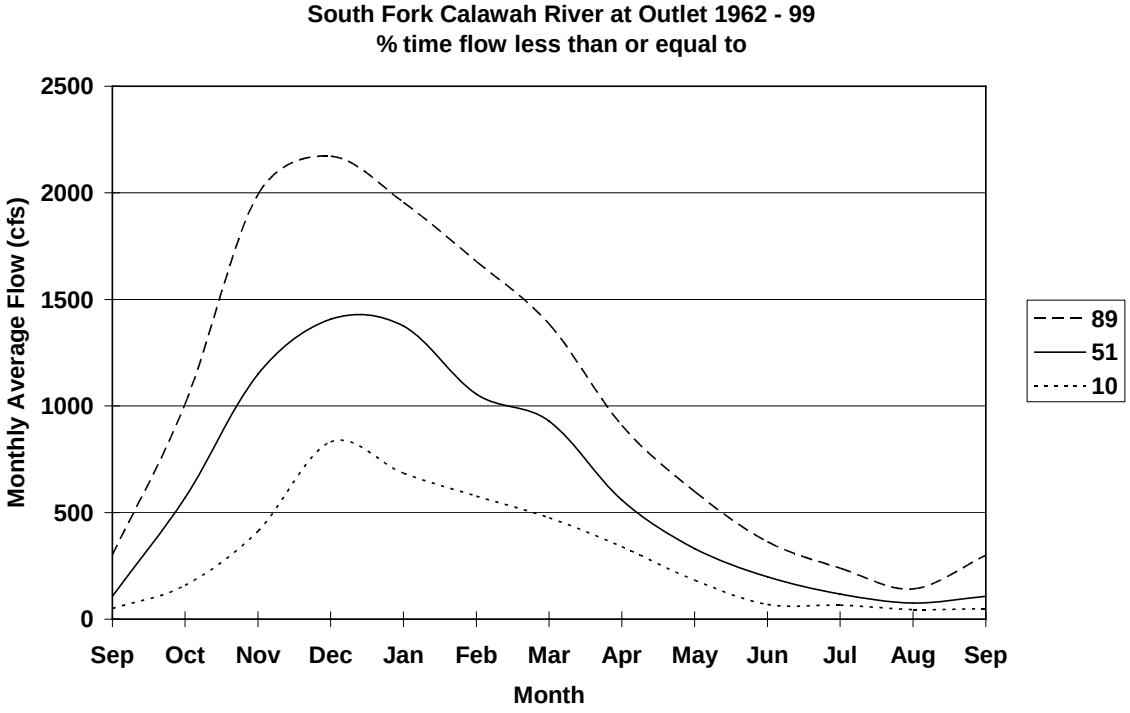

Table 27. The percent of time that average monthly streamflow (cfs) in the South Fork Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1008	1992	2172	1956	1678	1385	909	598	363	239	142	300
51	570	1150	1406	1375	1056	929	559	331	199	117	76	107
10	158	412	832	684	577	475	340	182	69	66	45	50

North Fork Calawah River at the Outlet –

The North Fork Calawah River watershed is located north of the Sitkum River watershed and includes the large tributaries of Pistol Creek, Bonidu Creek, Albion Creek, Canyon Creek, Devils Creek, Fahnestock Creek, and Cool Creek. The entire watershed covers only 47.7 square miles in area, of which over 83 percent is characterized as upland subwatershed. The remaining 16.7 percent is also upland subwatersheds, but this area is ineffective towards streamflow under natural conditions due to large areas that are flat in slope. Specifically, the majority of the Cooper Ranch Valley is considered ineffective towards streamflow, but the steeper sloped areas on the valley walls would capture a portion of flow during high precipitation events and thus is considered effective. The other large ineffective area is located south of Bonidu Creek. North Fork Calawah streamflow is dominated by the winter-season precipitation. Since there are no highland subwatershed areas, the summer baseflow levels are lower than those of the South Fork Calawah River with minimum flows averaging between 5 and 20 cfs over the months of August and September. The months of greatest variation in streamflow are between November and January.

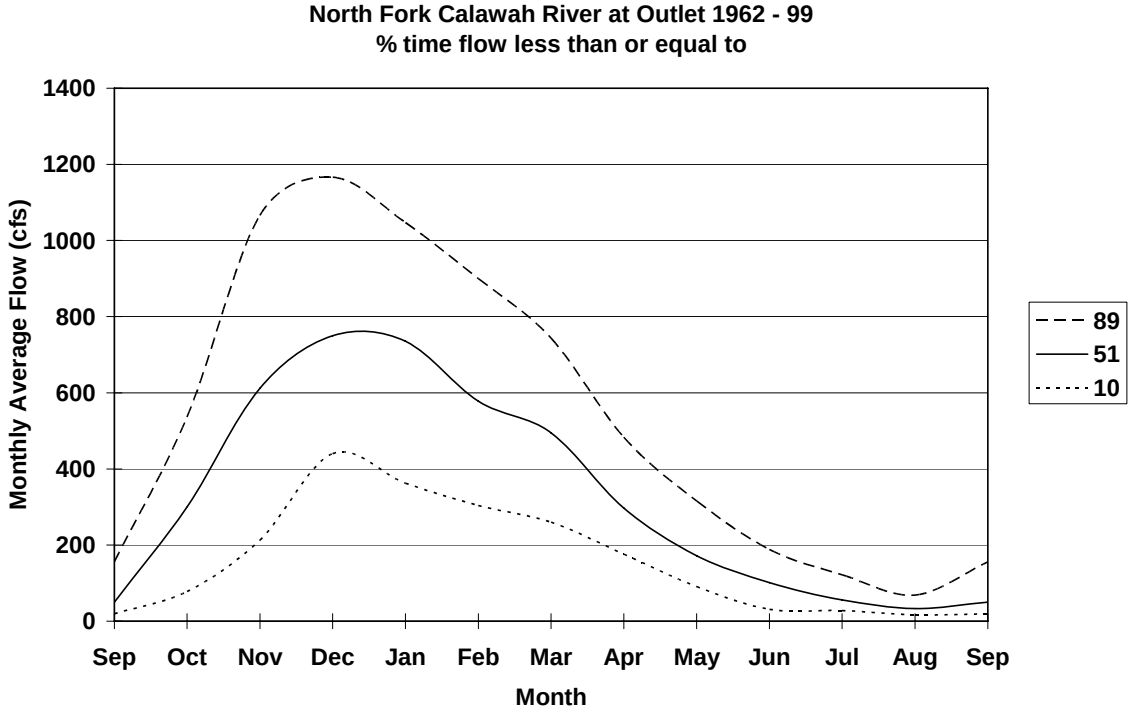

Table 28. The percent of time that average monthly streamflow (cfs) in the North Fork Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	536	1066	1166	1047	900	743	483	316	188	122	69	155
51	300	612	750	736	578	495	297	172	101	56	33	50
10	78	213	440	362	304	260	176	91	31	28	17	19

Calawah River near Forks (at USGS gage 12043000) –

As discussed previously, the USGS gaging station 12043000 has a fairly complete period of record and is still in operation today. Elk Creek is the last large tributary in the Calawah River and outflows 1.2 miles downstream of the North Fork and South Fork confluence. The area below this confluence down to the Calawah River outlet is called the Forks Prairie. The city of Forks is located in this area. A large portion of the Forks Prairie is considered ineffective towards streamflow because precipitation in these flat areas is most likely lost to interception or surficial groundwater aquifers that would not influence surface water streamflow gaging. The contributing area above the gage location measures 131.1 square-miles in area, of which over 82 percent is characterized as effective upland subwatershed. The months of greatest streamflow variation at USGS gaging station 12043000 are between November and January. Peak average monthly streamflow can reach over 4000 cfs during these months, and minimum baseflow levels average between 45 and 75 cfs in the months of August and September.

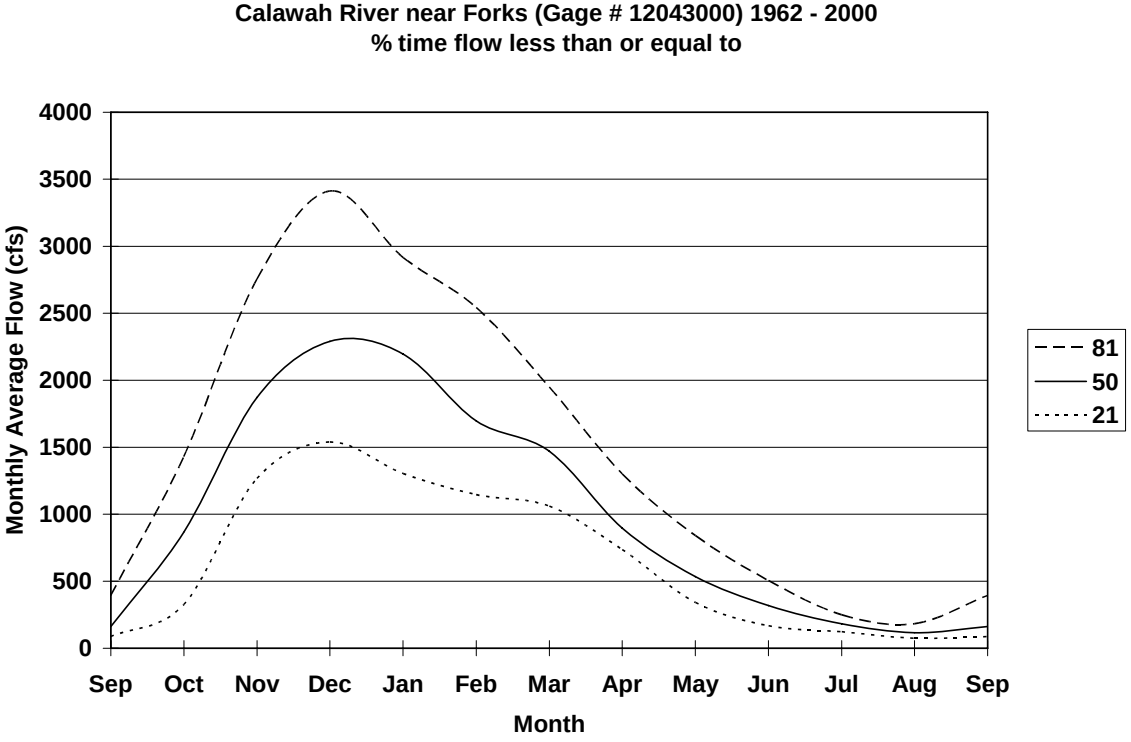

Table 29. The percent of time that average monthly streamflow (cfs) in the Calawah River at the Forks gage is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1640	3249	3557	3190	2739	2262	1479	970	604	382	223	483
50	867	1871	2291	2195	1697	1469	896	534	318	183	115	161
10	249	663	1351	1111	935	781	547	289	105	99	65	72

Calawah River at the Outlet –

Streamflow at the outlet of the Calawah River is quite similar to that measured at the USGS gaging station. Streamflow at the outlet of the Calawah River was estimated by adding gains in streamflow to flow measured at the upstream gage location. Only a small increase in streamflow can be seen between the gage and the outlet at low flow conditions while a large increase occurs at times of higher flows. Similar to the upstream gage, the months of greatest streamflow variation are between November and January and baseflow levels occur in August and September.

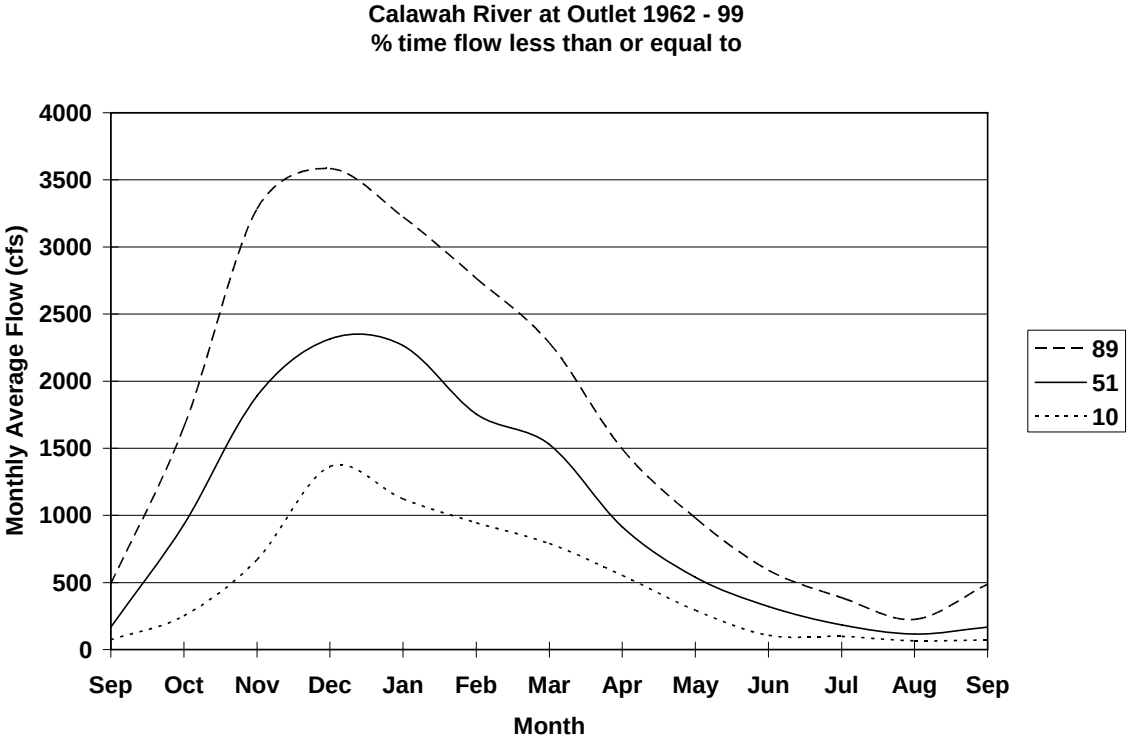

Table 30. The percent of time that average monthly streamflow (cfs) in the Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1657	3283	3584	3224	2767	2285	1494	980	591	386	225	488
51	933	1891	2315	2266	1755	1529	915	539	322	184	116	168
10	252	670	1364	1123	945	790	552	292	106	100	66	73

Soleduck River watershed –

The Soleduck River watershed includes over 35 percent of the Quillayute River watershed, covering approximately 225.4 square-miles in drainage area. The confluence of the Soleduck River and the Bogachiel River marks the beginning of the Quillayute River, which is only about 6.5 miles upstream for the coast. The location of the Soleduck River watershed is presented in Figure 17 below.

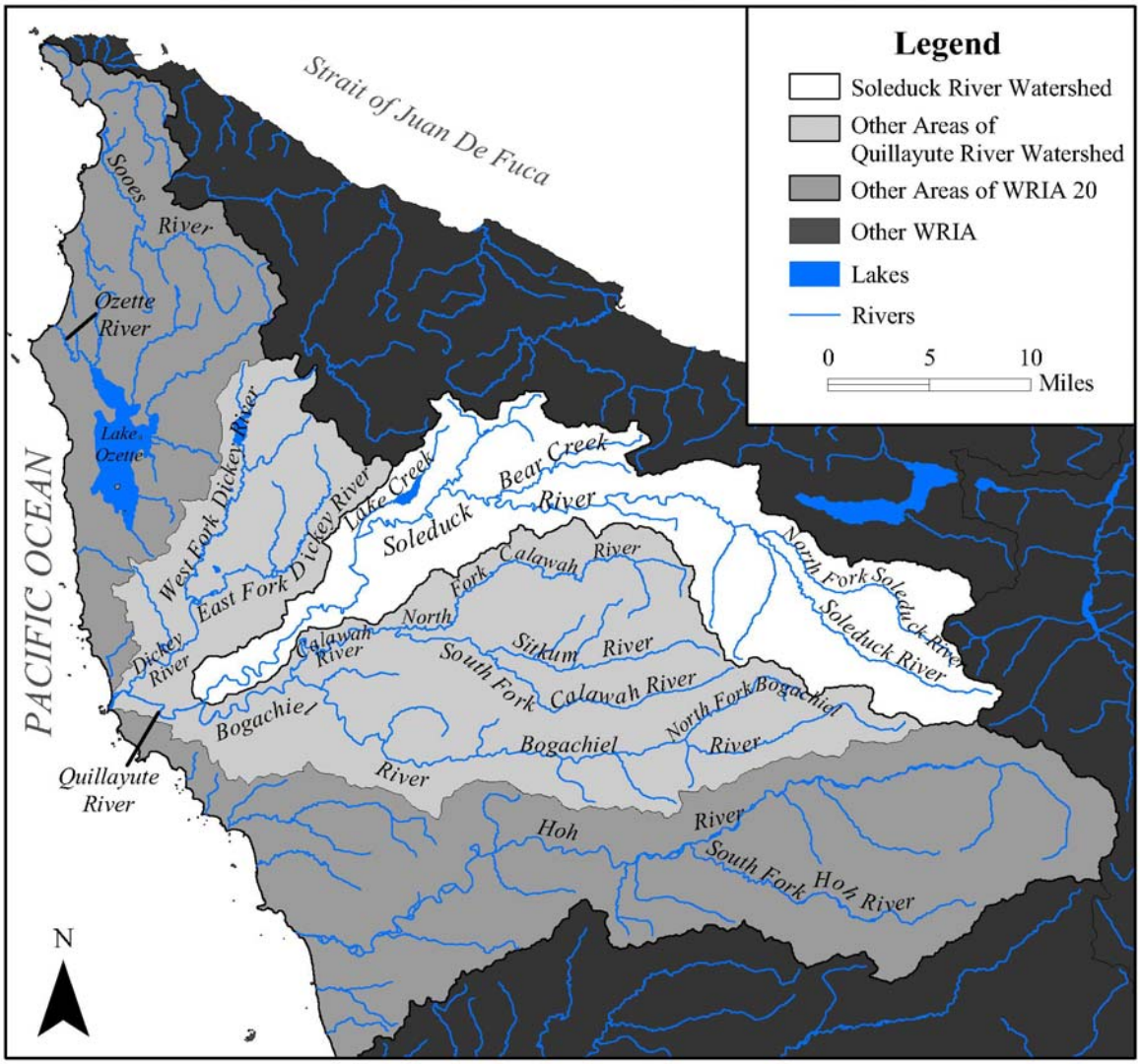

Figure 17. Location of Soleduck River watershed within WRIA 20.

The Soleduck River basin defines the eastern edge of WRIA 20 and is bound by the Dickey River watershed to the northwest and the Calawah and Bogachiel River basins to the south. The Pysht and Twin River basins of WRIA 19 are located to the north, along with the Lake Crescent basin also within WRIA 19.

The Elwah River basin, which is part of WRIA 18, is located to the east of the headwaters.

Elevation of the Soleduck River watershed ranges from about 25 feet above sea level at the outlet to over 6000 ft at the headwaters. Average annual precipitation is highest along the southern headwater edge, reaching over 122 inches per year near Deer Lake, and decreases to the north and west with the lowest values of less than 90 inches per year near the outlet. The Soleduck River headwaters are defined by the High Divide along the south and Happy Lake Ridge along the north. Several peaks define the eastern basin edge, including Bogachiel Peak, Mount Appleton, Everett Peak, Boulder Peak, and Lizard Head Peak. The southern Soleduck headwaters cover the Seven Lakes Basin within the Olympic National Park and continue northwest. The entire North Fork Soleduck River basin lies within the national park boundary as well. Table 31 below lists the Soleduck drainage areas by land management.

Table 31. Land administration within the Soleduck River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	72.6	32.2
Late-successional Reserves (USFS)	40.6	18.0
Adaptive Management (USFS)	31.0	13.8
State of Washington	30.3	13.4
Privately owned	50.9	22.6
Total Area	225.4	100

The largest portion of the watershed lies within the Olympic National Park, but almost an additional 18 percent has been designated Late-successional reserve in the President's Northwest Forest Plan of 1994. The land management activities in practice today likely relate to these administration areas, where the majority of timber removal occurs within state and privately owned lands, as well as within the Adaptive Management areas of the Olympic National Forest.

For demonstration purposes, the Soleduck has been separated into upper and lower areas. The administrative areas for the upper Soleduck are illustrated in Figure 18, and the lower Soleduck is illustrated in Figure 19. All Soleduck River basin lands within the Olympic National Park are included in the upper Soleduck area. The tributaries of the upper Soleduck include the North Fork and South Fork Soleduck River, which combine with the Soleduck River just upstream of the USGS gaging station on the Soleduck River near Fairholm (#12041500). The next downstream USGS gaging station, located upstream of Kugel Creek near the USDA Forest Service Snider Ranger Station, was named the Soleduck River near Beaver (#12042000). The location of this gage is illustrated on both the upper and lower Soleduck maps to illustrate map overlap, but is no longer in service.

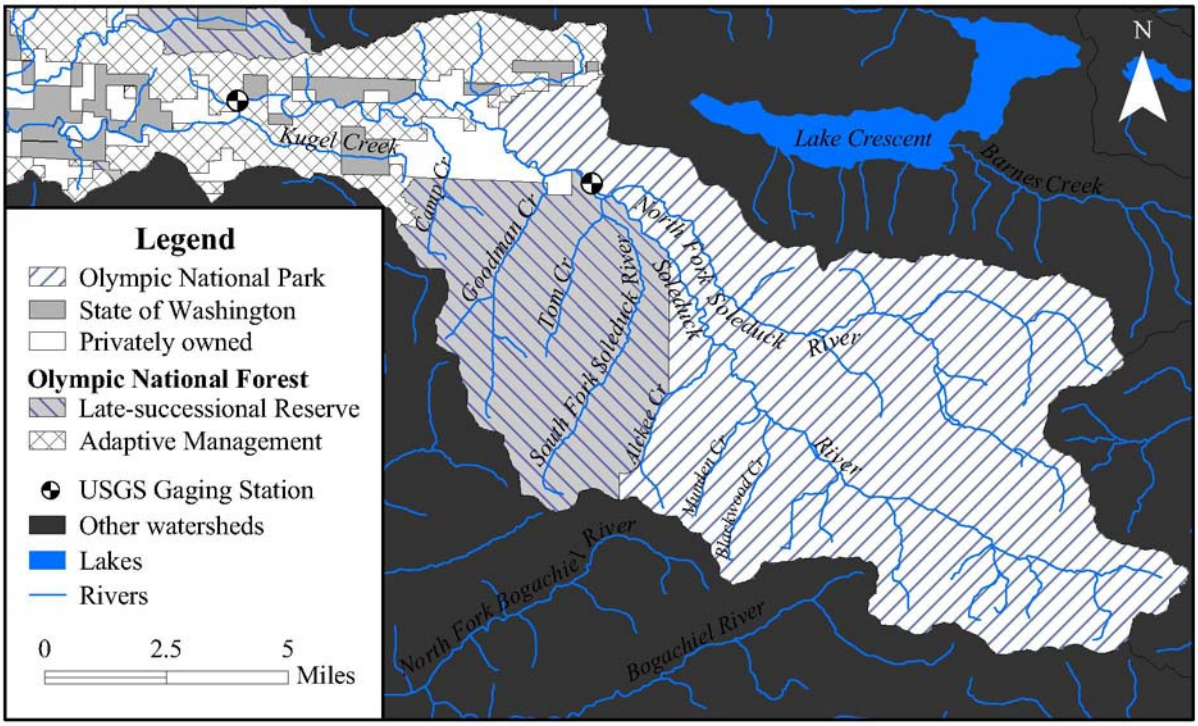

Figure 18. Land Administration within the upper Soleduck River watershed.

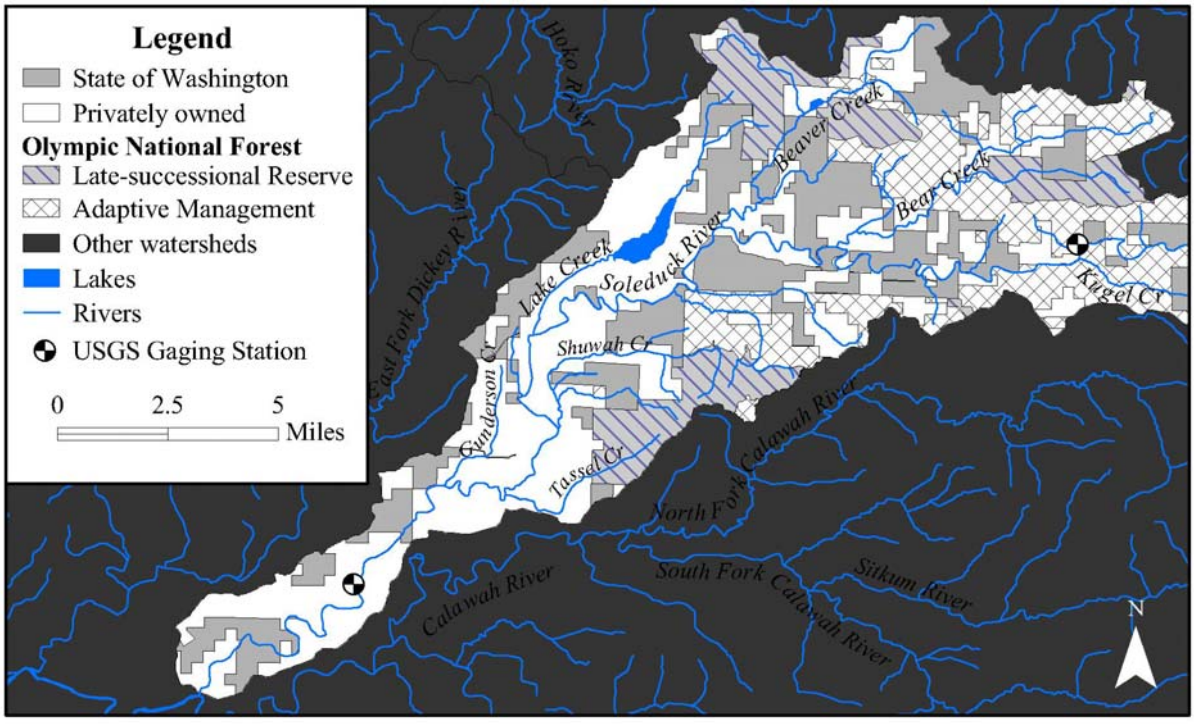

Figure 19. Land Administration within the lower Soleduck River watershed.

The lower Soleduck River watershed is dominated by state and privately owned lands, yet still includes a fair amount of Forest Service lands which are typically located at higher elevations. Several more tributaries outflow into the Soleduck River below USGS gaging station 1242000, including Bear Creek, Beaver Creek, Lake Creek, Shuwah Creek, Tassel Creek and Gunderson Creek. The most downstream USGS gaging station illustrated was located downstream of all these tributaries and is named the Soleduck River near Quillayute (#12042500). This gage was located at the bridge where Quillayute Road crosses the Soleduck River, but is no longer in service.

Relative age classes of timber on Forest Service lands within the Soleduck River basin were inventoried by the USDA Forest Service, and the resultant GIS coverage provided the information provided in Table 32 (ONF, 2000). This timber age class analysis did not characterize lands within the Olympic National Park, yet old-growth conditions likely exist within the park.

Table 32. Age class descriptions of part of the timber located within the Soleduck River watershed.

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	6.74	7.2
21 - 40 years	10.9	11.6
41 - 60 years	17.8	18.9
61 - 80 years	18.3	19.5
81 - 160 years	12.7	13.5
over 160 years	27.6	29.3
Total Area	94.2	100

The upper Soleduck River basin is split between highland and upland subwatershed areas. The highest elevation areas are characterized as Highland subwatershed types, as defined by the watershed characteristics method. These areas generally start near 1700 ft in elevation and extend to over 6000 ft. Figure 20 below illustrates the subwatershed types of the entire Soleduck River watershed. Upland areas generally begin near 600 ft above sea level and extend to less than 3200 ft. While the highland areas are characterized by snowmelt accumulation that continues to melt and provide streamflow into the late summer, the upland areas are either located below the average snow line or the snow usually melts within a short period of time. Upland areas contribute large portions of streamflow during winter precipitation months. The most downstream highland area is found along the southern slope of Mount Mueller, and the transition from upland to lowland subwatershed areas is another few miles downstream. This transition is also captured on the watershed characteristics map, Figure 20, below.

The summary of watershed characteristics above the gage was necessary to complete any work on the Soleduck River.

The transition between lowland and upland areas within the Soleduck River is located downstream of Kugel and Snider Creeks, as well as below the USDA Forest Service Snider Ranger Station. Lowland areas begin near 200 ft above sea level and extend only to 1300 ft, as described by the watershed characteristics method. These areas provide additional streamflow during the winter precipitation months with similar precipitation patterns as the upland areas. Precipitation that falls within lowland subwatersheds are more likely to be lost to subsurface water levels, especially within valley bottoms. When valley floors are expansive and flat, a larger portion of precipitation is lost to ground water and not reflected in surface water gaging, thus these areas are considered ineffective towards surface water streamflow.

A large coastal lowland subwatershed is found in the most downstream portion of the Soleduck River watershed. Coastal lowland areas begin at sea level and extend only up to 400 ft in elevation. These areas function very similar to lowland areas, but are located at lower elevations. Also, the amount of additional precipitation that is captured in flat coastal lowland areas is nearly equivalent to the amount of water lost to ground water, evaporation, and interception. Therefore, some coastal lowland areas were considered ineffective to surface water flows in the Soleduck River. Table 33 below summarizes the area of the Soleduck River watershed covered within each subwatershed type.

Table 33. Watershed characteristics of areas within the Soleduck River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	76.5	33.9
Upland	87.6	38.8
Lowland	34.0	15.1
Lowland, *but ineffective*	17.7	7.9
Coastal Lowland	5.09	2.3
Coastal Lowland, *but ineffective*	3.78	1.7
Lake Pleasant	0.77	0.3
Total Area	225.4	100

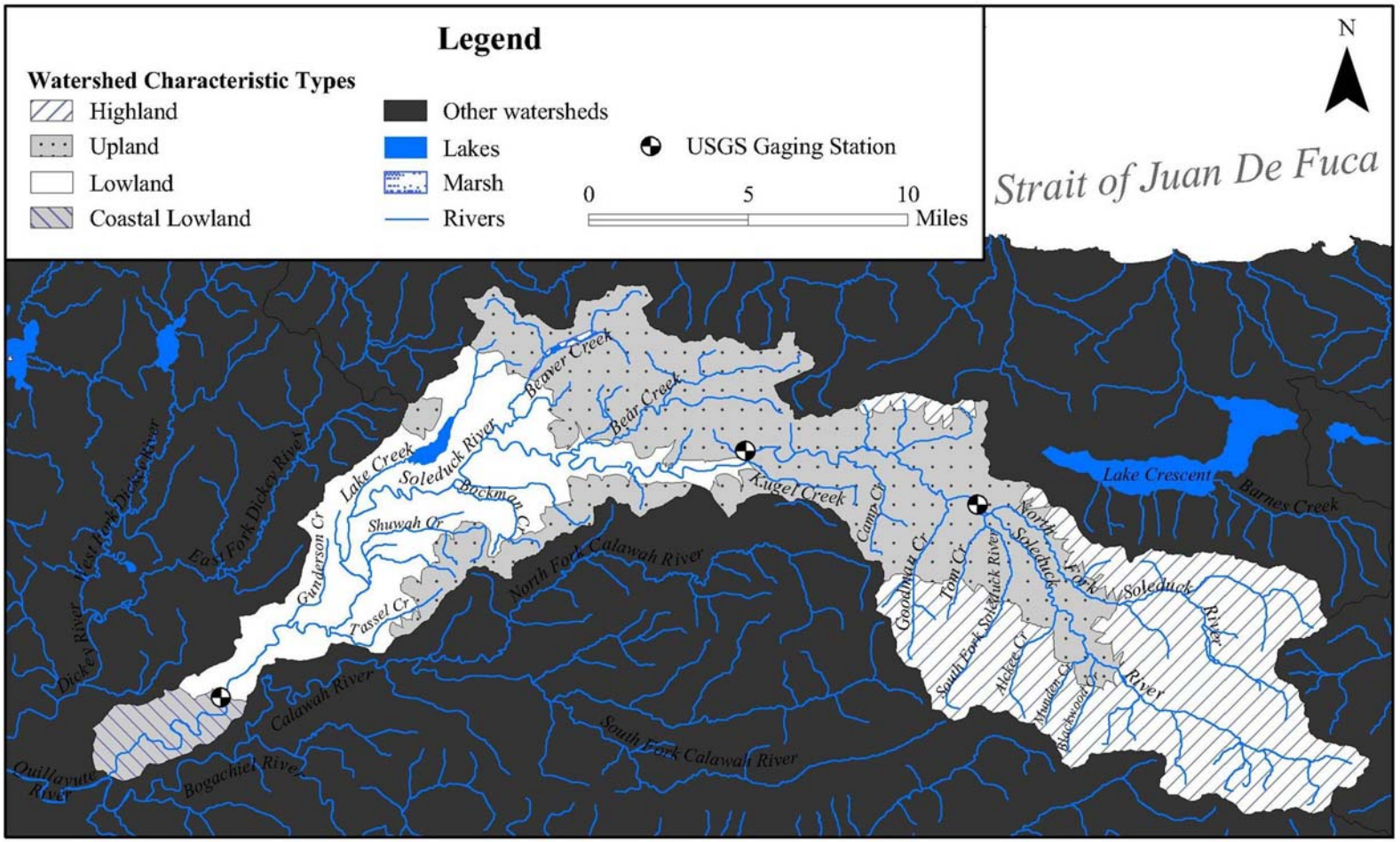

Figure 20. Watershed Characteristics of the Soleduck River watershed.

Another more specific watershed characteristic type is subsumed within the highland area called the alpine subwatershed. The alpine subwatershed functions similarly to the highland watershed, but differs slightly. Alpine subwatersheds are usually above the tree line, and therefore do not experience interception losses related to the forest cover of highland areas. Also, snow accumulated in some alpine areas does not melt entirely each year, creating small or sometimes large glaciers. Often these alpine areas are located on north facing slopes, which receive less direct sunlight and experiences slower snowmelt. The alpine area within the Soleduck River watershed is located at the highest elevations of the main stem and North Fork Soleduck River basins, particularly in the Seven Lakes Basin and along the north and south flanks of Mount Appleton. The alpine area continues north to the western slope of Boulder Peak. Since alpine subwatershed areas are not considered to function in a significantly different manner from the highland areas, they were not separated out from highland areas in Table 33 or Figure 20.

Streamflow Evaluations of the Soleduck River

Streamflow histories were determined at several locations within the Soleduck River watershed. A complete period of record was necessary for each pertinent location to evaluate streamflow at these locations. These streamflow histories needed to represent natural or unimpaired conditions to benefit the WRIA 20 management group. To estimate streamflow at multiple locations in the Soleduck River watershed, streamflow information was compiled from three USGS gaging station records within the Soleduck River. From upstream to downstream, these three gages are:

- USGS Station Number 12041500 Soleduck River near Fairholm, WA
- USGS Station Number 12042000 Soleduck River near Beaver, WA
- USGS Station Number 12042000 Soleduck River near Quillayute, WA

Streamflow measurements were collected at the most upstream gage near Fairholm between October 1933 and October 1971 as well as between November 1975 and September 1980. Of the gaged data available, the Fairholm gage has the longest period of record during the relevant flow history of October 1961 and September 1999. In order to use this gage to estimate natural streamflow in the remaining Soleduck River watershed, the gaged streamflow measurements needed to be unaffected by diversions or upstream timber removal. The USGS indicated in their gage summary each year that no diversions occur upstream of this gage, so the upstream contributing area was investigated for land management activities that may affect streamflow at the gage location.

The contributing area above the Fairholm gage is administered either by the USDA forest Service or by the National Park Service within the Olympic

National Park. Forest Service lands on the Olympic Peninsula were inventoried for relative timber age classes by the USDA Forest Service and provided a resultant GIS coverage of timber age classes. This timber age class analysis did not characterize lands within the Olympic National Park, yet old-growth conditions likely exist within the park. If we assume that old-growth conditions exist on the 68.7 square-miles of park land above USGS gaging station 12041500, Soleduck River near Fairholm, WA, then we can accurately describe all of the land above this gage. If we assume that the timber in these park lands are older than 160 years old, then Table 34 would represent the breakdown of all timber age classes above the Soleduck near Fairholm gage. Since less than 10 percent of the contributing area include stands of timber that average younger than 60 years, we assumed the streamflow information gathered at the Fairholm gage represent natural or unimpaired conditions. Consequently, this gage provided the majority of Soleduck River streamflow information used to estimate complete periods of record for other gaged and ungaged locations in the Soleduck River.

Table 34. Estimated* age class descriptions of the timber on all lands upstream of USGS gaging station 12041500, Soleduck River near Fairholm (ONF, 2000).

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	1.56	1.9
21 - 40 years	3.4	4.0
41 - 60 years	3.1	3.7
61 - 80 years	0.00	0.0
81 - 160 years	0.10	0.1
over 160 years*	75.7	90.3
Total Area	83.8	100

* Contributing area within the Olympic National Park (68.7 square-miles) was assumed to be older than 160 years old.

Regression techniques were used to extend USGS gaging station 12041500 based on the nearby USGS gaging stations Quinault River at Quinault Lake (#12039500), which has a period of record starting in 1911 and is still in operation today. These regressions were completed on a monthly-basis and exhibited highly similar relationships with the lowest R^2 value of 0.82 occurring in the month of May and six other monthly R^2 values over 0.90.

The extended synthetic streamflow history for the Fairholm gage was used to create streamflow histories at all the remaining Soleduck River locations based on the watershed characteristics method. Available streamflow measurements at the remaining gaged and ungaged locations were used to calibrate estimates generated through the watershed characteristics method. The watershed characteristics method relies on a nearby streamflow gage to estimate relative streamflow contributions from each type watershed, e.g. highland, upland,

lowland, etc. For the Soleduck River, the watershed characteristics method was applied against USGS gaging station 12042800, the Bogachiel River near Forks, to estimate type watershed streamflow histories.

The locations where natural streamflow histories were developed in the upper Soleduck River are illustrated in Figure 21, and the remaining locations in the lower Soleduck River watershed are illustrated in Figure 22. Gage markers indicate locations were USGS gaged information was available, where as ungaged locations were streamflow was evaluated are designated by a black triangle. The contributing watershed of each flow evaluation site is also indicated by the thick black line encompassing the white subwatershed. The watershed characteristics of each contributing area are summarized by area in Table 35 and the corresponding average annual precipitation of these areas are summarized in Table 36. Keep in mind, each additional portion of the Soleduck River watershed discussed in Table 35 and Table 36 represent the remaining additional area before the next downstream location. To accurately characterize the watershed characteristics that contribute to each location on the Soleduck River, the preceding columns to the left of the indicated location need to be summed.

The estimated range of natural streamflow at each pertinent location is described below. These discussions include a description of how the streamflow information was estimated, which may indicate that instantaneous streamflow information was available to calibrate streamflow estimates. To clearly illustrate the range of streamflow expected at each location, a graphical illustration of monthly average streamflow in cfs is included, as well as a table summarizing the expected range is streamflow in each month. The percentiles indicated in both the graphs and the tables represent the amount of time when average monthly streamflow is expected to be equal to or exceed the indicated value in cfs. A complete period of record was estimated for each site, and these records can be found in Appendix 3.

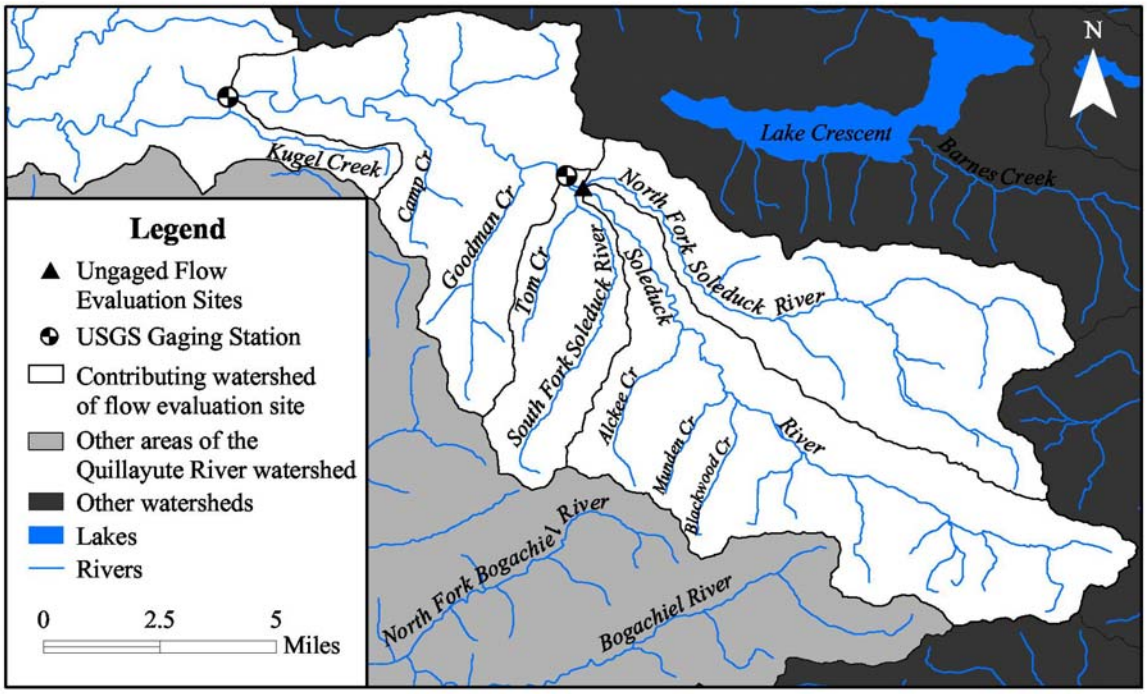

Figure 21. Locations within the upper Soleduck River watershed where natural flows were developed.

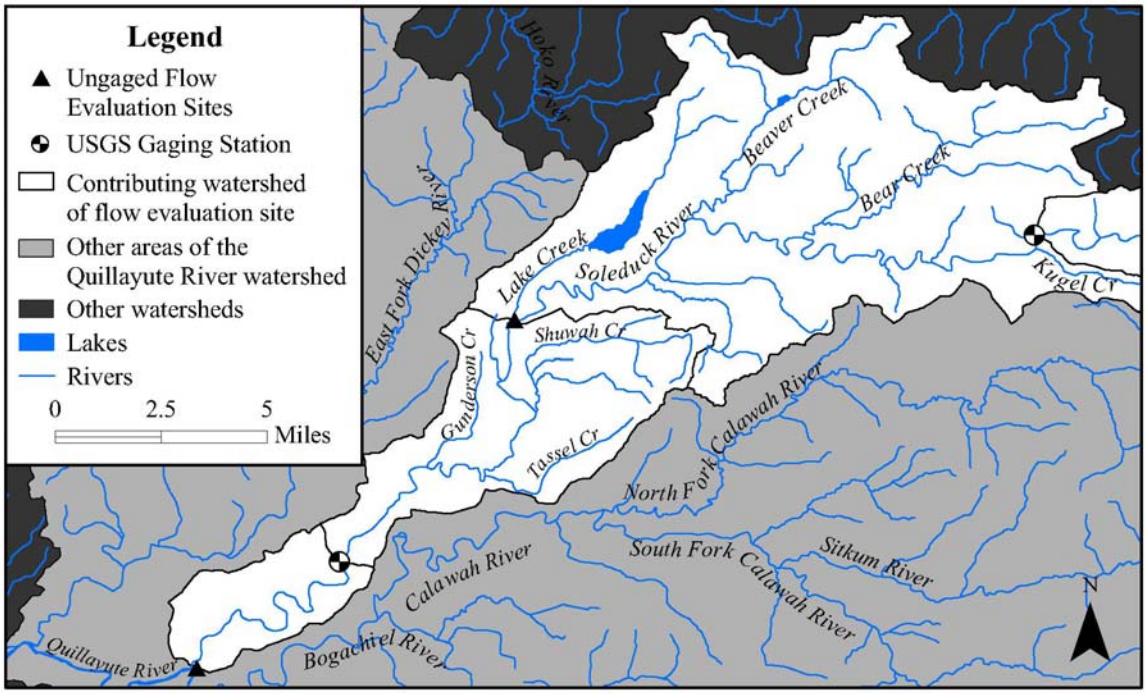

Figure 22. Locations within the lower Soleduck River watershed where natural flows were developed.

Table 35. Watershed characteristics within each portion within the Soleduck River watershed.

Watershed Characteristic Types	North Fork Soleduck River at Outlet	Soleduck River above North Fork Soleduck River confluence	Soleduck River at gage # 12041500 - Soleduck River nr Fairholm	Soleduck River at gage # 12042000 - Soleduck River nr Beaver	Soleduck River below Lake Creek	Soleduck River at gage # 12042500 - Soleduck River nr Quillayute	Soleduck River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	26.8	35.5	7.97	6.27	-	-	-
Upland	3.91	5.18	4.44	25.1	44.7	4.33	-
Lowland	-	-	-	-	20.0	13.9	-
Lake Pleasant	-	-	-	-	0.77	-	-
Lowland-*ineffective*	-	-	-	-	9.91	7.82	-
Coastal Lowland	-	-	-	-	-	-	5.09
Coastal Lowland-*ineffective*	-	-	-	-	-	-	3.78
Entire area	30.7	40.6	12.4	31.3	75.4	26.1	8.87

Table 36. Average annual precipitation of each portion within the Soleduck River watershed.

Watershed Characteristic Types	North Fork Soleduck River at Outlet	Soleduck River above North Fork Soleduck River confluence	Soleduck River at gage # 12041500 - Soleduck River nr Fairholm	Soleduck River at gage # 12042000 - Soleduck River nr Beaver	Soleduck River below Lake Creek	Soleduck River at gage # 12042500 - Soleduck River nr Quillayute	Soleduck River at Outlet
	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)
Highland	89.8	103.4	111.0	104.8	-	-	-
Upland	94.2	94.6	98.4	98.9	100.5	122.2	-
Lowland	-	-	-	-	116.0	111.9	-
Lake Pleasant	-	-	-	-	122.6	-	-
Lowland-*ineffective*	-	-	-	-	116.3	109.0	-
Coastal Lowland	-	-	-	-	-	-	93.2
Coastal Lowland-*ineffective*	-	-	-	-	-	-	88.8
Entire area	90.4	102.3	106.5	100.1	106.9	112.8	91.3

North Fork Soleduck River at the Outlet –

The North Fork Soleduck River outlets into the Soleduck River at RM 55.2, about 0.7 mile upstream of USGS gage 12041500. Precipitation in the contributing watershed varies between about 80 inches annually near Boulder Peak to over 102 inches at Aurora Peak. Streamflow for this location was estimated by separating out streamflow from the North Fork Soleduck River from that generated in the remaining areas of Soleduck River upstream of the gage using the watershed characteristics method.

The North Fork Soleduck River is dominated by highland subwatershed, which explains the bi-modal distribution of the hydrograph illustrated below. Winter precipitation creates the largest increase in streamflow, and an additional increase is attributable to snowmelt runoff in the spring month of May. The greatest variation in streamflow is exhibited between November and February, and baseflow conditions begin in August and can extend into October.

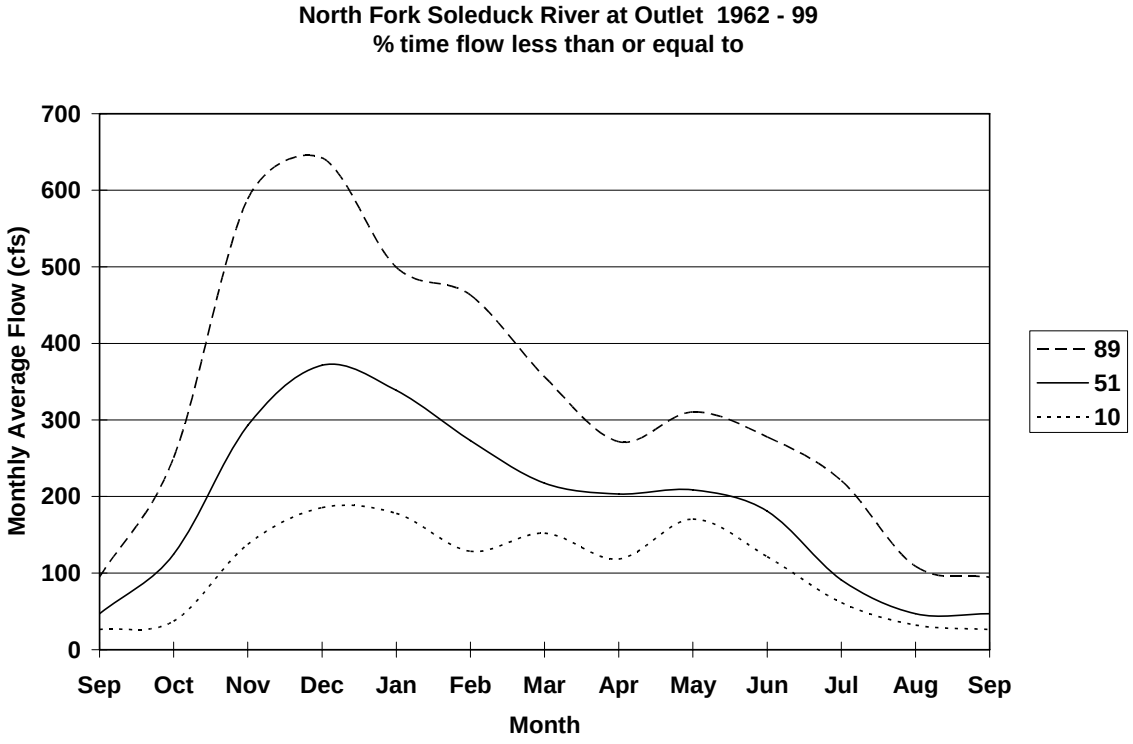

Table 37. The percent of time that average monthly streamflow (cfs) at the outlet of the North Fork Soleduck River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	250	589	642	499	463	356	272	311	278	221	109	95
51	125	293	372	339	273	217	203	209	181	91	47	47
10	37	138	185	178	128	152	118	170	121	61	32	26

Soleduck River above North Fork Soleduck River -

The Soleduck River above the North Fork Soleduck River contains several tributaries, including Blackwood Creek, Munden Creek, and Alckee Creek. Average annual precipitation is highest along the southern edge, where averages exceed 130 inches annually, and decreases to the north, averaging about 83 inches annually along the ridge separating the Soleduck and North Fork Soleduck River watersheds. Streamflow information was developed for this location using the watershed characteristics method against the USGS gage 12041500.

The months with the greatest variation in streamflow are November through January, as also seen in the North Fork Soleduck River. Baseflow levels can extend into October, but more often ends in September. Streamflow in the main stem Soleduck River also exhibits a bi-modal distribution, since the contributing area is dominantly characterized as highland subwatershed.

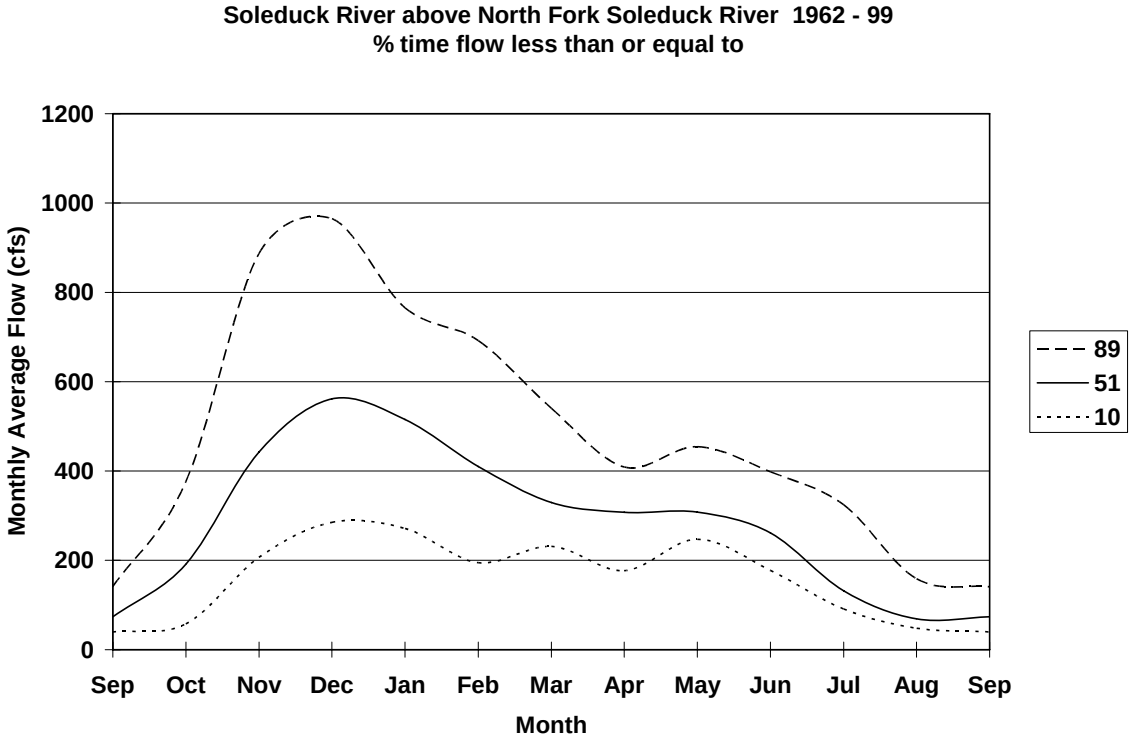

Table 38. The percent of time that average monthly streamflow (cfs) in the Soleduck River above the outlet of the North Fork Soleduck River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	376	887	965	765	692	541	409	455	398	324	159	141
51	191	443	561	515	410	330	308	308	261	132	69	73
10	58	207	285	272	195	231	177	247	177	91	48	40

Soleduck River near Fairholm (at USGS gage 12041500) –

Streamflow at this discontinued USGS streamflow gaging station is the result of the three major upstream basins, specifically the North Fork Soleduck River, the Soleduck above the North Fork, and the South Fork Soleduck River drainage. The gage summary provided by the USGS provides a latitude and longitude for the gage of having been located at River Mile 54.5. The contributing drainage area at this point was measured as 83.8 square-miles, and the altitude of the gage is about 1060 ft, where precipitation averages over 97 inches annually. Regression equations against the Quinault River USGS gage were used to estimate streamflow during ungaged times, as previously discussed.

Similar to each upstream basin, the months indicated with the greatest variability in streamflow are November through January and baseflow streamflow levels typically end in September.

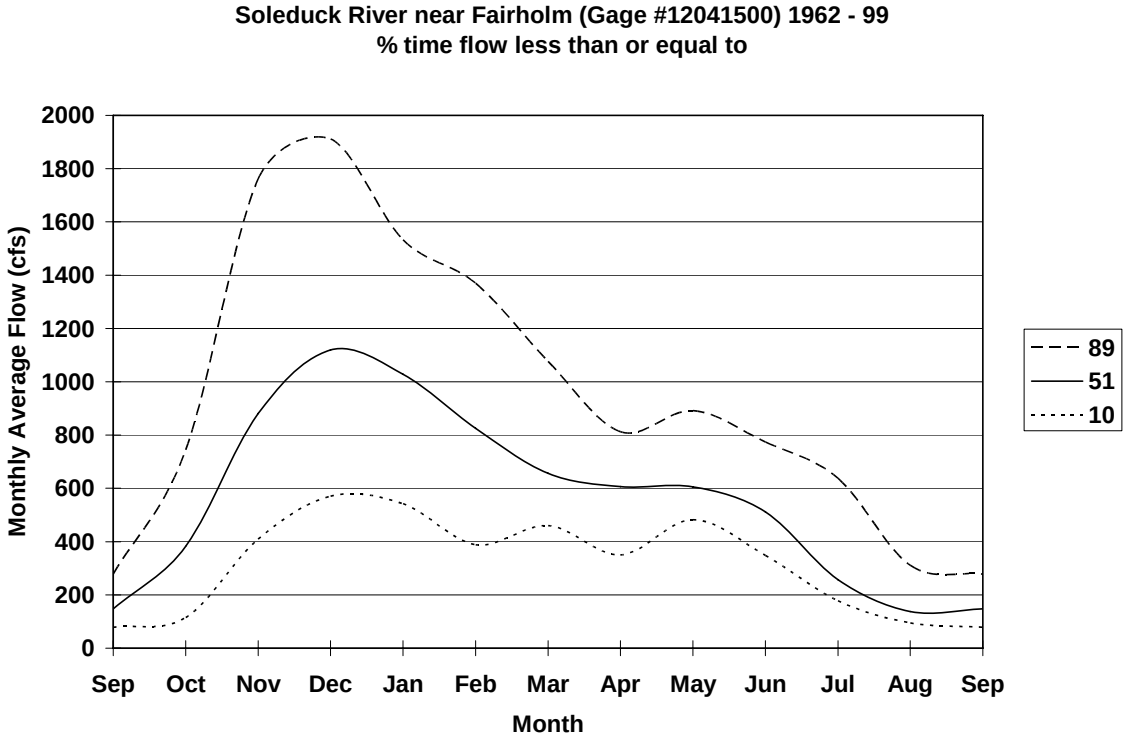

Table 39. The percent of time that average monthly streamflow (cfs) in the Soleduck River at the Fairholm gage is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	744	1761	1911	1533	1370	1077	812	892	773	638	311	278
51	383	881	1119	1028	825	656	606	606	512	257	138	148
10	115	410	571	542	388	460	350	483	348	177	95	79

Soleduck River near Beaver Creek (at USGS gage 12042000) –

The contributing area above this location measures 115.1 square-miles, and includes contributions from several tributaries, such as Goodman Creek and Camp Creek. Approximately 65 percent of this entire area is classified as highland subwatershed, and the remaining 35 percent is characterized by upland subwatershed. The watershed characteristics method was used to estimate streamflow at this location, since this gage only operated during the 1920's and no other Soleduck River gages were in operation at the time.

Flow in the Soleduck River is highest during the winter season precipitation maximum and recedes to minimum flow during the late summer and into the fall. This minimum flow season is indicated to extend occasionally into October, but more often ends in September. The months between November and January exhibit the greatest indicated variation in streamflow. The streamflow pattern is similar to that estimated at the USGS Fairholm gage, but the spring snowmelt runoff is less defined due to the increase of upland subwatersheds contributions.

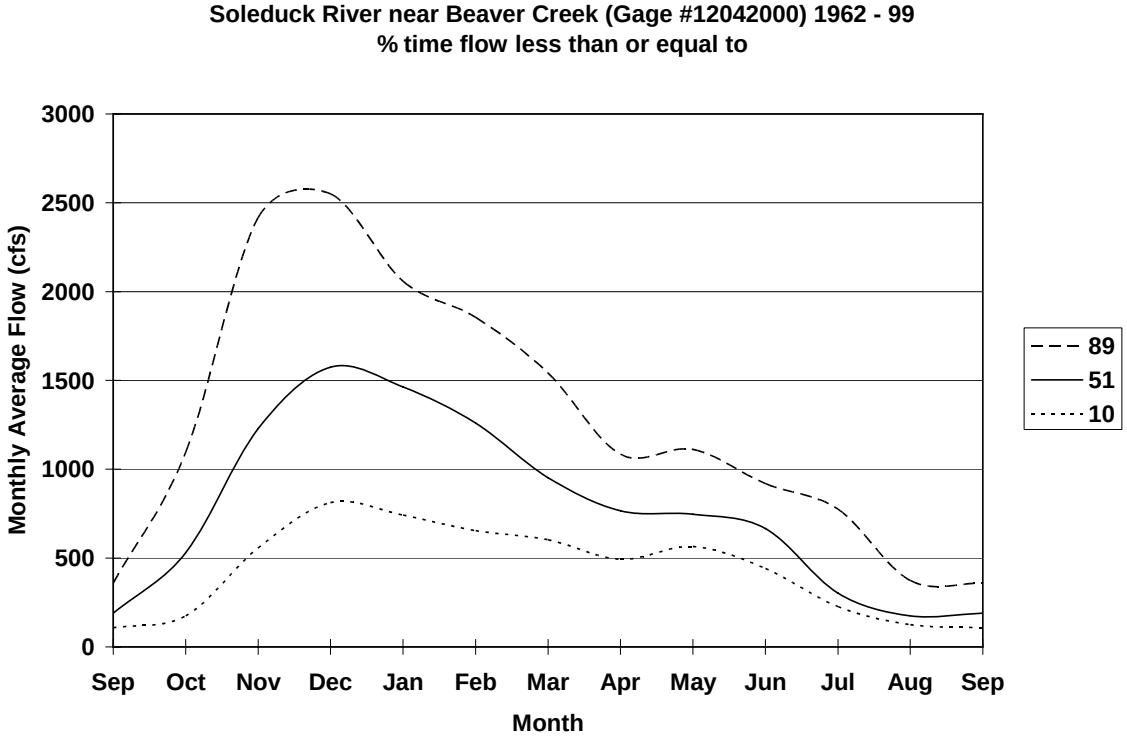

Table 40. The percent of time that average monthly streamflow (cfs) in the Soleduck River near Beaver Creek is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1094	2417	2550	2058	1855	1542	1084	1112	918	776	373	358
51	530	1229	1575	1463	1260	953	766	747	666	302	174	189
10	174	557	812	742	654	603	493	565	441	227	125	108

Soleduck River below Lake Creek –

The Soleduck River continues to the west and south, and is fed by Kugel Creek, Bear Creek, Beaver Creek, and Lake Creek. Soleduck River streamflow at this point represents flow at RM 24.46. Precipitation varies from around 90 inches annually along the northern edge of the Bear Creek drainage to over 125 inches to the north of Lake Pleasant, which feeds Lake Creek. Streamflow at this location was estimated using the watershed characteristics method.

Flow in the Soleduck River below Lake Creek is highest during the winter season precipitation maximum and recedes to minimum flow during the late summer and into the fall. This minimum flow season is indicated to extend occasionally into October, but more often ends in September. The months between November and January exhibit the greatest indicated variation in streamflow.

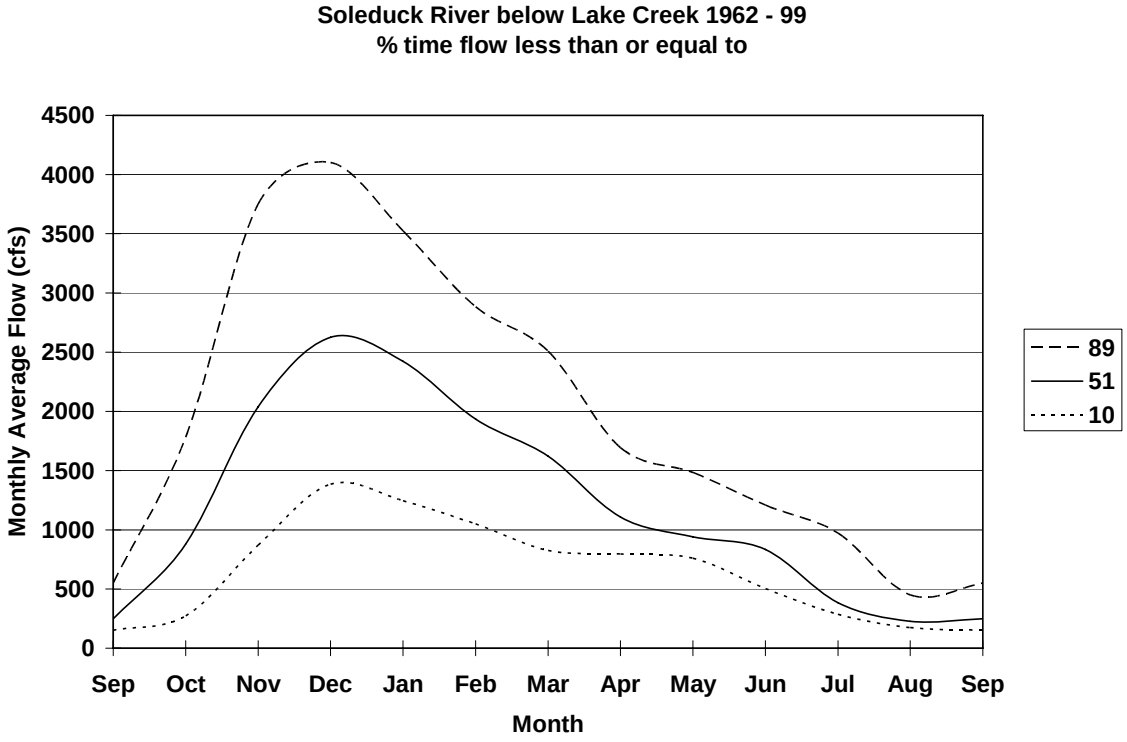

Table 41. The percent of time that average monthly streamflow (cfs) in the Soleduck River below Lake Creek is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1781	3751	4101	3525	2884	2509	1693	1483	1207	972	450	549
51	881	2039	2625	2422	1934	1621	1108	941	834	385	227	248
10	272	869	1386	1245	1049	826	796	760	503	286	174	152

Soleduck River near Quillayute (at USGS gage 12042500) –

Another small tributary name Gunderson Creek outflows into the Soleduck River downstream of Tassel Creek and is the last named tributary before the discontinued USGS gaging station near Quillayute. This gage was located at RM 13.81, where the Quillayute Road crosses the Soleduck River. The contributing drainage area above this location measures 216.6 square-miles. Precipitation ranges from 95 inches annually north of the gage up to over 123 inches annually along the Calawah Ridge.

Gaged streamflow information for the USGS gage 12042500 near Quillayute during the pertinent period of record between October 1961 and September 1999 was readily available between October 1977 and September 1980. To estimate the gains in streamflow that occurred between the Soleduck River gage near Fairholm and the gage near Quillayute, the Fairholm gaged data for this time period was subtracted from the Quillayute gaged data. These resultant change data were regressed back to the Fairholm gage as well as other nearby streamflow gages in the Calawah and Dickey River watersheds to estimate a complete period of record for the gains that occurred between the two Soleduck gage sites. After application of regression equations against the Calawah and Dickey River USGS gages, 14 percent of the period of record (64 months) had not been estimated due to a lack of sufficient gaged data. These remaining months were estimated from the extended synthetic Calawah River streamflow record. As a result, these remaining 64 months were created from data that originated from:

- Bogachiel River gaged streamflow data (6 values, April – Sept 1975)
- Hoko River gaged streamflow data (15 values, Oct 1973 - Sept 1974 and Aug - Oct 1983)
- Hoko River synthetic data made from precipitation data from Sappho, Clallam Bay, Forks, and Neah Bay (43 values)

This complete record of estimated gains was added to the extended Fairholm gage record to create an extended synthetic period of record for the Soleduck River at the Quillayute gage site between October 1961 and September 1999.

Calibration of these streamflow estimates for the Quillayute gage location was enabled by the discovery of several instantaneous streamflow measurements collected by the USGS at the gage location between November 1975 and August 1977. These instantaneous measurements provided anchor points in the streamflow hydrograph that were used to rescale the streamflow variation (or average daily streamflow values) exhibited at the Soleduck near Fairholm gage. This process of rescaling the Soleduck River gage near Fairholm produced an estimated daily hydrograph for the Quillayute gage location. These average daily values were summarized into total monthly streamflow in ac-ft, and then the total monthly streamflow values were compared to the estimated monthly streamflow value generated by adding the estimated gains between the two gages to the extended record for the Fairholm gage. This calibration provided uniquely beneficial information, since the data provided a relatively good estimate of

monthly total flow. For example, this calibration illustrated that gain values developed from other low elevation streamflow gages, such as the Dickey River and Calawah River USGS gages, provided better estimates of gains between the two Soleduck River gages than gain values deriven directly from the Soleduck River gage near Fairholm. High flow months were especially poorly developed from the Fairholm gage, as the values developed were extremely too large and provided estimates of streamflow at the Soleduck River gage near Quillayute that were unrealistically large. As a result of these findings, gain values developed using the Soleduck gage near Fairholm were used sparingly and only for months when the Calawah and Dickey River gage were not in operation.

Streamflow at this location is dominated by the winter season precipitation maximum, as illustrated throughout the Soleduck River. The snowmelt runoff during spring months does not exhibit a dramatic increase in streamflow on a monthly basis, unlike upstream areas. Streamflow levels recede to minimum flow in the late summer and extend most often in to September.

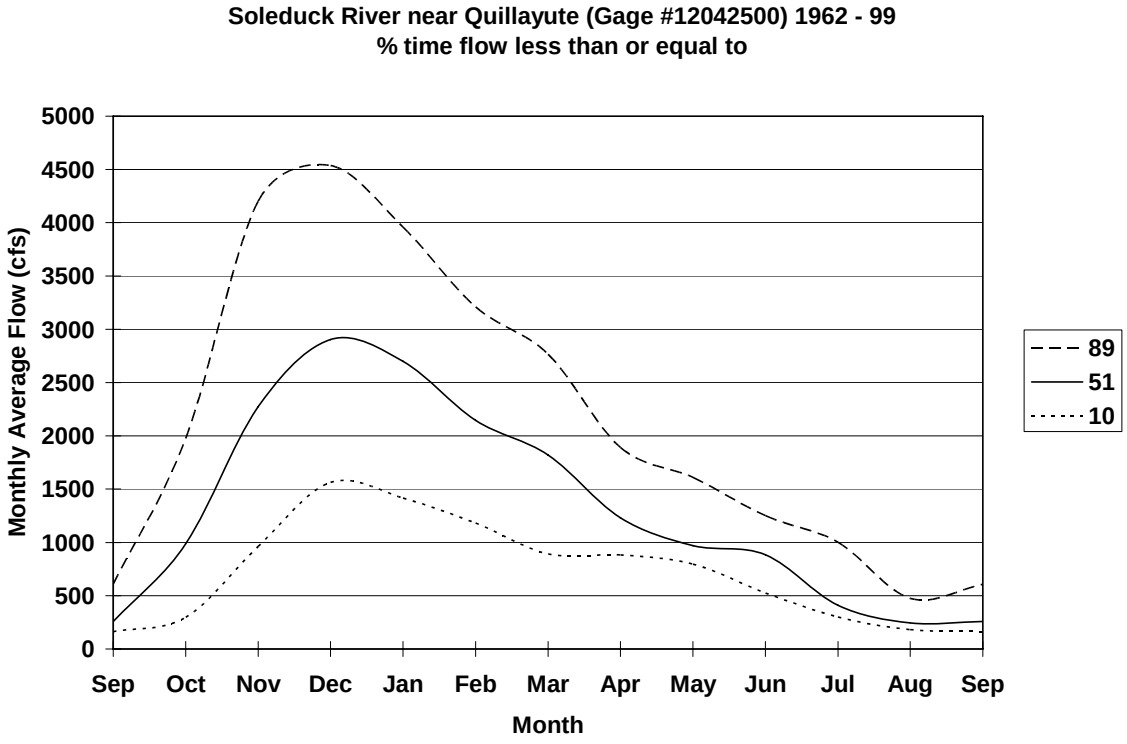

Table 42. The percent of time that average monthly streamflow (cfs) in the Soleduck River near Quillayute is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1976	4202	4537	3959	3211	2766	1891	1610	1249	1002	474	607
51	987	2274	2904	2699	2146	1820	1230	970	884	410	244	258
10	297	962	1564	1416	1181	893	883	796	525	300	183	162

Soleduck River at the Outlet –

As discussed previously, the Soleduck River outflows into the Bogachiel River to mark the beginning of the Quillayute River. Numerous historical instantaneous streamflow measurements were used to determine the change in streamflow in the Soleduck River the USGS gaging station 12042500 near Quillayute and the outlet. Specifically, 49 instantaneous streamflow measurements were collected at the mouth of the Soleduck River between September 20, 1977 and September 29, 1978. The Soleduck River gage near Quillayute was in operation during 46 of these measurements, beginning on October 1, 1977. The increase in Soleduck River streamflow between the gaging station near Quillayute and the outlet is considered to be negligible in most months, with the majority of months exhibiting a slight decrease in total monthly streamflow. This result can be explained by the characteristics of the last few downstream miles of the Soleduck Valley, which are wide and flat. The majority of precipitation that falls in this area does not directly contribute to streamflow due to interception and losses to evaporation or subsurface flow.

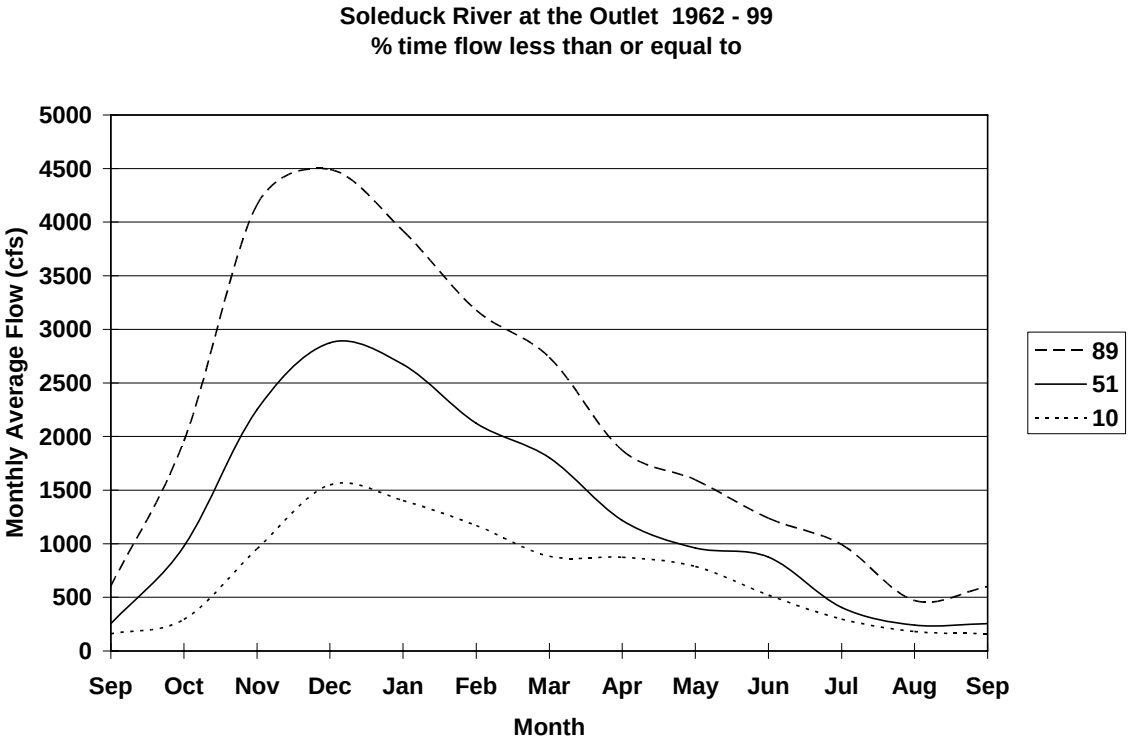

Table 43. The percent of time that average monthly streamflow (cfs) in the Soleduck River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1956	4160	4492	3919	3179	2739	1872	1594	1237	992	469	601
51	977	2251	2875	2672	2125	1802	1218	961	875	405	242	256
10	294	953	1549	1402	1169	884	874	788	519	297	181	160

Dickey River watershed –

The Dickey River watershed is the last major contributing area to the Quillayute River before it outflows into the Pacific Ocean. As illustrated in Figure 23 below, the Ozette River watershed is located to the west of the Dickey River watershed, while the Soleduck River is located to the east. Dickey River is fed by two main tributaries, the East Fork and West Fork Dickey Rivers. The direction of flow is in the southwestern direction before outflowing into the Quillayute River at RM 1.2.

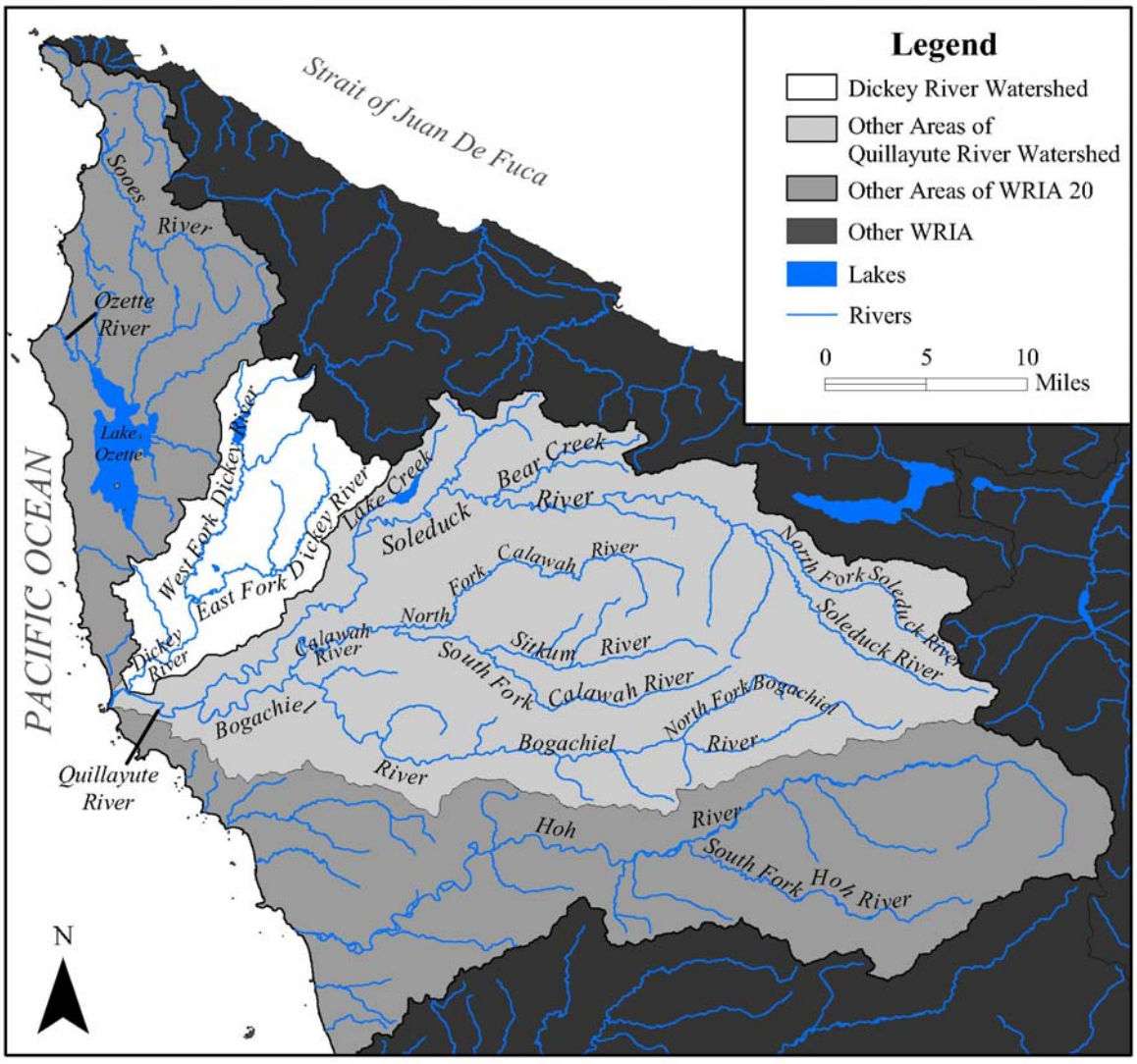

Figure 23. Location of Dickey River watershed within WRIA 20

The Dickey River watershed measures over 107 square-miles in area, of which the majority is private owned. The remaining areas are administered either by the

State of Washington or fall within the Olympic National Park, as summarized in Table 44 and illustrated in Figure 24 below. The small portion of land within the Olympic National Park is located at the mouth of the Dickey River watershed.

Table 44. Land Administration of the Dickey River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	0.5	0.5
State of Washington	30.9	28.8
Privately owned	75.8	70.7
Total Area	107.2	100

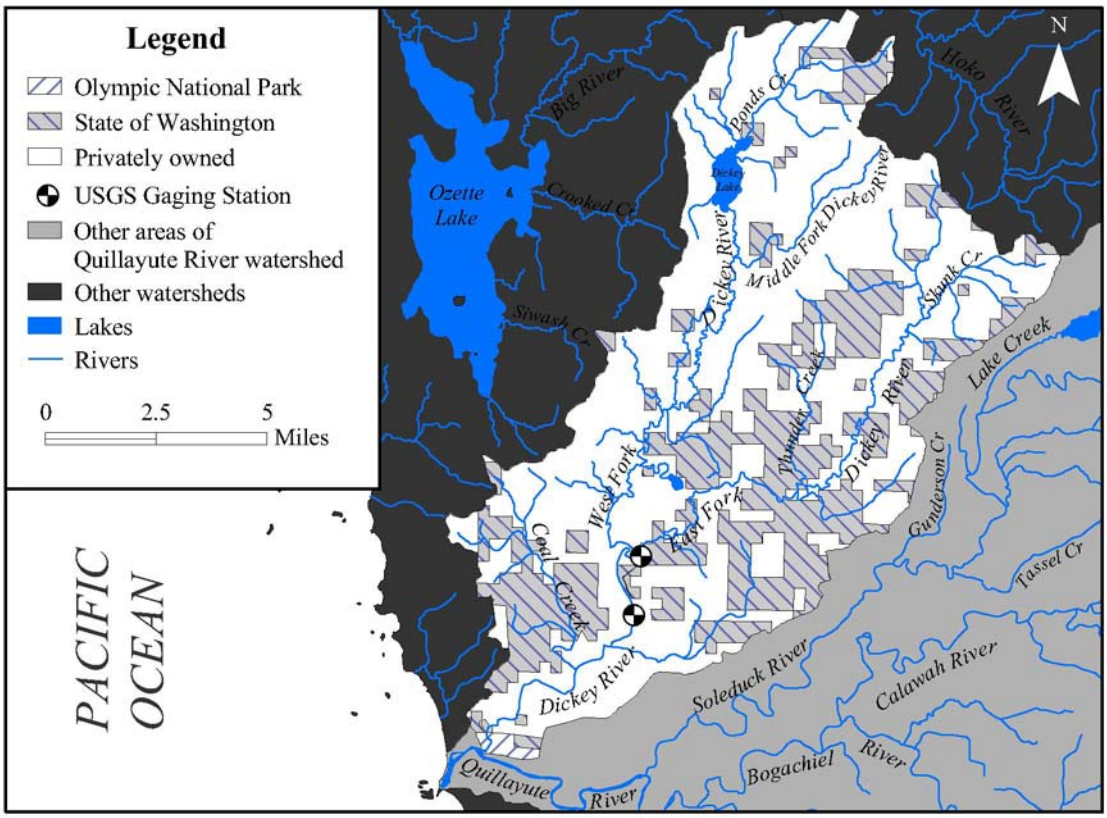

Figure 24. Land Administration of the Dickey River watershed.

Precipitation in the Dickey River watershed decreases from east to west, averaging over 120 inches annually at the headwaters down to less than 77 inches near the outlet. Also, elevation ranges from below 20 feet above sea level at the outlet to over 1950 at the headwaters. Since the elevation of this watershed are lower than most seen in the other Quillayute River watersheds, the watershed characteristics are dominated by upland and lowland subwatershed. The distribution of watershed characteristics is illustrated in Figure 25 and

summarized in Table 45. Unlike other Quillayute subwatershed, the coastal lowland subwatershed of the Dickey River was found to contribute directly to streamflow and is indicated to be "effective."

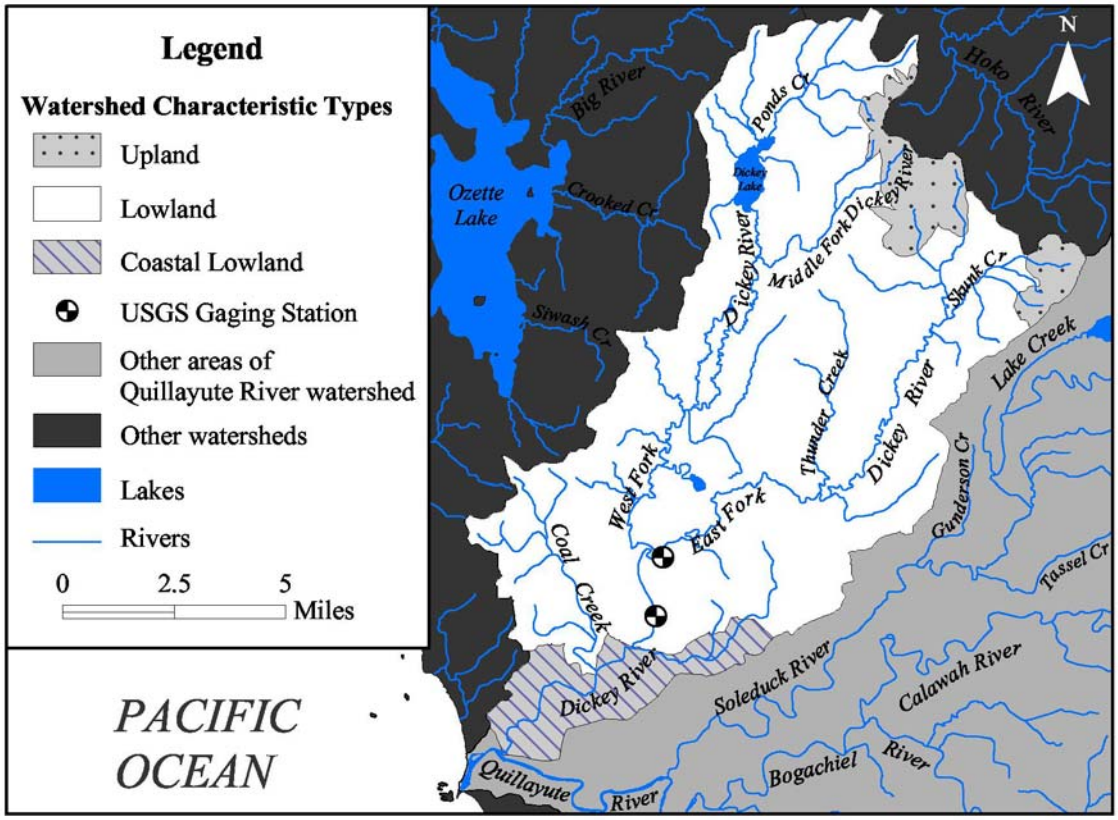

Figure 25. Watershed Characteristics within the Dickey River watershed.

Table 45. Watershed Characteristics within the Dickey River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Upland	6.6	6.2
Lowland	92.3	86.1
Coastal Lowland	8.3	7.7
Total Area	107.2	100

Streamflow Evaluations of the Dickey River

Streamflow in the Dickey River watershed was estimated at the locations indicated in Figure 26. Streamflow evaluation sites were either gaged by the USGS or are illustrated as ungaged. Streamflow for each gage location was first extended beyond the gaged period of record to create an complete, extended, synthetic period of record between October 1961 and September 1999. The watershed characteristics of the area above each gage enabled the estimation of streamflow at ungaged locations by use of the watershed characteristics method.

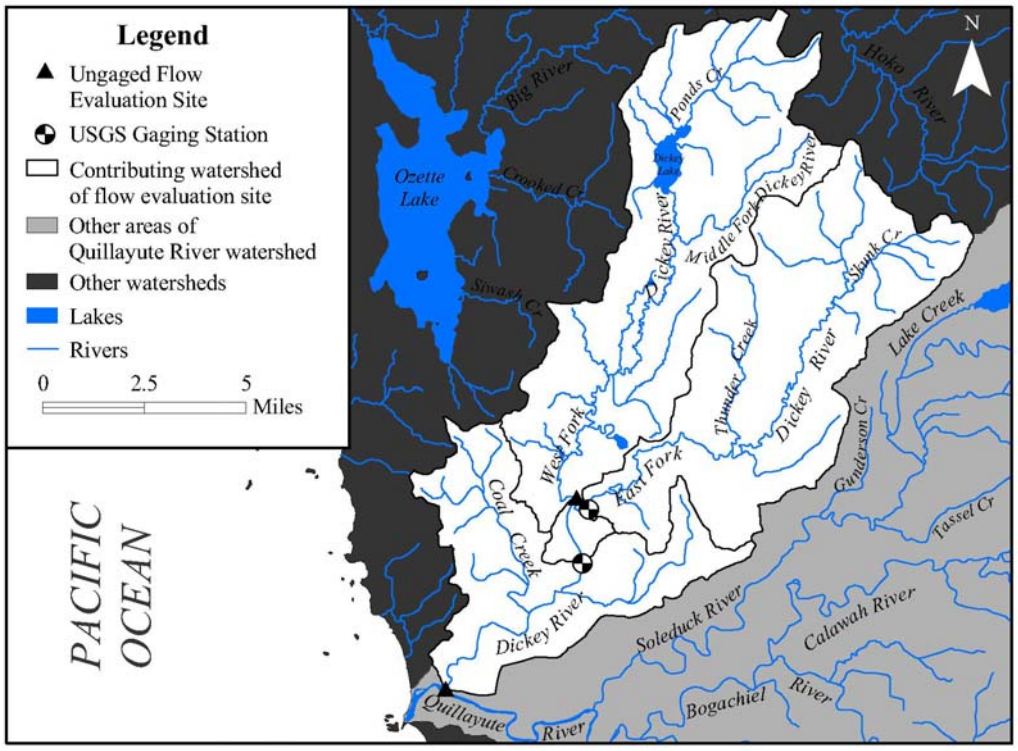

Figure 26. Flow evaluation sites within the Dickey River watershed.

Streamflow of the Dickey River watershed was measured by the USGS at two gage locations. These gages are:

- USGS Station Number 12043080 East Fork Dickey River near La Push, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

Extended periods of record for these gages were reconstructed using regression techniques in two separate efforts due to a change in personnel at Reclamation. A separate explanation for each final extended synthetic record is needed to clarify how the final data was developed and is documented in detail in the following sections, under their respective flow evaluation descriptions.

Streamflow was estimated at the ungaged sites by the watershed characteristics method. As such, watershed characteristic information was needed for each contributing watershed. A summary of the areas within each watershed characteristic type designated by contributing watershed, as described in Table 46. Also, the average annual precipitation values used to weight streamflow in the watershed characteristics method are summarized in Table 47.

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table for each evaluation site. These values are estimated from how frequent a monthly total flow occurred in the period between October 1961 and September 1999.

Table 46. Watershed characteristics within each portion of the Dickey River watershed.

Watershed Characteristic Types	East Fork Dickey River at gage # 12043080 or at Outlet Area (sq. mi.)	West Fork Dickey River at Outlet Area (sq. mi.)	Dickey River at gage # 12043100 – Dickey River nr La Push Area (sq. mi.)	Dickey River at Outlet Area (sq. mi.)
Upland	4.09	2.54	-	-
Lowland	35.5	40.9	1.64	14.2
Coastal Lowland	-	-	-	8.30
Entire area	39.6	43.4	1.64	22.5

Table 47. Average annual precipitation of each portion within the Dickey River watershed.

Watershed Characteristic Types	East Fork Dickey River at gage # 12043080 or at Outlet Ave Ann Precip (in.)	West Fork Dickey River at Outlet Ave Ann Precip (in.)	Dickey River at gage # 12043100 – Dickey River nr La Push Ave Ann Precip (in.)	Dickey River at Outlet Ave Ann Precip (in.)
Upland	117.3	114.6	-	-
Lowland	102.3	96.8	85.5	84.0
Coastal Lowland	-	-	-	83.2
Entire area	103.8	97.8	85.5	83.7

East Fork Dickey River at the Outlet (at USGS gage 12043080) –

Streamflow measurements were collected by the USGS in the East Fork Dickey River at a gage location just upstream of the confluence with the West Fork Dickey River, where the Mina Smith Rd crosses the East Fork Dickey River. The USGS measured streamflow at this location for the two months of August and September 1962 and continuously between April 1963 and September 1968. As mentioned previously, an extended period of record for this gage was reconstructed using regression techniques in two separate efforts due to a change in personnel at Reclamation. The initial reconstruction effort created a complete synthetic period of record for this gage between October 1961 and September 1998. This reconstruction was undertaken after an extended synthetic period of record was generated for the Dickey River main stem gage. The original East Fork extended record was estimated directly from the original synthetic record for the Dickey River gage. The Dickey River gaged record was extended using regressions developed against the extended record of USGS Gage 12043300, Hoko River near Sekiu. Both the extension of the Hoko River gage and the Dickey River gage were completed on a monthly basis (an equation was developed for each month to accurately reflect seasonal variability). As mentioned previously, the Hoko River gage was extended against total monthly precipitation measured at gages in Sappho, Clallam Bay, Forks, and Neah Bay.

When new personnel was assigned to this project, several values in the original extended record for the East Fork Dickey River gage were updated to more accurately account for baseflow conditions in the late summer months of August and September, as well as to extend the record to include water year 1999 (October 1998 to September 1999). These updated months were estimated mainly from regression equations developed against gaged monthly totals from the Hoko River streamflow gage, but 4 monthly total streamflow values were updated based the Hoko River synthetic record. Of course, the extended synthetic Hoko River period of record was updated also as a result of the change in personnel. This new Hoko River record was redeveloped based on entirely streamflow data and did not use any local precipitation gages. These remaining 4 months were estimated using regression equations against this updated synthetic record for the Hoko River gage, which originated through regressions between the Hoko River gage and the streamflow gages on the Calawah River and the Hoh River at Highway 101.

As a result of this secondary effort, total monthly streamflow estimates were generated for 118 months or 26 percent of the entire period of record. These later additions are reflected in the first 4 rows of Table 48 below, which indicates the source of monthly total streamflow data estimated for the East Fork Dickey River and the percent of the total synthetic record that was estimated from each source.

Table 48. Methods used to develop final synthetic period of record for the East Fork Dickey River (at USGS gage #12043080).

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow on East Fork Dickey River	68	14.9%
Estimated using regression equations against Hoko River gage	46	10.1%
Estimated using regression equations against Hoko River estimates derived from Calawah River gage	2	0.4%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	2	0.4%
Estimated using regression equations against Dickey River gage	109	23.9%
Estimated using regression equations against Dickey River estimates derived from Hoko River gage	84	18.4%
Estimated using regression equations against Dickey River estimates derived from Neah Bay Precipitation gage	85	18.6%
Estimated using regression equations against Dickey River estimates derived from Sappho Precipitation gage	50	11.0%
Estimated using regression equations against Dickey River estimates derived from Neah Bay Precipitation estimates	8	1.8%
Estimated using regression equations against Dickey River estimates derived from Sappho Precipitation estimates	2	0.4%
Total number of months	456	100%

The extended synthetic period of record developed for the East Fork Dickey River gage location was considered equal to the streamflow at the outlet, since the East Fork Dickey River only continues another 1100 feet before it joins the West Fork Dickey River to mark the beginning of the mains stem Dickey River. As such, the extended record was used to develop the illustration of streamflow variation in the East Fork Dickey River at the outlet. Streamflow in the East Fork Dickey River exhibits the greatest variation due to the winter seasonal precipitation maxima. The specific months with the greatest variation are from November to January. Streamflow recedes into baseflow conditions during the summer months of July and August, and baseflow conditions extend typically into September.

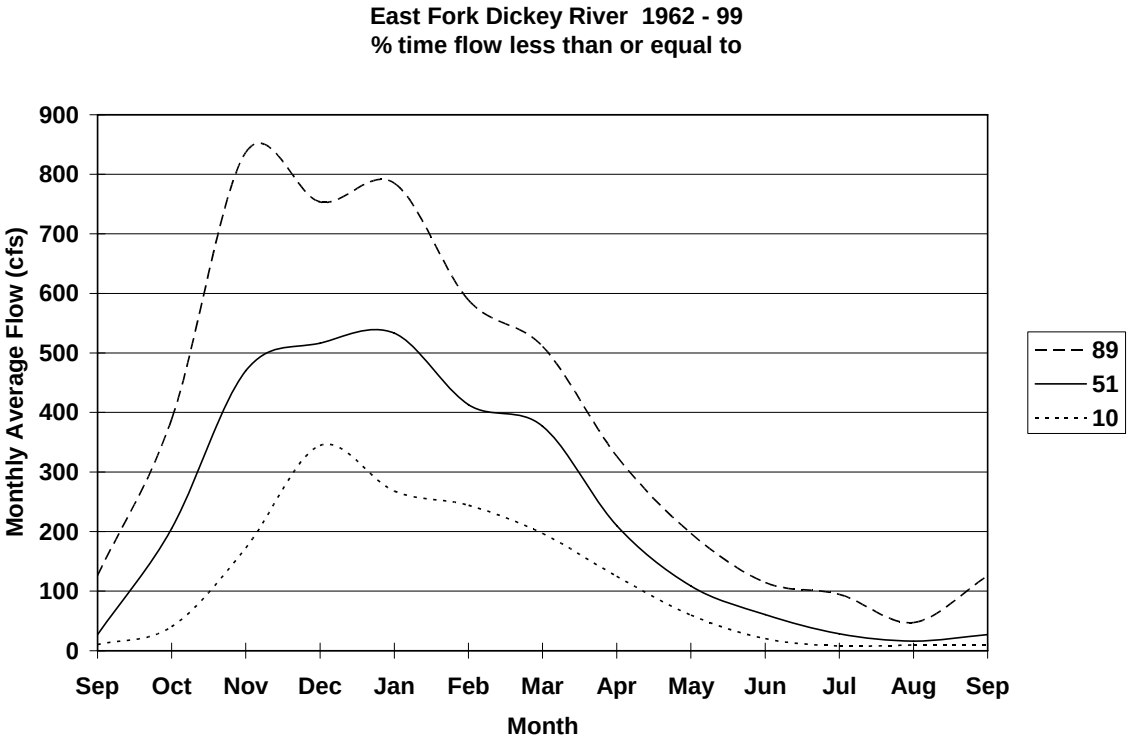

Table 49. The percent of time that average monthly streamflow (cfs) at the outlet of the East Fork Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	389	836	753	785	589	511	326	197	115	95	47	126
51	205	470	516	533	413	377	210	109	61	28	16	27
10	40	172	344	268	244	197	125	60	20	8	9	10

West Fork Dickey River at the Outlet –

Streamflow in the West fork Dickey River was estimated using the watershed characteristics method. The West Fork Dickey River was estimated by the WCM subtracting the extended synthetic record for the East Fork Dickey River gage from the extended synthetic record for the Dickey River near La Push gage. Some additional flow was also subtracted from this resultant flow, to account for the additional flow that is generated by the contributing area between the Dickey River gage location and the confluence of the East Fork and West Forks. Several miscellaneous streamflow measurements were also collected by the USGS at the mouth of the West Fork Dickey River watershed. These 8 measurements were collected in the summer months between July 1962 and August 1966, which enabled calibration of monthly baseflow estimates. The streamflow in the West Fork Dickey River is very similar to that exhibited by the East Fork Dickey River, but are slightly greater due to the larger contributing area of the West Fork Dickey River watershed. The months of greatest variation are between November and January each year, and baseflow conditions occur in the late summer months of August and September.

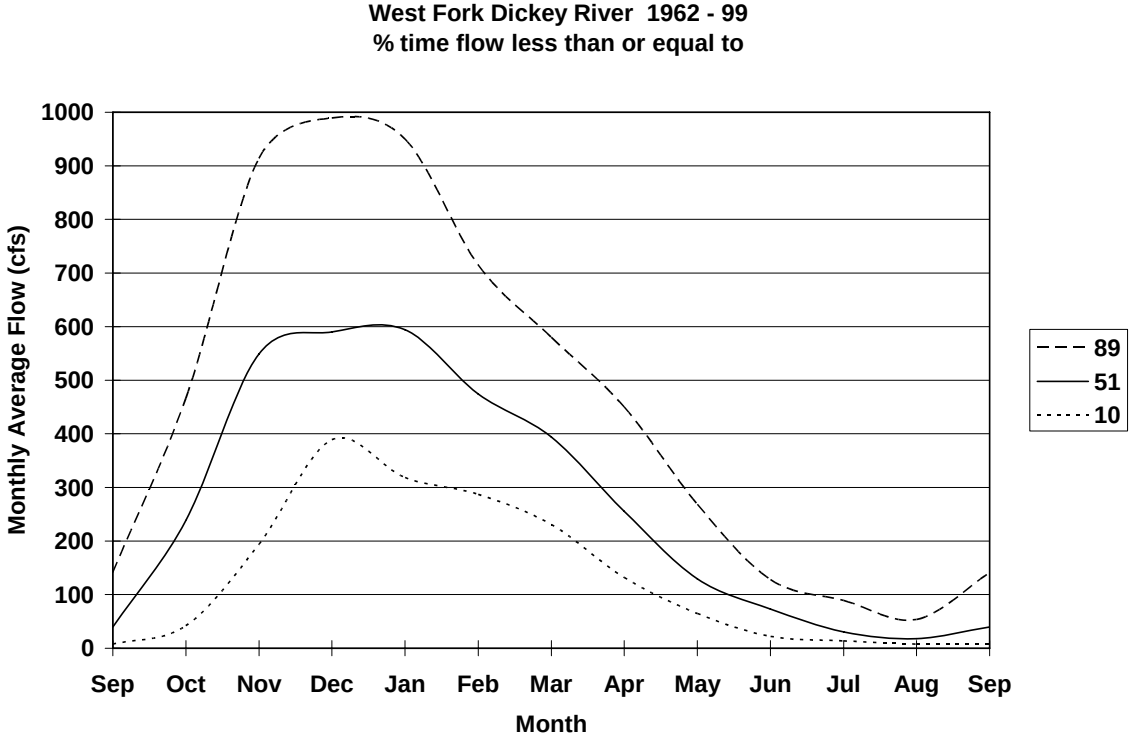

Table 50. The percent of time that average monthly streamflow (cfs) at the outlet of the West Fork Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	466	914	989	950	715	580	450	268	128	89	54	141
51	239	549	590	594	474	394	255	129	73	30	18	40
10	42	194	389	318	287	231	132	65	22	14	8	8

Dickey River near La Push (at USGS gage 12043100) –

Streamflow measurements were collected by the USGS on the main stem of the Dickey River at RM 6.0. This gage was in operation continuously between September 1962 and October 1973, as well as continuously between October 1976 and September 1980. As discussed previously, the Dickey River gaged record was initially extended using regression equations developed against an extended synthetic record developed for USGS Gage 12043300, Hoko River near Sekiu. When new personnel was assigned to this project, the extended synthetic record for this gage was redeveloped entirely based solely on streamflow data. These estimates were developed using regression equations that were developed either for individual months, if sufficient coincidental data existed, or by including all months together in one dataset to generate only one relationship of monthly total streamflow between the gages. Although 403 months or 88 percent of the entire period of record was developed from other gaged values, the remaining 53 months had to be estimated from the extended synthetic period of record for the Hoko River near Sekiu gage (USGS gage 12043300). Of course, the extended synthetic Hoko River period of record was updated also as a result of the change in personnel. This new Hoko River record was also redeveloped based on entirely streamflow data and did not use any local precipitation gages. These remaining 53 months needed to complete the extended period of record for the Dickey River gaged were estimated using regression equations against this updated synthetic record for the Hoko River gage. These 53 months are reflected in the last 4 rows of Table 51, which indicates the source of monthly total streamflow data estimated for the Dickey River near La Push and the percent of the total synthetic record that was estimated from each source.

Table 51. Methods used to develop final synthetic period of record for the Dickey River near La Push (at USGS gage #12043100).

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow	181	39.7%
Estimated using regression equations against Hoko River gage	128	28.1%
Estimated using regression equations against Hoh River at Highway 101 gage	54	11.8%
Estimated using regression equations against Calawah River gage	32	7.0%
Estimated using regression equations against Bogachiel River gage	5	1.1%
Estimated using regression equations against Soleduck River near Fairholm gage	3	0.7%

Estimated using regression equations against Hoko River estimates derived from Calawah River gage	24	5.3%
Estimated using regression equations against Hoko River estimates derived from Sooes River gage	16	3.5%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	10	2.2%
Estimated using regression equations against Hoko River estimates derived from Bogachiel River gage	3	0.7%
Total number of months	456	100%

Streamflow variation in the Dickey River near La Push is illustrated below in the percent of time an average monthly streamflow (in cfs) occurred between October 1961 and September 1999 (water years 1962 – 1999). The months with the greatest variation in streamflow occur during the winter months of November and January when winter precipitation is greatest. Baseflow conditions occur in the late summer months of August and September.

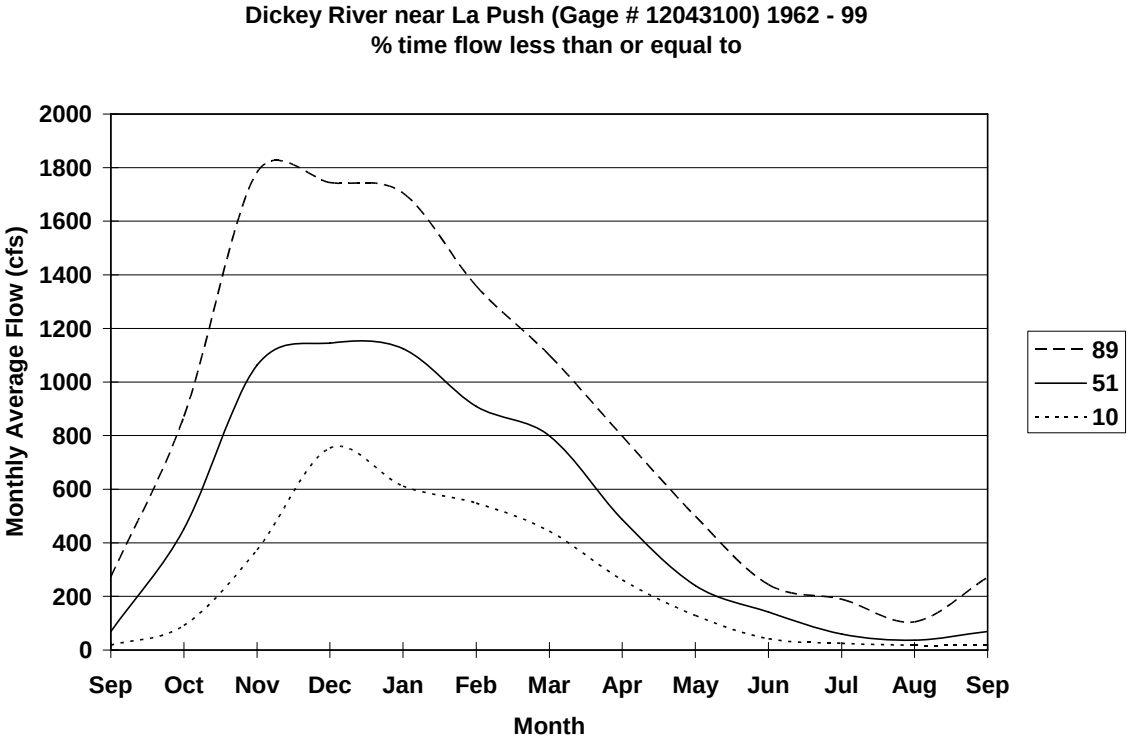

Table 52. The percent of time that average monthly streamflow (cfs) in the Dickey River near La Push is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	871	1782	1744	1704	1358	1100	798	499	244	189	105	271
51	452	1063	1145	1124	909	799	487	240	142	59	37	69
10	92	373	754	611	548	443	261	129	42	25	18	18

Dickey River at the Outlet –

The Dickey River is the last tributary to the Quillayute River before the outlet into the ocean, joining the Quillayute River at RM 1.25. Streamflow at the outlet of the Dickey River watershed was estimated by the WCM against USGS gage 120431000, Dickey River near La Push. Although the lower areas of the watershed exhibit coastal lowland characteristics, these areas were found to be effective by examining miscellaneous streamflow measurements collected during low flow conditions of September 2002. These measurements exhibited approximately a 3 cfs increase in streamflow between USGS gage 12043100, Dickey River near La Push and at RM 0.15 on the Dickey River. This estimated streamflow record can be found in Appendix 3. The resultant period of record was used to illustrate the variation in streamflow of the Dickey River at the outlet. The months of greatest variation are clearly between November and January. Baseflow conditions are similar to those found upstream, which extend between August and September.

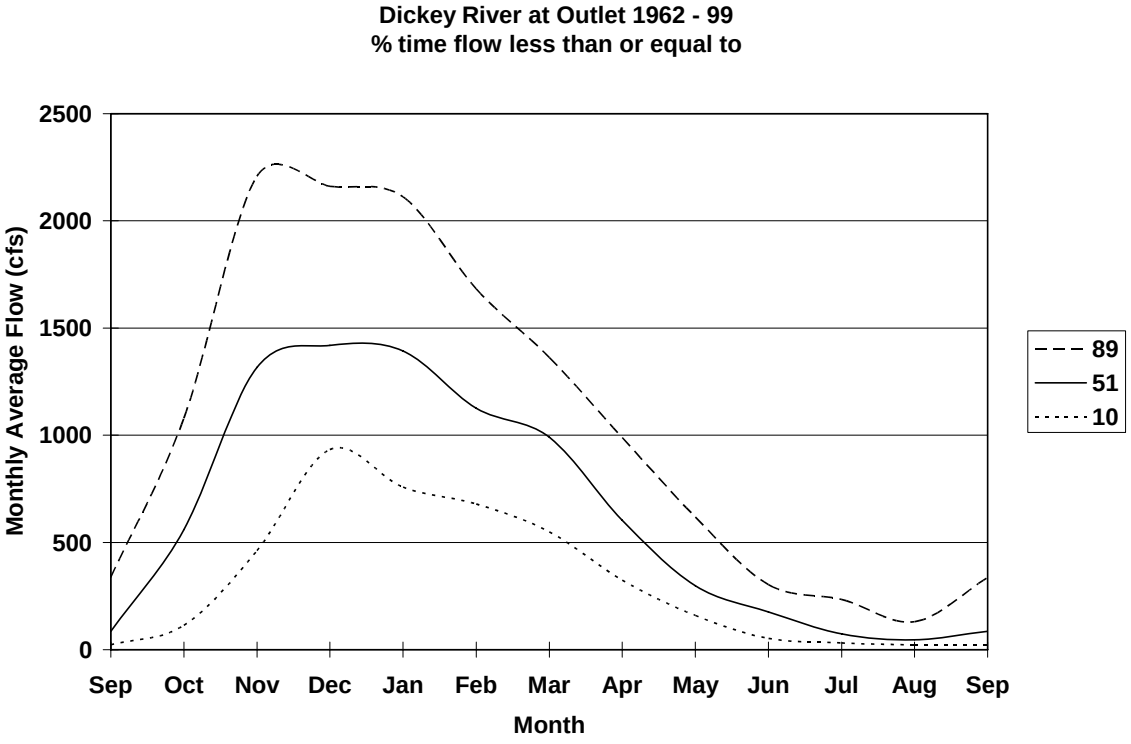

Table 53. The percent of time that average monthly streamflow (cfs) at the outlet of the Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1079	2208	2161	2112	1683	1363	989	619	302	234	131	336
51	560	1317	1419	1393	1126	990	604	298	176	74	46	85
10	114	462	934	757	679	549	324	159	52	31	22	22

Quillayute River watershed

The Quillayute River begins at the confluence of the Soleduck and Bogachiel Rivers and travels only 6.5 miles before it outflows into the ocean. The remaining 6.9 square-miles of contributing area in the Quillayute River watershed below the Soleduck and Bogachiel confluence is entirely below 300 feet above sea level. As a result, this entire area is characterized entirely as coastal lowland subwatershed and was considered ineffective to flow due to a lack of streamflow measurements that proved otherwise. Precipitation ranges from 74 inches annually near the outlet and increases to the east up to 87 inches annually at the Soleduck and Bogachiel River confluence. Administration of this area is dominated by private owners, as summarized in Table 54 and illustrated in Figure 27.

Table 54. Land administration within the Quillayute River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	1.9	27.1
State of Washington	0.52	7.6
Quillayute Indian Reservation	0.61	8.8
Privately owned	3.9	56.6
Total Area	6.9	100

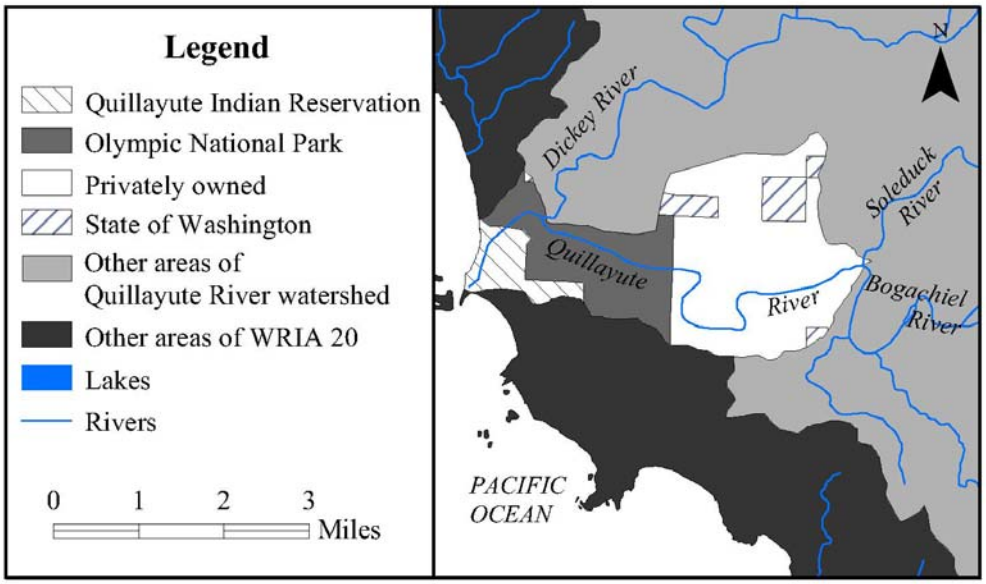

Figure 27. Land administration within the Quillayute River watershed.

Quillayute River below Soleduck and Bogachiel River confluence –

The Quillayute River begins at the Soleduck River and Bogachiel River confluence. Therefore streamflow at the top of the Quillayute River was estimated by merely adding together the outflow of these two rivers. The resultant streamflow was evaluated to demonstrate the variation in streamflow as illustrated below. Similar to the tributary watersheds, the months exhibiting the greatest variation are between November and January, and baseflow conditions occur in the late summer months of August and September.

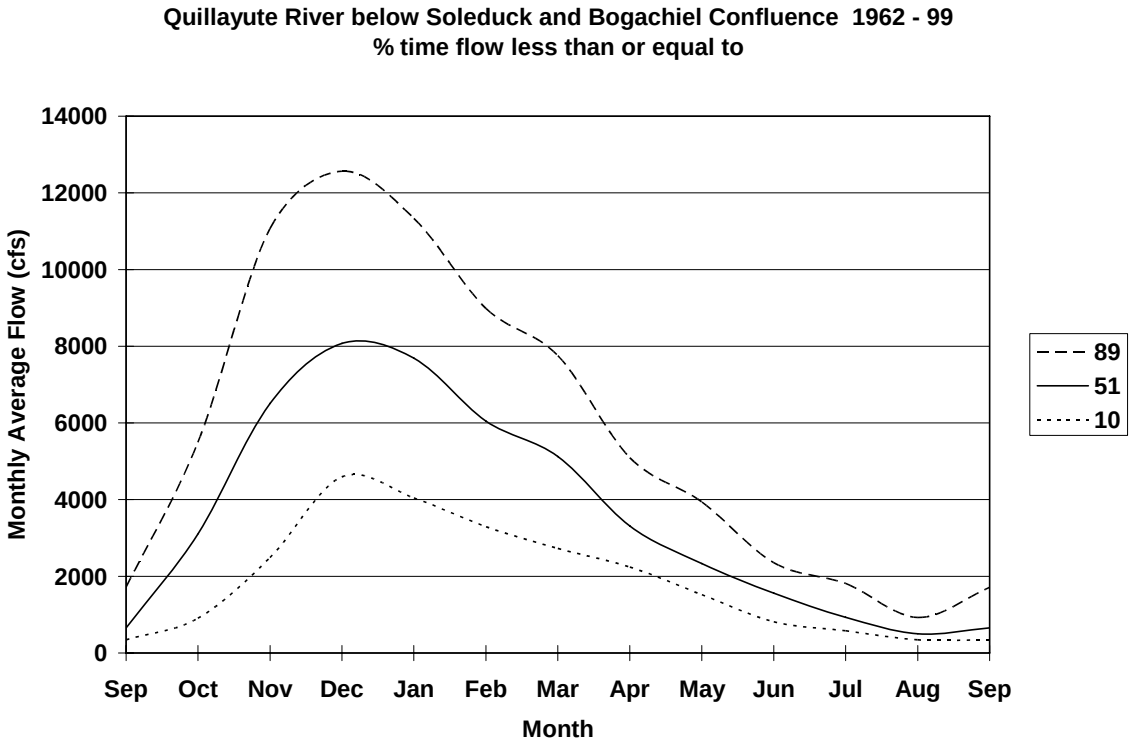

Table 55. The percent of time that average monthly streamflow (cfs) at the top of the Quillayute River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	5496	11062	12565	11335	8986	7756	5097	3937	2356	1813	926	1713
51	3108	6510	8073	7689	6049	5124	3314	2333	1559	932	502	656
10	904	2490	4593	4045	3292	2730	2246	1522	814	582	348	344

Quillayute River below Dickey River or at the Outlet –

As mentioned previously, the lowest areas of the Quillayute River watershed were not considered to contribute significantly to streamflow in the Quillayute River. For this reason, streamflow in the Quillayute River watershed below Dickey River was estimated by adding the Dickey River outflow to the estimates generated for the Quillayute River below the Soleduck and Bogachiel Rivers confluence. Again, the Dickey River outflows into the Quillayute River watershed only 1.25 miles upstream from the ocean outlet, thus streamflow at this point is considered equal to that at the outlet. Additionally, it may be difficult to accurately measure streamflow at this location, since it may be affected by tidal fluctuations in the Pacific Ocean. Nonetheless, the variation in streamflow expected at this location is illustrated below. The months exhibiting the greatest variation are between November and January, and baseflow conditions occur in the late summer months of August and September.

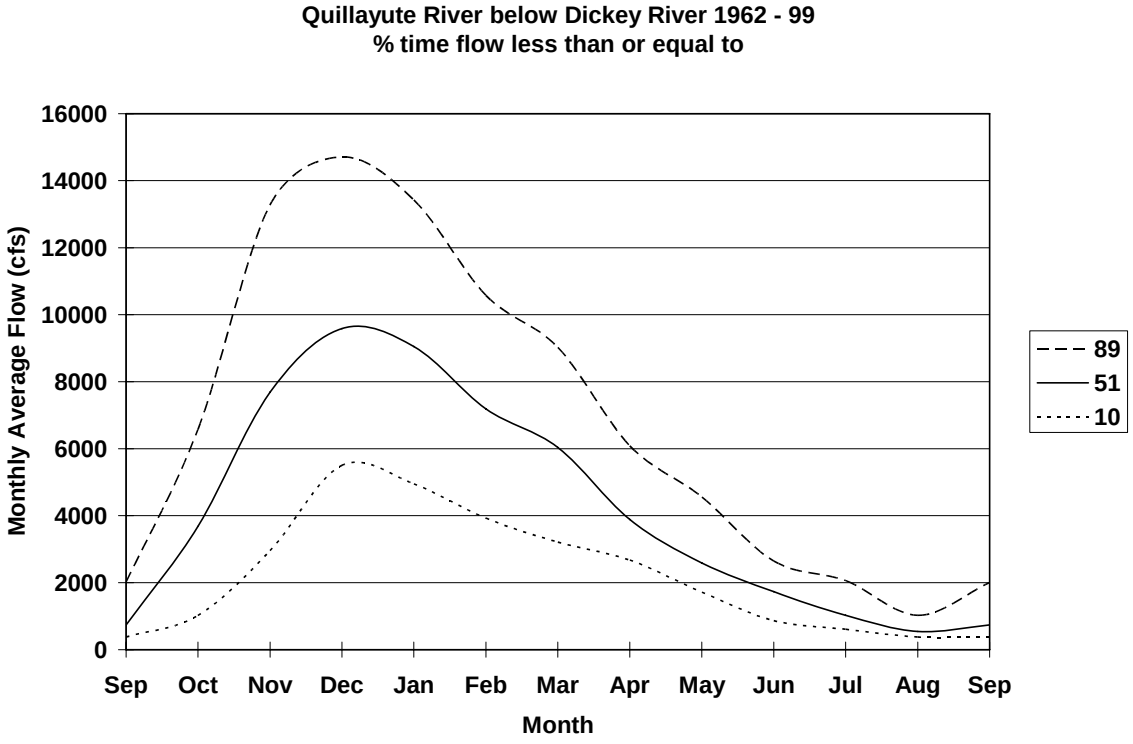

Table 56. The percent of time that average monthly streamflow (cfs) at the Quillayute River below Dickey River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	6564	13270	14707	13423	10576	9018	6087	4556	2642	2057	1023	2006
51	3676	7686	9589	9052	7188	6033	3887	2590	1731	1023	540	735
10	1018	2952	5503	4946	3920	3211	2672	1709	865	608	376	378

Ozette River watershed

The Ozette River is a major stream drainage on the western edge of the Olympic Mountains that drains into the Pacific Ocean. The entire drainage area measures 88 square-miles, and the outflow from Lake Ozette marks the beginning of the Ozette River. The Ozette River watershed encompasses approximately 7.4 percent of WRIA 20, and is located on the northern part of WRIA 20. Figure 28 below illustrates the location of the Ozette River watershed within WRIA 20.

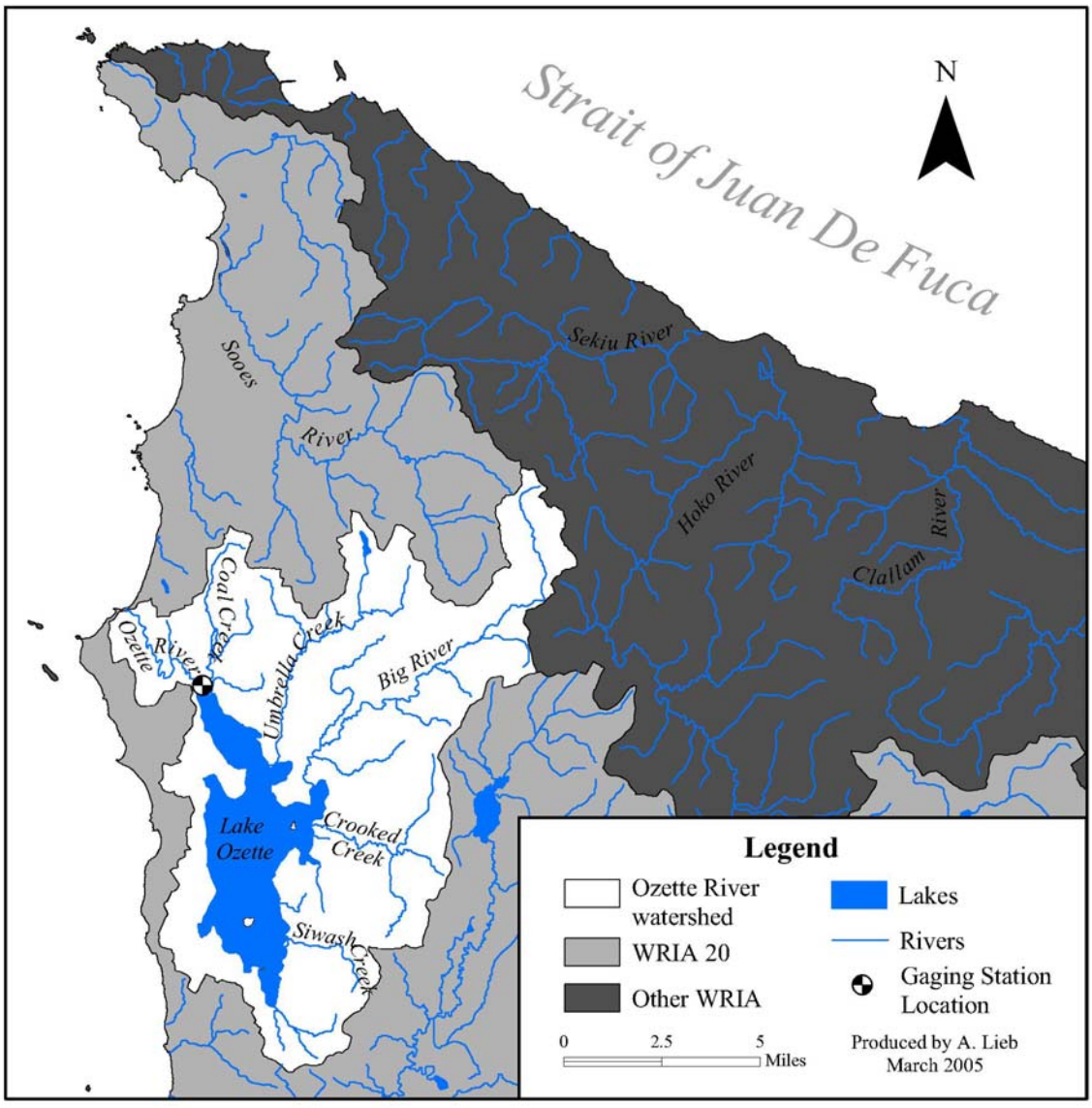

Figure 28. Location of Ozette River watershed.

The Sooes River basin is located to the north, and the Dickey River basin, within the Quillayute River watershed, borders the Ozette River basin on the South. The Ozette headwaters from Big River are located east of the Hoko River drainage, which is location within WRIA 19.

Elevation of the Ozette River watershed ranges from over 1950 ft at Sekiu Mountian down to sea level at the outlet. Average annual precipitation is highest along the eastern watershed edge, reaching over 130 inches per year at the headwaters, and decreases to the west with the lowest values of less than 73 inches per year occurring along the southwest edge of the drainage. The southeastern portion of the watershed lies within the Olympic National Park, which includes the area of Lake Ozette. The remaining drainage basin is either administered by the State of Washington or is privately owned. The administrative areas for the Ozette River water are illustrated in Figure 29, and Table 57 summarizes the Ozette drainage areas by land management.

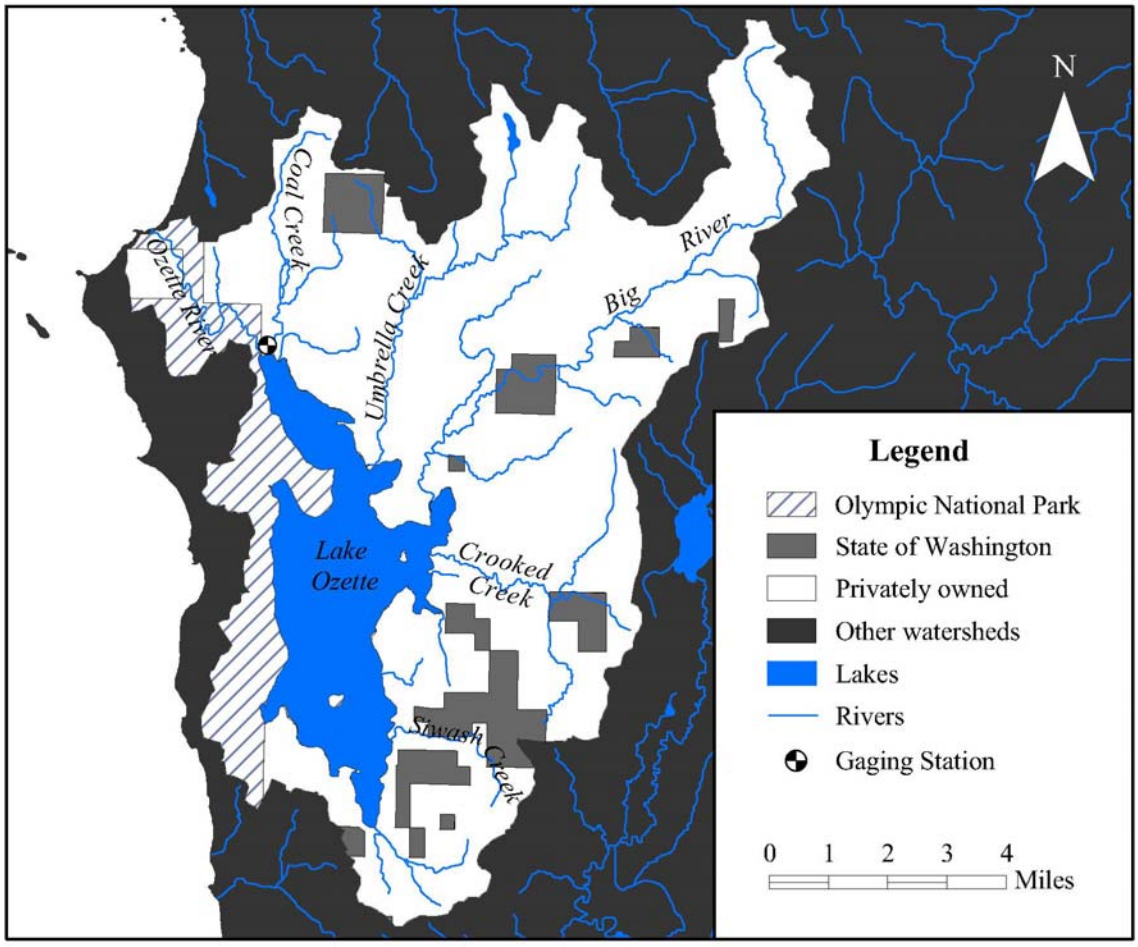

Figure 29. Land Administration within the Ozette River watershed.

Table 57. Land administration within the Ozette River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	8.4	9.6
Lake Ozette (Olympic National Park)	11.6	13.2
State of Washington	6.8	7.7
Privately owned	61.2	69.5
Total Area	88.0	100

The Ozette River basin is dominated by lowland areas, with only a small upland area at the headwaters of Big River. Upland areas generally begin near 600 ft above sea level and extend to less than 3200 ft. Upland areas are either located below the average snow line or the snow usually melts within a short period of time. Upland areas contribute large portions of streamflow during winter precipitation months. The transition from upland to lowland subwatershed areas is illustrated on the watershed characteristics map, Figure 30, below.

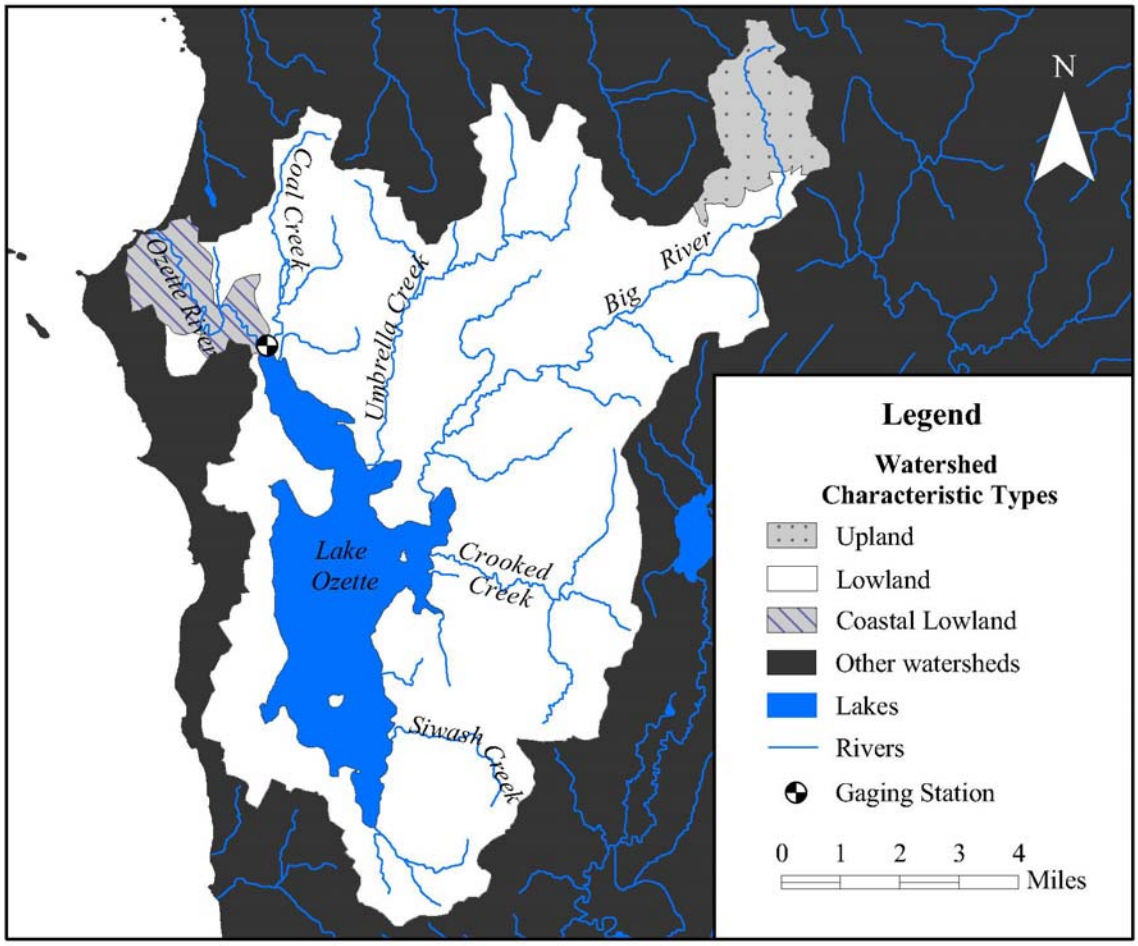

Figure 30. Watershed Characteristics of the Ozette River watershed.

Lowland areas begin near 200 ft above sea level and extend only to 1300 ft, as described by the watershed characteristics method. These areas provide additional streamflow during the winter precipitation months with similar precipitation patterns as the upland areas. Precipitation that falls within lowland subwatersheds is more likely to be lost to subsurface water levels, especially within valley bottoms. When valley floors are expansive and flat, a larger portion of precipitation is lost to interception, evapotranspiration, and ground water, so these areas are considered ineffective towards surface water streamflow. These ineffective areas are characterized as coastal lowland areas and begin at sea level and extend only up to 400 ft in elevation. Coastal lowland areas function very similar to lowland area, but the amount of additional precipitation that is captured in this drainage area is nearly equivalent to the amount of water lost to ground water. Therefore, coastal lowland areas are essentially ineffective in entirety to surface water flows. A small coastal lowland subwatershed is found in the most downstream portion of the Ozette River watershed, and this area was considered ineffective to streamflow when precipitation was low. Table 58 below summarizes the area of the Ozette River watershed characterized by each subwatershed type.

Table 58. Watershed characteristics of areas within the Ozette River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Upland	3.9	4.5
Lowland	69.4	78.8
Coastal Lowland	3.1	3.5
Lake Ozette	11.6	13.2
Total Area	88.0	100

Streamflow Evaluations of the Ozette River

Streamflow histories were determined for several locations within the Ozette River watershed. Two of these locations were on tributaries to Lake Ozette:

- Umbrella Creek at Hoko-Ozette Road Bridge
- Big River at 27E Big River Bridge

The final two locations are downstream of Lake Ozette:

- Ozette River below Coal Creek
- Ozette River at the ocean outlet

The locations of these sites are illustrated in Figure 31.

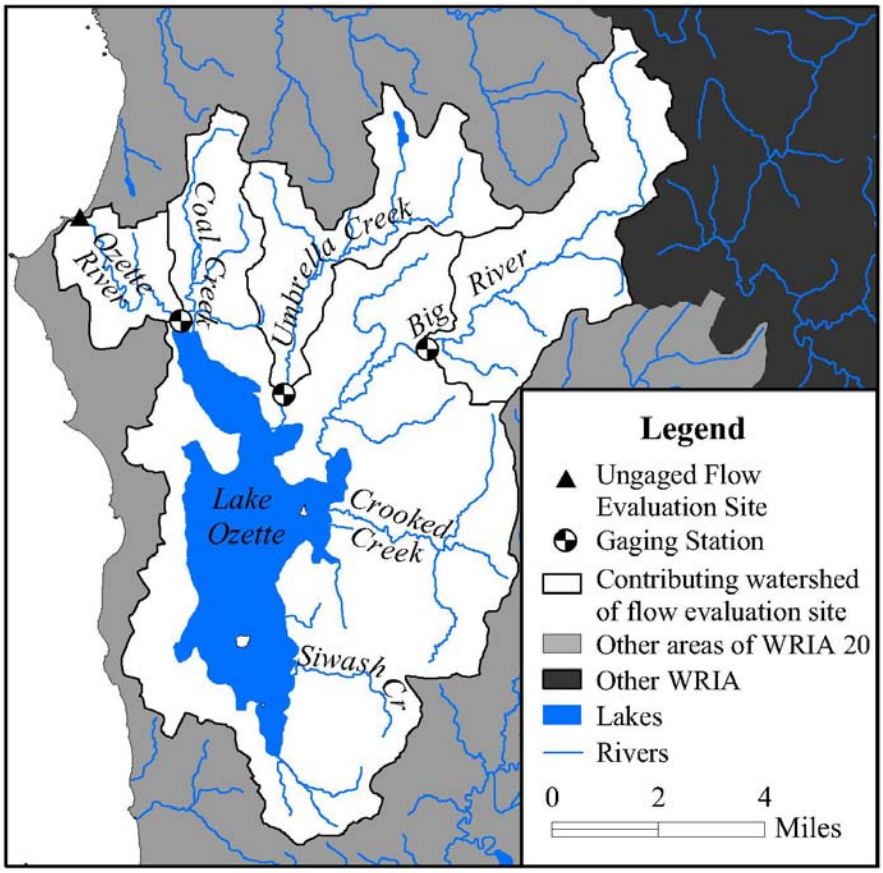

Figure 31. Locations within the Ozette River watershed where natural flows were developed.

As indicated in Figure 31, streamflow measurements were collected on the Lake Ozette tributaries of Big River and Umbrella Creek, but these measurements were by the Makah Indian Tribe, rather than the USGS. The Big River gage began operation in November 2003, and the Umbrella Creek gage began operation in October 2004. An extended synthetic period of record was generated for each between October 1961 and September 1999 through the use of regression techniques comparing these gaged measurements against USGS gaging station 12043300, Hoko River near Sekiu, which is still in operation.

The main stem Ozette River posed unique challenges for determining flow frequencies. Most importantly, the storage effects of Lake Ozette needed to be accounted for in Ozette River streamflow estimates. Since the Ozette River is affected by such a large lake, a different methodology was used to estimate streamflow frequencies for the Ozette River below Coal Creek than was used in other WRIA 20 watersheds. This methodology, as well as how data was developed for the Ozette River at ocean outlet, are described in Appendix 2.

The primary USGS gaging station used to develop Ozette River streamflow histories is the Ozette River at Ozette (#12043150), which has been discontinued since 1979. This gage has a continuous daily record between August 1976 and October 1979. Ozette River streamflow data was also derived from recorded lake levels in Lake Ozette collected by the National Park Service between November 1981 and September 1999, as well as stage-discharge rating information collected by the Makah Indian tribe.

Although the watershed characteristics method was not utilized in the Ozette River watershed, a summary of the areas within each watershed characteristic type designated by contributing watershed is described in Table 59. Also, the average annual precipitation values that could be used to weight streamflow in the watershed characteristics method are summarized in Table 60.

The variability of streamflow at each of these locations is described in detail below. The provided graphs illustrate the expected variation of naturally occurring streamflow for each accumulated watershed area. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table for each evaluation site. These values are estimated from how frequent a monthly total flow occurred in the period between October 1961 and September 1999.

Table 59. Watershed characteristics within each portion of the Ozette River watershed.

Watershed Characteristic Types	Big River above Makah gage (27E Big River Bridge)	Big River below Makah gage above Lake Ozette	Umbrella Creek above Makah gage (Hoko-Ozette Rd Bridge)	Umbrella Creek below Makah gage below Lake Ozette	Ozette River above Coal Creek	Coal Creek above Ozette River	Ozette River at outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Upland	3.91	-	-	-	-	-	-
Lowland	9.47	9.49	10.4	0.36	34.0	4.47	1.16
Lake Ozette (open water)	-	-	-	-	11.6	-	-
Coastal Lowland	-	-	-	-	0.030	-	3.08
Entire area	13.4	9.49	10.4	0.36	45.6	4.47	4.24

Table 60. Average annual precipitation of each portion within the Ozette River watershed.

Watershed Characteristic Types	Big River above Makah gage (27E Big River Bridge)	Big River below Makah gage, above Lake Ozette	Umbrella Creek above Makah gage (Hoko-Ozette Rd Bridge)	Umbrella Creek below Makah gage below Lake Ozette	Ozette River above Coal Creek	Coal Creek above Ozette River	Ozette River at outlet
	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)	Ave Ann Precip (in)
Upland	123.3	-	-	-	-	-	-
Lowland	104.7	90.0	92.1	81.9	82.9	81.0	75.9
Lake Ozette (open water)	-	-	-	-	78.8	-	-
Coastal Lowland	-	-	-	-	77.4	-	74.9
Entire area	110.1	90.0	92.1	81.9	81.8	81.0	75.2

Big River at 27E Big River Bridge –

The 27E Big River Bridge is located upstream of two additional Big River tributaries, Trout Creek and Dunham Creek. Precipitation averages range from 92 inches annually near the gage to over 130 inches annually along the northeastern ridge that separates the Ozette River watershed from the Hoko River watershed.

Streamflow information was collected at this bridge location by the Makah Indian Tribe starting on November 3, 2003 and is still being collected. Regression techniques were used to create a synthetic period of record for this location between October 1961 and September 1999. The synthetic record was developed using regression techniques on both daily and monthly streamflow data against the USGS gage 12043300, Hoko River near Sekiu. At low flow times, when average daily streamflow was less than 40 cfs in the Hoko River and 7 cfs in the Big River, a regression relationship of 49 concurrent measurements exhibited an R^2 of 0.84. Thus, a regression equation was used to estimate Big River daily average streamflow from the Hoko River at low flow times. Monthly total streamflow in the Big River during low flow times was estimated by summarizing estimates of daily average flow in months where all Hoko River streamflow measurements were less than 40 cfs. Since 17 months in the Hoko River gaged record included only average daily flows below 40 cfs, 17 months of the Big River synthetic record were generated by first estimating daily average values and then summarizing these values to estimate total monthly flow in ac-ft. The remaining 439 months in the period of record were estimated through regression equations against monthly totals measured or estimated at the Hoko River gage. Of these 439 months, 261 months were estimated from gaged Hoko River monthly total streamflow, and 178 months were estimated from the estimated Hoko River values that were developed though regressions against other local streamflow gages, specifically:

- USGS Station Number 12043100 Dickey River near La Push, WA
- USGS Station Number 12043163 Sooes River below Miller Creek near Ozette, WA
- USGS Station Number 12043000 Calawah River near Forks, WA
- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA

Big River streamflow was only assessed at this gaged location, but the record developed for this gage located could be used to estimate streamflow at the outlet into Lake Ozette in future analyses through use of the watershed characteristics method.

Streamflow in the Big River exhibits the greatest variation during the winter season precipitation maxima, or specifically between the months of November and February. Streamflow recedes to minimum and baseflow levels during the summer months and typically extend into the early fall months of September and October.

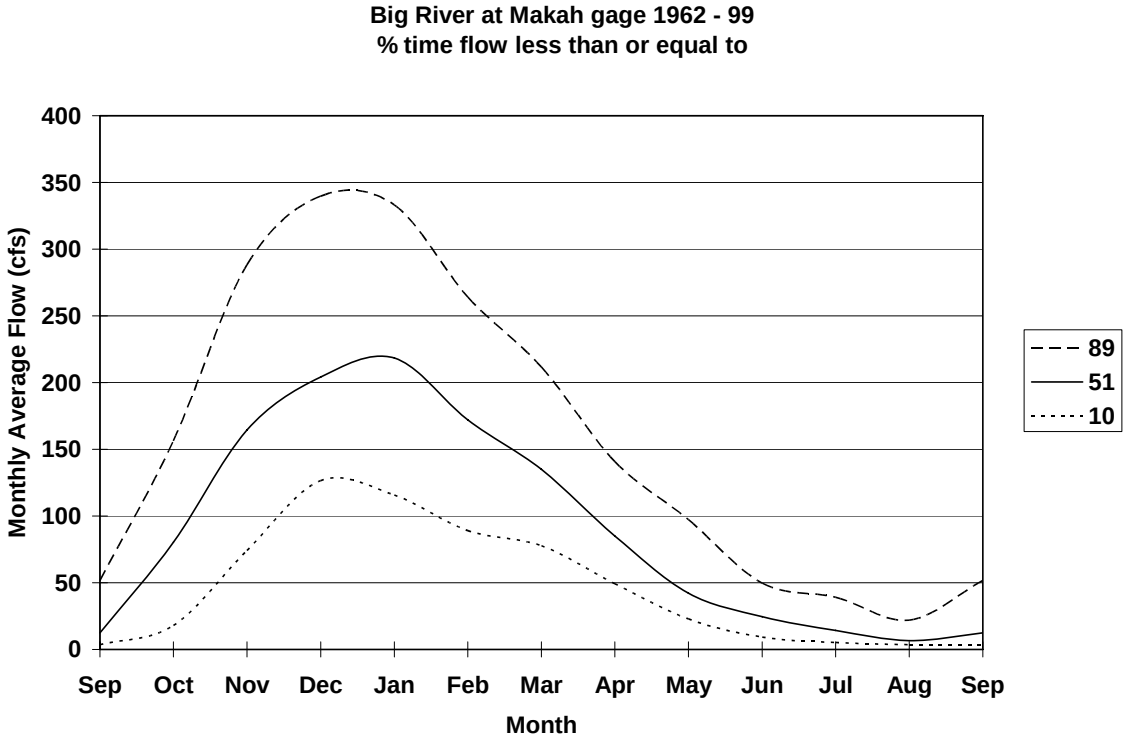

Table 61. The percent of time that average monthly streamflow (cfs) in Big River at the 27E Big River Bridge is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	156	288	340	333	264	212	141	97	50	39	22	52
51	80	165	204	218	172	135	85	42	25	14	7	12
10	18	74	126	116	89	78	49	23	9	5	3	4

Umbrella Creek at Hoko-Ozette Rd Bridge –

Streamflow in Umbrella Creek has been measured by the Makah Indian tribe where the Hoko-Ozette Road crosses Umbrella Creek, less than 1 mile upstream from the outlet into Lake Ozette. Approximately 97 percent of the entire Umbrella Creek watershed contributes to streamflow at this location, thus there is likely little difference between streamflow measured at this location and at the outlet into Lake Ozette. Precipitation increases in a northeastern direction and varies between 81 inches annually near the gage to over 105 inches annually at the northeastern ridgeline that separates the Ozette River watershed from the Sooes River watershed.

The Makah tribe began collecting streamflow information at this location on December 18, 2003, and this gage is still in operation. Regression techniques were used to create a synthetic period of record for this location between October 1961 and September 1999. Regressions were created using daily and monthly streamflow information from other local streamflow gages operated by the USGS, specifically:

- USGS Station Number 12043300 Hoko River near Sekiu, WA
- USGS Station Number 12043163 Sooes River below Miller Creek near Ozette, WA

Low flow months were estimated from a regression equation that was developed by comparing daily average flow in Umbrella Creek and the Hoko River. Average daily streamflow in Umbrella Creek was estimated from gaged average daily flows in the Hoko River, and the summer months between 1962 and 1965 were calibrated using instantaneous streamflow measurements taken in Umbrella Creek. When the Hoko gage was not in operation, gaged streamflow measurements from the Sooes River were used to estimate spring and summer average daily flows in Umbrella Creek between 1976 and 1986. In these months, daily average flow in Umbrella Creek was estimated from equations that were developed by comparing several instantaneous streamflow measurements collected in 1976 by the USGS to the USGS Sooes River gage. The remaining months were estimated from the latest revised version of the Hoko River extended synthetic record that did not use the USGS gage on Dickey River. Instead, this extended record relied on streamflow measurements from:

- USGS Station Number 12043163 Sooes River below Miller Creek near Ozette, WA
- USGS Station Number 12043000 Calawah River near Forks, WA
- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA

Table 62 summarizes the methods used and the percent of the final synthetic record developed through each source or methodology.

Table 62. Methods used to develop final synthetic period of record for Umbrella Creek at the Hoko-Ozette Rd Bridge (at the Makah streamflow gage).

Source/Method	Number of Months	Percent of Period of Record
Estimated daily streamflow using regression equations against daily streamflow in Hoko River gage	119	26.1%
Estimated daily streamflow using regression equations against daily streamflow in Sooes River gage	39	8.6%
Estimated monthly streamflow using regression equations against Hoko River gage	144	31.6%
Estimated monthly streamflow using regression equations against Hoko River estimates derived from Sooes River gage	69	15.1%
Estimated monthly streamflow using regression equations against Hoko River estimates derived from Calawah River gage	58	12.7%
Estimated monthly streamflow using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	15	3.3%
Estimated monthly streamflow using regression equations against Hoko River estimates derived from Bogachiel River gage	12	2.6%
Total number of months	456	100%

A previous draft version of these Umbrella Creek estimates was provided to the WRIA 20 planning group in early May 2005. A later review of these estimates uncovered an error in the estimation process and thus prompted an update of the erroneous estimates. The following graph illustrating streamflow variation in Umbrella Creek has been updated to reflect these new estimates, but the WRIA 20 group asked for the original draft to be included in this report. As such, the draft estimates originally provided to the WRIA 20 planning group has been included in Appendix 2.

Streamflow in Umbrella Creek is similar to that seen elsewhere in WRIA 20, especially in the Big River, which is also a tributary to Lake Ozette. The months of greatest streamflow variation are typically between November and February, while streamflow receded to minimum or baseflow levels between the summer

months of June and September. Baseflow levels typically cease in October each year, when precipitation increases in the fall.

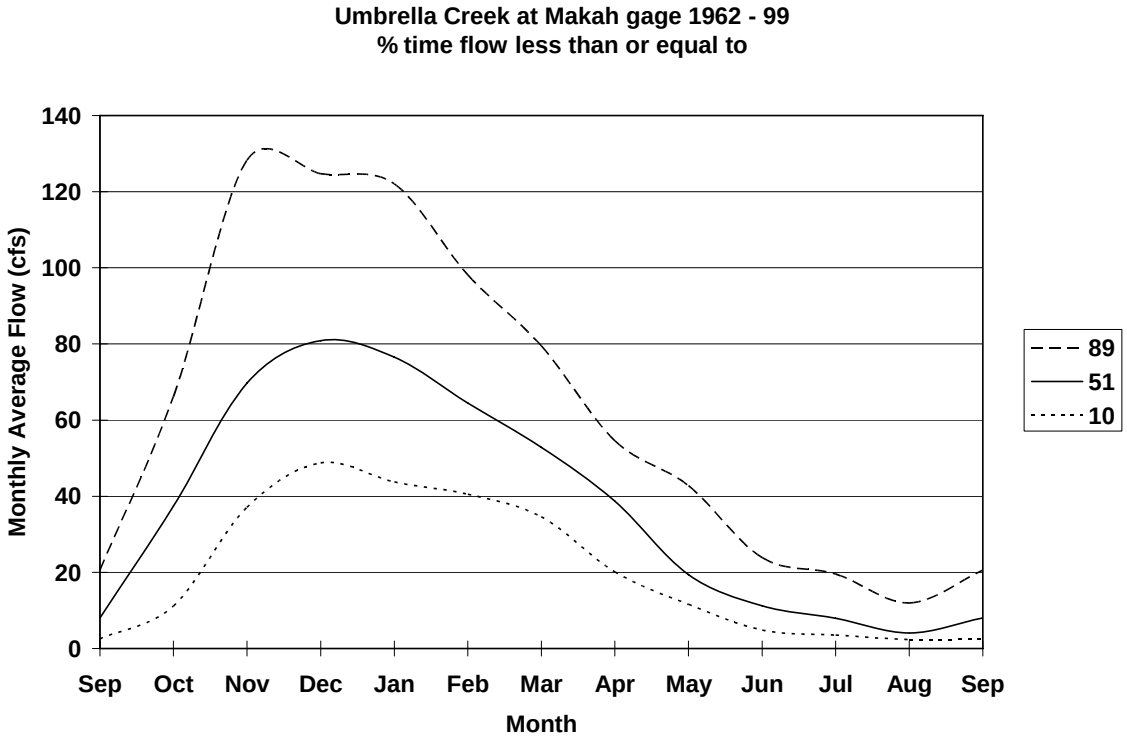

Table 63. The percent of time that average monthly streamflow (cfs) in Umbrella Creek at the Hoko-Ozette Rd Bridge is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	109	199	224	208	180	148	96	56	24	20	12	21
51	53	114	140	146	117	91	56	25	13	8	4	7
10	9	57	91	76	59	55	29	14	5	4	2	2

Ozette River below Coal Creek –

Coal Creek outflows into the Ozette River about 325 feet downstream of the outlet of Lake Ozette. The river basin covers approximately 83.7 square-miles in drainage area and is mainly owned and administered by private timber companies, thus active timber removal has likely occurred. The methodology used to estimate the Ozette River below Coal Creek is described in Appendix 2.

During the late summer, flow in the Ozette River recedes to minimum flow and occasionally extends into October. The months between November and March exhibit the greatest indicated variation in streamflow. The variability exhibited in February and March is greater than the variability estimated for other WRIA 20 watersheds. The cause of this heightened variability is due to the storage effects of Lake Ozette, which fills up and provides a natural regulation on streamflow being released. In essence, the storage effects of Lake Ozette allow higher outflows to be sustained for a longer period of time than compared to upland-lowland watersheds that do not contain a lake, which directly release winter precipitation into streams and groundwater as it falls from precipitation.

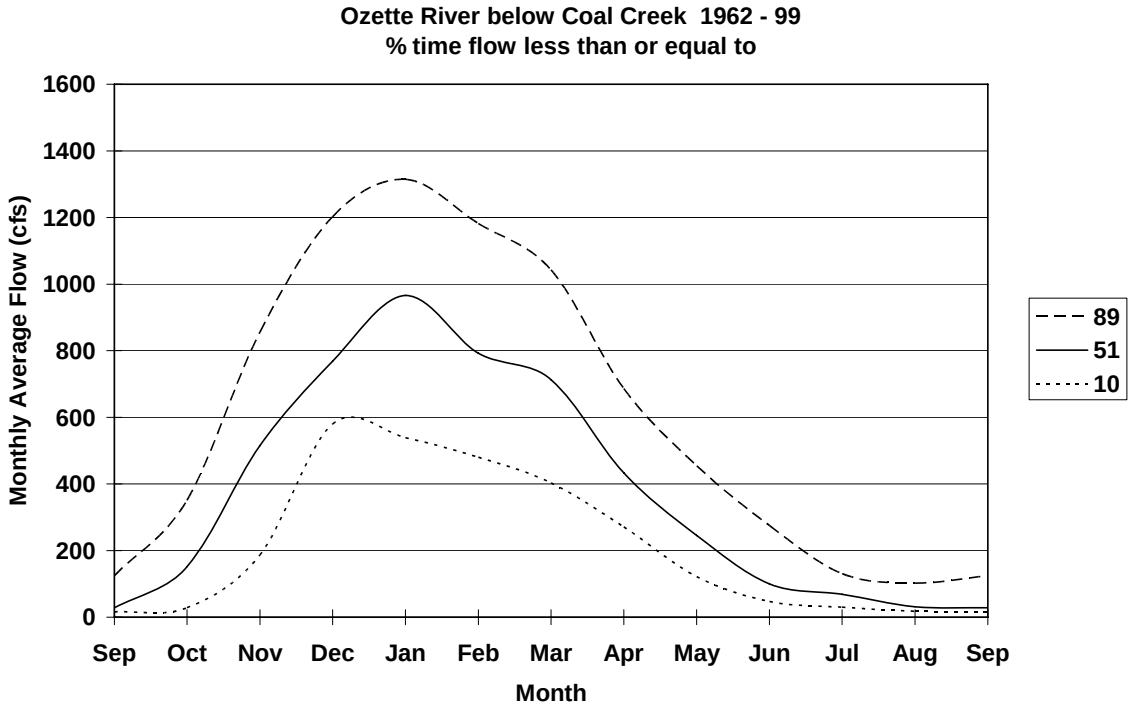

Table 64. The percent of time that average monthly streamflow (cfs) at the Ozette River below Coal Creek is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	351	856	1203	1315	1182	1043	686	454	275	131	102	125
51	152	515	769	966	793	713	433	246	100	69	32	28
10	28	187	580	539	480	403	271	121	47	30	18	16

Ozette River at the Pacific Ocean Outlet –

An additional 4.3 square-miles of drainage area contributes to streamflow in the Ozette River below Coal Creek. This area is characterized mainly as coastal lowland due to the low elevations and large, flat expanses of land. This coastal lowland area includes 72.8 percent of this remaining drainage area and was considered to directly contribute additional streamflow only in months of high precipitation. The remaining 27.2 percent of the drainage is characterized as a lowland subwatershed, which drain into two unnamed tributaries. These lowland areas contribute directly toward streamflow throughout the year.

Seasonal maxima in streamflow are clearly shown for the winter season precipitation maximum. During the late summer and into the fall, flow in the Ozette River recedes to minimum flow. Similar to the flow upstream below Coal Creek, this minimum flow season is indicated to occasionally extend into October. Again, the months between November and March exhibit the greatest indicated variation in streamflow, which is longer than most lowland subwatersheds in WRIA 20 because of the storage effects of Lake Ozette.

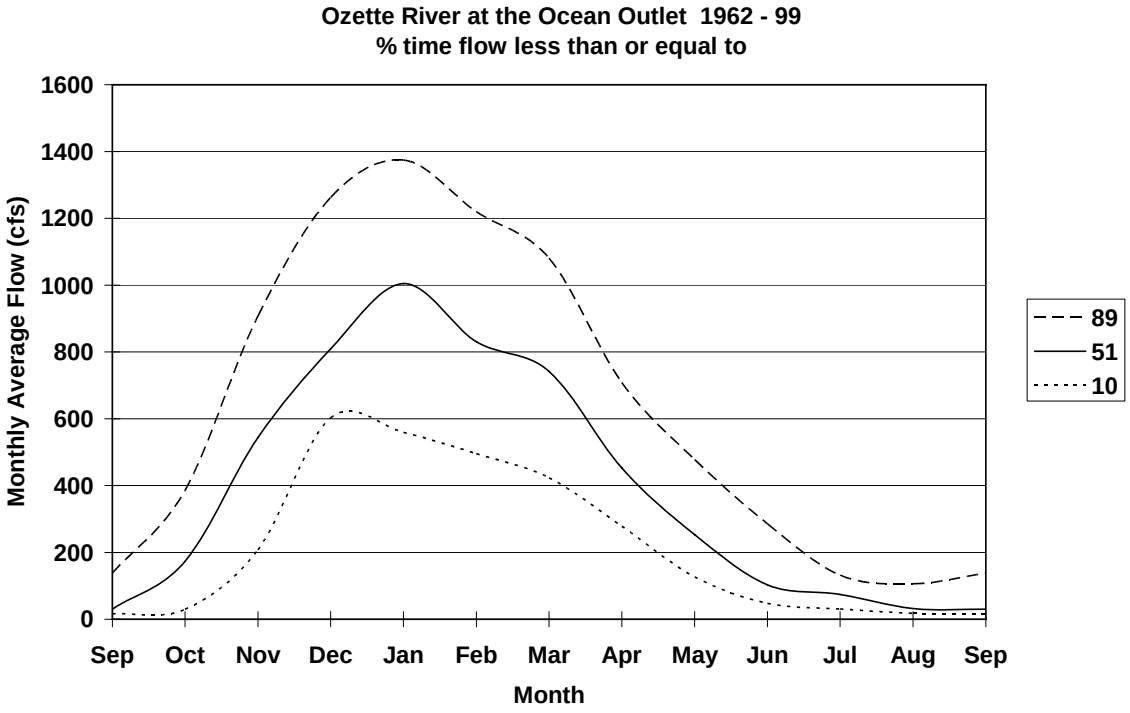

Table 65. The percent of time that average monthly streamflow (cfs) at the ocean outlet of the Ozette River is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	385	907	1262	1375	1220	1081	708	478	285	132	106	138
51	173	544	809	1004	830	742	453	253	103	74	32	30
10	29	208	603	559	496	423	278	126	48	30	18	16

Sooes River watershed

The Sooes River watershed is located north of the Ozette River watershed, south of the Wa'atch River watershed, and east of the Sekiu River watershed. Figure 32 illustrates the location of the Sooes River watershed within WRIA 20. Points of interest in this watershed are Sooes Peak to the northeast, Washburn Hill in the west-southwest, and the Makah National Fish Hatchery, which is managed by the US Fish and Wildlife Service and located between the discontinued USGS gaging station and the outlet to the ocean.

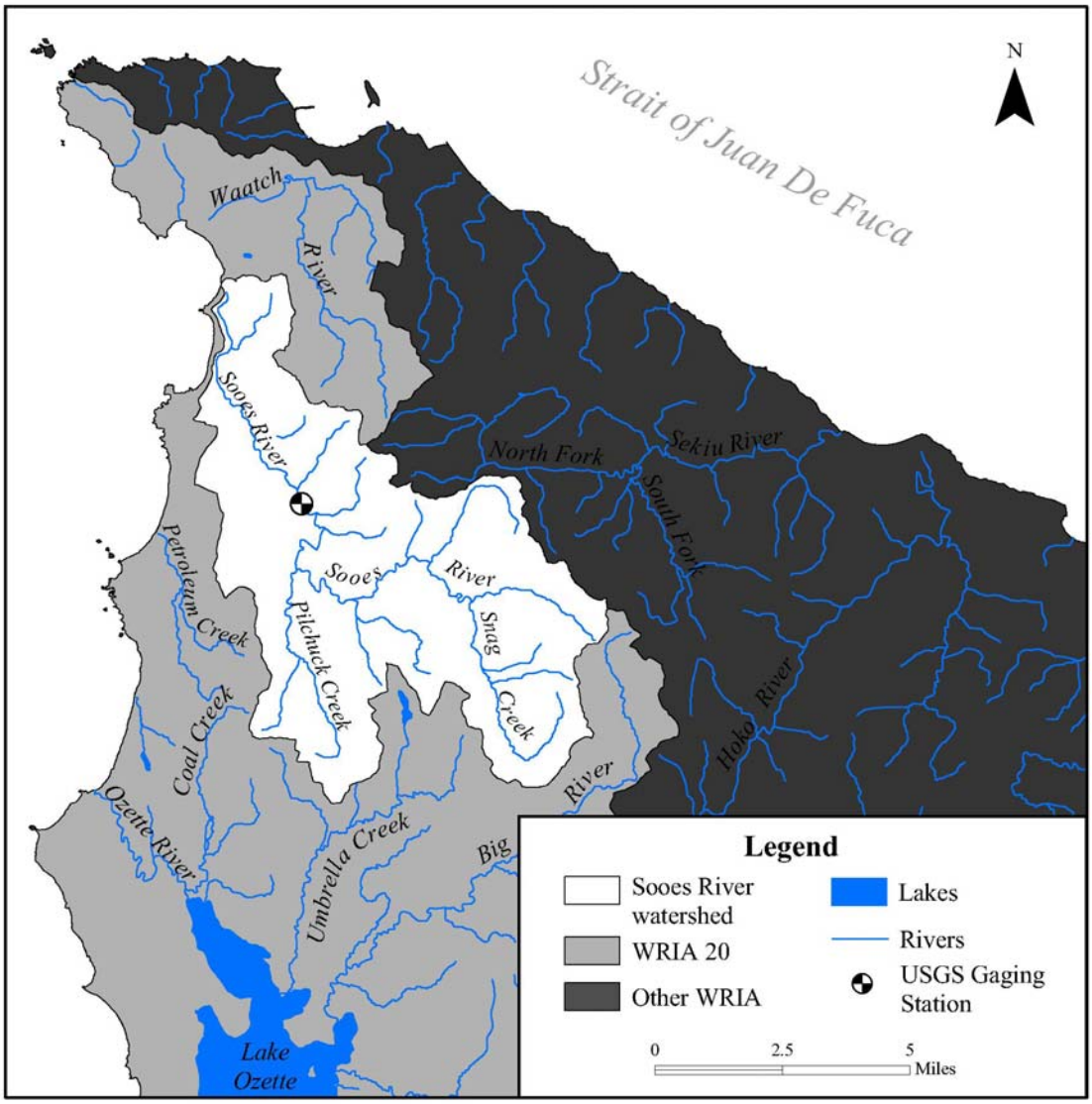

Figure 32. Location of Sooes River watershed within WRIA 20.

The Sooes River watershed measures 41.9 square-miles in area, with only 32.1 square-miles of area above USGS gaging station 12043163, Sooes River below Miller Creek near Ozette, WA. Precipitation increases from west to east, with the lowest annual total averaging less than 85 inches at the headwaters of the unnamed tributary flowing into Pilchuck Creek. The highest annual precipitation averages over 120 inches at the headwaters of the main stem Sooes River. Elevation ranges from sea level at the outlet to over 1880 feet above sea level on one mountain top in the Sooes River main stem headwaters. This range of elevation indicates that the entire watershed is characterized by either lowland or upland subwatershed types. Coastal lowland watershed characteristics were not exhibited in this watershed, since the ridge top elevations near the outlet extend over 400 ft above sea level. The areas of upland and lowland subwatershed types are summarized in Table 66 and illustrated in Figure 33.

Table 66. Watershed characteristics of areas within the Sooes River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Upland	6.7	16.0
Lowland	35.2	84.0
Total Area	41.9	100

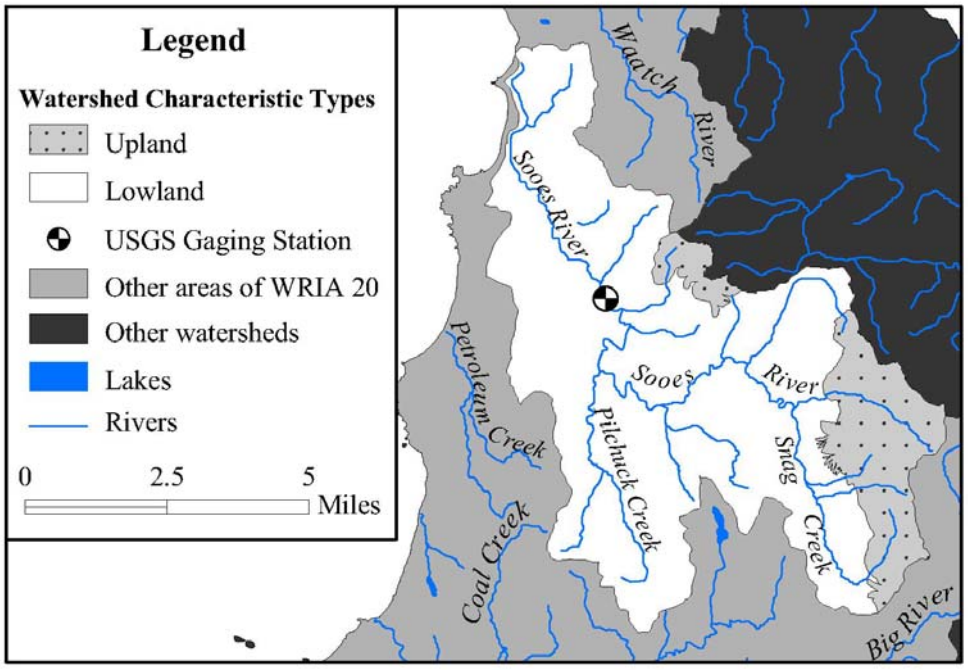

Figure 33. Watershed characteristics of areas within the Sooes River watershed.

The Sooes River watershed is administered primarily by private timber companies, thus recent logging activities has likely occurred. The Makah Indian Reservation also administers the downstream areas of the Sooes River watershed. Figure 34 illustrates the extent of each land administrator in the Sooes River watershed, including a small section included in the Olympic National Park, while Table 67 summarizes the area administered by each organization. The Makah National Fish Hatchery is located in the downstream portion of the watershed that is administered by the Makah Indian Reservation, although the hatchery is managed by the U.S. Fish and Wildlife Service.

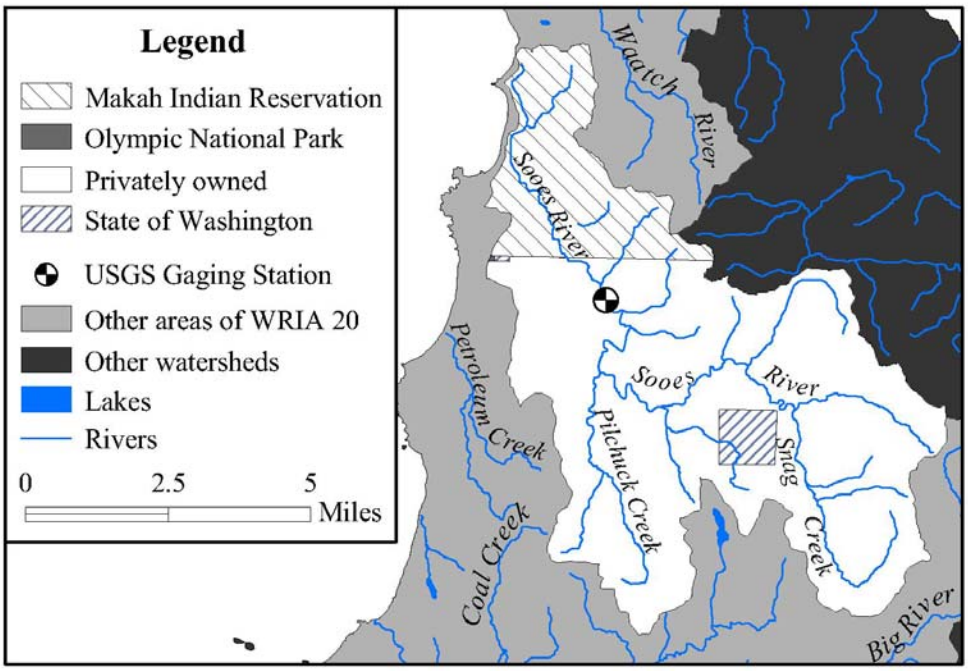

Figure 34. Land administration of the Sooes River watershed.

Table 67. Land Administration of the Sooes River watershed.

Land Administration	Area (sq. mi.)	Percent of Total Area
Olympic National Park	0.008	0.0
State of Washington	0.99	2.4
Makah Indian Reservation	7.55	18.0
Privately owned	33.3	79.6
Total Area	41.9	100

Streamflow Evaluations of the Sooes River

Streamflow was evaluated at two locations in the Sooes River watershed. The upstream location is the site of the discontinued USGS gaging station 12043163, Sooes River below Miller Creek near Ozette, WA, and the downstream location is just below the Makah National Fish Hatchery. Figure 35 illustrates the location of these two sites and the drainage area that contributes to each location.

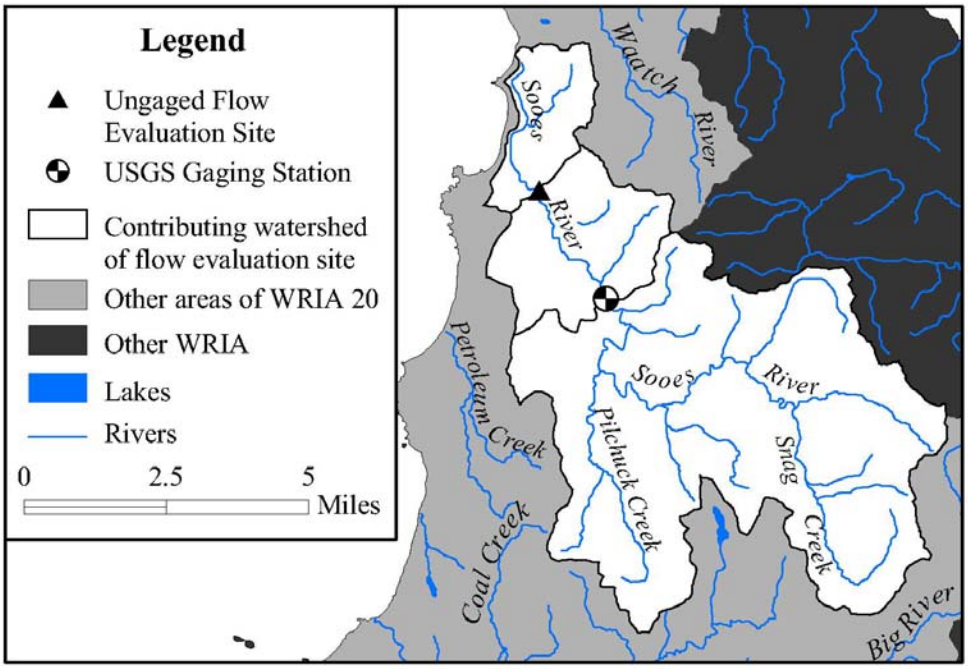

Figure 35. Locations within the Sooes River watershed where natural flows were developed.

Streamflow measurements taken by the USGS were used to estimate a complete period of record for both sites between October 1961 and September 1999. This estimated record was used to evaluate streamflow variation at both sites. USGS gaging station 12043163, Sooes River below Miller Creek near Ozette, was operated continuously between May 1976 and September 1986. An extended synthetic record was created for this gage through the use of regression techniques against other local streamflow gages. Monthly total estimates were made for the Sooes River using monthly total streamflow measurements from the following gages:

- USGS Station Number 12043100 Dickey River near La Push, WA
- USGS Station Number 12043300 Hoko River near Sekiu, WA
- USGS Station Number 12043000 Calawah River near Forks, WA
- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA

Although the Hoh River gage provided estimates for any remaining months in the pertinent period of record, these estimates were considered to be less representative due to the distance between the Sooes and Hoh River gage locations. As such, only 3 months were estimated from the Hoh River gage, and monthly precipitation totals from Neah Bay 1 E were used to estimate the other remaining 17 months that these other local streamflow gages were not in operation.

The watershed characteristics method was used to estimate streamflow at the downstream location just below the Makah National Fish Hatchery. Even though another 3.41 square-miles of drainage area is located downstream of this lower location, streamflow below this point and especially near the outlet is affected by tidal fluctuations in the Pacific Ocean. A summary of the areas within each watershed characteristic type designated by contributing watershed is described in Table 68. Also, the average annual precipitation values that were used to weight streamflow in the watershed characteristics method are summarized in Table 69.

Table 68. Watershed characteristics within each portion of the Sooes River watershed.

Watershed Characteristic Types	Sooes River at gage # - 12043163 Sooes River below Miller Cr near Ozette	Sooes River just below Makah National Fish Hatchery	Sooes River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Upland	6.70	-	-
Lowland	25.4	6.37	3.41
Entire area	32.1	6.37	3.41

Table 69. Average annual precipitation of each portion within the Sooes River watershed.

Watershed Characteristic Types	Sooes River at gage # - 12043163 Sooes River below Miller Cr near Ozette	Sooes River just below Makah National Fish Hatchery	Sooes River at Outlet
	Ave Ann Precip (in.)	Ave Ann Precip (in.)	Ave Ann Precip (in.)
Upland	109.0	-	-
Lowland	98.8	94.5	92.7
Entire area	100.9	94.5	92.7

Sooes River below Miller Creek (at USGS gage 12043163) –

The Sooes River gaging station was located at the first bridge (on a private road) upstream from where the river crosses into the Makah Indian Reservation approximately 0.25 miles upstream from the outlet of Grimes Creek. As previously described, gaged streamflow was used to create an extended synthetic period of record for this location. This estimated streamflow record is included in Appendix 3.

The variability of streamflow in the Sooes River is illustrated below. The range in variation is illustrated in approximate average monthly flow in cubic feet per second (cfs), and these values are summarized in the corresponding table. Streamflow in the Sooes River exhibits the greatest variation in the winter season precipitation maxima between the months of November and January. Streamflow recedes to baseflow in the summer months of July and August, and streamflow minimums extend typically into September.

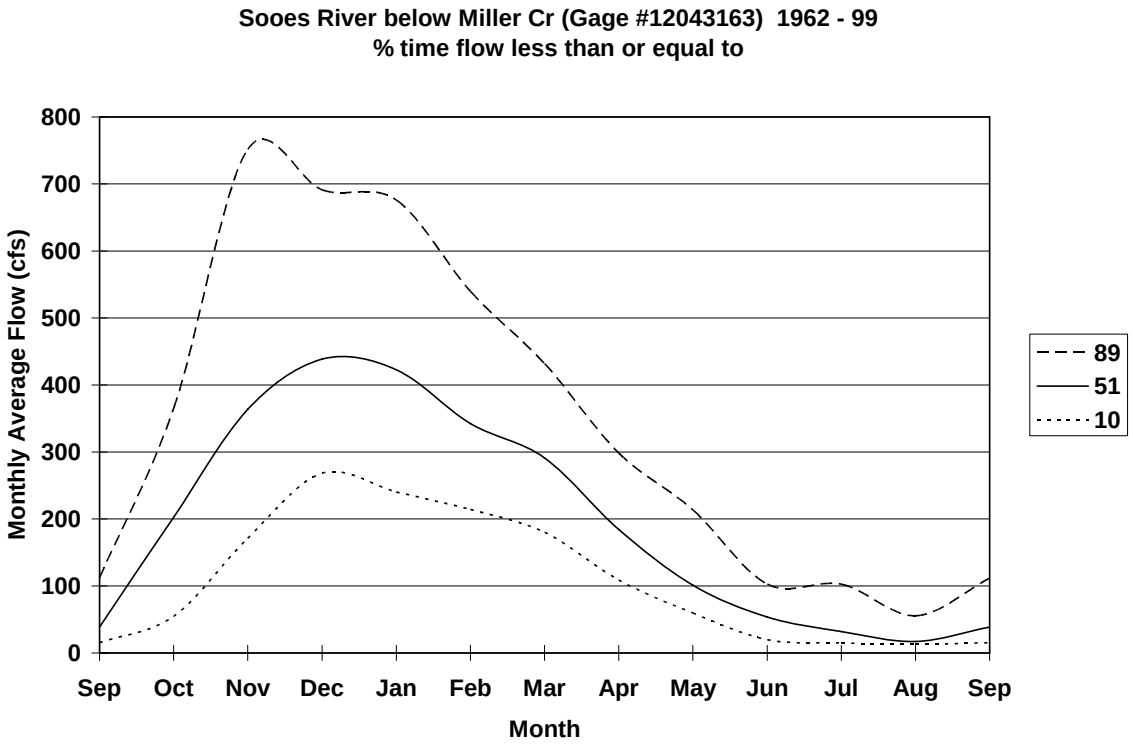

Table 70. The percent of time that average monthly streamflow (cfs) in the Sooes River below Miller Creek is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	365	752	691	676	540	432	298	213	103	102	55	111
51	203	364	438	423	342	291	184	101	54	32	17	39
10	54	171	268	240	214	180	109	59	20	15	13	15

Sooes River below the Makah Fish Hatchery –

The Makah National Fish Hatchery lies approximately 2.5 river miles downstream from the Sooes River gaging station. Streamflow was evaluated for a Sooes River location below the Makah National Fish Hatchery, as well as below the next downstream tributary, Tyler Creek. Streamflow was estimated for this location by rescaling the extended synthetic record developed for USGS gaging station 12043163, Sooes River below Miller Creek near Ozette. The rescaler value was calculated from the weight (area * average annual precipitation) of the area above the gage and the weight of the area between the gage and the location just below the Makah National Fish Hatchery. This estimated streamflow record can be found in Appendix 3. Streamflow in the Sooes River exhibits the greatest variation during the winter precipitation maxima between the months of November and January. Flows recede to minimum or baseflow levels in the summer months of July and August and typically extend into September.

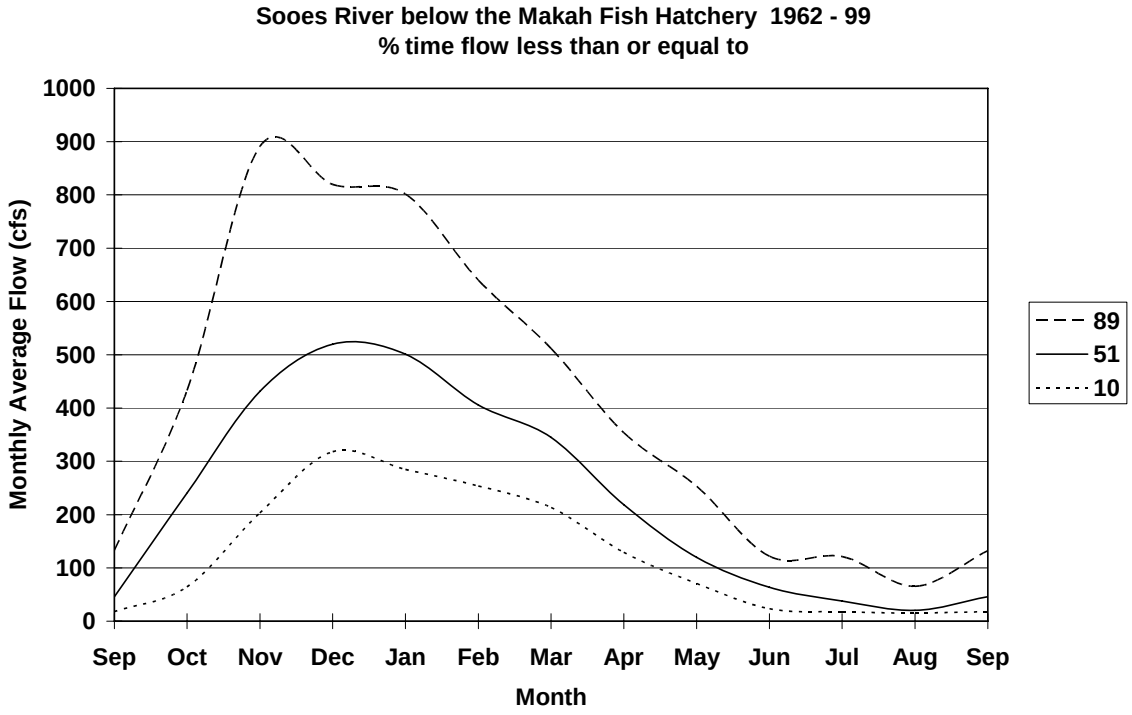

Table 71. The percent of time that average monthly streamflow (cfs) in the Sooes River below the Makah Fish Hatchery is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	433	891	820	802	640	512	354	253	122	122	66	132
51	240	431	520	501	406	345	219	120	64	38	20	46
10	65	203	318	285	254	213	129	70	24	18	15	18

Summary

This report has presented an overview of watershed conditions and natural streamflow variation for select streams within WRIA 20. These evaluations were developed for the period between October 1961 and September 1999, except in the Hoh River watershed where and additional year was included. These evaluations provide an appraisal level analysis of streamflow variation in WRIA 20 that can be referenced to estimate changes in streamflow conditions as a result of future land management activities.

Gaged streamflow data from the USGS provided the basis of these evaluations. These data were considered to represent natural conditions, since the investigation into upstream land management activities did not yield significant information proving otherwise. Although some streamflow data was available for every stream system assessed, evaluations were also completed at several ungaged locations. Streamflow estimates were therefore required for ungaged locations. The primary method used to estimate streamflow at ungaged locations was the WCM, which is a region-specific technique developed for the Olympic Peninsula of Washington. Calibration of these estimates was enabled by miscellaneous streamflow measurements, particularly at low flow conditions.

Streamflow patterns exhibited the greatest consistency in adjacent watersheds, with the greatest differences exhibited between watersheds that include high mountainous areas and those that only include lower elevations. Streamflow in watersheds that included high elevation areas were dominated by spring snowmelt-runoff and winter precipitation. Lower elevation streams are dominated by winter precipitation only. The greatest streamflow variation in all WRIA 20 streams was found to be during the winter precipitation maximum, and baseflow or minimum streamflow levels were exhibited during the late summer and early fall.

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Appendix 1: Methodology used to evaluate streamflow in WRIA 20

Streamflow evaluations were necessary for various locations in WRIA 20 selected by the WRIA 20 planning group, members of the initiating governments, and employees of Golder Associates in Seattle, who were asked to develop the WRIA 20 planning report. The method employed to evaluate streamflow at each location was dependent on the availability of measured streamflow data, the location of diversions, basin characteristics, and dominant flow regime (surface water or ground water). Streamflow evaluations within WRIA 20 were based on the time period between October 1961 and September 1999 (water years 1962-1999). The following sections describe how streamflow was estimated and evaluated for all selected gaged and ungaged drainage areas in WRIA 20.

Streamflow Evaluation Process

Streamflow was evaluated for each selected flow point through a 3-step process. Although this process differed slightly for each location depending on the availability of gaged streamflow records, the process is generally described as follows:

1. Compile available data, including:
    a. Daily average streamflow
    b. Miscellaneous, instantaneous streamflow measurements
    c. Lake stage data, specifically on Lake Ozette
    d. Precipitation data
    e. Land elevation
    f. Timber age class
2. Develop a complete period of record during the pertinent time frame of October 1961 – September 1999 (water years 1962 – 1999).
3. Evaluate and document streamflow variability during the pertinent period of record (water years 1962 – 1999).

This process was utilized to develop the streamflow variability table and graphs presented for each location in WRIA 20. The following summary will present a general description of each step and any underlying processes or methodologies that were used to complete each step. Site specific information for step 1, what streamflow information was available, and step 2, the development of a complete period of record, is presented under the "Streamflow Evaluations" section of each watershed with additional information included under each site description in the body of the report. The following methodology description will detail each step used to evaluate streamflow at select gaged and ungaged locations in WRIA 20.

1. Compile Available Data

Streamflow data were necessary to evaluate streamflow conditions in WRIA 20. Daily average streamflow data used in this investigation were available from the United States Geological Survey (USGS) and the Makah Indian Tribe. Miscellaneous, instantaneous streamflow information was available from the USGS, the Streamkeepers of Clallam County, and the Hoh Indian Tribe. Most gaged streamflow data collected by the USGS are readily available in CD-form from Hydrosphere Data Products, Inc., but miscellaneous and peak streamflow measurements are mainly found in the annual Water Resources Data Publications for Washington, including summary and individual water year volumes. The Makah Indian Tribe provided data from continuous streamflow gages as well as stage-discharge information for the outlet of Lake Ozette. The Lake Ozette data was used in conjunction with lake stage information collected by the National Park Service (NPS) to estimate the outflow of the lake.

Precipitation data was required for evaluating climatic changes throughout the region, as well as for estimating streamflow at ungaged locations. Precipitation data were available from the Western Regional Climate Center or the National Oceanic and Atmospheric Administration for specific locations within the study area. The average annual precipitation between 1930 and 1957 was used to develop a weighting factor for each subwatershed area. Mean annual precipitation was digitized into a Geographic Information System (GIS) from Plate 1 of USGS Water-Resources Investigations Report 97-4277, "Magnitude and Frequency of Floods in Washington," by Sumioka, Kresch, and Kasnick (1997). Isohyetal lines (lines of equal precipitation) from Plate 1 indicated precipitation changes in 5-inch increments, except in areas where precipitation changed drastically and larger intervals were used. GIS was used to interpolate additional isohyetal lines at 0.5 inch intervals between those taken from Plate 1. Subwatershed outlines were intersected with these precipitation bands to find an areal weighted average annual precipitation for each drainage area.

Watersheds and the contributing areas for each location were delineated using heads-up digitizing through GIS on electronic topographic maps (Digital Raster Graphics) available on the USGS EarthExplorer website. These DRGs were also used to identify specific ranges of elevation in contributing drainages. Land Administration and timber age class GIS information was downloaded from the USDA Forest Service, Olympic National Forest at http://www.fs.fed.us/r6/data-library/gis/olympic/.

2. Develop Complete Period of Record

Concurrent streamflow records were necessary to accurately represent the difference in streamflow variability between specific locations in the study area. Additionally, a sufficiently large sample of streamflow information was necessary

to represent a greater variety of streamflow levels. To enable future use or application of the recurrence intervals exhibited through the final streamflow evaluation, a sample of at least 25 years was considered necessary. The availability of gaged streamflow data at the onset of the project was also a limiting factor on the pertinent period of record. As such, the period of record was chosen between October 1961 and September 1999, or water years 1962 – 1999, to optimize the use of available gaged streamflow data.

The process for developing a complete period of record for each site varied significantly depending on whether or not continuously gaged streamflow data had been collected at the location in question. The estimation of streamflow at an ungaged location relied on gaged streamflow information collected up or downstream or in an adjacent watershed. Development of a complete period of record at gaged locations was undertaken first and will be discussed in detail first. This section will be followed by a discussion of techniques used to estimate streamflow at ungaged locations.

Gaged Streamflow Locations

Several methodologies were used to develop a complete period of record at gaged locations. The specific method used at each location was determined through an analytical process that considered available data, data quality, and discharge patterns.

Methodology Determination

The methodology determination process began by aggregating all gaged streamflow data from the USGS and the Makah Indian Tribe, or daily average discharge values, to determine monthly total volumetric streamflow in acre-feet. The appropriate methodology for each location was then determined by an analytical process that consisted of applying three questions to the available monthly data. These questions provided the basic separation points between methodologies that were employed[1]:

Question 1G: Do the available records provide a complete period of record between October 1961 and September 1999 (water years 1962-1999)?

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[1] NOTE: These questions do not represent all conditions that were applied against the available data, nor do they represent all questions required to estimate natural streamflow. For example, when streamflow records do not represent natural conditions, the next logical questions would be:

1. What human activities have affected streamflow?
2. Have any of these activities been recorded (do diversion records exist)?

These additional questions did not create additional separations in the decision-making process, and thus are not covered separately in this discussion.

Question 2G: Do the available data represent natural conditions, i.e. do they represent streamflow under predevelopment conditions?

Question 3G: Do the available records exhibit similar characteristics of nearby natural streams, in terms of streamflow response, basin characteristics, or dominant flow regime, e.g. winter-precipitation or snowmelt runoff?

Figure 1-1 illustrates the process of application of these questions as a flowchart. By following this framework, the appropriate record development action can be identified for each gage location. The flowchart ends by indicating the name of the gage under which method was employed to develop a complete period of record. The following section provides a detailed description of each question and the analysis undertaken to answer each question.

Question 1G: Do the available records provide a complete period of record between October 1961 and September 1999 (water years 1962-1999)?

Due to the diligence of the USGS and the Makah Indian Tribe, or specifically the Makah Fisheries group, streamflow records existed for every mainstem river in WRIA 20. Only one gage in WRIA 20 was continuously operated between October 1961 and September 1999, USGS gaging station 12041200, Hoh River at U.S. Highway 101 near Forks, WA. The remaining WRIA 20 gages had limited records in the pertinent period of record and contained several years of missing data. The process to fill in these gaps depended on the quality and amount of gaged streamflow information available and their relative similarities to available records from nearby streams.

Question 2G: Do the available data represent natural conditions, i.e. do they represent streamflow under predevelopment conditions?

Natural streamflow measurements are desired to enable filling in data gaps using single regression techniques. To determine how well the available data represent natural conditions, the presence of any upstream diversions or regulations were determined. The presence of these activities was researched by reviewing documentation provided by the USGS with their gaged data. A complete inventory was created that documented the "REMARKS" published by the USGS for each gage for every year of operation. This inventory is not included in this document, but is retained by Reclamation as supporting material. This information may be obtained from the primary author. All USGS gaged data used in this study were considered natural or "unregulated," since the gaged period remarks stated "no upstream diversions above station," except for the Ozette River gage, which documented "Flow effected by natural regulation from Ozette Lake. No diversion above station."

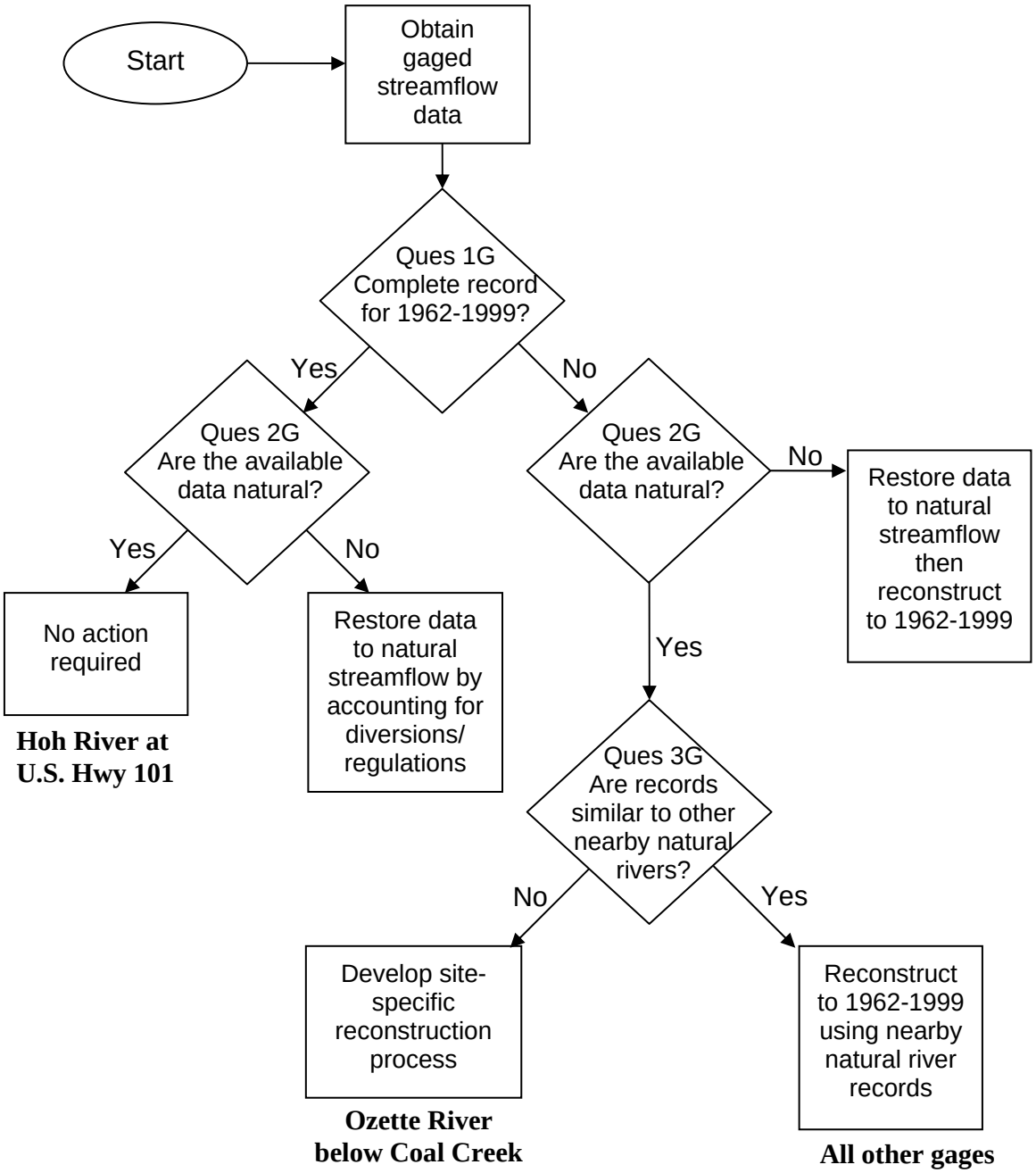

Figure 1-1. Decision framework used to determine appropriate methodology for reconstructing complete periods of record at gaged locations in WRIA 20. **Bold** indicates the names of specific WRIA 20 gages that were applicable to the indicated methodology.

Diversions are not the only human activities that could alter streamflow from natural conditions. Land management activities, such as timber harvesting, were also investigated in each watershed for their potential to affect streamflow. Land management practices were reviewed by researching federal land management policy and USFS documents. National Park Service policies were assumed to prohibit timber harvesting practices in Olympic National Park during the period of interest. Timber harvesting activities were easily assessed for 198.2 square-miles within WRIA 20 based on an analysis of timber age class by the Forest Service. This inventory was provided as a GIS coverage illustrating the geographic areas of specific timber age classes covering 155.9 square-miles of the 157.6 square-miles of Forest Service lands within WRIA 20, as well as 11.7 square-miles of state administered lands and 30.6 square-miles of privately owned lands (ONF, 2000). Additionally, 65 square-miles in the Soleduck and Calawah River watersheds were roughly inventoried for timber age class based on color-infrared satellite imagery from 1990.

More recent timber practices within the Olympic National Forest were assumed be consistent with the President's Northwest Forest Plan of 1994. In this plan, Forest Service and some state and private in-holding lands outside of wilderness areas were assigned specific management designations. The only wilderness areas within WRIA 20 are located within the Olympic National Park. USDA Forest Service lands designated as Late-successional Reserve (LSR) are "managed to protect and enhance old-growth forests and habitat conditions for species dependent upon old-growth within a system of well-distributed large blocks of forest (ONRC, [no date])." Areas designated as Adaptive Management are managed to provide both ecological and economic benefits. Although Riparian Reserve areas were not illustrated on land administration maps, State administered and Forest Service lands adjacent to most streams are designated as Riparian Reserve areas, where the land is "managed to provide high quality water supply, habitat for salmonids, and dispersal habitat for spotted owls and other wildlife (ONRC, [no date])."

Consequently, the gaged data provided by the USGS was considered to represent natural conditions, since the investigation into timber harvesting and upstream land management activities did not yield substantial information that could be used to clearly identify effects on streamflow. No investigation was performed on the Makah gage data provided for Umbrella Creek and Big River. These data were also assumed to represent natural conditions despite having been collected at a road crossing.

Question 3G: Do the available records exhibit similarities to nearby natural streams, in terms of streamflow response, basin characteristics, or dominant flow regime, e.g. winter-precipitation or snowmelt runoff?

As mentioned previously, the streamflow analysis required gaged data with a complete period of record between October 1961 and September 1999. A strong level of similarity between watersheds is necessary to fill in gaps in the period of record. The shapes of streamflow hydrographs were compared for similarities in streamflow between nearby watersheds. In particular, these comparisons were generated against streams with longer periods of records if the two periods of record overlapped. Reconstruction of missing streamflow records was easily completed between similar watersheds that included several overlapping monthly totals. In the case of dissimilarity, other gages were investigated for their applicability in record reconstruction.

The most obvious differences in streamflow hydrographs were identified between streams dominated by winter precipitation only or by winter precipitation and spring snowmelt runoff. Watersheds that included higher elevation areas were dominated by spring snowmelt-runoff as well as winter precipitation, which accounted for the greatest streamflow variation in all WRIA 20 watersheds. Streams with contributing areas in a similar elevation range, as well as streams that were in close proximity, demonstrated the most consistency. Streams in the south part of WRIA 20, such as the Hoh River, were found to be the most divergent from those in the north, most likely because elevation ranges decrease to the north. Additionally, the Ozette River did not exhibit similarities to nearby gages in several months due to the storage effects of Lake Ozette requiring a different methodology to be employed to estimate Ozette River discharge (discussed in Appendix 2).

Reconstruction Method using other Natural Rivers

As indicated in Figure 1-1, all available gaged records were assumed to represent natural conditions, but only one gage had a complete period of record between October 1961 and September 1999 (the Hoh River at U.S. Highway 101 near Forks, WA, USGS station number 12041200). Only one gage, the Ozette River near Ozette, WA, demonstrated dissimilarity with the available streamflow records. As such, extended streamflow records could be developed through regression techniques for the remaining gaged locations. These regressions were first applied between streams that exhibited the greatest similarities and then to less representative streams when no other highly similar gage was available. Extended synthetic records were developed for the gaged streamflow locations in WRIA 20 listed in Table 1-1.

Several WRIA 19 streams were also investigated for similarities to gage locations in WRIA 20. The only USGS gaging station to exhibit consistency to WRIA 20 streams was USGS station number 12043300, Hoko River near Sekiu, WA. As

such, an extended period of record was developed for the Hoko River gaged location.

Table 1-1. Streamflow gaging station records within WRIA 20 that were extended through regression techniques.

Managing Agency	Station Number	Gaging Station Name
USGS	12040900	South Fork Hoh River near Forks, WA
USGS	12041000	Hoh River near Forks, WA
USGS	12041500	Soleduck River near Fairholm, WA
USGS	12042000	Soleduck River near Quillayute, WA
USGS	12042800	Bogachiel River near Forks, WA
USGS	12043000	Calawah River near Forks, WA
USGS	12043080	East Fork Dickey River near La Push, WA
USGS	12043100	Dickey River near La Push, WA
USGS	12043163	Sooes River below Miller Creek near Ozette, WA
Makah Tribe	-	Umbrella Creek at Hoko-Ozette Rd Bridge
Makah Tribe	-	Big River at 27E Big River Bridge

Missing data records for all of these gages were estimated using regression techniques often employed for streamflow record extension, as described by Reid, Carroon, and Pyper (1968). Monthly total discharge values from a nearby, representative gage with a more extensive period of record were correlated to those from each desired gage to create a complete synthetic streamflow record between October 1961 and September 1999. Correlations were developed for specific flow regimes (low-flow or high-flow) within individual months, each season, or for all months, depending on the number of available concurrent values. The least-squares method defined by Pollard (1977) was used to determine the accepted best-fit line. However, the least-squares line does not always capture sufficient variability, which is imperative to the development of a more representative time series. The amount of explained variability captured by a line is determined by calculating R^2 (Lapin, 1983) as modified for the line of minimum absolute deviation (MAD) or a generally similar fitted line (Zebrowski, 1979; Troutman and Williams, 1987; Williams 1983). The use of these modified lines ensured that sufficient variability was represented in the extended streamflow record.

Several data gaps were also reconstructed by relating instantaneous flow measurements to at least two other concurrent daily gaged records. When sufficient concurrent measurements were available between a nearby gage and the desired watershed (i.e., at least one measurement per month for several months), monthly total flows for the otherwise ungaged watershed were estimated by rescaling the daily gaged records from nearby watersheds to create a daily record

for the ungaged site. This rescaling, or *hydrograph-matching*, was typically done using at least two nearby gages. The rescaled estimates were compared and reviewed for consistency. When estimates for the same month were consistent or showed very little difference, then results from either effort were considered adequate. When results differed significantly, values estimated beyond the original range of data were refined using professional judgment. Usually, the lower of the refined estimates were considered more conservative and were used. In general, most rescaled estimates for the same period of record produced similar results. Only daily discharge estimates that were generated from concurrent instantaneous flow measurements recorded in months before, during, and after the pertinent month were considered to be accurate.

Ungaged Streamflow Locations

Streamflow evaluations were required for several ungaged locations within WRIA 20. The watershed characteristics method was the primary method used to estimate streamflow at these locations. This method uses the complete or extended records from nearby streamflow gages as a basis for estimating flow at ungaged sites based on observed watershed characteristics. In a few cases, a site-specific methodology was developed, as in the case of the Ozette River (described in Appendix 2).

The following discussion will first outline the analytical process used to determine the appropriate methodology for estimating streamflow at each ungaged location, followed by a more detailed explanation of each methodology. A calibration process was also used to refine the initial estimates. The following discussion will conclude by describing the calibration process, as well as identifying which streamflow estimates were able to be calibrated.

Streamflow Estimation Methodology Determination

Several methods have been developed for estimating streamflow at ungaged locations. Perry (2001) completed an extensive analysis in the Olympic Peninsula of Washington that resulted in the Watershed Characteristics Method (WCM). This method relies on region-specific characteristics, such as snow and rainfall patterns, as well as the hydrologic function of specific elevations ranges observed in the Olympic Mountains. The WCM was used herein to estimate streamflow of most ungaged locations, but there were some locations where the WCM was found to be inapplicable. Also, the actual application of the WCM differed based on the amount of gaged data available. As such, an analytical process was used to determine which method was used to develop initial streamflow estimates at ungaged locations, which were then calibrated based on representative historical miscellaneous streamflow measurements. The following discussion will describe the process that determined which method was employed to each location and is followed by a detailed description of each methodology.

The appropriate methodology for each ungaged location was determined by a process that consisted of applying two questions to the available gaged data and watershed characteristics of the watersheds of interest. This process determined whether or not the WCM could be appropriately applied to estimate streamflow at an ungaged location, as well as which variation of the WCM should be applied to yield the most accurate results. Initially, the first step of the WCM was completed, where watershed characteristic types are delineated on topographic maps, so that the watershed characteristics of drainages could be compared to determine the applicability of the WCM or other standard methods, such as a modified drainage-area method.

Two questions provided the basic separation points in the methodologies employed herein[2]:

Question 1U: Are two complete gaged or extended streamflow records available within the watershed where ungaged streamflow will be estimated?

Question 2U: Do the watershed characteristics of the watershed where ungaged streamflow will be estimated exhibit similarities to adjacent or neighboring watersheds?

Figure 1-2 illustrates the application of these questions in the streamflow estimation process as a flowchart. By following this framework, the appropriate streamflow estimation method can be identified for each ungaged location. The flowchart ends by indicating the name of each ungaged location under the method that was employed to develop an initial complete streamflow record between October 1961 and September 1999. A detailed description of each question and the analysis undertaken to answer each question will further explain this methodology determination process.

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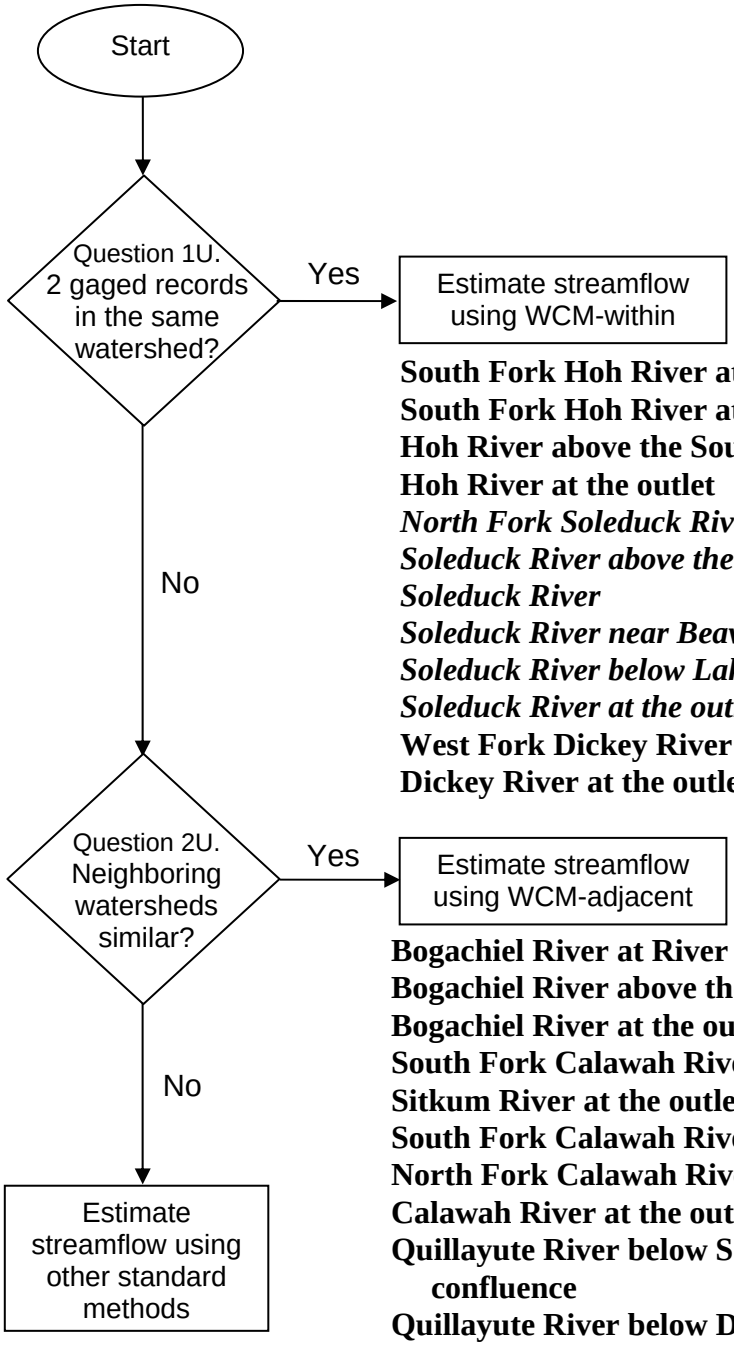
[2] NOTE: These questions do not represent all considerations that were applied against the available data, nor do they represent all conditions required to estimate natural streamflow at ungaged locations. For example, the WCM requires two coincidental gaged streamflow records to estimate streamflow at ungaged locations. Fortunately, gaged streamflow information was available in each WRIA 20 watershed evaluated herein. If gaged streamflow information had not been available for any of these watersheds, one additional question that would have been included in this analytical process would be:

> Question 3U: Does the watershed of interest exhibit similar watershed characteristics to the contributing areas of two nearby streamflow gages with a complete period of record?

If the answer to this question were false, some other methodology would be necessary, since the WCM would not be applicable for estimating streamflow in this watershed.



South Fork Hoh River at River Mile 3.6
South Fork Hoh River at the outlet
Hoh River above the South Fork Hoh River
Hoh River at the outlet
North Fork Soleduck River at the outlet
Soleduck River above the North Fork
Soleduck River
Soleduck River near Beaver Creek
Soleduck River below Lake Creek
Soleduck River at the outlet
West Fork Dickey River at the outlet
Dickey River at the outlet

Bogachiel River at River Mile 22.0
Bogachiel River above the Calawah River
Bogachiel River at the outlet
South Fork Calawah River above Sitkum River
Sitkum River at the outlet
South Fork Calawah River at the outlet
North Fork Calawah River at the outlet
Calawah River at the outlet
Quillayute River below Soleduck and Bogachiel River confluence
Quillayute River below Dickey River or at the outlet

Ozette River at the outlet
Sooes River below Makah Fish Hatchery

Figure 1-2. Decision framework used to determine appropriate methodology for developing initials streamflow estimates at specific ungaged locations in WRIA 20. The ungaged locations evaluated herein are indicated below the methodology used. ***Italics*** indicates locations that were estimated using a combination of WCM-within and WCM-adjacent.

Question 1U: Are two complete gaged or extended streamflow records available within the watershed where ungaged streamflow will be estimated?

As mentioned previously, the WCM requires two coincidental gaged streamflow records to estimate streamflow at ungaged locations. More than one continuous recording gaging station was operated by the USGS in several WRIA 20 watersheds. Specifically, two gaged streamflow records were available in each of the Hoh River, Dickey River, and Soleduck River watersheds[3]. The streamflow records at these gaged locations are inherently similar, since they are each located on the main stem river or a significant tributary and are representative of similar hydrologic conditions in that watershed. As such, the WCM could be applied to estimate streamflow at ungaged locations using gaged data from within the same watershed. This process of applying the WCM using data from the same watershed is entitled "WCM-within." Since the Soleduck River exhibited obvious similarities to the Bogachiel River, the comparison of watershed characteristics in the Bogachiel and Soleduck River watersheds enabled a combination approach for estimating streamflow at ungaged locations in the Soleduck River watershed. This combination approach is indicated by the ***italic*** text in Figure 1-2.

Question 2U: Do the watershed characteristics of the watershed where ungaged streamflow will be estimated exhibit similarities to adjacent or neighboring watersheds?

As stated previously, the WCM requires streamflow information from two concurrent gaged records to enable estimation of streamflow at an ungaged location. Since gaged streamflow data was available in every WRIA 20 watershed evaluated herein, another nearby, similar gaged watershed was needed to enable use of the WCM. When two gaged records are not available from within the watershed where the ungaged sites are located, neighboring watersheds are investigated for similarities in discharge pattern and specific watershed characteristics. When a gage in a neighboring watershed is found to have a similar discharge pattern to the gage within the watershed of interest, then streamflow could be estimated at any ungaged location in either watershed using the WCM. This variation of the WCM is referred to as "WCM-adjacent" in Figure 1-2.

Similarities in discharge pattern were found by reviewing coefficients of determination (R^2) developed during the gage reconstruction process.

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[3] Although a third gaging station was operated in the Soleduck River watershed, streamflow records from USGS gaging station 12042000, Soleduck River near Beaver Creek were not utilized in this process since the gage was only in operation during the 1920's, which was not within the period of interest between October 1961 and September 1999.

Regression equations that exhibited an R^2 of at least 0.80 in all months were considered to have similar discharge patterns. As long as these "hydrologically similar" watersheds possessed a common boundary, they were used in the WCM-adjacent method.

As indicated in Figure 1-2, 21 ungaged locations within WRIA 20 were initially estimated using either the WCM-within or WCM-adjacent procedure, or a combination of both methods. Only two ungaged location evaluated herein had to be estimated using methods other than the WCM. Discharges for the Ozette and Sooes Rivers were never developed using the WCM. The following explanation will briefly describe why the WCM was not used for these locations and what was done instead.

The discharge effects of Lake Ozette on the Ozette River create a dramatically different discharge pattern in comparison to any other WRIA 20 gaged location. As such, a site specific methodology was developed for the Ozette River at the outlet, which is dominated by outflow from Lake Ozette. This methodology is described in Appendix 2.

Although the Sooes River exhibited a similar discharge pattern to gaged streamflow in the Dickey River, the Sooes River is not adjacent to the Dickey River watershed. The Ozette River watershed lies between these two drainages. An adjacent watershed in WRIA 19, the Sekiu River, was also investigated for similarities. Although the Sekiu River exhibits similar watershed characteristics to the Sooes River, an extended gaged record could not be developed from the short period of gaged streamflow data collected on the Sekiu River by the USGS. As such, a modified drainage-area method was employed to estimate streamflow at the downstream Sooes River location below the Makah Fish Hatchery. This method is very similar to the WCM, in that it transfers streamflow information from a gaged location to an ungaged location based on a weighting factor assigned to the subwatershed area. The weighting factor is calculated by multiplying the contributing drainage area (in square-miles) times the average annual precipitation (in inches). To develop accurate weights in this investigation, GIS was used to generate average annual precipitation. Each drainage area was intersected with isohyetal polygons of average annual precipitation (in inches) between 1930 and 1957 derived from Plate 1 of USGS Water-Resources Investigations Report 97-4277 by Sumioka, Kresch, and Kasnick (1997). An areal average annual precipitation was found for each subwatershed area through the distribution of isohyetal polygons, which was then multiplied against the subwatershed area (in square-miles) to calculate the weight of each subwatershed area.

Streamflow in the Sooes River below the Makah Fish Hatchery was estimated using this modified drainage-area method based on the gaged streamflow measured upstream at USGS gage 12043163. The estimated streamflow record for the Sooes River below the Makah Fish Hatchery was estimated by multiplying

the gaged streamflow record by 1.18597, which directly corresponds to the difference in weights associated with the contributing area above each site.

The remaining ungaged locations were initially estimated using the WCM. The following discussion will first describe the WCM and specifically the two variations of WCM-within and WCM-adjacent. This discussion will be followed by a discussion of the calibration process and how initial estimates were ultimately refined. The following description of the WCM provides a review of the method and is meant to supplement currently existing documentation.

Watershed Characteristics Method (WCM)

As previously mentioned, the WCM utilizes gaged streamflow information to estimate streamflow at an ungaged location based on watershed characteristics. The WCM estimates discharge for an ungaged location by adjusting a gaged discharge history to represent the discharge of the ungaged location based on a comparison of watershed characteristics upstream of each location. This method will be described first in more general theoretical terms and will then be presented in detail.

The Theoretical Basis of the WCM

As Perry (2001) describes, watersheds in the Olympic Peninsula of Washington exhibit two distinctively different seasonal variations in streamflow. Higher mountain watersheds exhibit two seasonal maxima in streamflow, one for the winter precipitation maximum, and the other for the spring snowmelt maximum. Lower elevation watersheds exhibit only the winter precipitation maximum in streamflow. These lower elevation streams have a characteristic minimum flow season during the late summer, especially where late-summer streamflow may be comprised primarily of ground-water supported baseflow. Where streamflow is developed by a watershed made up of both higher and lower watershed areas, streamflow will be a composite of the proportional seasonal discharge components that are contributed by each of these areas.

The WCM separates gaged streamflow records into several pieces that each relate to a different watershed characteristic type. Perry (2001) identified five primary watershed characteristic types on the Olympic Peninsula based primarily on elevation and precipitation-runoff patterns, or as Perry describes as the "elevation-dependent seasonal distribution of flow variability." Each of these subwatershed areas has a contributing hydrograph, which result in the streamflow measured at a specific location. In other words, when you add together the specific discharge from each contributing subwatershed area, you get the discharge pattern measured at a gaged location.

By comparing two concurrent streamflow records, each of the two discharge histories can be broken into contributing pieces based on the distribution of contributing watershed characteristics. Each piece of the gaged discharge pattern represents the discharge from a specific "type-watershed." This type-watershed

flow history can then be reduced or enlarged to represent the contributing discharge from the same watershed characteristic type in another nearby location. The streamflow at ungaged location can therefore be estimated by summarizing the flow histories from the type-watersheds above that location.

Initiating the WCM

Application of the WCM depends on the availability and similarity of gaged data and similarities between gaged and ungaged locations. Gaged discharge information is needed at more than one location to begin the WCM.
Two concurrent gaged records within the same watershed can be used to estimate streamflow at an ungaged location in the same watershed, which is required for the **WCM-within** process. Otherwise, two gaged streamflow records from similar neighboring watersheds are needed for estimating streamflow using the **WCM-adjacent** process. These two variations of WCM are similar in procedure, with the exception that the first step of each process is slightly different.

Most importantly, the two gages used in the WCM need a concurrent period of record. Concurrent records are not always available; therefore the discharge histories can include some estimates. The concurrent period of record must be of sufficient length to enable further analyses. When monthly flow variability is the final desired result, as is needed herein, a typical time period of at least 25 years is considered sufficient.

To carry out the analysis, two concurrent gages need to be similar in discharge pattern or exhibit differences in discharge pattern that are explainable through the contributing watershed characteristics. In this investigation, similarity in gaged discharge was measured through correlations, which were initially completed to determine which streamflow gages should be used in gage reconstruction. The regression relationships used in gage extension/reconstruction provided the most obvious similarities in gaged discharge patterns. If the regression equations exhibited a coefficient of determination (R^2) of greater than 0.80 in all months, then these same two gaged/reconstructed records were used in the WCM. Ultimately, the two gaged locations should exhibit similarities, but not necessarily in discharge pattern. Highly similar discharge patterns provide the best candidates for use in the WCM, but dissimilar patterns can also provide valuable information, especially if the two gaged locations are in adjacent watersheds.

In the case of two gages from adjacent watersheds with dissimilar discharge patterns, the difference between them may indicate the existence or lack of a specific watershed characteristic type in one watershed. One watershed may contain high mountain areas and thus have two seasonal maxima in streamflow. The adjacent watershed may only include lower elevations and thereby only exhibit the winter precipitation maximum in streamflow. As long as these two watersheds are adjacent and show other similarities in watershed cover, land management, aspect, geology, and regional precipitation patterns, then the differences in discharge could illustrate how the distribution of watershed

characteristics produces differences in streamflow. When adjacent watersheds exhibit dissimilar discharge patterns that are not easily explained through such differences in subwatershed areas, then the comparison of these two watersheds would not be applicable for use in the WCM.

The gaged streamflow measurements used in this method should also be geographically close to the ungaged area of interest. Gaged measurements should be from within the desired watersheds where ungaged streamflow will be estimated or within the vicinity of the watersheds being evaluated, since regional climatic variability directly affects the accuracy of WCM results. For the WCM to work properly, the regional distribution of seasonal precipitation and long-term climatic variability in precipitation and streamflow must be consistent with the area where ungaged streamflow will be estimated. Regional climatic variability can be eliminated as an adverse variable in the analysis by using nearby gaging-station histories that show climatic consistency.

Watershed Characteristic Types

Perry (2001) identified five primary watershed characteristic types on the Olympic Peninsula based on elevation and precipitation-runoff patterns. The spatial distribution of these subwatershed areas must be found above each gaged and ungaged location. Subwatershed areas are delineated based on elevation ranges identified on USGS topographic maps at 1:24,000 scale, either on paper or electronically using Digital Raster Graphics (DRG's) and GIS. The watershed characteristic types identified in the Olympic Peninsula of Washington are classified as follows:

Subwatershed Classification	Elevation range (ft above sea level)	Flow Classification
Coastal lowland	~ sea level to 300 ± 100 ft	net gain minimal
Lowland	~ 200 ft to ~ 1000 ± 300 ft	winter precip/seasonal
Upland	~ 600 ft to less than 3200 ft	winter precip/seasonal
Highland	~ 1500 ± 250 ft, to more than 3400 ft	snowmelt/seasonal
Alpine	~ 3000 ± 500 ft, to more than 5600 ft	snowmelt/seasonal

Coastal lowland subwatersheds were assumed to not contribute any significant gain to streamflow. Coastal lowland subwatersheds typically have low or moderate relief with limited integration of the drainage network. Winter-season snowfall is assumed to melt quickly and remain, at most, only a few days because winter season temperatures are mild and moderately above freezing. Most precipitation in coastal lowland subwatersheds produces little to moderate runoff and accumulation to streamflow because this precipitation primarily replenishes soil moisture, is evapotranspired by vegetation, or is lost to groundwater that is not directly measurable in the stream.

When this method was developed to estimate flow in ungaged locations in the northeastern part of the Olympic Peninsula, specifically WRIA 18, coastal

lowlands were originally identified to have an annual average precipitation of less than about 30 inches. Average annual precipitation in WRIA 20 was never less than 30 inches. The lowest precipitation levels in WRIA 20 average at least 70 inches annually, yet there are still flat, low elevation areas in WRIA 20 where the contributing drainage area contributes a minimal net gain to streamflow. The identification of coastal lowland and the other subwatershed types in WRIA 20 relied on the elevation range, relief, and drainage network factors. Miscellaneous instantaneous streamflow measurements were also used to evaluate how these coastal lowland areas affect streamflow, i.e. whether the area is effective or ineffective towards measured streamflow.

Lowland and upland subwatersheds were assumed to produce gains or losses to streamflow in proportion to area and annual precipitation evident in a nearby gaged watershed having characteristics representative of these areas. For lowland subwatersheds, winter-season snowfall was assumed to melt within a period not exceeding a few days because winter season temperatures are mild although only moderately above freezing, and rarely below freezing for any extended period of time. Winter-season precipitation usually exceeds the replenishment capacity of soil moisture, and consequently produces direct runoff, or recharge through deep-soil percolation to ground-water that in turn supports stream baseflow. Summer season precipitation may be insufficient to produce runoff with most of this precipitation replenishing deficiencies in soil moisture, and supporting evapotranspiration by vegetation. Relief in lowland subwatersheds may be moderate, and integration of the drainage network is low.

Although upland subwatersheds generally exhibit similar winter-season characteristics as lowland subwatersheds, accumulated snowfall may remain somewhat longer than a few days. Snowmelt in upland areas is responsive to winter season temperature variability and weather conditions that affect snowmelt. Because weather conditions will not cause winter season temperatures to fall below freezing for extended periods of time, snowfall may be assumed to melt within a week of accumulation. The snowline in upland watersheds is assumed to retreat rapidly after snowfall events, with occasional snow accumulations persistently remaining only in the highest portions of these watersheds. Runoff from condensation on snow may be of fleeting significance under certain weather conditions during the spring season. Relief in upland subwatersheds may be more than moderate, and integration of the drainage network is well developed.

Highland subwatersheds were assumed to produce gains to streamflow in proportion to area and annual precipitation evident in a gaged watershed having representative characteristics. Snowfall accumulation and snowmelt are dependent on seasonal weather conditions and temperature variability. Under these conditions, interactive snow accumulation and melt are likely to occur in the lower elevations of these subwatersheds where winter season temperatures may vary from just above, to somewhat below freezing, and stay below freezing for

extended periods of time. Snowline fluctuations at elevations below 2,500 ft in elevation reflect the interactive accumulation and melting of snow during the winter and early spring seasons. During the winter, precipitation in the form of rain produces significant runoff, while condensation on snow and thermal melting of snow during the spring and early summer produces significant runoff from melting of the previous fall and winter snowpack. During the spring-to-summer transition, the snowline may initially retreat rapidly in the lower elevation segments of these watersheds, and then slow to a more progressive retreat as the snowmelt season advances. Valleys defining highland subwatersheds typically show evidence of extensive alpine glaciation. Relief in highland subwatersheds is characteristic of mountain sub-alpine and alpine zones. Integration of the drainage network ranges from moderate to more than moderate in some areas, but usually may be well developed throughout most of the watershed.

Alpine subwatersheds are present in the headwaters of the Hoh River, Bogachiel River, and Soleduck River watersheds of WRIA 20. These subwatersheds are characterized by well formed glacial cirques and high-elevation, glacial-stepped, mountain valleys that head at elevations in excess of 4,800 feet. Watersheds with these characteristics are generally well developed for valley aspects facing eastward or northward, and are substantially less developed for valley aspects facing southward or westward. Valleys in this elevation range with aspects facing south or west have topographic characteristics that are the same as, or very similar to, highland subwatersheds. During the late fall and into the winter, precipitation at the higher elevations falls as snow and produces considerable snowpack accumulation throughout the winter with little comparable runoff. Winter temperatures remain somewhat below to well below freezing for substantial periods of time. Spring season rain contributes to snowpack density and increases storage in the watershed, but produces little initial melting or runoff. With the initiation of thermal and convective melting in late spring, these subwatersheds produce a snowmelt cascade that reaches a maximum in early summer. Condensation melting contributes significantly to runoff during this seasonal runoff peak and may accelerate the snowmelt process. Snowline retreat during the spring and summer, however, may not be complete within alpine subwatersheds, since substantial accumulations of snow may remain on steeper north-facing slopes in higher elevation valleys. At the highest elevations in these headwaters regions, the snowpack may be perennial in the form of snowfields and glaciers.

Alpine subwatersheds are highly similar to highland subwatersheds. These high-mountain watershed areas were not delineated separately from highland areas in WRIA 20 because 1) the seasonal discharge characteristics of these subwatersheds are transitional to and included within those of highland subwatersheds, and 2) two watersheds with significant alpine subwatershed areas are needed to define the streamflow contribution that results from this subwatershed type, but the alpine subwatershed area and resulting runoff is only a significant factor in the Hoh River watershed.

Developing the Discharge of Type-Watersheds

Once the contributing area of two appropriate gaged locations has been delineated into subwatershed areas, the discharge of each watershed characteristic type can be found. A cross-comparison of watershed characteristics above the gaged locations is used to determine the discharge for the each watershed characteristic type. This comparison is completed by first assigning a weight factor to each subwatershed area. This weight is calculated as:

Weight = estimated areal average annual precipitation X subwatershed area

To develop accurate weights in this investigation, GIS was used to generate average annual precipitation. Each subwatershed area, of which there were several within each watershed characteristic type, was intersected with isohyetal polygons of average annual precipitation (in inches) between 1930 and 1957 derived from Plate 1 of USGS Water-Resources Investigations Report 97-4277 by Sumioka, Kresch, and Kasnick (1997). An areal average annual precipitation was found for each subwatershed area through the distribution of isohyetal polygons, which was then multiplied against the subwatershed area (in square-miles) to calculate the weight of each subwatershed area. The weights of each subwatershed area are then summarized by watershed characteristic type within the entire contributing area for a streamflow gage to compile a list of each watershed characteristic type and the total weight of that watershed characteristic above the gage.

Once these weights have been defined for two applicable gages, the weights of each watershed characteristic type can be used to make an initial discharge separation through the use of algebra. This initial attempt of gage separation typically focuses on separating the two main flow regimes e.g. areas with two streamflow maxima (highland/alpine) from areas with one streamflow maxima (upland/lowland), but this same technique can be used to separate upland from lowland or upland/lowland from coastal lowland if the two gages do not include any high mountainous areas. Examples of performing this initial separation are provided for WCM-within and WCM-adjacent. These two examples are provided separately since this initial step of WCM-within is very simple to perform, whereas WCM-adjacent is more complex.

For WCM-within: When two gaged streamflow records are available within the same watershed, particularly on the same branch of the river, e.g. the main stem, the difference between the measurements represents the gains and losses that occur between the two sites. Although transit time between the two sites should be considered, monthly total streamflow at the upstream location can be subtracted from the same month downstream to assess the change in streamflow between the two sites.

In a similar fashion, the difference in the weights of each gage represents the weight of the area between the gages. Since the weight of the downstream gage includes everything above the upstream gage as well as everything between the two locations, the weight of the upstream gage should be subtracted from the weights of the downstream gage to determine the weight of the area between, which will be assigned to the discharge values calculated by subtracting the upstream gage from the downstream gage. This subtraction should still happen within each watershed characteristics type, e.g. highland weights are subtracted from highland weights only. If the area between the gages only includes upland and lowland subwatershed areas, but the area above the upstream gage includes a highland subwatershed area, then this calculation can easily remove the effects of the highland area from an upland/lowland composite type-watershed.

For example, two main stem gaging stations have been operated by the USGS on the Hoh River. Figure 1-4 illustrates the location of these two main stem gages, as well as the location of a gaging station on the South Fork Hoh River. Since all of the highland subwatershed area is above the upstream gage, USGS Gaging Station 12041000, Hoh River near Forks, WA, then the highland discharge contribution can be separated by first subtracting discharge at this location from the downstream gage, USGS Gaging Station 12041200, Hoh River at U.S. Highway 101 near Forks, WA.

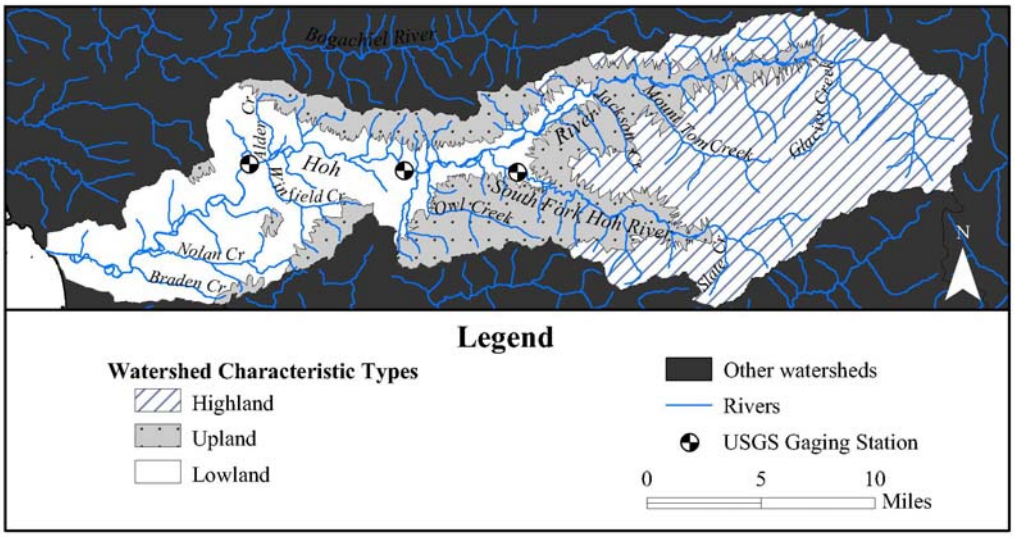

Figure 1-4. The watershed characteristics and locations of USGS gaging stations in the Hoh River watershed.

The weight above each gage is provided in Table 1-2 below. This table also includes the precipitation and area values used to calculate the weight for each subwatershed above each gage. The difference in weights is presented in the column entitled "Area between two gages." This column provides the weights

assigned to the discharge history calculated by subtracting the upstream gaged (extended) discharge record from the downstream (complete) gage record.

Table 1-2. Watershed characteristics and the respective weights of areas above the two main stem Hoh River gages.

Watershed Characteristic Types	Hoh River at USGS gage # 12041000 - Hoh River nr Forks			Hoh River at USGS gage # 12041200 - Hoh River at U.S. Hwy 101			Area between two gages
	Mean Annual Precip (in)	Area (sq. mi.)	Weight = Area * Precip	Mean Annual Precip (in)	Area (sq. mi.)	Weight = Area * Precip	Weight
Highland	186.0	124.3	23119.8	186.0	124.3	23119.8	0.0
Upland	150.6	62.8	9455.6	147.2	75.7	11135.5	1679.8
Upland-ineffective	175.1	3.73	653.5	175.1	3.74	654.8	1.3
Lowland	135.9	10.4	1420.1	127.8	36.3	4637.5	3217.4
Lowland-ineffective	141.2	6.0	845.2	132.1	12.9	1707.6	862.4
Entire area	171.2	207.3	35494.2	163.1	252.9	41255.1	4897.2*

*There are areas in the Hoh River watershed that are considered ineffective toward streamflow. These weights should not be included in the total weight of this area.

The resultant discharge now represents streamflow from a composite upland/lowland watershed with an upland weight of 1680 and a lowland weight of 3217. This flow history could be further separated in a variety of ways to separate upland from lowland, but this separation does not easily produce accurate results in a highland dominated watershed such as the Hoh River watershed. Often, the derived upland/lowland composite flow history could be used directly to estimate streamflow at an ungaged location. The application of this type-watershed will be covered in the next section.

For WCM-adjacent: In this example, highland-generated discharge will be separated from an upland/lowland composite. If:

A represents the total highland weight in gage 1
B represents the total combined upland and lowland weights in gage 1
C represents the total highland weight in gage 2
D represents the total combined upland and lowland weights in gage 2

Then we can estimate A by:

1. Make B = D by
    a. Estimating the ratio of B / D, then
    b. Multiply gage 2 by B / D.
2. Estimate the rescaled highland weight from the affected streamflow gage in step 1, gage 2, by multiplying C by B / D. This rescaled highland weight for gage 2 will be termed X, which is equal to (C * B / D).

3. Since B = D, we can subtract discharge from the two gages from each other to find a residual highland discharge. In other words:
    a. If X > A, then subtract gage 1 from (gage 2 * B / D)
    b. If A > X, then subtract (gage 2 * B / D) from gage 1

    The resultant discharge represents a discharge contribution for a highland area with the resultant weight after subtraction of the two weights, i.e.:
    c. If X > A, then the residual highland weight = X - A
    d. If A > X, then the residual highland weight = A - X
4. The residual highland discharge can then be rescaled to represent the total highland discharge generated in either watershed. Total highland discharge is estimated by multiplying the residual highland discharge by a factor that makes the residual highland weight equal to either A or C for each respective watershed.
5. Estimate a combined upland-lowland discharge history for either gage by subtracting the total highland discharge from the original gaged streamflow record.

The total highland discharge should generally yield positive streamflow volumes in all months, whereas the upland-lowland composite discharge history may include several negative numbers in the summer months. The occurrence of negative streamflow volumes in snowmelt-runoff months indicates that some streamflow generated by snowmelt runoff in highland subwatersheds is lost along the streamcourse before reaching the gage downstream. A similar algebraic process can be used to separate upland from lowland discharge contributions. The resultant discharge contributions from each type-watershed can now be applied to estimate total streamflow discharge at an ungaged location.

Application of Type-Watershed Streamflow Contributions

The definition of the estimated type-watershed streamflow contributions allows estimation of ungaged watershed/subwatershed responses to seasonal precipitation input. Transference of type-watershed streamflow contributions to an ungaged location can be accomplished two different ways depending on the transference convention being applied. The result can be considered either the cumulative sum of total flows for all of the subwatersheds in a watershed or the sum of total flows for higher elevation subwatersheds and net flows derived for lower elevation subwatersheds. Calibration of the transference is based on observed conditions within the watershed/subwatershed for which the flow history is being estimated.

Total flow is the estimated or measured output of the entire watershed above a specific location, i.e. a gage on the streamcourse. Net flow is determined as the difference in the observed, or estimated, flow between two successive locations along the streamcourse. Net flow is representative of instream losses caused by evaporation from the water surface of the stream, and infiltration losses along the streamcourse. Similarly, net flow is also representative of instream gains caused by ground-water discharge to the stream, and the gain in flow caused by runoff

from the intervening watershed area. The convention in transference indicates whether the accumulated discharge being determined for a watershed will be the sum of total flows from each of the contributing subwatersheds or the sum of a combination of total flows from higher elevation subwatershed segments and net flows from lower elevation subwatershed. Use of the net flow attributable to a subwatershed allows for adjustments during the calibration of streamflow estimates.

The flow history for a desired subwatershed is developed by using the historical streamflow information from a corresponding type-watershed. This transference is accomplished by rescaling the type-watershed flow history to that of the desired subwatershed being evaluated. The scaling factor is simply the ratio of the precipitation weighted watershed areas for each of these subwatersheds. The elevation-dependent flow history and precipitation weighted type-watershed area are the defined watershed characteristics for the type-watershed. The precipitation weighted area and subwatershed classification are the determined watershed characteristics for the subwatershed being evaluated. Because type-watershed conditions are assumed for conditions of natural cover, and natural flows are the desired result, consideration of watershed cover is not a factor in the transference.

The summation of resulting subwatershed flows developed by the WCM transference procedure provided the initial estimates of flow at select locations. This estimated flow history, although assumed to be representative, may in fact not represent actual details of flow. Representative, in the sense of qualification regarding the estimated these flow histories, indicates an attempt to *generically reproduce the flow variability and range in magnitude of flows that would be observed at the field sites for which these estimated histories have been determined*.

Calibration

Calibration of the WCM transference can be based on conditions observed within the watershed or actual measurements of streamflow at specific locations. These observations and measurements indicate the objective flows, or target flows, that are desired in the resulting transference of watershed characteristics. These streamflow measurements were assumed to be representative of the flows developed by the watershed that is being evaluated.

The calibration of initial streamflow estimates at ungaged locations in WRIA 20 relied on “miscellaneous” streamflow measurements. Such streamflow measurements provided information regarding gains and losses between particular stream locations, especially at lower elevations near watershed outlets. An analysis of available miscellaneous streamflow information enabled identification

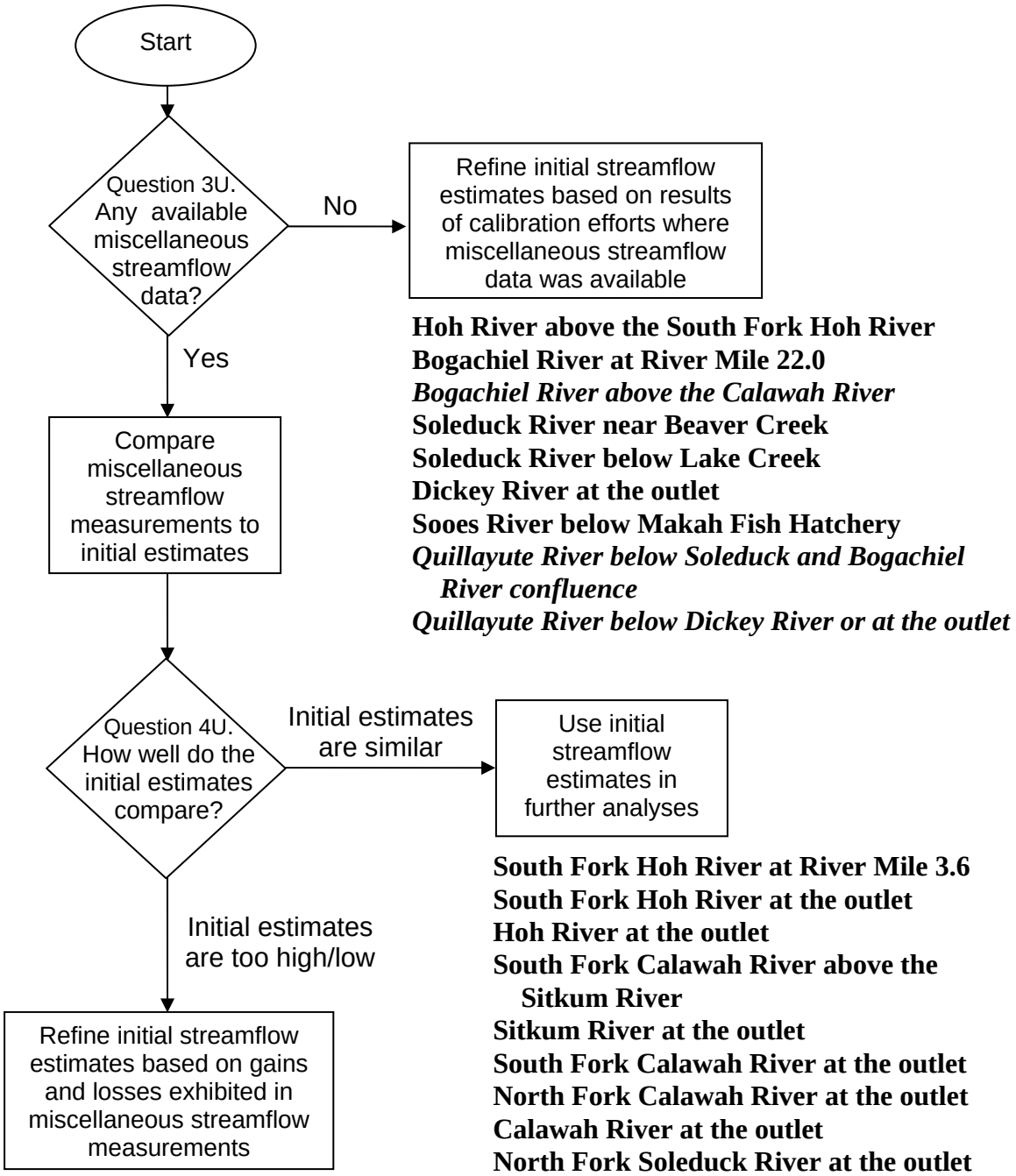

Figure 1-3. Calibration process used to refine initial streamflow estimates at specific ungaged locations in WRIA 20. The ungaged locations evaluated herein are indicated below the methodology used. ***Italics*** indicate locations where the initial streamflow estimates were refined as a result of this calibration process.

of locations where initial streamflow estimates needed to be refined in order to accurately represent streamflow at ungaged locations.

Figure 1-3 illustrates the calibration process as a flowchart. Again, two questions were applied to the ungaged locations of interest and the initial streamflow estimates for these sites. These two questions provided the separation points in the calibration process:

Question 3U: Are any miscellaneous streamflow measurements available for these ungaged locations, particularly at low flow times?

Question 4U: How well do the initial streamflow estimates compare to the available miscellaneous streamflow measurements?

By following this framework, the resultant calibration action is indicated for each ungaged location. The flowchart ends by indicating the name of each ungaged site in terms of whether the initial estimates were verified or refined through this calibration process. The following section provides a detailed description of each question and refinements made as a result of the calibration process.

Question 3U: Are any miscellaneous streamflow measurements available for these ungaged locations, particularly at low flow times?

Miscellaneous streamflow records have historically been collected in WRIA 20 by the USGS and more recently by the Streamkeepers of Clallam County, particularly in the summer and fall of 2002. Miscellaneous measurements were also taken within the Hoh River watershed in the summer and fall of 2002 by the Hoh Indian Tribe's Natural Resource staff. These measurements were used to evaluate the veracity of the initial streamflow estimates for ungaged locations in WRIA 20, particularly during times of low or base flows. More than half of the ungaged locations evaluated herein had miscellaneous streamflow measurements that were able to be used. Singular instantaneous measurements from 2002 were available for several locations, particularly in the Hoh River watershed, yet these measurements were still instrumental for evaluating the veracity of streamflow estimates in baseflow months.

Question 4U: How well do the initial streamflow estimates compare to the available miscellaneous streamflow measurements?

Miscellaneous streamflow measurements were compared to initial streamflow estimates for ungaged locations. Instantaneous streamflow measurements were available for most sites. These data could only be compared to initial streamflow estimates by developing monthly total streamflow estimates using a hydrograph matching technique, as described previously in the gaged record extension discussion, or by comparing instantaneous streamflow measurements from low

flow months to initial estimates of average monthly streamflow in the lowest months.

Streamflow on the Olympic Peninsula reached minimum levels in 2002. Low flow measurements from that summer/fall were invaluable for calibration efforts. Instantaneous streamflow measurements were collected throughout WRIA 20 between August and October of 2002 by the Streamkeepers of Clallam County and the Natural Resource staff of the Hoh Indian Tribe. These measurements were compared to the lowest average monthly streamflow estimates generated for August, September, and October at each location. Since the lowest average monthly streamflow estimate is considered to represent baseflows in dry years, the initial estimates were considered accurate if the lowest instantaneous streamflow measurements were close to the minimum average monthly streamflow estimates. For large rivers, the minimum average monthly flow was considered acceptable for purposes of this study if it was within 5% of the lowest instantaneous streamflow measurement. For small creeks, a larger percent of flow was considered similar. Specifically, small creeks (4 - 5 cfs) were considered similar if they were within 20% of the instantaneous measurement, since a 20% difference in a streamflow with a baseflow of 5 cfs is only a difference of 1 cfs. More generally, this comparison was used to assess whether the initial estimates were relatively over or underestimated at low flow conditions.

Through this calibration process, only two ungaged locations in WRIA 20 were found to be overestimated through the WCM. Specifically, the outlet of the Bogachiel and Soleduck Rivers were initially overestimated, thereby requiring additional efforts to accurately estimate streamflow at these locations. As a result of these findings, streamflow estimates for three other ungaged locations were redeveloped due to their geographic and elevation proximity:

- Bogachiel River above the Calawah River
- Quillayute River below Soleduck and Bogachiel River confluence
- Quillayute River below Dickey River or at the outlet

Miscellaneous streamflow measurements were not available for these three sites, yet the final estimates are considered more accurate considering the investigation into the Soleduck and Bogachiel River data. The following section will describe how streamflow was refined at each of these sites.

Final Refinements to Initial Streamflow Estimates

Initial streamflow estimates at several WRIA 20 locations were refined through the results of the miscellaneous streamflow investigation. In some cases, these refinements still included an application of the WCM, while the WCM was not used in other locations.

Many miscellaneous streamflow measurements were available for the Soleduck River at the outlet, which determined the WCM overestimated streamflow at this

location, even during the winter months of December and January and during spring runoff months of May and June. As a result of these findings, it was considered inappropriate to use the WCM for estimating additional runoff into the Quillayute River downstream of the Soleduck River outlet. Therefore, the WCM was not used to generate the final streamflow estimates for:

- Soleduck River at the outlet
- Quillayute River below Soleduck and Bogachiel River confluence
- Quillayute River below Dickey River or at the outlet

Miscellaneous streamflow measurements were also available at the outlet of the Bogachiel River. A comparison of these data to the initial estimates WCM demonstrated the WCM overestimated streamflow at this location during baseflow events, but insufficient data was available to disprove the accuracy of estimates generated for higher volume months. As such, the following locations were refined, while still including an application of the WCM:

- Bogachiel River above the Calawah River
- Bogachiel River at the outlet

The following discussion will describe each of these locations in detail and how each final streamflow record was estimated.

The **Soleduck River** provides a specific example of when miscellaneous streamflow measurements illustrated that the initial estimates generated through the WCM transference were too large. In particular, 49 instantaneous streamflow measurements were collected at the mouth of the Soleduck River between September 20, 1977 and September 29, 1978. The Soleduck River gage near Quillayute was in operation during 46 of these measurements, beginning on October 1, 1977. These instantaneous streamflow measurements were used to generate monthly total flows for the outlet of the Soleduck River between September and December of 1977, as well as during May, June, and September of 1978. A comparison of these monthly totals to monthly totals measured at the upstream gage at Highway 101 illustrated that the increase in Soleduck River streamflow in this stretch of river is negligible in most months, with the majority of months exhibiting a slight decrease in total monthly streamflow. The WCM estimates were also compared to these monthly totals and were found to be higher. As a result, the WCM was not considered appropriate for estimating streamflow this location.

The last two locations where the WCM was not used are located on the Quillayute River. No streamflow measurements were available for the **Quillayute River**. Instantaneous streamflow measurements were only available at the outlet of tributaries to the Quillayute River. Additionally, the USGS only monitored water level fluctuations during high and low tide events at several Quillayute River locations near La Push, WA, but stage-discharge relationships were not developed

for these locations, not even during low tide events. Since the comparison of gaged and instantaneous streamflow measurements in the Soleduck River demonstrated minimal gains to streamflow in lower elevation areas and even some losses, the streamflow in the Quillayute River was estimated using simple arithmetic means. No adjustment for gains or losses was included in the final Quillayute River estimates due to lack of available information. In other words, Quillayute River streamflow was estimated at the most upstream location by summing the inflow from the Bogachiel and Soleduck Rivers, which form the beginning of the Quillayute River. The next downstream location was estimated by simply adding the outflow from the Dickey River watershed to the upper Quillayute River estimate without adjusting for any other gains or losses.

Very few miscellaneous streamflow measurements were available for calibrating streamflow estimates for the **Bogachiel River** watershed. The Streamkeepers of Clallam County collected several instantaneous measurements in the late summer and early fall of 2002 on the Bogachiel River, specifically at:

- Bogachiel River at river mile 15.0, approximately 1900 ft below U.S. Highway 101
- Bogachiel River at the outlet

The Streamkeepers also measured streamflow at the outlet of the Calawah River on these same days within a few hours of each other. A brief analysis of these data indicated gains between the Bogachiel River gage and the outlet and that estimates for the Bogachiel River at the outlet generated through the WCM at minimum flow times were slightly over estimated. As such, the lowest months in the WCM estimates for the outlet of the Bogachiel River were identified. These months were then monitored for gains while the loss factors were incorporated. Minimal gains of about 100 ac-ft were used between the outlet of the Calawah River and the Bogachiel River gage to estimate Bogachiel River outflow in some of the baseflow months. Otherwise, WCM estimates were used to estimate Bogachiel River outflow in the majority of months. The estimated outflow of the Bogachiel River was then used to back calculate the Bogachiel River above the Calawah River. The gains between the Bogachiel River gage and the outlet were rescaled based on the watershed characteristics exhibited between the Bogachiel River gage and the confluence with the Calawah River.

The initial estimates for all other ungaged locations in WRIA 20 where left unchanged as a result of the calibration process.

3. Evaluate Streamflow Variability

Flow variability was evaluated by using a flow duration analysis procedure. By rank-sorting the monthly total flows on a calendar month basis, the percentage of time that flow was less than, or equal to, an indicated level of flow for that month,

may be determined. This forms the core of what is termed the flow duration analysis procedure. For each of the flow histories that were evaluated, the result of this procedure is depicted as the indicated variability in flow distributed across the year on a monthly basis. For the results of this process to be representative, a sufficiently large sample of monthly flows must be obtained from which the sort may be accomplished. The resulting percentage-of-time values are determined without regard to the statistical plotting position. For a sufficiently large sample, the differences between the resulting percentage-of-time values, and those determined by the statistical plotting position, are not likely to be significant. A condensed plot illustrating the 10, 50, and 89 percent levels of exceedence was provided under the "Streamflow Evaluation" section for each primary watershed. A sample plot from the Hoh River at U.S. Highway 101 is provided below. This plot is followed by the corresponding table of values illustrated in the plot. A complete flow duration plot was also generated for each location as well. The complete flow duration plot for the Hoh River at U.S. Highway 101 is also provided as an example below. A complete set of these plots are located in Appendix 3.

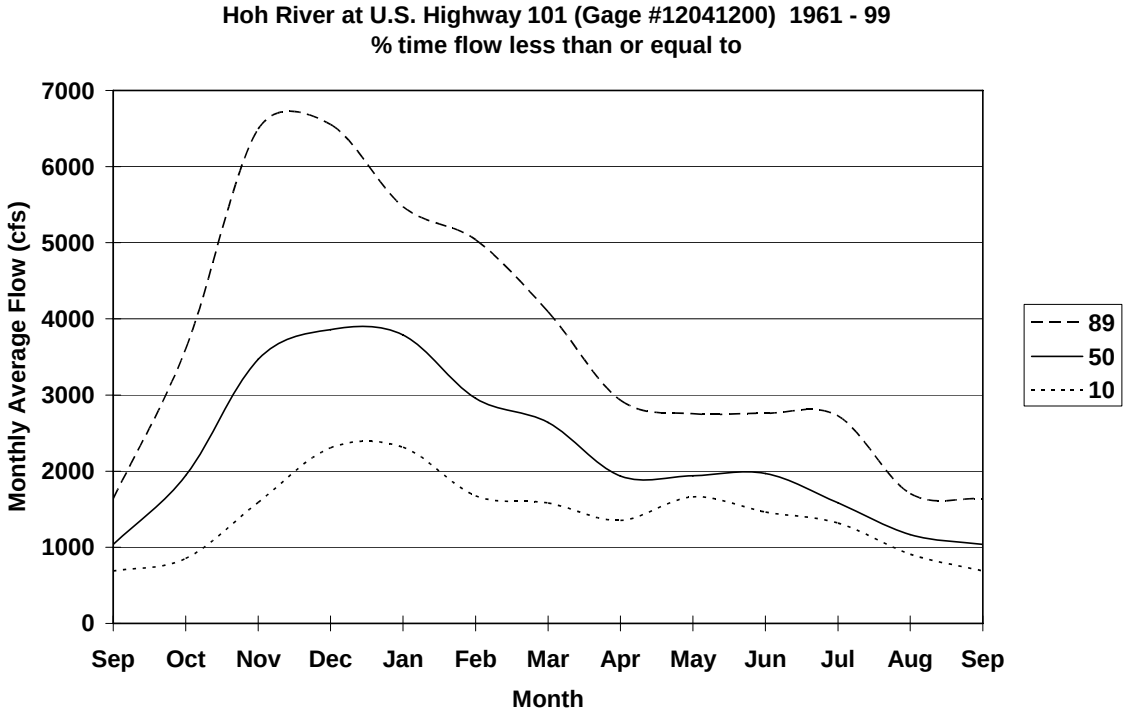

Table 1-3. Percent of time that average monthly streamflow (cfs) would be less than or equal to the indicated value for each month at the Hoh River at U.S. Highway 101.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	3601	6493	6553	5472	5039	4092	2932	2755	2761	2725	1703	1639
50	1942	3470	3860	3790	2957	2641	1935	1940	1970	1585	1167	1038
10	852	1589	2304	2314	1675	1580	1352	1662	1464	1318	907	688

STATION NUMBER 12041200 HOH RIVER AT U.S. HIGHWAY 101 NEAR FORKS - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
890705.4													14771.63
777569.8													12895.36
678804.3		X											11257.42
592583.9			X										9827.52
517315.6													8579.26
451607.1		9	9	X									7489.54
394244.9	X			9	X	X							6538.23
344168.7					9								5707.76
300453		7	7	7									4982.77
262290.1			5		7	9							4349.87
228974.7	9	5		5									3797.36
199890.8	7		3	3	5	7	X	X	X				3315.03
174501		3				5		9	9	X	X		2893.96
152336.3							7	7	7			X	2526.37
132986.8	5		1	1	3	3	5	5	5			9	2205.48
116095.1							3	3	3	7	9		1925.34
101349					1	1		0		5			1680.79
88475.84	3	1	0			0			1	3	7		1467.30
77237.81							1		0	1	5	7	1280.93
67427.21		0		0	0					0	3	5	1118.23
58862.74							0				1	3	976.19
51386.11	1										0		852.20
44859.14													743.95
39161.26												0	649.46
34187.07													566.96
29844.7													494.95
26053.88	0												432.08
22744.57													377.20
19855.6													329.29
17333.59													287.46
15131.91													250.95
13209.89													219.08
11531.99													191.25
10067.22													166.96
8788.503													145.75
7672.204													127.24
6697.702													111.08
5846.973													96.97
5104.302													84.65
4455.963													73.90
3889.975													64.51
3395.878													56.32
2964.542													49.16
2587.991													42.92
2259.271													37.47
1972.303													32.71
1721.785													28.55
1503.088													24.93
1312.168													21.76
1145.499													19.00
1000.001													16.58

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Appendix 2: Natural Streamflow synthesis for Ozette River

Introduction

A flow frequency analysis was requested for the Ozette River at the ocean outlet. To generate a flow frequency analysis for each WRIA 20 watershed, a complete period of record was developed for each contributing watershed between October 1961 and September 1999. If gaged natural streamflow information was available for this period, then no additional analysis was necessary. As with other WRIA 20 watersheds, some gaged streamflow information was available for the Ozette River drainage, but these data did not extend for the complete period of interest. Thus, streamflow estimates were developed to fill gaps and complete a period of record at the gaged locations. Since gaged streamflow data were collected upstream of the ocean outlet, additional work was necessary to create a flow frequency analysis that is representative of streamflow at the ocean outlet.

The following section will describe the methods used to generate the desired period of record for the Ozette River at two locations:

- Ozette River below Coal Creek
- Ozette River at the ocean outlet

This river was segregated from other WRIA 20 watershed analyses because the methods employed deviated from the watershed characteristics method (WCM), which is described in Appendix 1.

Methodology for estimating Ozette River streamflow

As mentioned previously, Ozette River streamflow data was first generated for the location below Coal Creek. Very little additional watershed area is gained below this point, only 4.2 square-miles as illustrated in Table 2-1 below.

Table 2-1. Areas of Ozette River watershed sections upstream of the ocean outlet.

Watershed section	Area (sq. mi.)	Percent of Total Area
Contributing area upstream of Lake Ozette	67.66	76.89
Lake Ozette surface area	11.59	13.18
Coal Creek watershed	4.47	5.08
Remaining area between Lake Ozette and the ocean outlet	4.27	4.85
Total drainage area at ocean outlet (rounded)	88.0	100.0

The estimation of streamflow at the ocean outlet relied upon streamflow estimates developed below Coal Creek. Therefore, the following methodology discussion will first detail the techniques employed to estimate the Ozette River below Coal Creek, followed by a description of the techniques used to estimate flows at the ocean outlet.

Ozette River below Coal Creek -

To complete the period of record desired for the Ozette River between October 1961 and September 1999, gaged historical streamflow information for the Ozette River was compiled. Several years of gaged data was collected on the Ozette River by the USGS between August 1976 and September of 1979. These records were collected at:

- USGS Station Number 12043150 Ozette River at Ozette, WA

This historical streamflow information was considered natural, since the USGS reported only the "natural regulation from Ozette Lake" and "no diversion above station" in their published streamflow records. Average daily outflow from Lake Ozette was developed between November 1981 and September 1999 using stage-discharge rating information collected by the Makah Indian tribe and Lake Ozette stage-height data collected by the National Park Service. Lake Ozette outflow data could not be developed between September 1994 and December 1997, since lake stage information was unavailable. The Lake Ozette outflow data was also considered natural, since historical information regarding upstream diversions and land management was unavailable. Since it is likely that land management activities upstream of Lake Ozette included timber harvesting, it may be more accurate to refer to the Lake Ozette outflow and the USGS streamflow data as "actual" streamflow data, rather than as an estimate of "natural" streamflow conditions. All available average daily streamflow data was summarized into monthly total streamflow in acre-feet. Table 2-2 below summarizes the number of monthly totals that were available from each source and percent of the period of record derived from these gaged data.

Table 2-2. Source of available Ozette River streamflow data.

Source	Number of Months	Percent of Study Period of Record*
USGS gaged streamflow	38	8.3%
Lake Ozette outflow	176	38.6%
Total months available	214	46.9%

*NOTE: The entire period of record between October 1961 and September 1999 includes 456 months.

Although very little distance separates the two gaging sites, approximately 700 feet of river channel, the data used in the flow frequency analysis should only represent one flow point to ensure consistency. A comparison of annual total streamflow fluctuations was used to assess relative differences between the USGS and Lake Ozette outflow data. This assessment compared fluctuations in total annual streamflow from a nearby streamflow gage with an overlapping period of record to annual fluctuations in the Ozette River or Lake Ozette outflow data.

Nearly identical annual fluctuations occurred between the Ozette River /Lake Ozette outflow data and several nearby streamflow gages, including the Sooes River, Dickey River, and Hoh River, but the analysis also showed that the USGS gaged records included a significant amount of additional streamflow than the Lake Ozette outflow data. Based on this observation, the stage-discharge rating curve for Lake Ozette outflow was reviewed and redeveloped, but the results did not change. The USGS records still exhibited considerably more streamflow on an annual basis. The reason for the greater flows was postulated to be either baseflow accruals to the stream downstream of the lake or possibly additional streamflow from the next downstream tributary of Coal Creek. Estimates of baseflow gains between Lake Ozette and Coal Creek were therefore generated from streamflow measurements taken the same day at the Lake Ozette outlet, at the Coal Creek outlet, and just below Coal Creek. When these baseflow estimates were included, the annual USGS data still demonstrated a significant unexplainable increase over annual Lake Ozette outflow data, even during periods of low flows.

Since baseflow accruals could not explain the higher annual flows in the USGS data, the inflated annual fluctuations were assumed to be caused by the location where field measurements were taken. Although the published USGS records describe where the stage-height recorder was located, the stage-discharge rating curve information was not published or available on the internet. If the field-measured discharge data used to develop the USGS rating curve was collected a short distance downstream of the stage-height recorder, approximately 175 feet, it would have included streamflow contributions from Coal Creek. It is likely that discharge measurements were taken further downstream due to the thick vegetation that lines the river. As a result of this analysis, the USGS data was considered adequate to represent Ozette River streamflow below the Coal Creek confluence.

In order to represent only one stream location, the Lake Ozette outflow data was used to estimate Ozette River streamflow below Coal Creek between 1981 and 1999. The equation used to develop estimates of the Ozette River below Coal Creek from the available Lake Ozette outflow data was:

Ozette River below Coal Creek = Lake Ozette outflow + Coal Creek outflow + baseflow accruals

Estimates of Coal Creek and baseflow accruals were necessary to represent the additional streamflow gains captured by the Ozette River below Coal Creek. Baseflow estimates were developed as previously described and ranged between 619 and 860 ac-ft in additional streamflow each month. In most cases an average baseflow value of 739 ac-ft was used, except in low flow months when a lower baseflow value was used. The WCM, as described in Appendix 1, was used to estimate the streamflow of Coal Creek from two records of gaged streamflow data collected by the USGS:

- USGS Station Number 12043163 Sooes River below Miller Creek near Ozette, WA
- USGS Station Number 12043300 Hoko River near Sekiu, WA

Estimates of Ozette River streamflow below Coal Creek were developed for the period between November 1981 and September 1999, excluding the period between September 1994 and December 1997 when Lake Ozette outflow data could not be developed. A comparison of annual fluctuations between the Ozette River below Coal Creek and other nearby gages exhibited similar annual fluctuations with no apparent difference between the directly gaged streamflow data from the USGS and the data developed using Lake Ozette outflow. For illustration purposes, table 2-3 below describes the methods used to develop primary monthly total streamflow estimates for the Ozette River below Coal Creek, which were used as the primary data in further estimation procedures, e.g., regression analyses.

Table 2-3. Methods used to develop primary data for the Ozette River below Coal Creek.

Source/Method	Number of Months	Percent of Study Period of Record
USGS gaged streamflow	38	8.3%
Lake Ozette Outflow + Coal Creek estimate from WCM using Sooes River gage + baseflow estimate	59	12.9%
Lake Ozette Outflow + Coal Creek estimate from WCM using Hoko River gage + baseflow estimate	63	13.8%
Total number of months	160	35.1%

NOTE: Several months (54) of available Lake Ozette outflow information were not used to estimate data gaps for months of primary Ozette River below Coal Creek data, as noted by comparing the total number of months available in Tables 2-1 (214 months) to the number of months estimated as seen in Table 2-2 (160 months). The reason these months were not used is due to the accuracy of Coal Creek estimates generated using the WCM. As described previously, Coal Creek outflow needed to be estimated and added to Lake Ozette outflow, along with a baseflow estimate, to generate the primary Ozette River data. The closest streamflow gages used to develop the Coal Creek estimates, the Sooes and Hoko

River gages, were not in service for several winter/spring months between November 1986 and May 1994. Therefore Coal Creek estimates during these months could not be derived from these closer gages, which were considered to have the most representative watershed characteristics to the Coal Creek watershed. To estimate Coal Creek flows during these months, the WCM was therefore applied to data derived from streamflow gages further to the south, (e.g., the Calawah River gage). The Coal Creek estimates derived from the Calawah River gage were considered to be less representative of the true outflow of Coal Creek, since they were based on a more distant streamflow gage. As such, the estimates of the Ozette River generated for these months are not considered "primary" data, and were not used as the basis for further analysis, e.g. regression equation development.

Monthly total streamflow estimates on the Ozette River were necessary for the entire period of record between October 1961 and September 1999 in order to develop the flow frequency analysis and exceedence curves. Once all available gaged records were compiled, the remaining period of record for each WRIA 20 watershed was estimated using the WCM. The Ozette River is located downstream of Ozette Lake, which has an open water surface measuring approximately 11.6 square-miles. Unfortunately, no other nearby river has a large lake upstream that directly affects the gage; therefore direct application of the WCM was considered inappropriate for developing streamflow for the Ozette River.

Instead of relying on watershed characteristics, the remaining streamflow estimates for the Ozette River were dependent on the primary data described previously. Synthetic streamflow estimates for the Ozette River were developed using regression techniques similar to those used to extend gaged streamflow records. The main difference between the two applications is that regression analyses require more data and time to complete than the WCM. Specifically, regressions require sufficient simultaneous data from two streams to compare streamflow fluctuations. When very little gaged streamflow data is available, the WCM can be used to develop a flow frequency analysis, as long as upstream watershed characteristics are similar to those of a nearby gage. The use of regressions is considered more accurate than the WCM, but does rely on some fundamental principles, such as a sufficient period of record, than can limit application.

The extension of gaged streamflow records using regression techniques is based on the premise that watersheds within close proximity to each other or have similar climatic and physical characteristics will exhibit similar fluctuations in streamflow. In other words, the rise and fall of streamflow will occur at approximately the same time with differing amounts of variability. This assumption of similar timing between watersheds is most apparent when comparing daily streamflow hydrographs from two nearby gages. This comparison illustrates that streamflow is responding to the same contributing

factors, such as rainstorms, watershed characteristics, or snowmelt runoff. The streamflow variability between gages, or how high or low the flow varies, may show some similarities on a daily basis, but greater similarities are evident when streamflow is aggregated over a month or a year. Thus, simultaneous gaged streamflow data, e.g. monthly total streamflow, for two similar watersheds should exhibit sufficient similarities when compared (usually with an R^2 of greater than 0.80) in order to use the regression equation for estimation procedures.

A comparison of all simultaneous data from nearby gages and the primary Ozette River data did not exhibit sufficient similarities for direct comparison in all months. Similarities were found only when the monthly streamflow hydrograph was increasing or decreasing from month-to-month, or on the increasing and receding limbs of the hydrograph. The specific timing of these events can be explained by the natural storage effects that occur due to Lake Ozette. In the late summer and early fall, lake levels are the lowest, and streamflow is captured by the lake, only allowing minimal flow to be released. As streamflow increases, water levels in Lake Ozette approach storage capacity, thereby releasing more water.

To estimate the remaining period of record based on these similarities, regression equations were developed for:

a. Increasing months - when the current monthly total is greater than the previous month
b. Decreasing months - when the current monthly total is less than the previous monthly
c. Peak months - when the current monthly total is greater than the previous month and the next month
d. First month after peak months - when the previous month was the peak

These equations were based on the relationships between monthly total streamflow for the Ozette River below Coal Creek and total monthly streamflow at nearby gages including:

- USGS Station Number 12043100 Dickey River near La Push, WA
- USGS Station Number 12043163 Sooes River below Miller Cr near Ozette, WA
- USGS Station Number 12043300 Hoko River near Sekiu, WA

In general, these four equations were developed using each of these gages to estimate Ozette River streamflow below Coal Creek at different time periods. The estimates generated from the Dickey River served as a check against the values generated by the Sooes and Hoko River equations. The Dickey River estimates were similar to the Hoko River estimates between August 1962 and September 1974. Since the Hoko River is closer to the Ozette River, the

estimates generated by the Hoko equation were used in the Ozette River synthetic record instead of those developed from the Dickey River gage.

The primary Ozette River data was used to calibrate the application of the equations, (i.e. the months between August 1976 and September of 1979, as well as between November 1981 and September 1999, were estimated using the developed regression equations and compared to the original Ozette River data in an effort to refine estimation procedures). The calibration resulted in several refinements of the application procedure. One refinement was the development of definition caveats, such as how large a peak month must be to substantiate the need to shift from the "Increasing" equation to the "Peak" equation. Such refinements were necessary because the regression equations basically created different estimates from the monthly totals of a nearby gage. For example, the "Increasing" equations developed the lowest Ozette River flow estimates from each of the gaged totals; whereas the "First month after peak" equation developed the highest Ozette streamflow estimates from a gaged total. The "Decreasing" and "Peak" equations each generated increasingly higher estimates for the Ozette River Streamflow, which both generated lower estimates than those found using the "First month after peak" equation.

Another refinement was necessary to account for the timing of peak monthly streamflow. This was done since the largest monthly streamflow in the Ozette River did not always occur the same month as the peak monthly streamflow in the nearby gaged stream. Sometimes the Ozette River or the outflow of Lake Ozette has a larger monthly total streamflow the month after a peak occurs in a nearby gaged stream. Therefore, a peak-definition equation was developed to determine if the peak in Ozette River streamflow would occur in the same month or the next month than the peak exhibited by the primary gage. If peak Ozette streamflow was determined to occur in the month after a peak occurred in the nearby gaged stream, then Ozette peak streamflow was estimated through a *lagged* regression equation that was based on the peaked monthly total streamflow in the nearby gaged stream.

Although a large period of record was estimated using gaged streamflow records from the Dickey, Hoko, and Sooes Rivers, these gages were not in operation during several months between October 1961 and September 1999. To develop a complete period of record with the most accuracy, the closest gages in proximity and watershed characteristics were used first, after which more distant streamflow gages were used to estimate streamflow. A total of 35 months were developed using data from more distant streamflow gages, which amounts to 7.7% of the 456 months within the entire period of record. The more distant gages used to fill out the entire period of record are:

- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA
- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12043000 Calawah River near Forks, WA

To minimize the number of regression equations developed, estimates of the Hoko River that were derived from these gages were used to estimate the final 35 monthly totals of additional streamflow. This shortcut was considered to create estimates that would not adversely impact the resultant flow frequency analysis.

Summary for Ozette River below Coal Creek

Several methods were used to develop a complete period of record between October 1961 and September 1999 in order to assess flow frequency in the Ozette River below Coal Creek. Table 2-4 below summarizes the number of months derived using each described method and the percent of the entire period of record (456 months) those months represent

Table 2-4. Methods used to develop monthly total streamflow estimates for the Ozette River below Coal Creek.

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow	38	8.3%
Lake Ozette Outflow + Coal Creek estimate from WCM using Sooes River gage + baseflow estimate	59	12.9%
Lake Ozette Outflow + Coal Creek estimate from WCM using Hoko River gage + baseflow estimate	63	13.8%
Lake Ozette Outflow + Coal Creek estimate from WCM using Hoko River estimates derived from Calawah River gage + baseflow	54	11.8%
Estimated using regression equations against Sooes River gage	29	6.4%
Estimated using regression equations against Hoko River gage	178	39.0%
Estimated using regression equations against Hoko River estimates derived from Calawah River gage	8	1.8%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	15	3.3%
Estimated using regression equations against Hoko River estimates derived from Bogachiel River gage	12	2.6%
Total number of months	456	100%

To better illustrate how each month was developed, Table 2-5 provides a color coded complete "synthetic" period of record for the Ozette River below Coal Creek between October 1961 and September 1999, and Table 2-6 provides the definitions of the colors. This record is termed "synthetic" because it includes estimates of total monthly streamflow. The monthly totals are provided in water year, which begins in October and ends the following September.

Table 2-5. Synthetic period of record for the Ozette River below Coal Creek - Total monthly streamflow in ac-ft.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Total
1962	7594	11115	42609	62226	27921	24015	19441	10969	6029	2789	1564	5009	221282
1963	9826	37507	61883	46759	44636	30044	21092	20979	2958	7565	2610	951	286811
1964	12355	40139	69632	74346	38762	55891	34086	14831	7424	4146	6984	3594	362191
1965	8045	12165	35006	63492	80033	38824	19806	16773	3231	1578	1885	1770	282608
1966	7644	15729	39609	70348	52272	55120	18365	7911	5468	4863	2279	1307	280914
1967	10508	32153	92402	98342	69101	57243	22703	11413	3461	1386	912	1008	400633
1968	41884	26128	49668	81284	71305	50479	31107	12582	7474	4411	3882	9209	389413
1969	33087	31075	40168	61547	52771	42959	41391	12906	5914	2823	1834	6040	332516
1970	8233	9228	15282	34340	43313	29795	53876	21279	3087	2141	1731	3543	225849
1971	8349	22763	40953	77886	66273	62908	33867	11281	8242	4782	2144	1714	341163
1972	10817	29432	47468	63218	70708	71167	46211	17989	2234	14950	1912	1574	377682
1973	2686	11290	45941	86882	35343	38292	21681	19370	17514	4121	1822	951	285893
1974	12282	53891	64821	79326	74116	74339	42076	37007	17675	13215	2433	1832	473013
1975	1040	12862	46007	66910	38883	36115	13906	17156	9802	3956	12424	6290	265351
1976	42044	51648	72560	79130	55675	43345	23194	11528	9810	7120	6016	7474	409545
1977	5950	13482	25214	30534	30486	47145	24480	15013	12712	6141	3025	5802	219984
1978	11768	50898	70673	40211	29808	23153	23750	17367	12182	5570	5373	22403	313156
1979	14527	18579	28705	17332	39138	54579	21876	12883	5296	3614	1811	7202	225542
1980	13977	15276	62625	47099	50244	45608	29044	7028	4802	5812	3617	11190	296321
1981	8313	47993	67062	41229	34670	30509	34960	20887	18749	7886	2128	7208	321595
1982	35456	44804	55539	57256	77586	44833	27711	11439	2483	1500	1006	1286	360898
1983	9170	29113	45974	54738	53292	55682	24622	6618	3118	19868	7774	6367	316338
1984	5182	65160	46378	59116	47829	40401	29830	27413	14716	4666	1654	1484	343830
1985	20416	37443	52139	24040	15857	23120	26142	17140	4835	1807	951	1166	225057
1986	12802	36357	20752	34784	40213	46913	28652	29752	14792	5563	2152	1206	273939
1987	1715	18565	40182	46314	35653	43028	24141	14016	10185	3182	1201	930	239113
1988	787	6503	39522	25638	26810	29839	36698	24547	15415	3993	1362	1340	212455
1989	7668	37890	37785	58276	28975	32850	29850	8268	2854	2652	1366	1078	249511
1990	3518	44307	43418	37549	62874	35484	13711	7318	16557	5538	1569	1310	273153
1991	10437	58389	75303	48543	64100	34838	23012	10564	4311	2074	6671	19508	357748
1992	4143	26308	46866	49062	58892	25342	15356	19815	4287	1952	969	1058	254051
1993	5991	32603	35193	32529	21757	24320	29647	29384	16591	4969	1903	1107	235995
1994	1344	4034	38724	39069	37336	61476	7864	8435	7432	4938	1633	800	213086
1995	2386	12565	83129	58395	64616	54621	27390	6461	2373	924	6159	2141	321160
1996	11944	112248	60178	36232	29522	16096	23414	16755	5737	2354	1319	936	316735
1997	12668	15707	41556	95117	55299	76726	50650	32411	35183	29498	3157	7518	455490
1998	21178	32425	51274	59589	46176	33915	16324	4336	2305	1825	1060	788	271195
1999	1326	38840	96510	71305	84941	66592	29691	12298	5886	3246	1607	1166	413408

Table 2-6. Color coded methods used to develop monthly total streamflow estimates for the Ozette River below Coal Creek.

Source/Method	Number of Months	Percent of Period of Record
USGS gaged streamflow	38	8.3%
Lake Ozette Outflow + Coal Creek estimate from WCM using Sooes River gage + baseflow estimate	59	12.9%
Lake Ozette Outflow + Coal Creek estimate from WCM using Hoko River gage + baseflow estimate	63	13.8%
Lake Ozette Outflow + Coal Creek estimate from WCM using Hoko River estimates derived from Calawah River gage + baseflow	54	11.8%
Estimated using regression equations against Sooes River gage	29	6.4%
Estimated using regression equations against Hoko River gage	178	39.0%
Estimated using regression equations against Hoko River estimates derived from Calawah River gage	8	1.8%
Estimated using regression equations against Hoko River estimates derived from Hoh River at Highway 101 gage	15	3.3%
Estimated using regression equations against Hoko River estimates derived from Bogachiel River gage	12	2.6%
Total number of months	456	100%

Ozette River at Pacific Ocean Outlet -

An additional 4.27 square-miles of drainage area is located downstream of the Coal Creek confluence within the Ozette River watershed. No streamflow measurements exist at the ocean outlet of the Ozette River, therefore the estimates for the Ozette River below Coal Creek became the basis for estimating streamflow at the ocean outlet. The equation used to estimate streamflow for the Ozette River at the ocean outlet was:

Ozette River at ocean outlet = Ozette River below Coal Creek + additional streamflow from remaining drainage area

The WCM was used to estimate additional streamflow generated by the remaining drainage area. Some portions of this area are relatively flat and were considered noncontributing to streamflow, especially in low flow times like the late summer. At such times, the majority of precipitation that falls within these areas is considered to be captured by interception and is lost to evaporation, evapotranspiration, and groundwater percolation, rather than contributing directly to streamflow in the Ozette River. This area is categorized as coastal lowland.

The amount of monthly total precipitation recorded at the discontinued precipitation gage in Neah Bay was used as the determinant for when this coastal lowland area was considered contributing or noncontributing toward streamflow. Unfortunately, the Neah Bay precipitation gage was not in operation between May 1987 and September 1999, as well as for several months between 1982 and 1986. For the months when precipitation was unavailable, the determining factor of when this coastal lowland area was considered contributing or noncontributing relied on the amount of streamflow estimated for the Ozette River below Coal Creek, which is affected by precipitation. When the following conditions of high precipitation or high streamflow were in effect, the remaining 4.27 square-miles area was considered to be entirely effective towards streamflow in the Ozette River:

1. When precipitation data was available: If total monthly precipitation at Neah Bay was over 5 inches.
2. When precipitation data was NOT available: If total monthly streamflow on the Ozette River below Coal Creek was over 3000 ac-ft.

At times when these high flow criteria were not met or exceeded, then only a portion of the remaining drainage area was considered to contribute additional streamflow to the Ozette River. The areas that were considered effective during low precipitation or low flow times were the watersheds of two unnamed tributaries that were observed on USGS topographic quadrangles. These watersheds were characterized as lowland watershed types, as described in Appendix 1. The average annual precipitation of these two watersheds were used

in the WCM to create an estimate of additional streamflow using the following two streamflow gages:

- USGS Station Number 12043163 Sooes River below Miller Cr near Ozette, WA
- USGS Station Number 12043300 Hoko River near Sekiu, WA

As stated previously, these gages were not in operation throughout the entire period between October 1961 and September 1999, therefore 35 months required data derived from more distant gages. These more distant gages used were the same gages used to generate estimates of the Ozette River below Coal Creek, namely:

- USGS Station Number 12041200 Hoh River at U.S. Highway 101 near Forks, WA
- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12043000 Calawah River near Forks, WA

To simplify the WCM process, estimates of Hoko River flow derived from these gages were used to estimate these final 35 monthly totals of additional streamflow.

Table 2-7 summarizes the drainage area and average annual precipitation of the remaining portions of the Ozette River between the Coal Creek confluence and the ocean outlet. As described in Appendix 1, the WCM uses a weighted value to rescale a nearby gaged streamflow record so that streamflow can be estimated for an ungaged watershed. This weighted value is found by multiplying the drainage area in square-miles against the average annual precipitation in inches. Weights were computed for the areas above the Sooes River gage and the Hoko River gage, as well as for the remaining areas of the Ozette River watershed. The weight of each ungaged area was then divided by the weight of a gaged watershed to develop a *rescaler*. This rescaler is then multiplied against a gaged streamflow record to estimate streamflow in the ungaged area. The rescalers used to estimate streamflow contributed by each remaining area are also included in Table 2-7.

Table 2-7. Remaining areas of Ozette River watershed downstream of Coal Creek confluence and statistics used to estimate contributing streamflow from these areas.

Watershed section	Area (sq. mi.)	Average Annual Precip	Rescalers used in WCM against respective record	
			Sooes River	Hoko River
2 unnamed tributaries below Coal Creek	1.16	75.9	0.02725	0.01376
Remaining area between Coal Creek confluence and Ozette River ocean	3.11	74.9	0.07192	0.03632
Total	4.27		0.09917	0.05008

The rescalers in Table 2-7 were multiplied against the indicated streamflow record if sufficient data was available. When gaged streamflow data was available from both the Sooes and the Hoko River gage, the Sooes River data was used because it showed greater similarities to the gaged Ozette River data collected by the USGS.

The equations used to estimate additional streamflow were created using IF/THEN statements in Microsoft Excel. For example, for a month when precipitation data was available at Neah Bay and streamflow data is available from the Sooes River gage, then the additional streamflow would be estimated based on the following logic and process:

Additional Ozette River streamflow generated from remaining drainage area =

a. If Total Monthly Precipitation at Neah Bay was greater than 5 inches, then multiply the monthly total streamflow from the Sooes River gage by 0.09917.
b. If Total Monthly Precipitation at Neah Bay was less than 5 inches, then multiply the monthly total streamflow from the Sooes River gage by 0.02725.

The same procedure was used for the Hoko River record using the indicated rescalers when precipitation was available from the Neah Bay record. When precipitation was not available, the same rescalers were used, but total monthly streamflow at the Ozette River below Coal Creek was used to determine whether the entire 4.27 square-miles of remaining drainage area was effective, or whether only this area was partially effective. For example, for a month when precipitation data was not available at Neah Bay and streamflow data is available from the Hoko River gage, then the additional streamflow would be estimated as:

Additional Ozette River streamflow generated from remaining drainage area =

c. If Total Monthly Streamflow in the Ozette River below Coal Creek was greater than 3000 ac-ft, then multiply the monthly total streamflow from the Hoko River gage by 0.05008.
d. If Total Monthly Precipitation in the Ozette River below Coal Creek was less than 3000 ac-ft, then multiply the monthly total streamflow from the Sooes River gage by 0.01376.

Table 2-8 provides a color coded indication of the methods used to estimate each month in the synthetic record for the Ozette River at the ocean outlet. The colors indicate which method was used to determine whether the entire area or only part of the remaining drainage area was considered effective towards streamflow in the river. The colors also indicate which streamflow record was used to create the streamflow estimates. The designation of each color is found in Table 2-9.

Table 2-8. Synthetic period of record for the Ozette River at the ocean outlet - Total monthly streamflow in ac-ft.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual Total
1962	8383	12328	44823	64129	28779	24742	20508	11069	6095	2824	1773	5066	230517
1963	10860	40166	64126	47120	46108	30975	22047	21151	2995	7847	2643	975	297012
1964	13800	42880	71840	77317	40007	57843	34949	15275	7529	4638	7057	4043	377178
1965	8879	13568	36604	66476	82715	38974	20397	16973	3271	1599	1910	1793	293157
1966	8438	17491	41738	73593	53383	57038	18514	7990	5688	4919	2308	1352	292453
1967	11632	33942	96641	102214	71739	59259	23387	11516	3503	1405	924	1035	417196
1968	44678	27628	52686	85002	73585	52192	32075	12692	7551	4462	3928	10169	406648
1969	34916	32815	42910	63422	54583	44365	42735	13018	5979	2858	1859	6686	346147
1970	9087	10190	17016	36223	44503	30718	55737	21394	3125	2169	1752	3988	235903
1971	9215	24229	43719	81446	68340	65203	34102	11383	8324	4836	2172	1948	354917
1972	11985	31819	49864	66191	73443	73930	47746	18079	2263	15528	1938	1632	394417
1973	2720	12530	50052	89925	36251	39520	21800	19529	17657	4169	1844	974	296971
1974	13710	57026	68242	82952	77071	77309	43447	38186	17819	13328	2464	1856	493411
1975	1070	14411	48348	69003	40132	37262	14023	17962	9895	4003	12893	6357	275359
1976	44843	54722	76177	81554	57323	44766	23428	11996	9965	7202	6107	7581	425664
1977	6480	13741	26820	31758	32334	48930	24648	15593	12825	6213	3075	6332	228750
1978	12580	54526	73979	41731	30954	24135	24598	18043	12270	5600	5922	23563	327904
1979	14889	19604	30305	17490	41660	55010	22734	12989	5340	3664	1830	7638	233154
1980	14798	16175	67357	48632	52324	47460	30142	7109	4857	5901	3658	11842	310254
1981	8408	51348	70218	42089	36799	31671	37109	21102	19859	7952	2150	7616	336322
1982	37640	47453	58162	61456	81334	46191	29127	11512	2515	1530	1037	1334	379290
1983	10456	30698	48452	57740	56546	57423	24790	6856	3181	21382	7854	6515	331894
1984	5746	69907	47748	63123	50107	41968	30879	28817	14825	4709	1677	1534	361040
1985	22113	40105	54288	24201	16908	24360	27308	17290	4887	1830	972	1229	235490
1986	14565	37934	21443	37289	42760	48802	29520	31414	14874	5659	2178	1245	287683
1987	1776	20873	41635	48397	37356	45402	24967	14648	10547	3299	1219	945	251065
1988	798	7099	41526	26818	27950	31585	38189	25584	15811	4143	1380	1382	222265
1989	8487	40318	39450	60600	29900	34616	31277	8515	2883	2684	1385	1091	261205
1990	3977	47173	45215	39826	65742	36813	14377	7623	17216	5682	1590	1328	286561
1991	11565	63420	77956	50912	67430	35748	24251	10983	4519	2101	7558	19867	376312
1992	4312	28187	48821	52527	60720	25794	16387	20246	4394	1971	982	1096	265437
1993	6584	33849	36363	33741	22081	25539	31157	30261	17083	5125	1928	1120	244831
1994	1399	4413	40666	40852	39350	63517	8742	8699	7928	5117	1654	839	223178
1995	2478	14062	87004	60465	67001	56516	28230	6712	2404	946	6401	2164	334381
1996	13301	117331	62336	37862	31190	16730	24762	17478	5966	2384	1337	958	331634
1997	14193	17468	43729	99471	57225	80235	52109	33424	36296	30410	3299	8300	476158
1998	23230	33985	53810	62431	47470	35015	16795	4586	2355	1894	1085	800	283457
1999	1406	42629	100207	74065	88862	68672	30262	12821	6227	3475	1639	1188	431452

Table 2-9. Color coded methods used to estimate the additional Ozette River streamflow generated by the remaining drainage area between the Coal Creek confluence and the ocean outlet.

Determinant of entirely or partial effective area	Additional flow estimated using indicated record or USGS streamflow gage
Neah Bay Precipitation Station	Hoko River gage
Neah Bay Precipitation Station	Sooes River gage
Neah Bay Precipitation Station	Ozette River gage
Neah Bay Precipitation Station	Hoko River estimates derived from Hoh River at Highway 101 gage
Neah Bay Precipitation Station	Hoko River estimates derived from Calawah River gage
Neah Bay Precipitation Station	Hoko River estimates derived from Bogachiel River gage
Ozette River below Coal Creek	Sooes River gage
Ozette River below Coal Creek	Hoko River estimates derived from Calawah River gage
Ozette River below Coal Creek	Hoko River gage

Appendix 3: Flow histories and streamflow variability for selected streams.

This appendix provides flow histories and indicated variability in flow assessments between October 1961 and September 1999 for the following streams. Any deviations from this period of record will be indicated after the location information. Flow assessments are provided at the following respective locations:

Hoh River watershed[1]

South Fork Hoh River at River Mile 3.6
South Fork Hoh River at the Outlet
Hoh River above the South Fork Hoh River confluence
Hoh River near Forks (at USGS Gage 12041000)
Hoh River at U.S. Highway 101 (at USGS Gage 12041200)
Hoh River at the Outlet

Quillayute River watershed

Bogachiel River watershed

Bogachiel River at River Mile 22.0
Bogachiel River near Forks (at USGS Gage 12042800)
Bogachiel River above the Calawah River confluence
Bogachiel River at the Outlet

Calawah River watershed

South Fork Calawah River above Sitkum River
Sitkum River at the Outlet
South Fork Calawah River at the Outlet
North Fork Calawah River at the Outlet
Calawah River near Forks (at USGS gage 12043000)
Calawah River at the Outlet

[1] NOTE: All Hoh River locations were developed between October 1960 and September 1999

Soleduck River watershed

North Fork Soleduck River at Outlet
Soleduck River above North Fork Soleduck River
Soleduck River near Fairholm (at USGS gage 12041500)
Soleduck River near Beaver Creek (at USGS gage 12042000)
Soleduck River below Lake Creek
Soleduck River near Quillayute (at USGS gage 12042500)
Soleduck River at the Outlet

Dickey River watershed

East Fork Dickey River at the Outlet (at USGS gage 12043080)
West Fork Dickey River at the Outlet
Dickey River near La Push (at USGS gage 12043100)
Dickey River at the Outlet

Quillayute River watershed

Quillayute River below Soleduck and Bogachiel River confluence
Quillayute River below Dickey River or at the Outlet

Ozette River watershed

Big River at 27E Big River Bridge
Umbrella Creek at Hoko-Ozette Rd Bridge
Ozette River below Coal Creek
Ozette River at the Pacific Ocean Outlet

Sooes River watershed

Sooes River below Miller Creek (at USGS gage 12043163)
Sooes River below the Makah Fish Hatchery

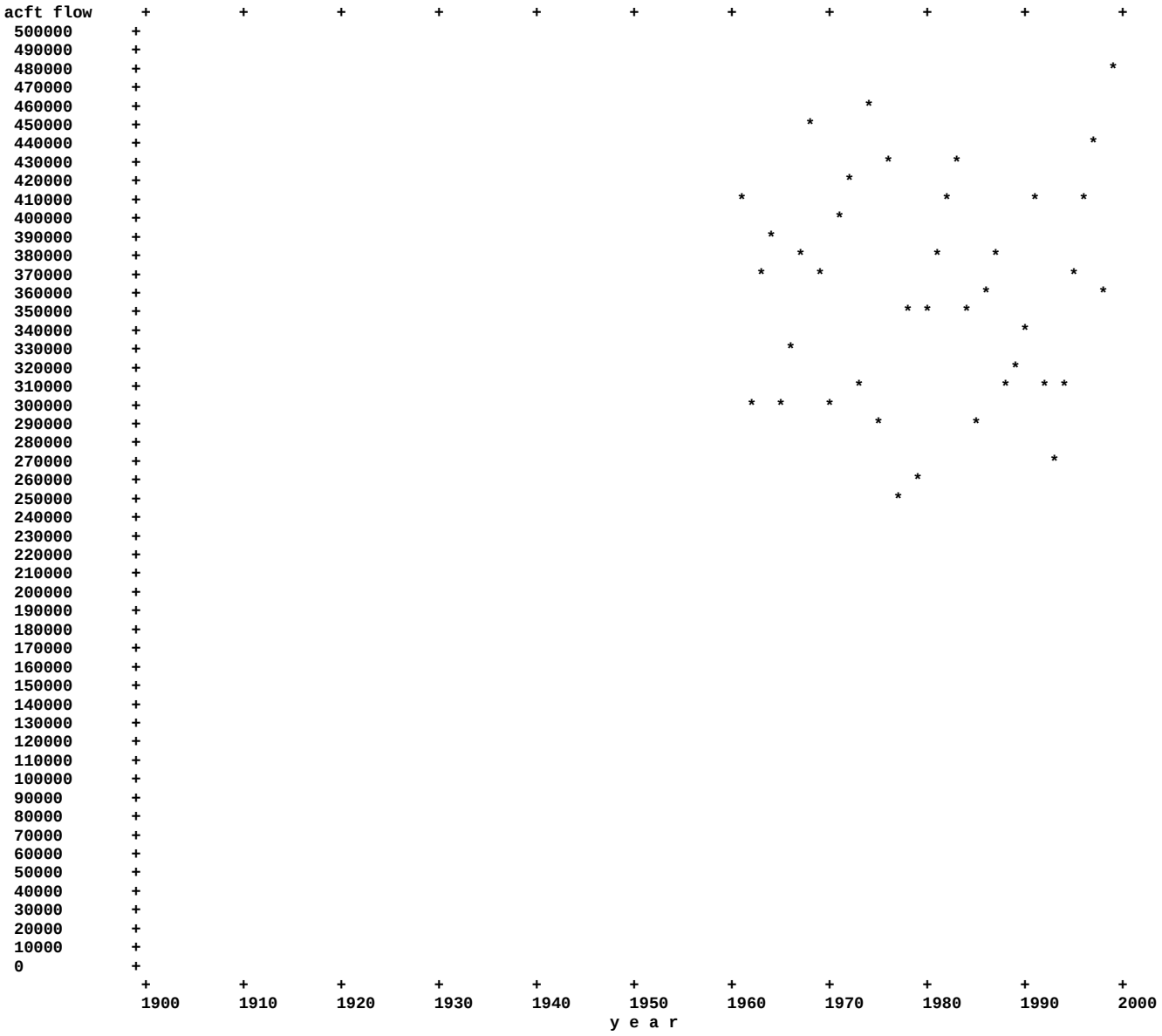
Hoh River watershed

South Fork Hoh River at outlet of Rainforest WAU at River Mile 3.6 - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
112905.8													1872.45
102721.6													1703.55
93456.06													1549.89
85026.28		X											1410.09
77356.86													1282.90
70379.23		9	X	X									1167.18
64030.99	X			9	X	X							1061.90
58255.36			7										966.12
53000.7		7		7		9							878.97
48220.01	9		5		7				X				799.69
43870.54				5				X	9				727.56
39913.39		5	3			7	X			X			661.93
36313.18				3	5			9					602.22
33037.71		3					7	7		9			547.90
30057.7						5			7			X	498.48
27346.47	7		1		3	3	5	5	5		X		453.52
24879.81				1			3	3	3				412.61
22635.64	5							1		7			375.39
20593.89					1	1		0			9	9	341.53
18736.31		1	0						1	5			310.73
17046.29	3			0		0	1			3			282.70
15508.7		0								1	7	7	257.20
14109.81									0		5	5	234.00
12837.1					0						3		212.89
11679.18										0	1	3	193.69
10625.72							0						176.22
9667.271	1												160.32
8795.277											0		145.86
8001.939													132.71
7280.16												1	120.74
6623.486												0	109.85
6026.044	0												99.94
5482.491													90.92
4987.968													82.72
4538.05													75.26
4128.716													68.47
3756.304													62.30
3417.483													56.68
3109.224													51.56
2828.769													46.91
2573.613													42.68
2341.472													38.83
2130.27													35.33
1938.118													32.14
1763.299													29.24
1604.248													26.61
1459.544													24.21
1327.893													22.02
1208.116													20.04
1099.143													18.23
1000													16.58

South Fork Hoh River at outlet of Rainforest WAU at River Mile 3.6 - Total monthly flow in ac-ft
hydrograph of annual recorded flows



South Fork Hoh River at outlet of Rainforest WAU at River Mile 3.6 - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

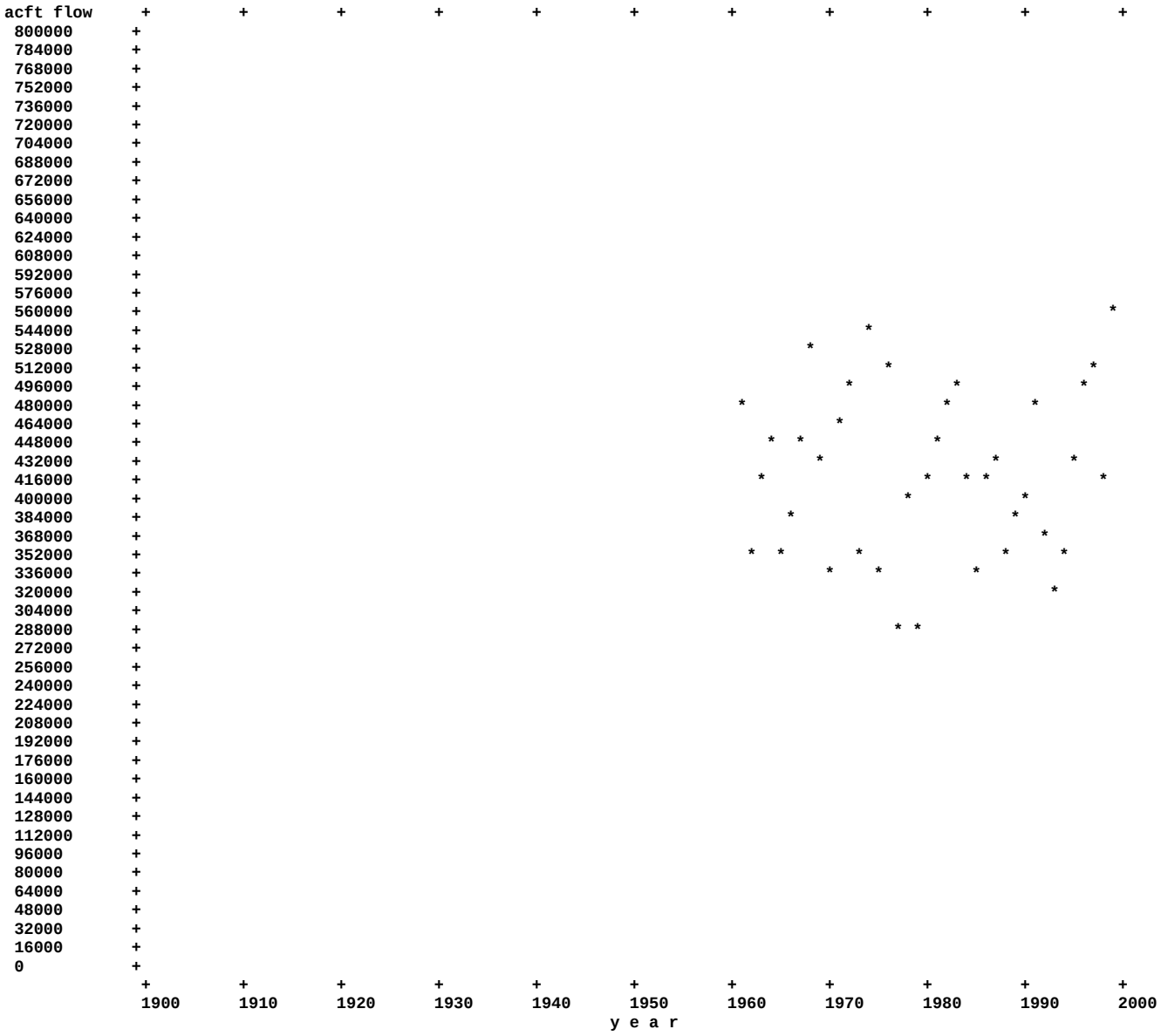
YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	ANNUAL
1961	23689	41702	38450	62384	61892	47107	23853	31170	31846	18231	12291	12600	405214
1962	20083	30091	47305	36763	18334	16913	26320	26428	25121	18569	15696	13590	295212
1963	32932	58455	54131	32235	54274	23251	26014	25438	18165	16913	12581	11237	365626
1964	29182	59121	43392	49977	23200	23619	22305	23916	41127	31637	19497	18644	385618
1965	21121	26576	41933	32714	41344	21669	25688	27514	21977	14933	11852	6909	294230
1966	21053	37013	41605	45550	23688	31509	27992	23084	26235	21732	14778	11763	326002
1967	21722	34739	67195	61425	34347	34348	18517	25725	34419	22036	13374	11283	379128
1968	62941	35339	52537	64657	57261	42382	21252	26017	27880	19289	14358	19473	443386
1969	28895	37943	51251	30608	21093	25461	37036	33978	41204	19321	12902	24282	363974
1970	24163	26747	35443	36520	26679	24714	32130	22812	22559	14476	11073	14003	291318
1971	19932	39251	41949	49403	37947	34339	26384	31639	35023	36230	21057	17157	390309
1972	20224	45871	33567	42260	46752	63273	34408	32649	30433	31522	15040	16842	412841
1973	8022	30816	63543	44475	20154	25547	17045	27369	26272	17050	11798	11836	303926
1974	21375	41053	64006	65275	34949	50639	31551	34878	45154	36645	20105	13521	459152
1975	6471	32751	52665	36198	24053	29067	10542	23178	23061	22759	17468	11663	289876
1976	59302	63579	64895	49527	29217	21656	21249	32789	27449	28388	17773	13297	429121
1977	12275	18312	26147	24172	25641	28170	23202	26702	23740	13416	11665	16252	249692
1978	20283	67971	61757	33346	21317	21330	16500	20557	23363	15271	15042	29123	345861
1979	14274	20584	22800	15894	36357	37118	19253	22518	18989	17662	11106	18493	255048
1980	26564	14825	68961	32767	51556	29899	31171	21476	18112	16311	11093	25146	347881
1981	12400	64531	65237	29015	59023	20525	33221	25688	25579	14876	13675	13033	376802
1982	34475	52340	56704	37647	62980	29066	26830	26030	35605	21982	14074	11605	409337
1983	30223	30617	59945	61351	59628	50791	23624	24726	26621	30066	14775	14598	426962
1984	8948	65714	25915	49458	33364	36488	23550	31104	27317	21532	13031	12131	348553
1985	30106	52405	29016	17288	15714	16756	31108	26880	25017	15600	11053	14128	285069
1986	45156	31039	18212	61026	48132	34606	18521	38199	23958	16604	12755	9089	357296
1987	16695	56607	37289	47419	38776	60802	26414	33405	24053	14557	9652	7564	373233
1988	5590	15050	53027	32185	20930	28176	36610	36088	27917	22504	12911	13656	304645
1989	23117	50950	32732	34622	20613	31868	36908	22741	25504	21048	12599	7011	319712
1990	21232	47491	39406	39854	36181	29644	27411	24496	32585	16457	11398	9197	335352
1991	24716	80647	47576	42536	62635	25309	27767	21577	18643	15622	18021	19462	404511
1992	9939	38707	40254	61976	42850	15593	29240	23193	13616	11607	10861	11657	309492
1993	15081	30705	23274	23008	12156	31251	37006	38668	24867	14299	12028	6608	268949
1994	12489	14174	49051	40492	25297	49790	27502	23088	25121	15052	8694	12915	303665
1995	16497	32083	64508	49937	58714	42598	22575	23096	21403	15146	12499	10284	369341
1996	26873	70929	62878	53349	51598	22591	37485	27194	18044	13891	10937	11960	407727
1997	25900	31097	45955	63785	33826	62113	35390	42975	35063	28603	15231	18162	438100
1998	52682	42467	39035	57866	39793	32412	13840	24839	21270	16757	11260	6902	359123
1999	16196	65000	64603	58313	59857	40125	23014	30808	41766	37695	25118	14413	476906
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	23662.0	41930.6	46875.6	43776.3	37746.7	33141.4	26421.2	27811.1	27078.9	20417.7	13874.9	13884.3	356620.3
med =	21232.0	38707.0	47305.0	42536.0	36181.0	29899.0	26384.0	26030.0	25504.0	17662.0	12902.0	13033.0	359123.0

South Fork Hoh River at the Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
145058.2													2405.67
131314.2													2177.74
118872.3													1971.40
107609.3		X											1784.61
97413.5													1615.52
88183.7			X	X									1462.46
79828.34	X	9	9	9	X	X							1323.89
72264.72			7		9								1198.45
65417.73		7		7		9							1084.90
59219.49			5		7								982.11
53608.53	9			5				X	X				889.05
48529.19		5	3										804.82
43931.12				3	5	7	X	9	9	X			728.56
39768.7		3								9			659.53
36000.68						5	7	7				X	597.04
32589.66	7						5		7				540.47
29501.83			1	1	3	3		5	5		X		489.26
26706.55	5						3	1	3	7			442.91
24176.14					1	1		0			9	9	400.94
21885.48		1	0						1				362.95
19811.87	3						1			5			328.56
17934.72				0		0				3	7		297.43
16235.43		0							0	1		7	269.25
14697.14					0						5	5	243.74
13304.61										0	3	3	220.65
12044.02							0				1		199.74
10902.86													180.82
9869.821	1										0		163.68
8934.669													148.17
8088.122												1	134.13
7321.783												0	121.43
6628.054													109.92
6000.055	0												99.51
5431.558													90.08
4916.925													81.54
4451.053													73.82
4029.322													66.82
3647.55													60.49
3301.946													54.76
2989.091													49.57
2705.879													44.87
2449.5													40.62
2217.414													36.77
2007.317													33.29
1817.126													30.14
1644.956													27.28
1489.098													24.70
1348.008													22.36
1220.286													20.24
1104.666													18.32
1000													16.58

South Fork Hoh River at the Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



South Fork Hoh River at the Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

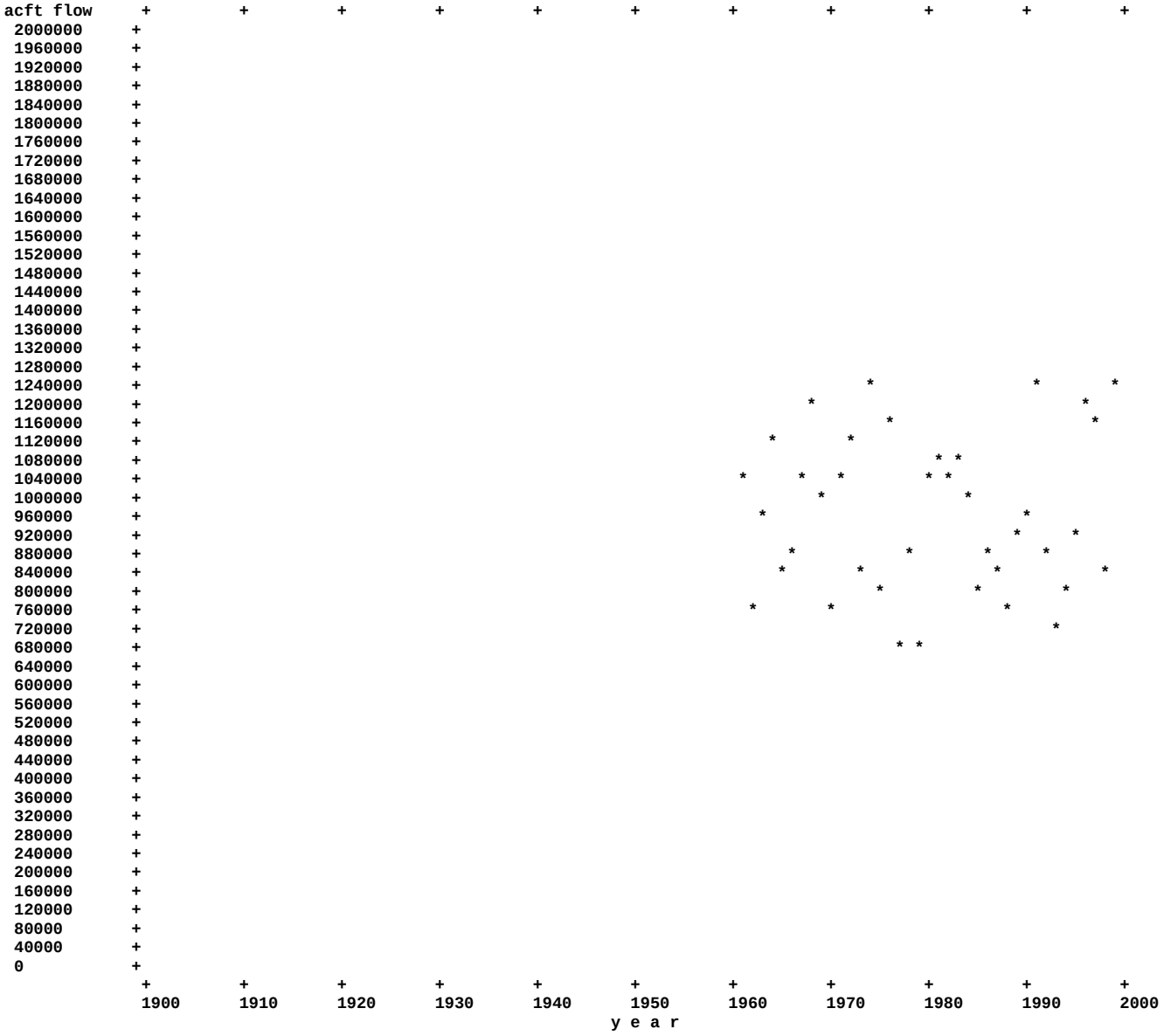
YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	ANNUAL
1961	29085	49799	45592	79046	75200	54913	27129	33734	33135	19251	12851	13661	473396
1962	23579	34571	56217	42316	21179	21269	30424	29574	27063	19853	17273	14888	338205
1963	37620	70723	60988	36283	59097	26824	29963	28444	19443	18558	13682	12406	414030
1964	35431	67569	50477	60857	28085	30481	25681	25480	42954	33401	22145	20886	443448
1965	24482	31573	47899	39697	49047	23762	28538	31011	24561	16751	13333	7507	338159
1966	24323	43681	49031	54366	26717	36350	31107	25997	29450	24471	16324	12868	374684
1967	24923	40261	84159	72558	39470	39961	20127	28459	38679	24192	14815	12435	440037
1968	74878	40883	62633	78570	66879	48789	23949	29137	31550	22264	15960	23101	518593
1969	34466	44624	61065	36313	23727	29753	42155	39010	46385	21306	14216	28146	421166
1970	26338	30131	40796	42052	30337	27336	37263	24934	25245	16185	12230	15740	328586
1971	22839	45261	50120	59832	44727	41259	29838	36325	39364	40903	24128	18872	453468
1972	22862	54193	39681	50182	55445	75431	39851	36867	34049	36597	16887	18619	480664
1973	8720	34816	75904	53571	22317	28882	18420	31219	30156	19036	12988	12902	348927
1974	24539	49038	76792	79932	41489	60352	36427	39763	50988	41634	22707	14915	538574
1975	6994	38313	60892	42662	27539	32672	11573	26111	25969	25476	19990	12821	331012
1976	69587	75969	79093	57819	34166	27574	23787	36650	30673	31955	19724	14633	501630
1977	13402	19965	29444	27110	29155	32477	25826	29520	26700	14837	13404	17837	279677
1978	22813	78754	73046	37476	23864	23878	18206	22637	25555	16951	16824	32973	392976
1979	15524	22660	25649	17114	42580	42220	21173	25313	20693	20168	12199	20504	285797
1980	30154	16341	88049	37583	60352	34716	35768	24045	20712	18432	12269	28485	406905
1981	13438	78245	79847	33309	68312	22588	39252	29240	30445	16697	14905	14586	440864
1982	40226	60663	65605	45594	74942	33028	30724	28898	40440	25270	15736	12693	473818
1983	36336	35761	70465	72449	70029	58374	26201	27311	30152	35297	16338	15859	494573
1984	9747	80897	29954	59282	38843	41933	26691	35655	30983	24288	14516	13465	406255
1985	36527	61537	33870	18813	17309	18408	35378	30162	28279	17462	12089	15167	325001
1986	52193	36598	19869	70574	55821	39883	20490	43700	27090	18262	13977	9818	408276
1987	18218	65850	42509	54086	44063	69087	29205	37361	27278	16124	10578	8252	422609
1988	5840	16591	60105	36884	24478	33213	42275	41366	31844	25136	14128	14855	346715
1989	29067	59669	37972	41226	23431	36644	42503	25399	28630	23136	13895	7629	369199
1990	24083	58435	46216	46649	43521	34360	30810	27693	37409	18387	12793	10068	390422
1991	30069	103613	54972	49621	74387	28417	31900	24097	20290	17360	22682	21598	479004
1992	10880	46278	47070	73372	49439	17196	33666	26065	15175	12815	11881	12953	356790
1993	16887	35523	26853	26497	13370	35155	41816	43874	28206	15756	13252	7156	304347
1994	13532	15375	57063	46762	30336	58112	31144	25201	28385	16839	9515	13939	346204
1995	18127	37389	78126	57442	67951	48433	25152	25155	23487	16950	13850	11255	423316
1996	34068	92382	74775	61320	58888	24669	42772	30892	19921	15523	11963	12944	480116
1997	30703	36312	53580	76353	38936	73580	40833	48574	40119	33423	17138	20056	509606
1998	61388	48314	44603	66962	45089	36916	15245	27865	23854	18528	12292	7499	408555
1999	17924	79326	78452	68261	70344	46983	25861	34916	47256	43030	29228	15641	557222
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	27482.4	49689.3	55370.1	51558.8	43868.2	38355.8	29977.5	31221.9	30322.2	22884.7	15505.3	15375.2	411610.9
med =	24482.0	45261.0	54972.0	50182.0	42580.0	34716.0	29963.0	29240.0	28630.0	19251.0	14128.0	14586.0	408555.0

Hoh River above SF outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
446371.7													7402.71
395096.3													6552.35
349710.6		X											5799.67
309538.7													5133.45
273981.3			X										4543.76
242508.6													4021.81
214651		9	9	X									3559.81
189993.7													3150.89
168168.8	X			9	X	X							2788.94
148850.8			7		9								2468.57
131752.1	9	7		7	7	9			X	X			2185.00
116617.4			5	5									1934.00
103221.4	7	5		3	5		X						1711.84
91364.05		3	3			7	9	X	9	9	X		1515.20
80868.91						5	7	9				X	1341.15
71579.37	5		1	1	3			7	7				1187.09
63356.87						3	5	5	3	7	9	9	1050.72
56078.96					1	1	3	0	1	3	7		930.02
49637.03	3	1	0							1	5	7	823.19
43935.14							1		0				728.63
38888.2		0			0		0			0	3	5	644.93
34421.05				0							1	3	570.85
30467.04	1										0		505.27
26967.22						0						0	447.23
23869.45													395.86
21127.51													350.38
18700.55													310.13
16552.38	0												274.51
14650.98													242.97
12967.99													215.06
11478.33													190.36
10159.79													168.49
8992.713													149.14
7959.705													132.01
7045.354													116.84
6236.042													103.42
5519.698													91.54
4885.636													81.02
4324.415													71.72
3827.659													63.48
3387.969													56.19
2998.785													49.73
2654.309													44.02
2349.403													38.96
2079.522													34.49
1840.643													30.53
1629.205													27.02
1442.055													23.92
1276.403													21.17
1129.78													18.74
1000													16.58

Hoh River above SF outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Hoh River above SF outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

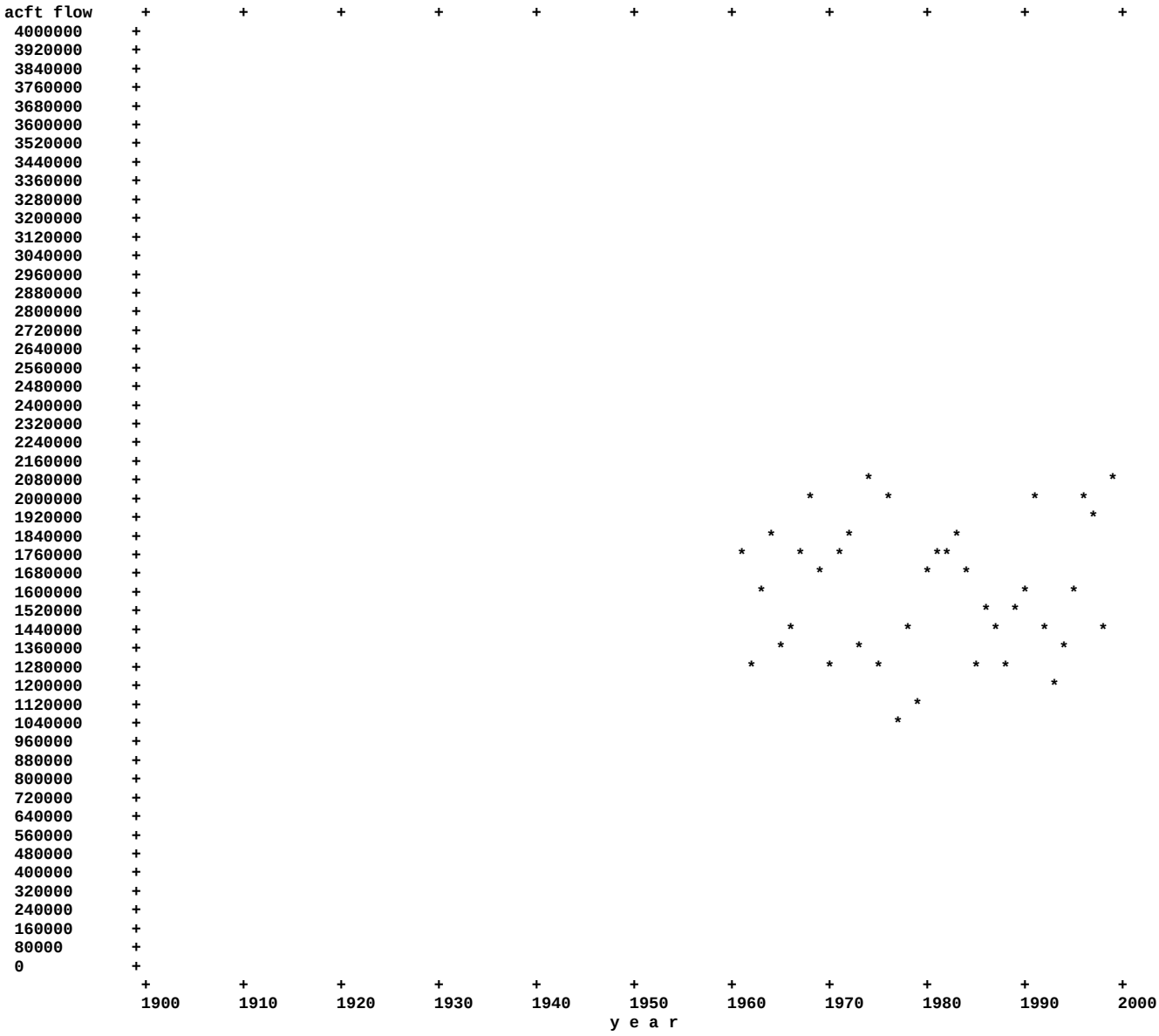
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1961	72774	90343	85684	159621	146449	85839	53308	76279	86710	68186	53258	30178	1008630
1962	60683	73216	96370	95016	41721	26929	64388	54913	72449	59232	50616	37198	732730
1963	64809	122181	154149	71626	143223	53537	46964	61972	54719	65188	45775	39998	924141
1964	105667	146485	104782	129695	63715	64936	60601	72006	128633	119282	65292	47169	1108263
1965	67490	89855	87770	114975	116660	54181	54276	62239	54396	54128	47313	25231	828514
1966	66147	104868	111877	129848	59355	81613	55743	58242	59308	57095	45557	35261	864914
1967	64302	88901	237012	149039	82898	90845	42734	52429	66155	55766	44000	37408	1011488
1968	160339	88574	142518	190428	129274	94414	57014	58102	64510	63594	47911	73547	1170225
1969	96495	104001	139442	96682	56208	76986	79702	81842	75868	53773	40543	71684	973228
1970	53589	61360	85353	87023	65699	51839	85631	53638	55329	51200	37816	52754	741231
1971	61799	91615	123553	151569	105604	112088	62872	75986	66723	70480	63059	47879	1033228
1972	57266	121455	99894	119153	126465	163553	88001	67539	60719	85376	54930	50315	1094667
1973	26997	66260	166525	135632	58440	61971	37058	67886	69695	56798	37935	33888	819086
1974	64122	121582	172883	201781	105201	138500	79059	78403	81893	78047	56840	42285	1220595
1975	23399	91863	112044	102514	66062	62114	34477	58437	58194	55576	58635	37108	760424
1976	137731	166961	194791	116734	86012	110513	54516	61820	58046	62323	54725	40713	1144886
1977	35302	44396	60690	57398	64664	74101	53607	52586	58230	43324	55858	44888	645044
1978	55517	135766	151186	65361	54577	54604	48456	55243	55187	49218	52820	65873	843809
1979	36638	55071	57585	33549	98422	79339	51778	57069	45153	58154	35708	55735	664203
1980	64776	44526	269436	76711	122551	83082	75150	54749	59109	62096	38441	62518	1013146
1981	32276	187342	201076	72928	121897	54739	98948	65189	88881	54322	36801	48047	1062447
1982	92943	113967	118303	124911	160694	67676	69202	54162	73730	65357	50236	34932	1026113
1983	103754	87547	140810	148575	139260	103769	52403	51256	63801	89616	46121	36591	1063504
1984	29076	209827	72531	141670	89812	85652	61251	74499	65090	57592	45868	42171	975040
1985	108892	127030	84717	41590	45921	46402	70120	59623	61457	54678	33947	30031	764408
1986	101433	93801	44664	123788	108563	85093	54312	84560	60651	46786	37749	26605	868006
1987	42295	123950	81055	92796	80430	103518	52501	62578	61994	46541	32227	27294	807177
1988	15696	45053	92963	75565	70628	88658	89052	83382	68458	54548	37381	35807	757191
1989	109336	122013	86673	106623	59617	77123	87578	54675	58773	54853	40344	25725	883331
1990	59430	162132	104395	103643	116751	78767	60833	61039	77048	55738	45093	31066	955937
1991	97805	318837	104447	105253	157685	58708	71841	53869	43740	50664	91314	58467	1212631
1992	32340	117590	103529	152680	96832	46328	74713	57483	47497	38809	33693	41541	843034
1993	53581	82172	68392	67322	38265	64256	71738	79231	62835	43323	38776	24021	693914
1994	32307	35175	112730	94392	92031	116912	64503	53001	61376	52989	30082	31152	776649
1995	45990	88491	185806	103479	121418	84881	53603	51248	54240	53409	42231	32871	917667
1996	125210	305554	159766	107086	98061	52503	81910	65721	51973	49509	33796	31087	1162176
1997	87489	88153	110037	169589	83276	153652	86877	80600	80961	84615	56586	52353	1134189
1998	119768	85201	84673	120100	79363	72257	42214	57992	55226	50226	33540	25202	825763
1999	49560	196723	189434	133412	140367	104351	57310	67944	80238	82428	74537	35745	1212049
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	69616.0	115380.4	123065.3	112045.1	94719.8	81185.4	63749.8	63575.2	65358.8	60380.5	46855.2	41085.6	937017.4
med =	64122.0	93801.0	110037.0	107086.0	92031.0	78767.0	60833.0	61039.0	61457.0	55738.0	45557.0	37198.0	924141.0

STATION NUMBER 12041000 HOH RIVER NEAR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
717403.4													11897.55
628996.6													10431.40
551484.1		X											9145.92
483523.8			X										8018.85
423937.8													7030.67
371695.2		9	9	X									6164.26
325890.6				9		X							5404.63
285730.5	X				X								4738.61
250519.4		7	7	7									4154.66
219647.4					7	9							3642.67
192579.9	9	5	5	5					X				3193.78
168847.9	7		3	3	5	7	X	X		X			2800.21
148040.5		3				5		9	9	9	X		2455.13
129797.1							7	7	7			X	2152.58
113801.9	5		1	1	3	3		5	5			9	1887.31
99777.91					1		3	3	3	7	9		1654.74
87482.1						1		0	1	3			1450.82
76701.52	3	1	0				1		0	1	7	7	1272.03
67249.45						0					5		1115.28
58962.18		0		0	0					0	3	5	977.84
51696.12							0				1	3	857.34
45325.51	1										0		751.69
39739.97												1	659.06
34842.74												0	577.84
30549.01													506.63
26784.4													444.20
23483.71	0												389.46
20589.77													341.46
18052.45													299.39
15827.8													262.49
13877.31													230.14
12167.19													201.78
10667.8													176.92
9353.189													155.12
8200.579													136.00
7190.007													119.24
6303.963													104.55
5527.114													91.66
4845.998													80.37
4248.817													70.46
3725.228													61.78
3266.161													54.17
2863.666													47.49
2510.77													41.64
2201.364													36.51
1930.085													32.01
1692.237													28.06
1483.699													24.61
1300.86													21.57
1140.553													18.92
1000.001													16.58

STATION NUMBER 12041000 HOH RIVER NEAR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12041000 HOH RIVER NEAR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

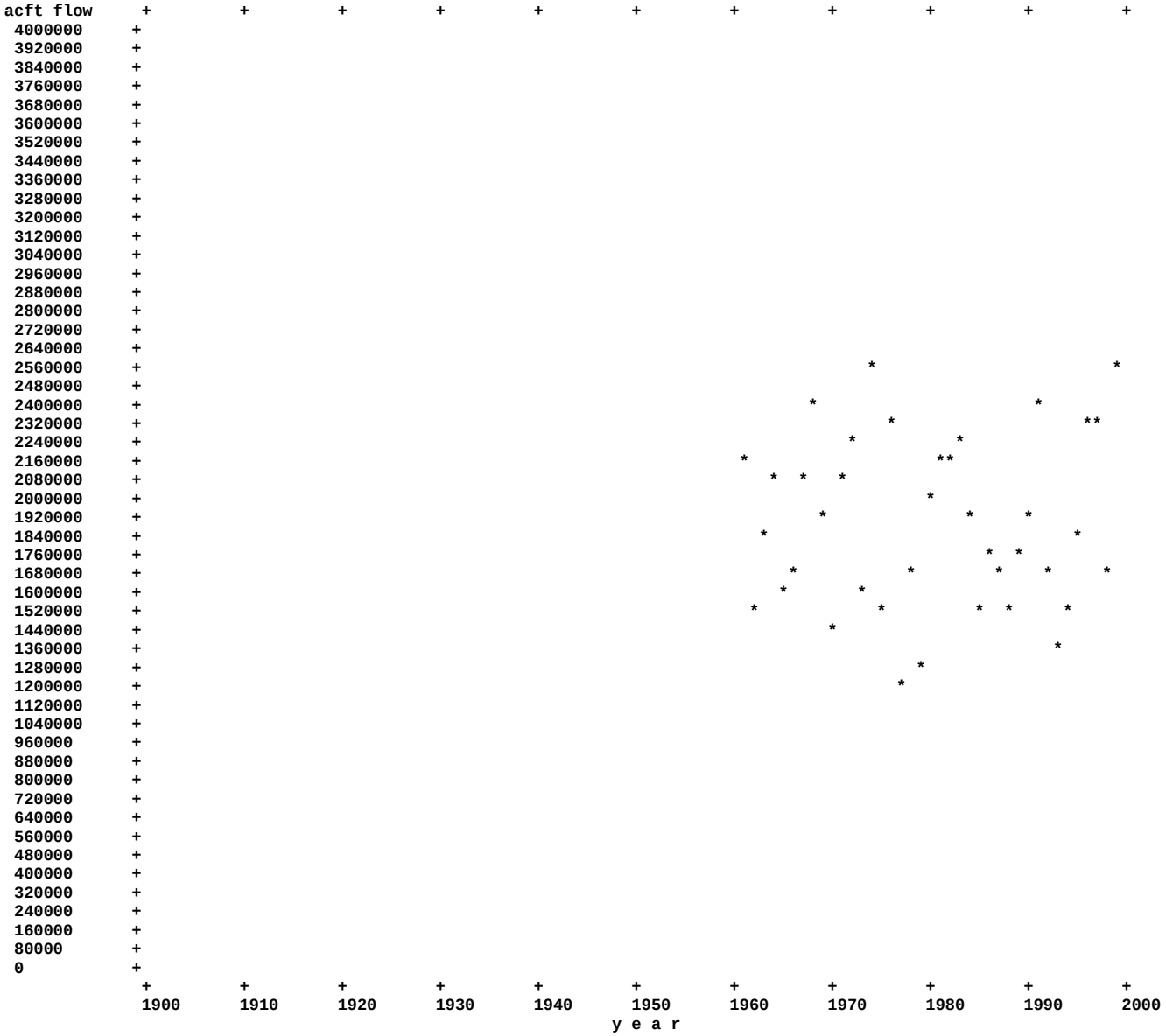
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1961	122820	171372	158757	303808	273223	170598	92807	119226	123868	90883	67914	47663	1742939
1962	97666	124800	186902	158440	73736	65207	110440	96238	106433	83583	73686	56836	1233967
1963	120178	240397	240873	123092	219812	93957	91944	101633	78654	89772	63441	56717	1520470
1964	165312	246049	182321	232740	110717	122321	99114	102922	177441	158638	97428	76433	1771436
1965	104791	140666	158253	181722	195351	85603	93394	106380	88594	77679	66203	34899	1333534
1966	102922	174161	189425	218208	97448	136387	98416	95168	100790	91841	67587	52162	1424513
1967	101371	150218	387350	264376	141826	152248	68687	90998	120794	87863	64149	54085	1683964
1968	281196	150582	244066	322916	232952	167558	91092	98900	109878	97182	69819	110609	1976750
1969	152440	174255	238329	154952	89812	123167	141197	139955	141684	82391	59600	114569	1612349
1970	87828	104191	146497	150110	109846	88865	142477	86309	90608	73761	54312	75004	1209808
1971	95663	159746	205191	251784	176362	180087	105709	130100	122355	128944	98837	73050	1727828
1972	90052	207628	163078	199831	215362	285849	148601	120262	108270	141339	78732	75499	1834504
1973	38240	116118	290104	224369	88760	103397	60405	113666	114594	83237	55296	50660	1338847
1974	100669	201419	299053	338620	171866	236285	134051	136638	154810	138509	89327	62337	2063584
1975	32270	151471	204280	169995	106817	108292	49832	95552	95074	91201	88181	54182	1247146
1976	246742	290722	328952	206276	139122	161240	87781	112876	100742	107660	81684	60257	1924054
1977	52808	70370	102503	95502	107089	122964	89187	92513	96027	63415	75867	68534	1036777
1978	87813	255636	267630	118311	87953	88003	72950	85532	88743	72397	76295	113344	1414606
1979	56686	85366	93918	55005	164841	140828	80003	92857	72035	87805	51913	83692	1064948
1980	108471	66450	432199	132568	216589	136183	128367	88391	89671	88502	55058	103584	1646030
1981	49454	318703	337645	122542	225611	84911	161381	107848	138069	77838	56175	68431	1748608
1982	155168	206371	217830	201277	281715	115656	114688	93700	132412	103116	72175	51597	1745704
1983	163714	142989	251627	263669	249175	190950	88156	88110	107255	144970	68236	57009	1815859
1984	41725	349749	117873	238879	149591	148271	99775	127415	109894	92232	65909	60583	1601895
1985	170296	223583	137157	65930	69101	70874	121621	102070	102008	79094	49816	48875	1240425
1986	180431	151746	70563	230741	193716	145049	82080	149104	99524	71141	56197	39034	1469326
1987	66053	225107	143303	172102	144451	203871	92014	114703	101430	68467	46190	38049	1415739
1988	22335	67321	179742	130272	108691	141213	152892	144766	115156	89499	55954	55003	1262844
1989	161630	215080	144640	173296	93684	131912	151352	89983	99103	85653	59016	35590	1440939
1990	94264	263103	176707	176314	188639	131115	104381	100758	132771	81321	63106	44317	1556796
1991	148628	512431	187585	181974	277313	98759	119435	87360	69998	74478	132196	87983	1978139
1992	46657	193080	176692	269878	171348	69431	125206	94309	68474	56083	49297	59301	1379755
1993	77220	136057	108863	107089	56095	114047	131646	142738	103632	64446	56536	33149	1131516
1994	49595	54877	200397	165028	141826	206858	109362	85894	102039	76502	42593	48756	1283728
1995	70095	146164	316659	189441	224574	155345	88343	83876	85360	77096	61082	47673	1545708
1996	187413	482156	280363	198684	184536	84738	144686	110565	78818	71121	49504	47566	1920148
1997	136672	144419	192773	294448	141637	271340	148428	150236	140238	136481	80872	79397	1916940
1998	214434	155596	150362	221729	144403	126196	62629	97182	88750	75297	49587	34859	1421024
1999	73873	331631	321548	239774	250936	177604	93840	118341	148161	145645	119466	55816	2076635
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	111681.9	194917.4	211077.2	193479.3	161962.2	139414.8	107137.7	107566.0	107798.9	92489.3	68441.9	61977.0	1557943.3
med =	100669.0	171372.0	189425.0	189441.0	149591.0	131912.0	99775.0	101633.0	102039.0	85653.0	64149.0	56717.0	1545708.0

STATION NUMBER 12041200 HOH RIVER AT U.S. HIGHWAY 101 NEAR FORKS - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
890705.4													14771.63
777569.8													12895.36
678804.3		X											11257.42
592583.9			X										9827.52
517315.6													8579.26
451607.1		9	9	X									7489.54
394244.9	X			9	X	X							6538.23
344168.7					9								5707.76
300453		7	7	7									4982.77
262290.1			5		7	9							4349.87
228974.7	9	5		5									3797.36
199890.8	7		3	3	5	7	X	X	X				3315.03
174501		3				5		9	9	X	X		2893.96
152336.3							7	7	7			X	2526.37
132986.8	5		1	1	3	3	5	5	5			9	2205.48
116095.1							3	3	3	7	9		1925.34
101349					1	1		0		5			1680.79
88475.84	3	1	0			0			1	3	7		1467.30
77237.81							1		0	1	5	7	1280.93
67427.21		0		0	0					0	3	5	1118.23
58862.74							0				1	3	976.19
51386.11	1										0		852.20
44859.14													743.95
39161.26												0	649.46
34187.07													566.96
29844.7													494.95
26053.88	0												432.08
22744.57													377.20
19855.6													329.29
17333.59													287.46
15131.91													250.95
13209.89													219.08
11531.99													191.25
10067.22													166.96
8788.503													145.75
7672.204													127.24
6697.702													111.08
5846.973													96.97
5104.302													84.65
4455.963													73.90
3889.975													64.51
3395.878													56.32
2964.542													49.16
2587.991													42.92
2259.271													37.47
1972.303													32.71
1721.785													28.55
1503.088													24.93
1312.168													21.76
1145.499													19.00
1000.001													16.58

STATION NUMBER 12041200 HOH RIVER AT U.S. HIGHWAY 101 NEAR FORKS - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12041200 HOH RIVER AT U.S. HIGHWAY 101 NEAR FORKS - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

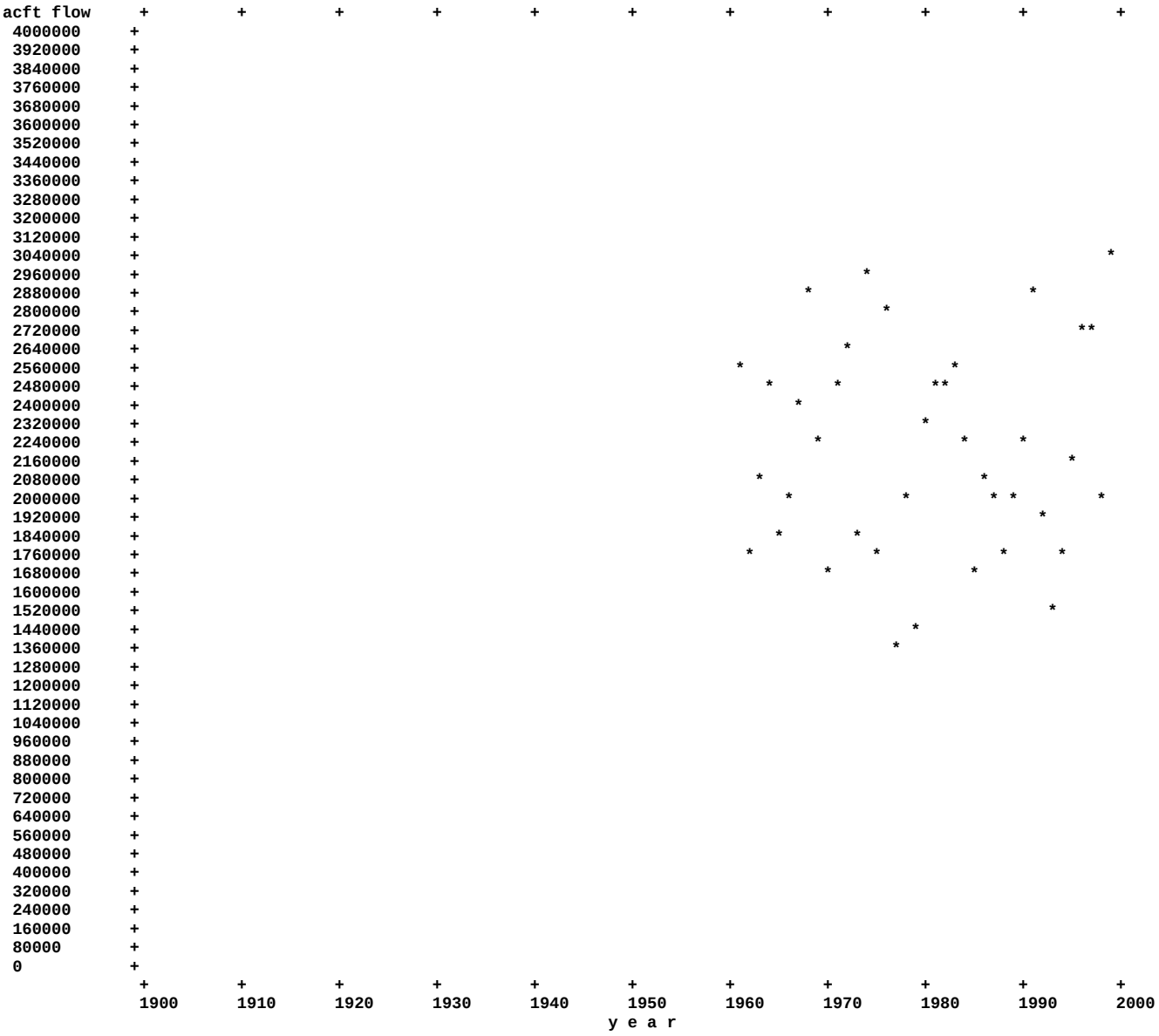
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1961	151656	214334	196562	393421	344172	211656	109825	131901	129402	95623	70397	52923	2101872
1962	116106	148205	234109	187478	88643	88606	131940	112403	115954	89772	81661	63370	1458247
1963	144595	305732	276278	143980	243876	112661	112602	117064	84833	98063	68922	62650	1771256
1964	198623	290063	219550	290777	136740	159332	116767	110400	185494	166830	111173	87959	2073708
1965	122424	167131	189322	218935	236132	96141	107948	124443	101851	87035	73847	37872	1563081
1966	120052	209395	228654	264972	113097	161732	114327	110202	117342	105977	75437	57711	1678898
1967	118080	179185	478393	323226	168595	181745	76701	104906	142750	98737	71486	59921	2003725
1968	344449	179643	297600	397091	283577	201064	105025	114942	128886	112760	78002	129814	2372853
1969	181987	209514	290360	185157	103398	145765	167802	166235	168416	92450	66258	134844	1912186
1970	98697	121662	174490	179048	128846	102196	169416	96952	104410	82532	60182	83960	1402391
1971	110830	191207	248549	307339	212172	216873	123590	154572	144734	153104	114863	81715	2059548
1972	103704	251623	195411	241785	261382	350320	177144	142076	126843	167980	88245	84530	2191043
1973	41712	136812	355690	272747	99769	120654	67184	133698	134876	93421	61313	55985	1573861
1974	117189	243788	366982	416906	206499	287782	159590	162050	184978	164410	102783	69404	2482361
1975	34852	180766	247398	204139	124998	126871	55033	110690	110083	105164	101328	60032	1461354
1976	300976	356469	404707	249917	165183	193091	100820	132694	117283	126069	91636	67014	2305859
1977	58453	78635	119518	110626	125343	145507	102605	106830	111292	70643	84952	76526	1190930
1978	100859	312198	327332	139597	101038	101101	81600	96059	99749	80965	85444	133289	1659231
1979	62910	95869	108615	60978	197635	167335	89704	107266	80549	100850	57425	93945	1223081
1980	127099	74130	534982	157706	262929	161474	152370	101593	103220	99471	61039	120892	1956905
1981	54599	391775	415676	144972	274314	95345	193269	126307	163854	87217	62323	76407	2086058
1982	185431	250036	264496	243610	345104	136225	134995	108337	157507	120297	80709	57062	2083809
1983	196213	170063	307140	322334	304046	230578	101296	101236	125554	172562	76183	63281	2170486
1984	45717	430949	139041	291054	178393	176727	116053	151160	128906	106473	73509	67388	1905370
1985	204518	271755	162704	73533	77177	79214	143802	118969	118889	88661	55016	53935	1448173
1986	217307	181113	78857	280786	234069	172661	92093	177778	115735	79521	62348	42625	1734893
1987	73674	273677	170459	206797	171907	246883	106195	135015	118155	76449	50848	41492	1671551
1988	23435	75132	216436	154790	127378	167821	182559	172304	135590	103002	62069	60976	1481492
1989	193583	261025	172145	208304	108317	156873	180615	103616	115200	96198	65587	38668	1700131
1990	109053	321620	212608	212112	227663	155861	121904	117302	157964	91220	70288	48696	1846291
1991	177177	636218	226334	219253	339550	114764	141025	100284	78208	83355	157234	98876	2372278
1992	51384	233266	212588	330168	205845	77556	148356	109111	76457	62217	54418	65915	1627281
1993	86507	161316	127597	125343	62231	134182	156535	169745	120952	71827	62737	35861	1314833
1994	54762	60831	242499	197871	168595	250651	128231	96476	118929	85682	46715	53798	1505040
1995	78319	174069	389196	228674	273005	185653	101534	94155	95861	86364	67962	52552	1827344
1996	226116	598016	343398	240337	222486	95147	172205	129759	88344	79497	54656	52429	2302390
1997	162094	171870	232883	361176	168359	332018	176928	179209	166594	161854	90705	89010	2292700
1998	260215	185973	179368	269419	171850	149615	69740	112762	102051	84299	54753	37827	1677872
1999	82662	408093	395371	292189	306272	213742	108517	139638	176591	173417	141067	61911	2499470
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	131744.1	235978.4	255982.0	234578.1	194117.6	166754.4	125585.8	125131.8	124468.9	105178.7	76808.2	69565.8	1845893.4
med =	117189.0	209395.0	232883.0	228674.0	178393.0	159332.0	116767.0	117064.0	118889.0	95623.0	70397.0	62650.0	1827344.0

HOH RIVER AT outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
1079627													17904.73
938875.9													15570.49
816474.6		X											13540.57
710030.7			X										11775.28
617463.9													10240.14
536965.6		9	9	X									8905.14
466961.4	X			9	X	X							7744.17
406083.6			7		9								6734.57
353142.4		7		7									5856.58
307103.2	9		5	5	7	9							5093.06
267066.2		5											4429.08
232248.7	7		3	3	5	7	X	X	X	X			3851.66
201970.6		3				5		9	9	9	X		3349.52
175639.7							7	7	7			X	2912.84
152741.5	5		1	1	3	3	5	5	5			9	2533.09
132828.6							3	3	3	7	9		2202.85
115511.7					1	1		0		5			1915.67
100452.5	3	1	0						1	3	7		1665.92
87356.46						0	1		0	1	5	7	1448.74
75967.8		0		0	0					0	3	5	1259.86
66063.87							0				1	3	1095.62
57451.17	1										0		952.78
49961.26													828.57
43447.8												0	720.55
37783.51													626.61
32857.67													544.92
28574.01													473.88
24848.82	0												412.10
21609.29													358.37
18792.09													311.65
16342.16													271.02
14211.63													235.69
12358.86													204.96
10747.64													178.24
9346.466													155.00
8127.967													134.80
7068.323													117.22
6146.831													101.94
5345.468													88.65
4648.579													77.09
4042.543													67.04
3515.517													58.30
3057.198													50.70
2658.633													44.09
2312.026													38.34
2010.607													33.34
1748.485													29.00
1520.535													25.22
1322.303													21.93
1149.914													19.07
999.9996													16.58

HOH RIVER AT outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



HOH RIVER AT outlet - Total monthly flow in ac-ft

monthly summary by water year remormatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1961	183091	261168	237774	491111	421516	256415	128377	145718	135435	100790	73104	58657	2493156
1962	136208	173720	285571	219133	104894	114114	155378	130025	126333	96519	90355	70493	1702741
1963	171213	376956	314874	166751	270109	133051	135122	133886	91569	107101	74897	69118	2044645
1964	234936	338044	260134	354045	165108	199679	136011	118552	194273	175760	126157	100524	2403224
1965	141647	195981	223192	259502	280588	107629	123814	144134	116303	97234	82180	41113	1813317
1966	138726	247805	271419	315951	130157	189361	131672	126592	135386	121387	83995	63760	1956210
1967	136296	210763	577641	387380	197777	213901	85438	120068	166685	110591	79485	66283	2352306
1968	413403	211323	355959	477951	338764	237590	120214	132430	149607	129742	86923	150751	2804657
1969	214198	247951	347081	218085	118209	170400	196805	194884	197557	103416	73517	156947	2239047
1970	110546	140708	205006	210594	149558	116728	198783	108555	119456	92094	66581	93723	1612331
1971	127364	225504	295815	367901	251210	256974	143083	181250	169130	179441	132333	91161	2421166
1972	118587	299583	230658	287520	311549	420602	208260	165856	147091	197023	98615	94375	2579717
1973	45497	159371	427187	325485	111770	139466	74574	155535	156986	104523	67872	61790	1830056
1974	135198	289976	441033	502248	244254	343920	187431	189752	217865	192646	117451	77108	2938882
1975	37667	212701	294402	241360	144818	147125	60703	127193	126445	120385	115660	66410	1694868
1976	360099	428141	487290	297491	193593	227813	115034	154298	135315	146137	102485	74380	2722076
1977	64607	87645	138067	127113	145243	170082	117233	122438	127933	78522	94856	85238	1358977
1978	115081	373858	392415	162802	115303	115379	91030	107534	111748	90305	95418	155031	1925904
1979	69695	107318	124637	67490	233385	196232	100280	122974	89830	115071	63434	105122	1395466
1980	147406	82503	647029	185110	313446	189045	178537	115985	117991	111429	67559	139760	2295799
1981	60208	471433	500740	169423	327406	106719	228031	146430	191963	97442	69025	85102	2453923
1982	218421	297637	315368	289759	414207	158648	157133	124293	184864	139027	90012	63019	2452387
1983	231641	199578	367656	386287	363862	273778	115620	115546	145503	202641	84846	70118	2557075
1984	50069	519467	162117	347932	209791	207748	133799	177046	149632	121998	81794	74807	2236197
1985	241825	324268	190553	81821	85981	88306	167982	137392	137292	99090	60685	59451	1674646
1986	257506	213127	87899	335342	278059	202762	103008	209037	133407	88657	69053	46540	2024396
1987	81982	326625	200062	244619	201838	293772	121655	157158	136388	85150	55926	45246	1950419
1988	24634	83647	256437	181518	147750	196828	214900	202324	157866	117722	68735	67487	1719847
1989	228416	311112	202130	246467	124269	184084	212515	118477	132748	107693	72751	42023	1982684
1990	125175	385411	251744	251136	270205	182838	141006	135337	185428	102011	78117	53469	2161878
1991	208300	771162	268575	259892	407397	132211	164561	114373	87158	93032	184529	110751	2801941
1992	56538	277074	251719	395893	243452	86414	173592	125248	85159	68904	60001	73125	1897117
1993	96632	188852	148019	145243	68920	156131	183667	199187	139834	79874	69497	38818	1514672
1994	60395	67322	288395	233674	197777	298391	148800	108011	137341	95690	51209	59294	1746299
1995	87285	204489	468271	271443	325801	218693	115914	105361	107308	96467	75462	57871	2134364
1996	268308	724319	412115	285744	263857	106494	202204	150683	98729	88628	60273	57731	2719083
1997	189808	201795	276608	433918	197490	398165	207997	210794	195326	189513	101425	99490	2702327
1998	310122	219088	210989	321408	201770	175145	77493	129746	116551	94112	60384	41063	1957870
1999	92243	491447	475847	349328	366596	253138	124517	162854	207584	203692	164615	68555	2960415
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	153614.7	280740.3	304934.1	279381.3	229171.3	196558.2	145696.8	144280.9	142641.5	119011.8	85928.6	77838.6	2159797.0
med =	136208.0	247805.0	276608.0	271443.0	209791.0	189045.0	136011.0	133886.0	136388.0	104523.0	78117.0	69118.0	2134364.0

Quillayute River watershed

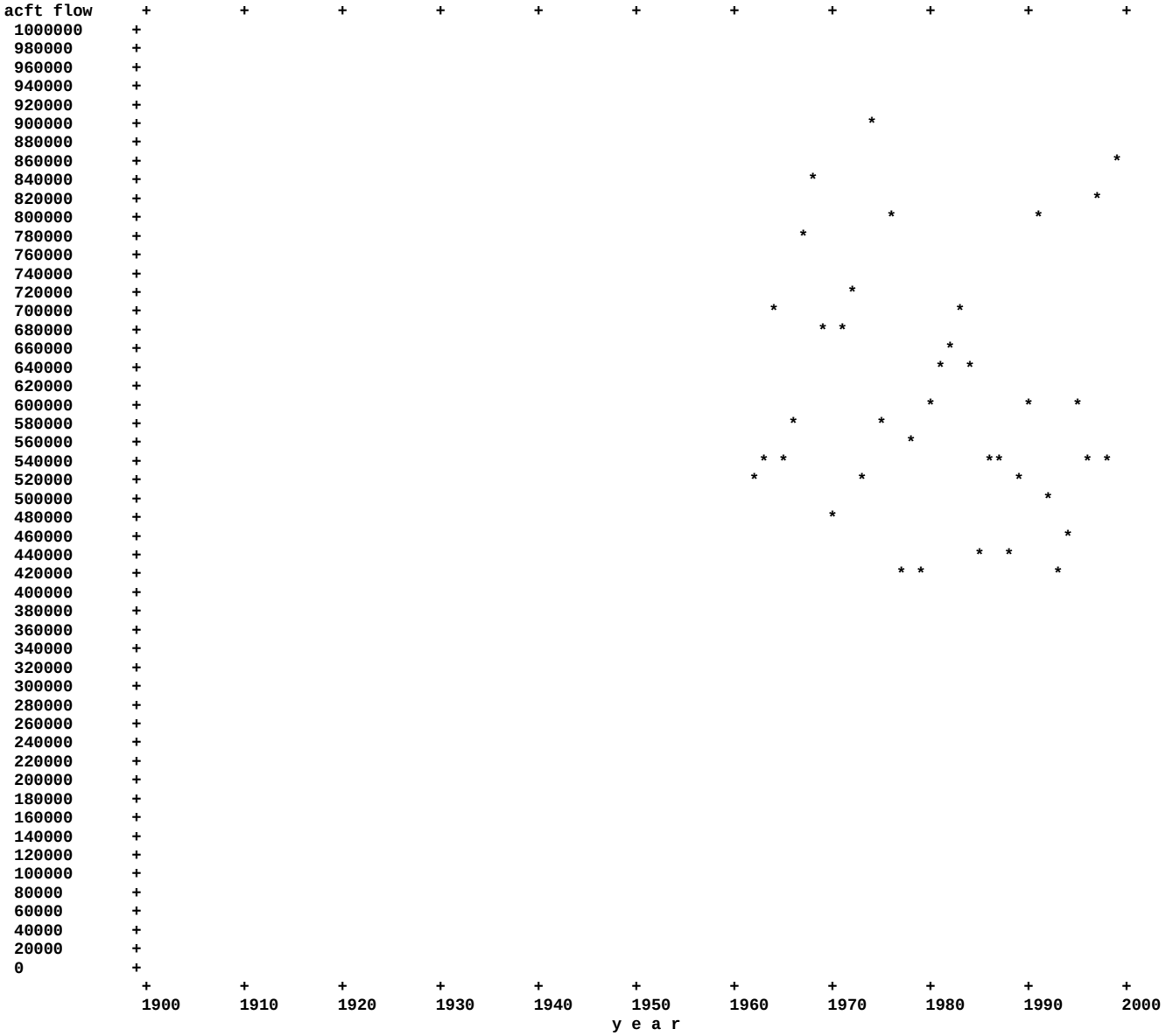
Bogachiel River watershed

Bogachiel River at outlet of Upper Bogachiel WAU at River Mile 22.0 - (Total monthly flow in ac-ft)
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
272620.7													4521.19
243695.6													4041.49
217839.4		X											3612.69
194726.6			X										3229.38
174066.1			9	X	X	X							2886.74
155597.6		9		9									2580.46
139088.7	X												2306.67
124331.3			7	7	9								2061.93
111139.7		7			7	9							1843.16
99347.79			5	5									1647.60
88806.96	9	5				7	X						1472.79
79384.52			3		5								1316.53
70961.8				3									1176.84
63432.74		3	1		3	5	9	X					1051.98
56702.51	7					3	7						940.37
50686.36				1				9					840.59
45308.53							5					X	751.41
40501.28	5				1		3		X	X	X		671.68
36204.09								7					600.42
32362.82		1	0			1			9			9	536.71
28929.12								5					479.77
25859.73				0			1						428.86
23116.01	3	0				0		3	7	9			383.36
20663.39					0		0						342.69
18471								1	5				306.33
16511.23												7	273.83
14759.38								0		7	9		244.77
13193.41									3				218.80
11793.58	1									5			195.59
10542.28												5	174.84
9423.743										3	7		156.29
8423.882									1				139.70
7530.105											5	3	124.88
6731.16									0				111.63
6016.982										1	3		99.79
5378.579										0	1		89.20
4807.91													79.74
4297.79												1	71.28
3841.793											0		63.71
3434.178												0	56.95
3069.811													50.91
2744.104	0												45.51
2452.954													40.68
2192.695													36.36
1960.05													32.51
1752.088													29.06
1566.191													25.97
1400.018													23.22
1251.476													20.75
1118.694													18.55
1000													16.58

Bogachiel River at outlet of Upper Bogachiel WAU at River Mile 22.0 - (Total monthly flow in ac-ft)
hydrograph of annual recorded flows



Bogachiel River at outlet of Upper Bogachiel WAU at River Mile 22.0 - (Total monthly flow in ac-ft)

monthly summary by water year reformatted file
this is a rewritten record

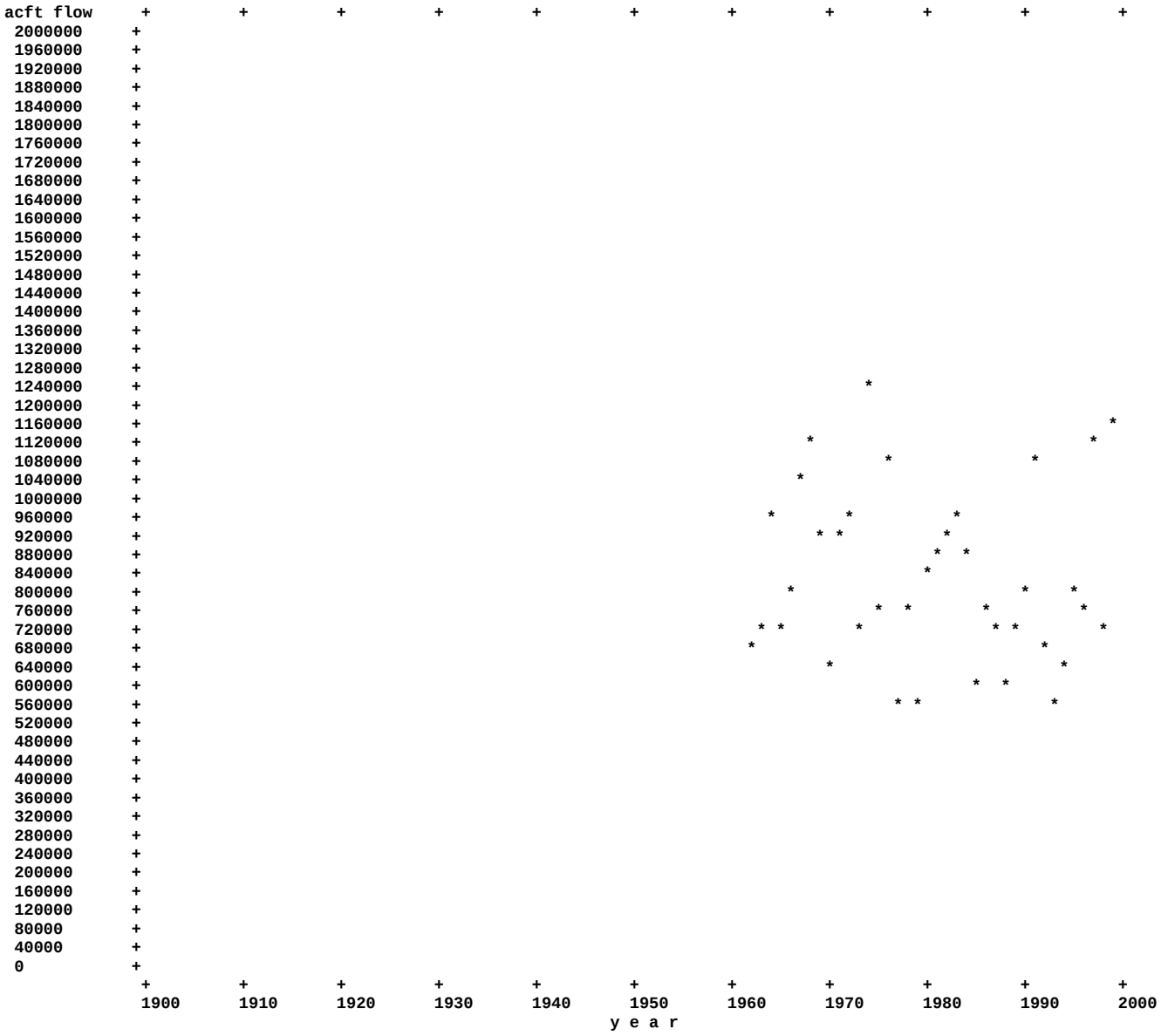
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	52938	65897	102207	59170	39881	47115	49050	30600	19728	12211	12899	10327	502022
1963	45107	106326	100777	58856	63772	42674	45746	26139	7261	14906	7245	5796	524604
1964	70466	125749	96319	127316	54871	84067	36457	17943	16992	22721	13058	23985	689944
1965	39984	66385	68878	123154	121372	26641	28250	33799	7711	5369	6989	6410	534943
1966	42708	82460	107414	129728	51057	83462	22011	14600	11075	9795	6640	9917	570867
1967	58084	87675	184058	163043	110200	86268	34707	17147	7943	5183	4504	7830	766640
1968	125601	64157	135671	164776	98371	82657	48079	22070	17531	10552	11139	41493	822096
1969	89971	82960	123219	86151	75536	56079	62348	21055	12541	7842	6299	36301	660298
1970	40316	47781	76317	82291	51341	41952	80006	18814	7087	5902	5075	20706	477586
1971	43944	63543	112590	151444	82500	100081	40350	18637	15762	10199	6413	15374	660835
1972	59016	95737	98657	103949	104907	108608	66281	13859	6205	32983	5976	15116	711292
1973	8222	50366	163057	111362	35784	53095	18968	28342	24900	8736	5468	6747	515046
1974	65827	119869	147355	137953	117371	121564	58349	57414	26103	20995	9383	9134	891316
1975	11470	90749	107973	90866	72011	65949	21159	36517	17597	10863	22905	13879	561936
1976	117169	128297	150248	102587	67672	56109	36272	45893	30705	22582	14518	11435	783488
1977	15818	30581	56785	45806	62165	60877	37633	34655	22279	8278	8325	19034	402236
1978	34987	131552	126007	52491	38861	30689	26823	31228	15302	6547	12443	43004	549933
1979	16284	33353	53587	23677	100632	61591	30386	27291	12030	13809	6040	21824	400503
1980	39093	24351	189327	58341	104119	53290	51394	21164	16356	14110	5493	20158	597196
1981	21781	140556	122513	47270	82549	56211	56977	28982	33925	8845	9086	21193	629887
1982	64239	85307	106569	113464	109370	60659	58272	18715	14167	10874	8972	7242	657850
1983	73064	57787	97143	110776	123038	96894	30987	22776	21766	20189	20961	14227	689607
1984	18416	152381	61393	119815	81440	59512	42023	52076	23287	12278	6107	10710	639437
1985	52777	105426	59192	28049	32520	33449	50359	30503	14467	6715	4196	9970	427623
1986	53931	53956	29607	115891	95391	57509	35759	51990	18687	14585	5873	5152	538329
1987	18394	95394	58130	82401	56857	99188	39663	31796	24081	10231	4845	3754	524734
1988	2539	24635	77825	52108	51236	63002	58949	48264	24174	13067	6098	10876	432772
1989	34001	102241	59473	96255	43709	64175	55008	16823	10724	13030	7219	4067	506726
1990	28519	111963	65891	93590	118389	55380	27549	24112	39553	11822	7100	5101	588968
1991	51011	194729	107091	98863	142674	43123	53413	24656	14521	7903	37279	20081	795343
1992	7505	70622	75036	145383	67744	22575	48016	25175	10096	5936	3581	12550	494218
1993	24402	53547	51882	52819	20315	52972	59376	41484	29142	11934	7219	4295	409387
1994	15188	22803	74274	65127	78433	79978	41832	17610	29926	13751	5718	8706	453346
1995	20327	59082	158312	81692	99810	71579	40253	15740	7556	5870	14085	6126	580429
1996	52835	165063	62893	50461	52235	28417	47633	38174	17040	9830	5325	7701	537606
1997	50130	57780	109915	156498	58141	161760	59456	45154	38250	38215	12782	29902	817981
1998	86244	62783	75523	118765	57653	51212	23324	16533	11805	14018	5645	3098	526605
1999	16850	151627	169487	131639	156122	98314	42468	39749	20331	15275	8357	5126	855345
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	43925.2	85933.4	100594.6	95627.0	78422.3	66281.0	43831.2	29144.2	18384.4	12840.8	9243.7	13903.9	598130.8
med =	40316.0	82460.0	98657.0	96255.0	72011.0	59512.0	42023.0	26139.0	16992.0	10874.0	6989.0	10327.0	561936.0

STATION NUMBER 12042800 BOGACHIEL R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
374385.1													6208.87
332546.4													5515.01
295383.3		X											4898.69
262373.1			X										4351.25
233052.1			9	X	X	X							3864.98
207007.8		9		9									3433.06
183874.1	X				9								3049.40
163325.4			7	7									2708.62
145073.3		7	5	5	7	9							2405.92
128860.9	9												2137.05
114460.3		5	3			7	X						1898.23
101669				3	5								1686.10
90307.13		3				5	9						1497.67
80215.03	7		1		3	3		X					1330.30
71250.76				1			7	9					1181.64
63288.27													1049.58
56215.55	5				1		5		X	X		X	932.29
49933.3							3				X		828.10
44353.1						1		7					735.56
39396.5		1	0						9			9	653.36
34993.79				0				5					580.34
31083.13	3	0				0	1		7				515.49
27609.49					0			3		9			457.88
24524.05							0						406.71
21783.41								1	5			7	361.26
19349.03								0			9		320.89
17186.72									3	7			285.03
15266.05	1												253.18
13560.02										5		5	224.88
12044.64										3	7		199.75
10698.61													177.43
9503.009									1				157.60
8441.019											5	3	139.99
7497.709									0	1	3		124.34
6659.811													110.45
5915.557										0	1	1	98.10
5254.475													87.14
4667.271											0		77.40
4145.686												0	68.75
3682.393	0												61.07
3270.874													54.24
2905.343													48.18
2580.662													42.80
2292.265													38.02
2036.096													33.77
1808.556													29.99
1606.444													26.64
1426.919													23.66
1267.456													21.02
1125.814													18.67
1000													16.58

STATION NUMBER 12042800 BOGACHIEL R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12042800 BOGACHIEL R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

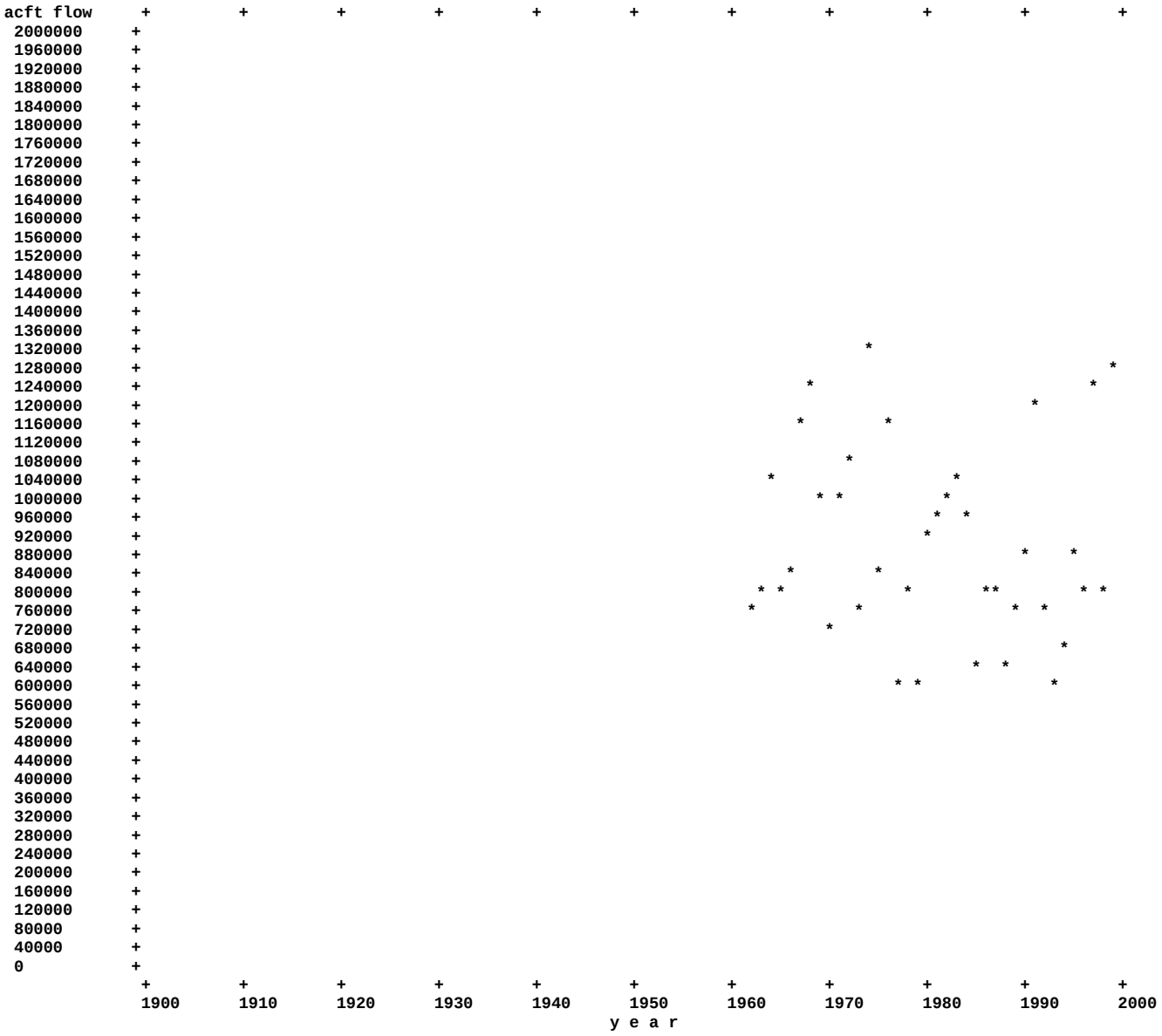
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	70933	88628	138478	79655	52846	63591	65884	39992	25230	15020	16023	12692	668972
1963	60276	144033	136441	79087	85813	56948	61150	34325	8498	18957	8475	6494	700497
1964	94971	170606	130341	172750	73635	113579	48442	23112	21812	29649	16429	31379	926705
1965	53268	89387	92799	167056	164618	35012	37213	44806	9114	5909	8126	7334	714642
1966	56995	111380	145521	176050	68417	112752	28678	18538	13716	11965	7648	12131	763791
1967	78030	118515	250380	221629	149333	116590	46048	22023	9431	5655	4726	9276	1031636
1968	170403	86339	184180	224000	133149	111650	64342	28759	22549	13001	13804	55332	1107508
1969	121656	112065	167144	116430	101907	75287	83864	27369	15722	9292	7181	48228	886145
1970	53721	63934	102976	111149	68805	55960	108023	24303	8260	6639	5507	26892	636169
1971	58685	85500	152602	205761	111435	135488	53768	24061	20129	12517	7338	19597	886881
1972	79306	129545	133540	140780	142091	147154	89245	17524	7053	43689	6740	19245	955912
1973	9813	67472	221649	150922	47521	71205	24514	37339	32630	10516	6045	7795	687421
1974	88626	162813	200593	187731	160153	166236	78551	76917	33977	27097	11215	10825	1204733
1975	14008	122787	146411	123135	97339	89558	27423	48458	22544	13321	29814	17451	752249
1976	158926	174168	204234	138167	95119	82566	50368	54954	36395	25916	16929	13831	1051573
1977	19857	39160	73575	57882	81227	87015	49438	43232	27812	10760	10409	23724	524091
1978	45808	172266	167054	71445	54059	43025	36512	41064	19644	8477	15078	55107	729539
1979	21011	43484	72014	31127	141546	83345	43694	33989	14337	17181	7527	28653	537908
1980	51675	33068	259406	82084	136673	76687	70550	26426	20648	17847	7412	24740	807216
1981	28162	191248	166416	63330	111932	76132	76682	37764	44709	10391	10809	27126	844700
1982	86447	115308	144480	154137	149074	82265	78446	23626	17599	13181	10653	8269	883483
1983	98561	77482	131511	150448	168001	132222	41278	29217	28026	25989	26953	17710	927398
1984	23544	207501	82328	162849	110396	83401	55833	70496	30031	15043	7606	13153	862177
1985	71711	142104	82845	36589	42746	44026	67515	39968	17884	8339	5303	12261	571291
1986	73714	73758	38734	155406	129349	79925	47207	70345	23695	18046	7323	6454	723956
1987	23291	129353	81002	112838	78792	134176	52584	41749	31124	12576	6085	4770	708340
1988	3305	31887	107021	70551	69037	88180	82423	64429	31252	15994	7594	13353	585026
1989	44786	138056	83333	130447	58156	89671	75584	21129	13169	15949	8946	5148	684374
1990	37236	150413	91852	127060	158581	76229	35900	31167	52433	14493	8802	6393	790558
1991	68647	267418	144220	133762	189449	57348	72816	31916	17958	9770	49301	25615	1068220
1992	9290	97866	103476	194270	94207	29050	64087	32631	12413	7400	4561	15370	664620
1993	31566	73048	70158	71785	25938	72051	83165	55091	38094	14629	8946	5422	549890
1994	18877	29364	102507	90881	107794	109757	55571	22213	39174	16898	7137	10738	610910
1995	25954	82654	213435	111936	134966	99081	53396	19637	9352	7320	17358	7628	782714
1996	71813	223442	88041	67692	70771	37095	63560	50532	21428	12092	6663	9526	722656
1997	67118	80394	147810	210746	81021	218546	83303	60146	50638	50589	15650	39141	1105101
1998	117723	87902	104096	159060	80175	68995	30082	20729	14473	17265	7049	3979	711526
1999	21165	203526	230000	175423	210189	133064	56447	52702	25960	18997	10317	6423	1144213
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	58707.3	116259.8	136647.5	129369.7	106217.4	90391.1	59041.7	37965.2	23392.4	16009.7	11407.4	17610.7	803019.6
med =	53721.0	111380.0	133540.0	130447.0	97339.0	82566.0	55833.0	33989.0	21428.0	13321.0	8126.0	12692.0	752249.0

Bogachiel River above Calawah River - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
412377													6838.94
365585.2													6062.93
324102.8		X											5374.98
287327.1			X										4765.09
254724.5			9	X	X	X							4224.40
225821.3		9											3745.06
200197.7	X				9								3320.12
177481.6			7	7									2943.39
157342.9		7	5	5	7	9							2609.40
139489.4	9												2313.32
123661.8		5	3			7	X						2050.83
109630.1				3	5								1818.13
97190.52		3			3	5	9						1611.83
86162.46	7		1			3	7	X					1428.93
76385.66				1				9					1266.79
67718.3							5					X	1123.05
60034.41	5				1				X	X	X		995.62
53222.4						1	3						882.65
47183.33		1	0					7	9			9	782.50
41829.47													693.71
37083.15				0				5					614.99
32875.38	3	0				0	1		7				545.21
29145.06					0		0	3		9			483.35
25838.02													428.50
22906.22								1	5			7	379.88
20307.06								0		7	9		336.78
18002.85									3				298.56
15960.1	1												264.69
14149.13										5		5	234.65
12543.65										3	7		208.03
11120.33													184.42
9858.523									1				163.50
8739.892											5	3	144.94
7748.189									0	1	3		128.50
6869.015													113.92
6089.592										0	1	1	100.99
5398.616													89.53
4786.043											0		79.37
4242.978												0	70.37
3761.534													62.38
3334.715	0												55.30
2956.332													49.03
2620.88													43.47
2323.493													38.53
2059.85													34.16
1826.121													30.28
1618.914													26.85
1435.217													23.80
1272.365													21.10
1127.992													18.71
1000													16.58

Bogachiel River above Calawah River - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Bogachiel River above Calawah River - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

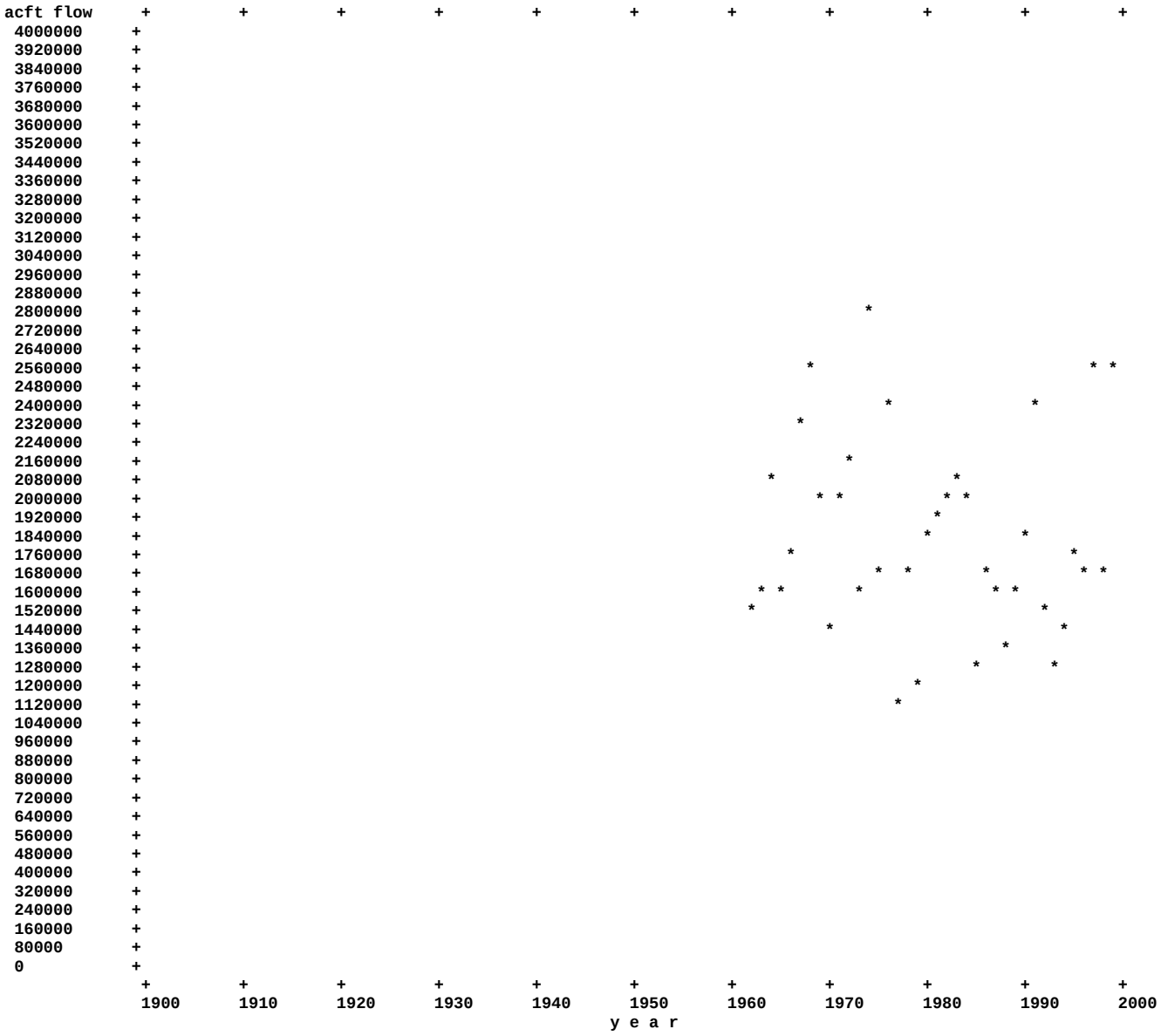
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	77437	96920	151878	87099	57452	69523	71950	43251	27021	15795	16917	13300	728542
1963	65714	157974	149611	86435	93844	62049	66677	37129	8680	20201	8655	6539	763507
1964	103931	187244	142892	189606	80429	124428	52679	24778	23346	31978	17416	33884	1012612
1965	57995	97780	101539	183334	180648	37886	40310	48674	9359	5914	8271	7398	779107
1966	62100	122006	159613	193241	74682	123517	30909	19739	14428	12499	7744	12682	833160
1967	85271	129865	275116	243447	163812	127745	50042	23578	9708	5660	4731	9537	1128511
1968	187021	94423	202196	246058	145985	122303	70193	30998	24158	13641	14525	60268	1211768
1969	133325	122761	183431	127569	111571	82249	91697	29467	16638	9555	7230	52443	967934
1970	58494	69744	112749	121752	75109	60960	118308	26090	8418	6684	5552	28942	692800
1971	63962	93499	167413	225968	122067	148561	58546	25823	21492	13107	7403	20906	968746
1972	86676	142015	146416	154390	155835	161411	97624	18623	7089	47444	6785	20518	1044825
1973	10129	73641	243469	165562	51665	77753	26322	40449	35262	10903	6090	7906	749150
1974	96943	178730	220393	206225	176009	182804	85888	83991	36663	29114	11621	11179	1319559
1975	14681	134589	160628	135025	106609	98180	29502	52679	24126	13964	32136	18514	820633
1976	174395	191189	224316	151306	105189	92263	55401	58088	38257	26889	17554	14450	1149297
1977	21096	42112	79625	62154	88134	96591	53607	46183	29615	11412	10911	25209	566649
1978	49606	187341	182255	78311	59508	47395	39883	44490	20998	8921	15788	59389	793884
1979	22510	47022	78681	33653	156697	91268	48430	36232	14923	18169	7804	30945	586332
1980	56137	36072	285559	90757	148670	85229	77492	28127	21983	18973	7852	26184	883035
1981	30285	210088	182694	69104	122732	83363	83831	40793	48492	10690	11174	29080	922327
1982	94540	126342	158498	169196	163768	90132	85772	25194	18610	13767	11003	8371	965191
1983	107895	84627	144193	165130	184679	145266	44876	31363	30103	27893	28929	18739	1013694
1984	25194	228011	89941	178799	121035	92129	60759	77160	32290	15801	7887	13790	942795
1985	78570	155656	91484	39526	46320	47732	73703	43255	18889	8667	5436	12842	622079
1986	80893	80945	41893	170029	141875	88097	51241	76986	25301	19068	7586	6661	790573
1987	24855	141880	89347	124036	86783	147091	57174	45220	33496	13177	6268	4869	774194
1988	3310	34339	117751	77224	75468	97394	90995	70243	33638	16814	7875	14003	639052
1989	48571	151283	92050	143062	63322	99005	83061	22469	13808	16766	9313	5271	747980
1990	40240	164634	101362	139402	173460	83810	38766	33544	57007	15216	9160	6596	863197
1991	75015	294555	157943	146644	206811	62431	79851	34370	18970	10190	53552	27418	1167751
1992	9679	107859	113921	212428	103906	31208	69865	35160	13002	7668	4647	16150	725493
1993	33984	80121	76768	78655	27774	78964	91855	59940	41187	15361	9313	5562	599484
1994	19984	31554	112874	100312	118586	120707	60470	23664	42379	17801	7388	11220	666940
1995	27792	91262	233946	123061	147944	109173	58070	20822	9745	7583	18308	7910	855615
1996	78688	245182	97244	73909	77479	40085	69284	54910	22799	12661	6883	9931	789054
1997	73242	88641	161822	230927	89368	239684	92015	65517	55027	54973	16448	42342	1210006
1998	129314	97094	114590	173976	88387	75419	32347	22027	15195	18206	7294	4027	777876
1999	22509	222820	252545	191656	230302	145890	61436	57305	27799	20117	10772	6629	1249778
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	63999.6	127416.3	149964.4	141815.0	116418.8	99202.5	64495.6	41008.7	24997.4	16927.4	11953.2	18726.4	876924.6
med =	58494.0	122006.0	146416.0	143062.0	106609.0	91268.0	60759.0	36232.0	22799.0	13964.0	8271.0	13300.0	820633.0

Bogachiel River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
865598.9													14355.25
756084.7													12539.05
660426.1		X	X										10952.63
576869.5			9	X									9566.91
503884.9		9		9	X	X							8356.52
440134.2	X												7299.27
384449.1			7	7	9								6375.78
335808.9		7	5	5	7	9							5569.12
293322.9	9												4864.52
256212.2		5	3		5	7	X						4249.07
223796.6				3			9						3711.48
195482		3			3	5		X					3241.91
170750	7		1			3	7						2831.75
149146.9				1				9					2473.48
130277.1	5				1		5		X			X	2160.54
113794.6							3			X	X		1887.19
99397.45						1		7					1648.43
86821.84		1	0						9			9	1439.87
75837.28				0				5					1257.70
66242.47	3	0				0	1		7				1098.58
57861.52					0		0	3		9			959.59
50540.98													838.18
44146.61								1	5			7	732.14
38561.25								0					639.51
33682.52									3	7	9		558.60
29421.06	1												487.92
25698.75										5		5	426.19
22447.39										3	7		372.27
19607.36													325.17
17126.67									1				284.03
14959.83										1	3	3	248.10
13067.14													216.71
11413.89									0				189.29
9969.825											1	1	165.34
8708.459										0		0	144.42
7606.678													126.15
6644.293	0										0		110.19
5803.663													96.25
5069.393													84.07
4428.021													73.44
3867.795													64.14
3378.445													56.03
2951.009													48.94
2577.652													42.75
2251.531													37.34
1966.671													32.62
1717.85													28.49
1500.51													24.88
1310.668													21.74
1144.844													18.99
1000													16.58

Bogachiel River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Bogachiel River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	158006	198653	314000	178700	115652	143042	147218	85566	51916	28631	31137	24050	1476569
1963	133639	326539	309054	176964	192454	125976	135653	73873	14392	38479	14337	9941	1551300
1964	213544	387739	295006	392677	164407	256401	106386	48048	45055	63104	32657	67088	2072111
1965	117501	200684	208543	379563	373948	75455	80524	98011	15810	8641	13534	11710	1583924
1966	126085	251337	329967	400277	152390	254497	60867	37514	26409	22376	12432	22758	1696908
1967	174529	267769	571465	505250	338746	263335	100872	45540	16541	8122	6218	16183	2314568
1968	387271	193666	419001	510710	301472	251958	143004	61054	46751	24762	26612	122253	2488514
1969	275004	252914	379766	262967	229519	168211	187965	57851	31029	16219	11358	105892	1978694
1970	118543	142064	231982	250806	153283	123699	243604	50791	13842	10238	7918	56754	1403524
1971	129976	191733	346275	468705	251463	306859	118651	50233	41178	23647	11721	39953	1980393
1972	177468	293173	302373	319048	322067	333727	200358	35178	11063	95439	10444	39142	2139478
1973	17420	150214	505295	342406	104264	158811	51277	80814	69968	19039	9020	12773	1521299
1974	198938	370576	458130	428511	366808	381891	176220	171354	72137	56632	20069	19020	2720283
1975	26310	277815	332407	279202	219789	203465	57699	106217	46445	25171	63213	34697	1672430
1976	361022	396179	465529	310697	226240	207496	117600	101476	65639	43479	29148	25497	2350002
1977	39468	81141	155934	117700	174464	211287	106770	85844	55037	22309	20208	46717	1116880
1978	98383	372024	367406	162681	126565	101609	82802	88696	40512	17320	27960	114604	1600560
1979	43733	92753	161097	67034	337316	188377	106520	67149	25706	33534	14331	61529	1199077
1980	112671	74676	597906	195385	296084	187664	162505	52279	41461	35856	16037	47433	1819956
1981	59055	436474	378825	140966	253945	172223	171939	80389	96947	17899	19135	55948	1883746
1982	193896	260483	327926	350860	340876	186496	175978	47542	34275	24368	18775	13228	1974702
1983	221923	172821	297834	342333	385176	302744	90879	60533	58380	54064	55996	34615	2077297
1984	48371	474139	183710	370997	250350	197513	122714	159302	62760	28471	14467	24912	1937704
1985	162902	319933	195867	77998	92306	95280	150477	85851	34537	15847	10130	23233	1264361
1986	168831	168963	82983	347414	293583	187222	102670	158857	48040	34914	13934	12298	1619709
1987	47101	293593	190412	259474	183867	303555	115163	89989	65300	23827	11603	9127	1593009
1988	6369	67074	247457	159465	154983	208534	194619	142688	65597	30262	14445	25288	1316782
1989	97046	311572	197312	295853	128111	211615	174367	42077	24943	30177	16990	9838	1539901
1990	79502	337099	216120	288855	353975	176278	76398	65401	114813	27435	16719	12183	1764777
1991	153827	618285	324306	302701	417744	126234	166172	67140	34709	18542	107535	52500	2389694
1992	17638	228543	240134	432308	220986	60480	141892	68803	23518	14079	8734	29087	1486201
1993	66327	166861	158302	163119	53249	163906	196814	120990	81497	27691	16990	10354	1226099
1994	36843	61210	238132	214114	249053	253110	122105	44594	84006	32246	13584	20365	1369361
1995	53287	195301	481034	257610	305187	231055	117051	38609	17754	13929	33313	14509	1758639
1996	163203	506478	208246	151002	160117	79175	140668	110397	42771	22915	12691	18084	1615747
1997	149302	188612	331722	474198	190467	494028	197224	132734	110642	110529	29614	83929	2493000
1998	269565	207959	241413	354962	187962	154859	62879	41146	27398	33099	13418	7638	1602298
1999	42160	455840	523151	388766	472782	301259	124140	115439	53302	37123	19572	12240	2545774
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	130175.2	262970.8	310947.9	292691.5	240569.7	206561.2	132385.4	80788.7	47686.3	31326.7	21736.8	35457.1	%1793296.4
med =	118543.0	251337.0	302373.0	295853.0	226240.0	188377.0	122714.0	68803.0	42771.0	25171.0	14467.0	24050.0	%1672430.0

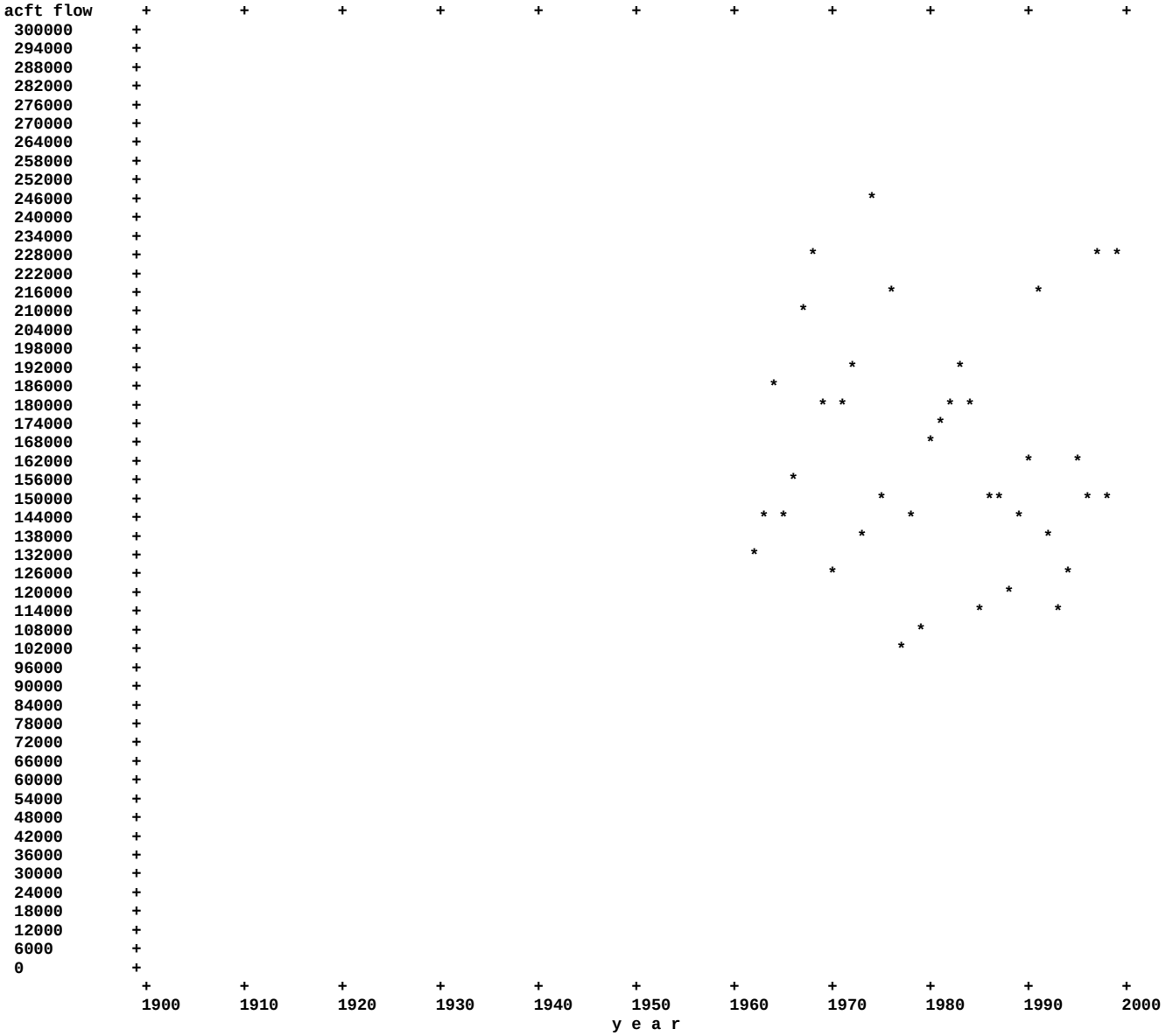
Calawah River watershed

South Fork Calawah River above Sitkum River - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
78565.16													1302.94
71998.84													1194.04
65981.32													1094.25
60466.67		X											1002.79
55412.99			X										918.98
50781.68													842.17
46537.45			9	X		X							771.79
42647.94		9		9	X								707.28
39083.47													648.17
35816.95	X				9								593.99
32823.44			7	7									544.35
30080.12		7				9							498.85
27566.06			5	5	7								457.16
25262.14	9												418.95
23150.78		5				7	X						383.94
21215.88			3	3	5								351.85
19442.7							9						322.44
17817.7		3				5							295.49
16328.53					3			X					270.80
14963.83	7		1			3	7						248.16
13713.18				1				9					227.42
12567.06													208.41
11516.72	5						5					X	191.00
10554.17					1				X	X			175.03
9672.075							3				X		160.40
8863.702						1							147.00
8122.891								7					134.71
7443.989		1	0						9			9	123.45
6821.834													113.13
6251.679				0				5					103.68
5729.176		0				0	1						95.01
5250.338	3								7	9			87.07
4811.525					0		0	3					79.80
4409.387													73.13
4040.859													67.01
3703.132								1	5			7	61.41
3393.628													56.28
3109.995								0					51.58
2850.068									3	7	9		47.27
2611.865													43.32
2393.569	1												39.70
2193.52										5		5	36.38
2010.188										3			33.34
1842.181											7		30.55
1688.214													28.00
1547.116													25.66
1417.812									1	1	5	3	23.51
1299.313													21.55
1190.719											3		19.75
1091.2													18.10
1000												1	16.58

South Fork Calawah River above Sitkum River - Total monthly flow in ac-ft
hydrograph of annual recorded flows



South Fork Calawah River above Sitkum River - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

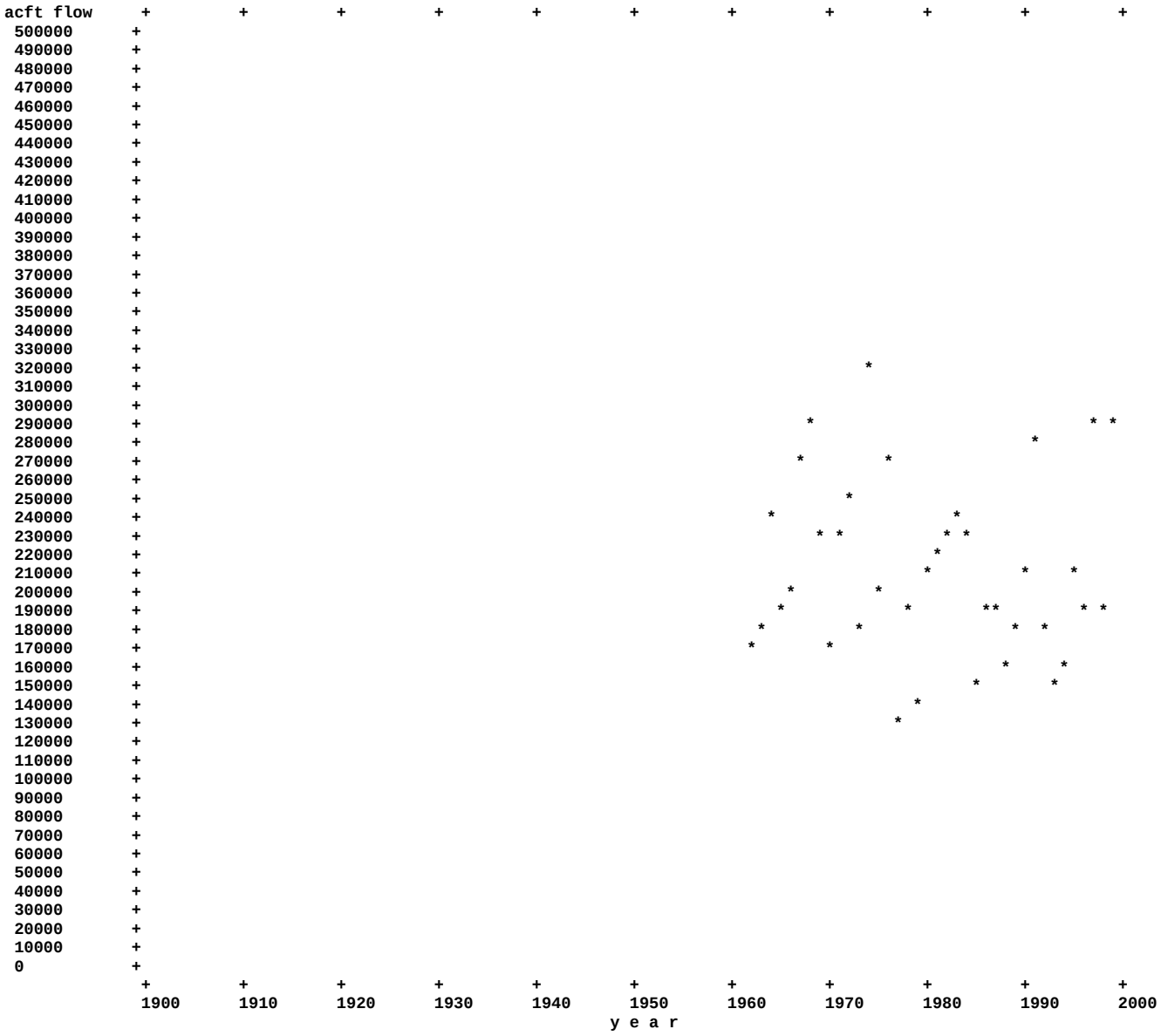
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	14156	17825	28271	16051	10300	12882	13215	7562	4535	2440	2674	2057	131967
1963	11961	29394	27814	15877	17276	11269	12143	6560	1184	3361	1179	767	138785
1964	19182	34925	26544	35371	14742	23055	9498	4226	3956	5587	2835	5947	185867
1965	10503	18020	18730	34186	33678	6703	7161	8741	1313	645	1107	942	141729
1966	11278	22598	29704	36058	13656	22883	5385	3274	2270	1906	1007	1940	151959
1967	15656	24083	51528	45545	30497	23682	9000	3999	1379	593	399	1346	207706
1968	34882	17386	37750	46038	27129	22654	12807	5401	4109	2122	2289	10932	223498
1969	24737	22740	34204	23649	20626	15085	16871	5112	2688	1349	910	9454	177425
1970	10597	12722	20849	22550	13736	11063	21899	4474	1135	798	562	5013	125396
1971	11630	17211	31178	42242	22609	27615	10607	4423	3605	2021	943	3494	177578
1972	15922	26378	27210	28717	28990	30043	17991	3063	884	8509	818	3421	191945
1973	1458	13459	45549	30828	9306	14236	4518	7187	6207	1604	674	1038	136063
1974	17862	33405	41340	38663	33160	34567	15829	15345	6365	4978	1674	1573	244761
1975	2230	24999	29940	25148	19779	18368	5087	9475	4069	2145	5586	3007	149832
1976	32518	35697	41969	27868	20829	19546	10785	8250	5290	3368	2330	2140	210589
1977	3407	7060	13639	10099	15350	19628	9456	7297	4703	2009	1767	3995	98410
1978	8697	32715	32596	14720	11614	9378	7524	7871	3563	1569	2347	9953	142546
1979	3857	8177	14460	5963	31035	16973	9957	5712	2121	2880	1267	5473	107873
1980	10019	6782	54147	18007	26096	17499	14780	4471	3594	3121	1501	3994	164010
1981	5195	39377	34149	12635	22888	15531	15443	7092	8611	1467	1590	4886	168864
1982	17406	23428	29534	31634	30800	16827	15807	4112	2938	2053	1557	1054	177150
1983	19944	15484	26805	30863	34832	27381	8137	5291	5120	4745	4908	2972	186481
1984	4228	42791	16457	33457	22560	18395	10933	14410	5497	2422	1359	2152	174660
1985	14786	28612	18223	6879	8176	8446	13490	7591	2938	1464	1030	2024	113656
1986	15404	15418	7331	30887	26430	17322	9116	14364	4162	2972	1318	1194	145916
1987	4077	26431	17654	23606	16972	27256	10249	7966	5727	2069	1142	954	144101
1988	744	5888	22611	14427	13960	19389	18093	12744	5754	2558	1357	2180	119706
1989	8606	27919	18374	26618	11423	19644	15981	3621	2154	2551	1550	1008	139448
1990	7015	30033	20017	26039	31430	16180	6734	5736	10217	2343	1530	1186	158458
1991	13839	56118	28974	27185	36709	11252	15126	5894	2953	1668	9557	4567	213842
1992	1600	21045	22005	38242	20420	5290	12672	6045	2046	1329	924	2468	134086
1993	5820	15198	14306	14808	4635	14890	18322	10777	7196	2362	1550	1047	110911
1994	3147	5356	21839	19851	22743	23079	10878	3850	7423	2730	1292	1806	123995
1995	4638	18164	42926	23452	27391	21253	10420	3307	1608	1318	2827	1362	158665
1996	14817	45371	19365	13545	14495	6985	12561	9816	3684	2000	1224	1633	145497
1997	13367	17467	29587	42269	17660	44175	18365	11842	9839	9828	2508	7416	224322
1998	24442	19341	22111	31511	17399	13947	5508	3537	2340	2807	1279	841	145063
1999	3629	40504	46974	34310	42133	27066	11063	10274	4639	3172	1746	1190	226699
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	11664.6	23671.6	28070.1	26310.5	21670.1	18722.0	11931.9	7124.0	4153.1	2706.9	1897.8	3116.5	161038.4
med =	10597.0	22598.0	27210.0	26618.0	20626.0	17499.0	10933.0	6045.0	3684.0	2145.0	1359.0	2057.0	149832.0

Sitkum River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
99433.57													1649.03
90694.82													1504.10
82724													1371.91
75453.78		X											1251.34
68822.5			X										1141.37
62774.02			9	X									1041.06
57257.05				9	X	X							949.56
52225		9											866.11
47635.19	X												789.99
43448.71				7	9								720.56
39630.21		7	7										657.23
36147.3			5	5	7	9							599.47
32970.48	9												546.79
30072.83		5				7	X						498.73
27429.88			3	3	5								454.90
25019.19							9						414.92
22820.35		3				5							378.46
20814.78					3			X					345.20
18985.46	7		1			3	7						314.86
17316.92				1				9					287.19
15795													261.95
14406.86	5				1		5					X	238.93
13140.71							3		X	X	X		217.93
11985.82													198.78
10932.44						1		7					181.31
9971.642		1	0						9			9	165.37
9095.271													150.84
8295.932				0				5					137.58
7566.841		0					1						125.49
6901.827	3					0			7	9			114.46
6295.252					0		0	3					104.40
5741.992													95.23
5237.355									5				86.86
4777.064								1				7	79.22
4357.23								0					72.26
3974.294										7	9		65.91
3625.012									3				60.12
3306.424													54.83
3015.838	1									5			50.02
2750.789										3		5	45.62
2509.035											7		41.61
2288.526													37.95
2087.399													34.62
1903.946									1	1	5	3	31.58
1736.617											3		28.80
1583.993													26.27
1444.783												1	23.96
1317.808									0				21.85
1201.991	0										1	0	19.93
1096.354													18.18
1000													16.58

Sitkum River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Sitkum River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
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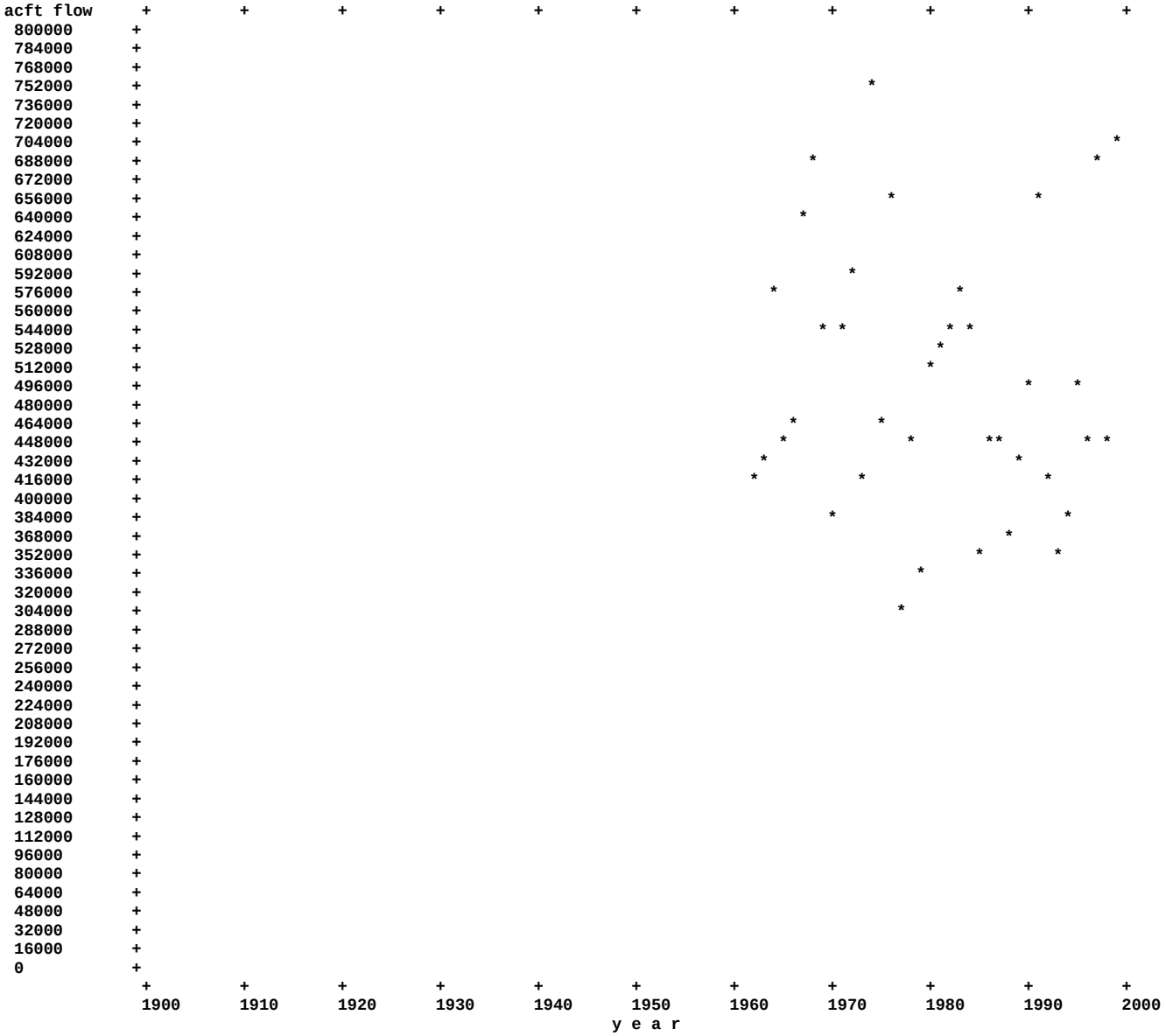
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	18053	22701	35912	20435	13191	16386	16838	9737	5895	3236	3528	2730	168643
1963	15269	37340	35340	20226	21999	14392	15500	8431	1625	4381	1619	1097	177219
1964	24412	44343	33732	44908	18790	29315	12151	5476	5134	7199	3715	7655	236828
1965	13423	22940	23840	43407	42765	8612	9192	11193	1787	943	1527	1318	180947
1966	14405	28736	37733	45777	17415	29098	6943	4271	3000	2539	1401	2582	193898
1967	19948	30616	65364	57788	38737	30109	11520	5189	1871	876	631	1830	264479
1968	44289	22137	47920	58413	34472	28807	16341	6964	5328	2812	3023	13966	284472
1969	31444	28916	43431	30067	26240	19225	21485	6598	3529	1834	1278	12095	226140
1970	13542	16233	26521	28675	17517	14132	27851	5790	1562	1135	837	6472	160268
1971	14850	21916	39599	53607	28750	35089	13554	5726	4690	2684	1320	4550	226335
1972	20284	33523	34575	36483	36829	38163	22903	4004	1244	10899	1162	4457	244524
1973	1972	17166	57793	39156	11908	18149	5846	9225	7984	2157	979	1440	173774
1974	22741	42397	52427	49038	42020	43771	20152	19570	8211	6444	2261	2138	311171
1975	2971	31770	38021	31942	25145	23314	6574	12127	5286	2851	7205	3941	191146
1976	41290	45314	53251	35474	26149	24238	13590	11131	7189	4699	3206	2869	268401
1977	4470	9173	17628	13205	19769	24523	12151	9604	6187	2594	2323	5261	126889
1978	11191	42095	41736	18668	14627	11782	9542	10111	4624	2029	3141	12927	182472
1979	4994	10540	18421	7660	38954	21569	12421	7524	2871	3796	1668	7035	137454
1980	12843	8608	68520	22599	33545	21824	18692	5882	4701	4079	1909	5305	208508
1981	6721	49946	43340	16114	29065	19732	19663	9144	11052	2007	2155	6349	215288
1982	22163	29785	37507	40147	39044	21368	20125	5379	3875	2748	2113	1477	225732
1983	25373	19742	34059	39171	44129	34696	10399	6868	6636	6150	6365	3916	237504
1984	5498	54261	20982	42453	28652	23394	13972	18362	7108	3225	1884	2884	222675
1985	18836	36293	23177	8853	10491	10831	17200	9752	3877	2016	1468	2724	145519
1986	19617	19635	9424	39166	33539	22039	11678	18304	5423	3920	1833	1676	186252
1987	5316	33540	22459	29974	21597	34581	13108	10226	7399	2780	1609	1372	183960
1988	1108	7602	28717	18384	17794	24649	23013	16259	7433	3397	1882	2920	153157
1989	11034	35419	23367	33776	14590	24971	20346	4740	2888	3389	2125	1440	178086
1990	9025	38088	25442	33045	39852	20598	8670	7411	13068	3126	2099	1665	202087
1991	17642	71024	36751	34492	46518	14375	19267	7610	3897	2274	12235	5934	272017
1992	2187	26740	27952	48454	25950	6847	16168	7800	2751	1846	1334	3284	171315
1993	7517	19358	18231	18865	6019	18969	23302	13775	9254	3151	2125	1490	142054
1994	4141	6931	27743	25232	28884	29308	13903	5028	9541	3615	1799	2449	158573
1995	6024	23103	54367	29779	34752	27003	13324	4343	2199	1832	3737	1888	202350
1996	18876	57455	24619	17269	18470	8988	16028	12562	4820	2693	1713	2230	185723
1997	17046	22222	37526	53538	22466	55944	23356	15120	12590	12577	3335	9532	285250
1998	31029	24589	28086	39955	22136	17777	7122	4634	3122	3712	1783	1229	185174
1999	4750	51310	59479	43489	53366	34342	14136	13140	6025	4173	2373	1670	288251
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	14902.5	30092.3	35657.7	33412.7	27529.9	23760.8	15211.2	9184.5	5412.5	3574.2	2544.7	4099.9	205382.5
med =	13542.0	28736.0	34575.0	33776.0	26149.0	22039.0	13972.0	7800.0	4820.0	2851.0	1884.0	2730.0	191146.0

South Fork Calawah River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
239909.6													3978.71
215004.2													3565.67
192684													3195.51
172681.2		X	X										2863.78
154754.7			9	X									2566.48
138689.3				9	X	X							2300.05
124291.6		9											2061.28
111388.7	X				9								1847.29
99825.22			7	7									1655.52
89462.09		7	5	5	7	9							1483.66
80174.88	9												1329.64
71851.71		5				7	X						1191.60
64392.66			3	3	5								1067.90
57707.88		3				5	9						957.04
51717.13					3			X					857.69
46348.28	7		1			3	7						768.65
41536.74				1				9					688.85
37224.74													617.34
33360.34	5				1		5		X	X		X	553.25
29897.14							3				X		495.82
26793.44						1		7					444.35
24011.96			0						9			9	398.22
21519.24		1											356.88
19285.27				0				5					319.83
17283.23	3	0				0	1		7				286.63
15489.01					0					9			256.87
13881.07							0	3					230.21
12440.04									5				206.31
11148.62								1				7	184.89
9991.26								0					165.70
8954.041									3	7	9		148.50
8024.506													133.08
7191.46	1									5			119.26
6444.902												5	106.88
5775.84										3	7		95.79
5176.239													85.84
4638.885													76.93
4157.31									1	1	5	3	68.95
3725.732											3		61.79
3338.954													55.37
2992.331												1	49.63
2681.691									0		1		44.47
2403.298	0											0	39.86
2153.807													35.72
1930.215										0			32.01
1729.835													28.69
1550.257													25.71
1389.322													23.04
1245.094											0		20.65
1115.838													18.51
1000													16.58

South Fork Calawah River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



South Fork Calawah River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

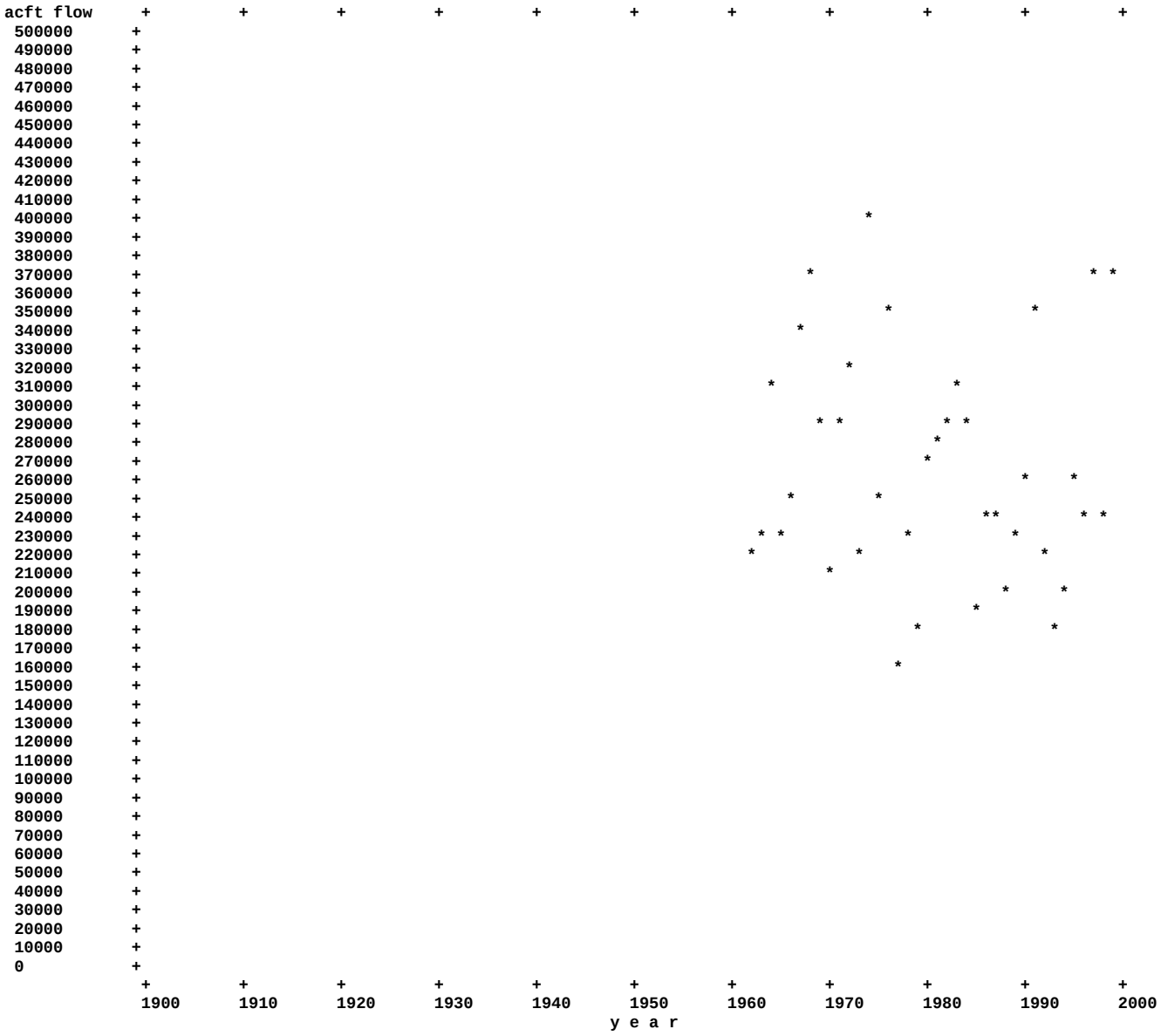
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	43160	54362	86265	48954	31377	39298	40299	23009	13771	7378	8096	6221	402188
1963	36461	89690	84865	48416	52690	34346	37016	19969	3555	10202	3540	2282	423033
1964	58510	106578	80989	107941	44951	70336	28941	12842	12017	16997	8595	18096	566793
1965	32007	54961	57130	104322	102773	20405	21804	26630	3946	1909	3319	2815	432021
1966	34376	68939	90636	110038	41635	69811	16380	9936	6871	5758	3014	5864	463258
1967	47744	73473	157276	139004	93059	72250	27419	12150	4148	1749	1158	4049	633478
1968	106449	53025	115205	140511	82773	69110	39045	16431	12485	6417	6927	33319	681697
1969	75469	69374	104378	72148	62918	46001	51452	15547	8146	4059	2718	28804	541015
1970	32295	38786	63598	68792	41882	33718	66805	13599	3404	2374	1654	15245	382150
1971	35450	52492	95136	128920	68973	84260	32325	13445	10947	6109	2818	10609	541485
1972	48555	80483	83022	87623	88456	91674	54871	9291	2637	25920	2438	10385	585354
1973	4391	41035	139017	94069	28355	43407	13733	21884	18891	4838	1996	3109	414723
1974	54480	101950	126184	118011	101233	105542	48278	46784	19362	15130	5042	4732	746727
1975	6738	76274	91363	76736	60342	56056	15467	28866	12360	6485	16990	9115	456792
1976	99230	108940	128090	84999	63706	59927	32964	24858	15915	10071	6989	6458	642147
1977	10327	21444	41471	30634	46709	60089	28785	22101	14245	6111	5354	12100	299369
1978	26467	99564	99302	44929	35501	28678	22966	23963	10825	4771	7082	30231	434279
1979	11723	24875	44096	18154	94926	51786	30494	17298	6385	8720	3836	16661	328954
1980	30516	20697	165347	55078	79436	53592	45139	13544	10900	9469	4578	12075	500370
1981	15794	120190	104219	38523	69842	47391	47100	21575	26221	4406	4785	14838	514883
1982	53086	71476	90122	96545	94020	51350	48212	12472	8894	6197	4686	3147	540207
1983	60837	47212	81788	94188	106342	83591	24797	16072	15558	14419	14912	9000	568716
1984	12839	130615	50179	102112	68842	56116	33320	43942	16711	7317	4070	6491	532555
1985	45089	87329	55592	20933	24896	25720	41130	23108	8893	4390	3065	6102	346247
1986	46978	47020	22314	94279	80664	52837	27767	43800	12634	8998	3946	3567	444805
1987	12374	80666	53853	72037	51768	83186	31228	24255	17415	6240	3406	2832	439260
1988	2193	17907	68997	43994	42566	59153	55194	38853	17498	7732	4065	6579	364730
1989	26210	85214	56052	81238	34815	59932	48742	10982	6499	7712	4655	2997	425046
1990	21349	91670	61071	79468	95939	49351	20490	17443	31131	7076	4592	3540	483121
1991	42198	171364	88435	82970	112067	34295	46131	17925	8941	5014	29115	13869	652324
1992	4805	64214	67145	116752	62302	16080	38633	18386	6168	3980	2741	7459	408664
1993	17700	46350	43623	45158	14077	45409	55893	32842	21902	7136	4655	3117	337862
1994	9532	16282	66639	60564	69401	70427	33152	11679	22597	8259	3865	5437	377834
1995	14087	55411	131060	71565	83599	64849	31751	10021	4832	3945	8554	4080	483755
1996	45185	138531	59080	41298	44202	21259	38294	29908	11174	6028	3658	4908	443526
1997	40756	53280	90310	129053	53871	134876	56024	36096	29976	29945	7582	22576	684343
1998	74589	59007	67469	96188	53073	42527	16745	10724	7068	8495	3827	2487	442197
1999	11005	123662	143428	104738	128637	82606	33715	31305	14091	9610	5253	3554	691603
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	35551.4	72219.5	85651.2	80286.4	66121.5	57137.9	36381.6	21672.0	12605.6	8193.8	5725.7	9440.8	490987.2
med =	32295.0	68939.0	83022.0	81238.0	62918.0	53592.0	33320.0	18386.0	11174.0	6485.0	4070.0	6221.0	456792.0

North Fork Calawah at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
129038													2139.99
117085.5													1941.77
106240.2													1761.91
96399.51		X	X										1598.71
87470.26													1450.62
79368.09			9	X		X							1316.26
72016.42		9		9	X								1194.33
65345.71													1083.71
59292.9	X				9								983.32
53800.79			7	7									892.24
48817.36		7				9							809.60
44295.52			5	5	7								734.61
40192.54	9	5				7							666.56
36469.6			3		5		X						604.82
33091.51				3									548.80
30026.35		3				5	9						497.96
27245.08								X					451.84
24721.44	7		1		3	3	7						409.98
22431.55				1				9					372.01
20353.77													337.55
18468.45	5						5					X	306.28
16757.78					1				X	X	X		277.91
15205.55							3						252.17
13797.09						1							228.81
12519.1			0					7	9			9	207.62
11359.49		1											188.39
10307.29				0				5					170.94
9352.556							1						155.10
8486.252	3	0				0				9			140.74
7700.19					0		0		7				127.70
6986.94								3					115.87
6339.757													105.14
5752.526								1	5			7	95.40
5219.684													86.56
4736.197								0					78.55
4297.495									3	7	9		71.27
3899.428													64.67
3538.234													58.68
3210.499	1									5		5	53.24
2913.117										3			48.31
2643.283											7		43.84
2398.442													39.78
2176.28													36.09
1974.698											5		32.75
1791.786									1	1		3	29.72
1625.817											3		26.96
1475.223													24.47
1338.576													22.20
1214.587												1	20.14
1102.083									0				18.28
1000											1		16.58

North Fork Calawah at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



North Fork Calawah at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

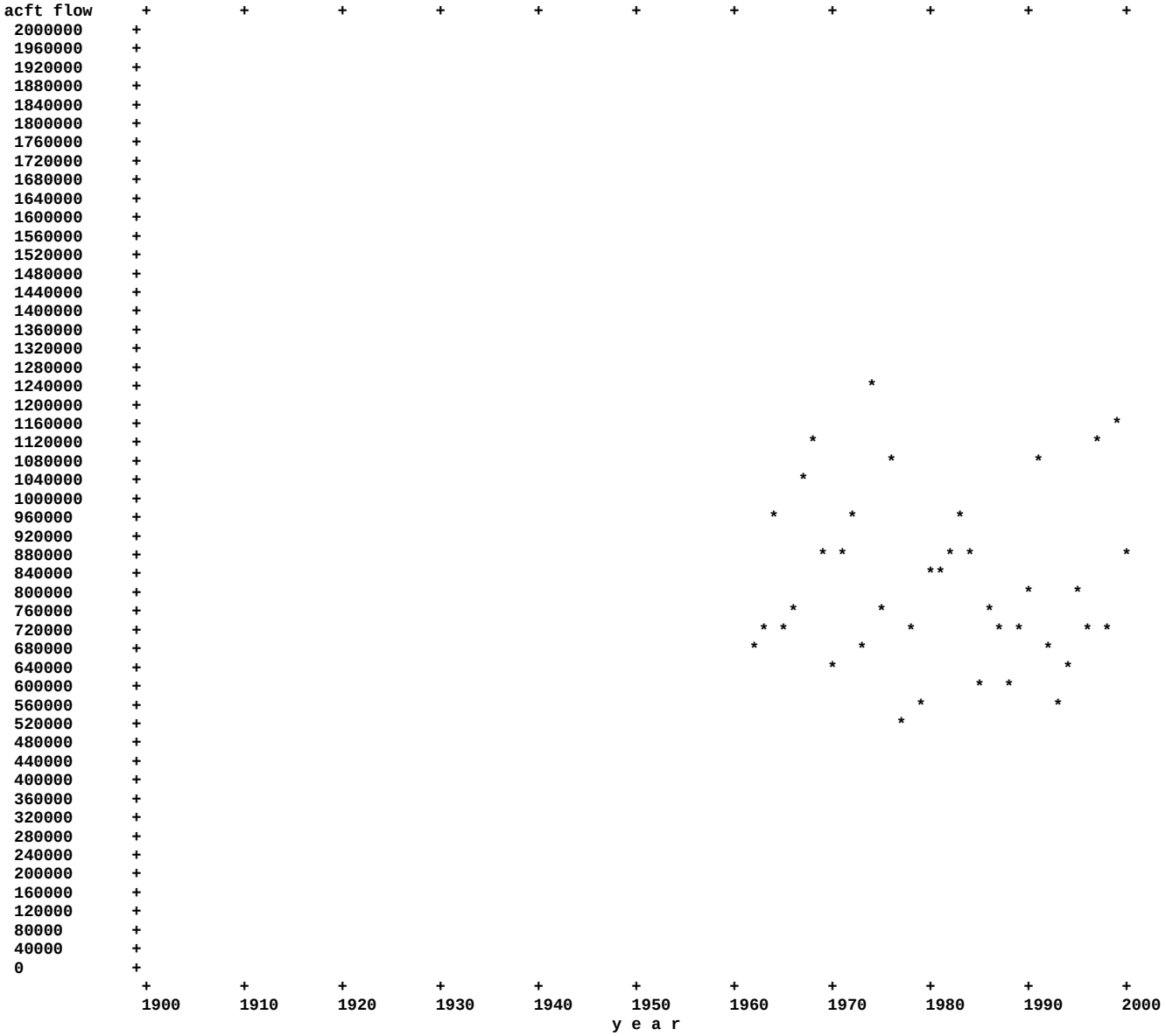
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	22826	28837	46027	25988	16438	20905	21354	11901	6964	3546	3948	2987	211722
1963	19239	47847	45254	25665	27962	18103	19538	10376	1555	5126	1546	870	223081
1964	31089	56924	43171	57656	23802	37446	15198	6546	6102	8779	4263	9369	300344
1965	16846	29182	30348	55711	54878	10610	11362	13955	1765	670	1427	1157	227912
1966	18119	36695	48356	58783	22020	37163	8447	4983	3337	2738	1263	2795	244700
1967	25304	39132	84171	74351	49658	38474	14380	6174	1873	583	266	1820	336185
1968	56854	28142	61560	75161	44130	36787	20628	8475	6353	3092	3367	17551	362099
1969	40205	36929	55741	38419	33459	24366	27296	8000	4022	1825	1104	15124	286490
1970	17001	20489	33824	36616	22153	17765	35548	6952	1473	920	533	7837	201109
1971	18696	27855	50775	68932	36713	44929	17016	6870	5527	2927	1158	5345	286742
1972	25739	42899	44263	46737	47184	48913	29134	4637	1061	13574	954	5225	310320
1973	2004	21698	74358	50201	14883	22973	7025	11405	9797	2243	716	1314	218615
1974	28924	54499	67567	63175	54302	56703	25630	24739	9975	7728	2308	2129	397676
1975	3204	40653	48778	40949	32137	29961	7934	15141	6263	3103	8753	4518	241393
1976	52989	58212	68513	45140	34868	33648	17901	11416	7160	4177	3028	3021	340071
1977	5107	10860	21267	15276	24155	33219	14962	10841	6994	3144	2634	5928	154387
1978	13714	51596	52044	24055	19301	15670	12297	12467	5497	2445	3323	15322	227733
1979	5986	12836	23377	9442	51978	27604	16916	8466	2905	4262	1879	8655	174305
1980	15952	11062	88960	30164	41259	29741	24319	6651	5429	4728	2435	5785	266483
1981	8082	64335	55715	20371	37286	25279	24999	11127	13669	1944	2169	7511	272485
1982	28173	38066	48108	51616	50392	27418	25594	6212	4338	2910	2116	1285	286226
1983	32349	24982	43611	50346	57071	44841	13050	8156	7927	7344	7587	4402	301665
1984	6491	69956	26555	54613	36744	29863	17538	23281	8559	3480	1725	3034	281839
1985	23901	46738	29580	10842	12985	13430	21761	12017	4332	1897	1181	2823	181486
1986	24923	24945	11588	50496	43134	28090	14536	23205	6355	4389	1658	1453	234771
1987	6214	43136	28640	38470	27512	44498	16407	12637	8940	2898	1366	1055	231773
1988	710	9205	36827	23309	22537	31505	29364	20530	8984	3704	1722	3081	191478
1989	13694	45594	29828	43445	18347	31926	25876	5462	3038	3694	2041	1144	224089
1990	11067	49085	32542	42488	51393	26205	10602	8955	16355	3350	2007	1438	255486
1991	22338	92170	47336	44381	60112	18066	24465	9215	4358	2235	15265	7022	346964
1992	2122	34241	35826	62645	33207	8218	20411	9464	2859	1676	1006	3557	215231
1993	9093	24583	23109	23939	7135	24074	29743	17280	11365	3382	2041	1209	176953
1994	4678	8327	35552	32268	37045	37600	17447	5838	11741	3989	1614	2464	198564
1995	7141	29482	70381	38215	44721	34584	16690	4942	2136	1657	4149	1730	255828
1996	23953	74420	31465	21852	23422	11018	20227	15694	5565	2783	1502	2178	234079
1997	21559	28330	48350	69296	28649	72444	29813	19039	15730	15713	3623	11730	364275
1998	39850	31426	36001	51528	28218	22516	8577	5322	3345	4117	1593	869	233361
1999	5474	66381	77067	56150	69071	44184	17752	16449	7143	4720	2364	1446	368199
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	18726.6	38467.1	45695.7	42860.3	35270.0	30545.8	19256.2	11179.5	6336.6	3986.6	2674.6	4636.4	259634.7
med =	17001.0	36695.0	44263.0	43445.0	33459.0	29741.0	17752.0	9464.0	5565.0	3144.0	1879.0	2987.0	241393.0

STATION NUMBER 12043000 CALAWAH R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
392047.8													6501.79
347914.2													5769.88
308748.9		X											5120.35
273992.5			X										4543.94
243148.6			9	X		X							4032.42
215777		9		9	X								3578.49
191486.5	X												3175.65
169930.6			7	7	9								2818.16
150801.2		7	5		7	9							2500.92
133825.2	9			5									2219.38
118760.3		5				7	X						1969.54
105391.2			3	3	5								1747.83
93527.13		3				5	9						1551.07
82998.61						3	7	X					1376.46
73655.3	7		1		3								1221.51
65363.79				1				9					1084.01
58005.67	5						5					X	961.98
51475.87					1		3		X	X	X		853.69
45681.14						1			9				757.58
40538.73			0					7				9	672.30
35975.21		1						5					596.62
31925.41				0									529.46
28331.51	3	0				0	1						469.86
25142.18					0				7	9			416.96
22311.88							0	3					370.02
19800.19									5				328.37
17571.25								1				7	291.40
15593.22								0					258.60
13837.86									3	7	9		229.49
12280.11										5			203.66
10897.72	1											5	180.73
9670.94										3			160.38
8582.265											7		142.33
7616.144											5		126.31
6758.781									1			3	112.09
5997.933										1	3		99.47
5322.734													88.27
4723.544													78.34
4191.807									0			1	69.52
3719.927											1	0	61.69
3301.168	0												54.75
2929.551													48.58
2599.766										0			43.12
2307.106													38.26
2047.391													33.95
1816.912													30.13
1612.379											0		26.74
1430.871													23.73
1269.795													21.06
1126.852													18.69
1000													16.58

STATION NUMBER 12043000 CALAWAH R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12043000 CALAWAH R NR FORKS (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

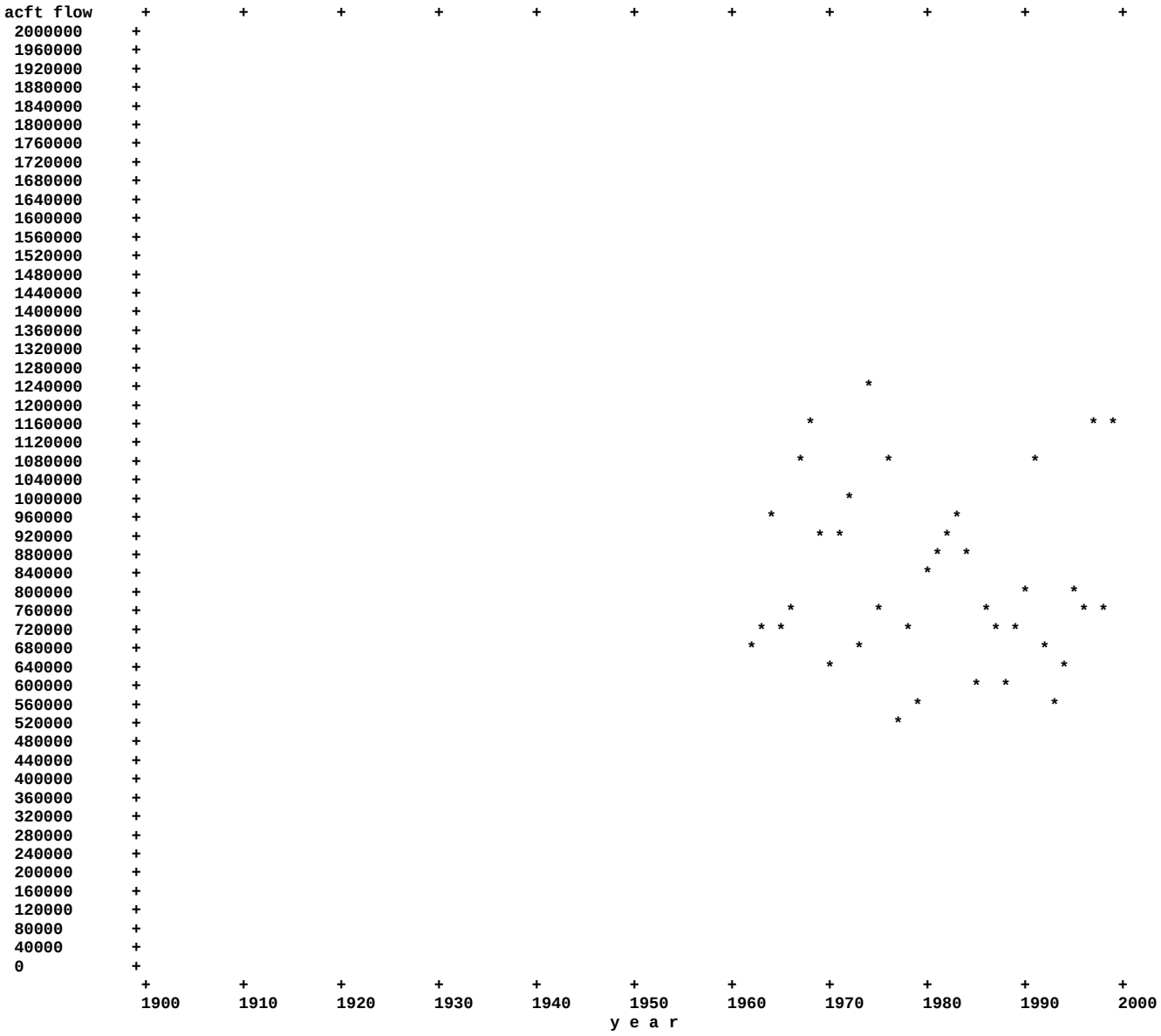
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	70072	88362	140531	79594	50758	63945	65476	37041	21982	11559	12750	9742	651811
1963	59144	146103	138221	78675	85658	55690	60052	32202	5388	16246	5363	3307	686049
1964	95165	173692	131888	175918	73014	114485	46859	20560	19211	27347	13622	29143	920904
1965	51869	89368	92911	170006	167475	32915	35200	43083	6027	2699	5001	4179	700733
1966	55739	112202	147649	179344	67597	113627	26339	15811	10805	8987	4504	9159	751763
1967	77577	119610	256515	226666	151606	117611	44373	19429	6357	2436	1471	6195	1029846
1968	173481	86204	187785	229127	134803	112482	63366	26423	19975	10063	10897	54011	1108617
1969	122871	112913	170098	117445	102367	74729	83634	24979	12888	6211	4020	46636	878791
1970	52339	62942	103477	111963	68000	54663	108716	21796	5140	3458	2282	24485	619261
1971	57493	85333	155000	210191	112259	137231	52388	21545	17463	9560	4184	16911	879558
1972	78902	131062	135209	142726	144087	149343	89221	14758	3887	41924	3562	16545	951226
1973	6753	66616	226686	153256	45902	70492	22015	35331	30441	7483	2840	4658	672473
1974	88583	166204	205846	192495	165255	172396	78496	75951	31122	24241	7763	7242	1215594
1975	10515	124205	148873	125016	98232	91380	24822	46717	19743	10143	27310	14442	741397
1976	161706	177572	208868	138220	104816	99598	54069	38317	24357	14995	10558	10020	1043096
1977	16348	34249	66545	48645	75187	99255	46425	34883	22491	9818	8460	19089	481395
1978	42635	160397	160663	73291	58258	47153	37464	38662	17306	7654	11000	48296	702779
1979	18781	40009	71657	29286	156208	84331	50438	27279	9810	13745	6052	26866	534462
1980	49323	33739	270232	90641	128081	88657	73811	21386	17300	15043	7448	18895	814556
1981	25323	196041	169908	62540	113803	77195	76574	34693	42337	6698	7342	23693	836148
1982	86303	116357	146842	157401	153433	83675	78387	19795	14009	9628	7180	4662	877671
1983	98977	76665	133206	153548	173629	136459	40184	25687	24904	23078	23857	14190	924382
1984	20492	213095	81488	166502	112164	91325	53998	71391	26803	11419	6103	10068	864848
1985	73269	142433	90466	33715	40205	41554	66787	37277	14001	6627	4457	9431	560222
1986	76362	76431	35976	153814	131520	85956	44906	71159	20126	14172	5901	5280	721603
1987	19700	131524	87620	117394	84206	135650	50573	39154	27955	9656	5016	4076	712524
1988	3029	28760	112417	71476	69138	96297	89815	63058	28090	12099	6095	10211	590485
1989	42355	138970	91220	132460	56446	97573	79250	17421	10080	12067	7061	4346	689249
1990	34397	149542	99439	129562	156531	80247	32989	28001	50414	11026	6958	5236	784342
1991	68535	280034	144244	135296	182941	55595	74975	28790	14079	7650	47113	22149	1061401
1992	7307	104584	109384	190611	101454	25769	62697	29544	9539	5956	3927	11653	662425
1993	28421	75334	70869	73382	22489	73793	90960	53216	35302	11123	7061	4542	546492
1994	15047	26100	108555	98608	113078	114758	53722	18563	36440	12962	5768	8342	611943
1995	22506	90171	214040	116622	136326	105624	51429	15848	7351	5899	13446	6119	785381
1996	73426	226274	96178	67061	71816	34249	62142	48411	17736	9310	5429	7476	719508
1997	66174	86681	147315	210753	87649	220288	91174	58543	48522	48471	11853	36405	1113828
1998	121573	96059	109914	156940	86342	69073	26857	16999	11012	13349	5705	3511	717334
1999	17459	201926	234291	170940	210072	134699	54645	50698	22513	15174	8041	5258	1125716
2000	46071	164242	214644	105532	70541	82783	48423	57904	46344	14232	8154	9364	868235
n =	39	39	39	39	39	39	39	39	39	39	39	39	39
avg =	57333.9	118769.4	141453.1	130170.8	106752.5	92885.8	58811.6	35443.7	20750.0	12928.4	8860.4	14764.9	798924.2
med =	52339.0	112913.0	138221.0	132460.0	102367.0	88657.0	54069.0	32202.0	19211.0	11026.0	6958.0	9742.0	751763.0

Calawah River at the Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
396142.5													6569.70
351474.9													5828.93
311843.9		X											5171.68
276681.6			X										4588.54
245484			9	X		X							4071.15
217804.3		9		9	X								3612.11
193245.5	X												3204.82
171455.9			7	7	9								2843.46
152123.1		7	5		7	9							2522.84
134970.3	9			5									2238.37
119751.5		5				7	X						1985.98
106248.8			3	3	5								1762.05
94268.58		3				5	9						1563.37
83639.2					3	3	7	X					1387.09
74208.43	7		1										1230.69
65840.96				1				9					1091.92
58416.98	5						5					X	968.80
51830.09					1		3		X	X	X		859.56
45985.93						1							762.64
40800.72			0					7	9			9	676.65
36200.18		1											600.35
32118.39				0				5					532.66
28496.84	3	0				0	1						472.60
25283.66					0				7	9			419.31
22432.77							0	3					372.03
19903.33									5				330.08
17659.11								1				7	292.86
15667.93								0					259.84
13901.27									3	7	9		230.54
12333.82													204.55
10943.1	1									5		5	181.48
9709.199										3			161.02
8614.426											7		142.86
7643.102													126.75
6781.294									1		5	3	112.46
6016.661										1	3		99.78
5338.244													88.53
4736.324												1	78.55
4202.273									0				69.69
3728.441											1	0	61.83
3308.035	0												54.86
2935.035													48.68
2604.091										0			43.19
2310.464													38.32
2049.945													34.00
1818.801													30.16
1613.72											0		26.76
1431.763													23.74
1270.323													21.07
1127.086													18.69
1000													16.58

Calawah River at the Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Calawah River at the Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	70796	89277	141992	80419	51279	64609	66153	37419	22203	11672	12876	9837	658530
1963	59755	147621	139657	79489	86545	56265	60672	32531	5437	16409	5412	3335	693128
1964	96152	175499	133258	177748	73769	115673	47341	20768	19405	27626	13757	29440	930435
1965	52404	90294	93874	171774	169217	33252	35560	43526	6083	2720	5046	4216	707965
1966	56314	113367	149184	181209	68296	114806	26607	15969	10911	9074	4544	9248	759528
1967	78380	120852	259186	229025	153182	118832	44829	19625	6417	2455	1480	6253	1040514
1968	175285	87097	189738	231512	136203	113649	64021	26692	20177	10161	11004	54568	1120107
1969	124147	114085	171867	118664	103429	75502	84500	25233	13016	6269	4055	47116	887882
1970	52879	63592	104550	113125	68703	55227	109844	22017	5187	3487	2299	24733	625642
1971	58086	86217	156612	212379	113424	138657	52928	21763	17639	9653	4221	17081	888657
1972	79719	132423	136614	144209	145584	150895	90145	14905	3921	42355	3592	16711	961074
1973	6817	67305	229045	154849	46374	71221	22238	35693	30752	7554	2863	4700	679411
1974	89501	167934	207990	194500	166978	174195	79309	76736	31439	24486	7836	7309	1228213
1975	10617	125494	150421	126315	99252	92331	25074	47198	19942	10242	27588	14585	749058
1976	163387	179419	211042	139653	105923	100666	54637	38679	24584	15128	10654	10116	1053887
1977	16510	34594	67220	49130	75954	100309	46900	35227	22713	9918	8543	19277	486293
1978	43070	162034	162314	74054	58870	47650	37854	39058	17481	7732	11106	48782	710006
1979	18971	40416	72399	29586	157857	85207	50975	27548	9902	13881	6111	27140	539993
1980	49829	34090	273055	91599	129390	89601	74583	21597	17473	15193	7525	19079	823014
1981	25580	198083	171676	63187	114986	77997	77367	35046	42770	6760	7411	23932	844795
1982	87197	117565	148369	159039	155032	84545	79199	19992	14146	9720	7247	4702	886754
1983	100004	77458	134589	155145	175440	137882	40598	25946	25156	23311	24098	14329	933956
1984	20698	215315	82331	168235	113330	92272	54555	72130	27074	11530	6158	10165	873791
1985	74028	143916	91405	34059	40617	41980	67478	37658	14139	6687	4494	9520	565981
1986	77153	77223	36344	155417	132889	86847	45367	71895	20328	14312	5954	5326	729053
1987	19897	132893	88529	118615	85079	137062	51094	39555	28239	9748	5059	4110	719879
1988	3052	29052	113586	72216	69853	97297	90747	63710	28375	12217	6150	10309	596562
1989	42790	140417	92166	133839	57028	98586	80071	17595	10177	12184	7126	4382	696361
1990	34748	151100	100472	130910	158162	81078	33326	28285	50933	11132	7022	5282	792450
1991	69244	282959	145746	136704	184848	56168	75751	29082	14217	7721	47597	22372	1072410
1992	7374	105670	110521	192599	102508	26030	63345	29845	9630	6009	3959	11766	669255
1993	28709	76114	71602	74142	22715	74557	91904	53764	35663	11230	7126	4580	552107
1994	15196	26364	109683	99632	114254	115951	54276	18748	36813	13089	5819	8420	618244
1995	22733	91107	216273	117835	137745	106721	51959	16005	7419	5952	13578	6174	793499
1996	74186	228635	97177	67755	72559	34599	62784	48909	17913	9398	5477	7546	726937
1997	66858	87580	148849	212952	88558	222587	92120	59147	49021	48970	11968	36777	1125388
1998	122838	97056	111056	158575	87238	69788	27129	17168	11118	13479	5756	3539	724739
1999	17633	204033	236736	172722	212264	136101	55208	51220	22740	15324	8116	5304	1137400
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	58224.7	118793.4	140977.0	132179.4	108824.6	94120.9	59696.0	35207.5	20277.7	13020.7	8963.9	15054.2	805339.5
med =	52879.0	113367.0	136614.0	133839.0	103429.0	89601.0	54637.0	29845.0	17913.0	10242.0	6158.0	9837.0	749058.0

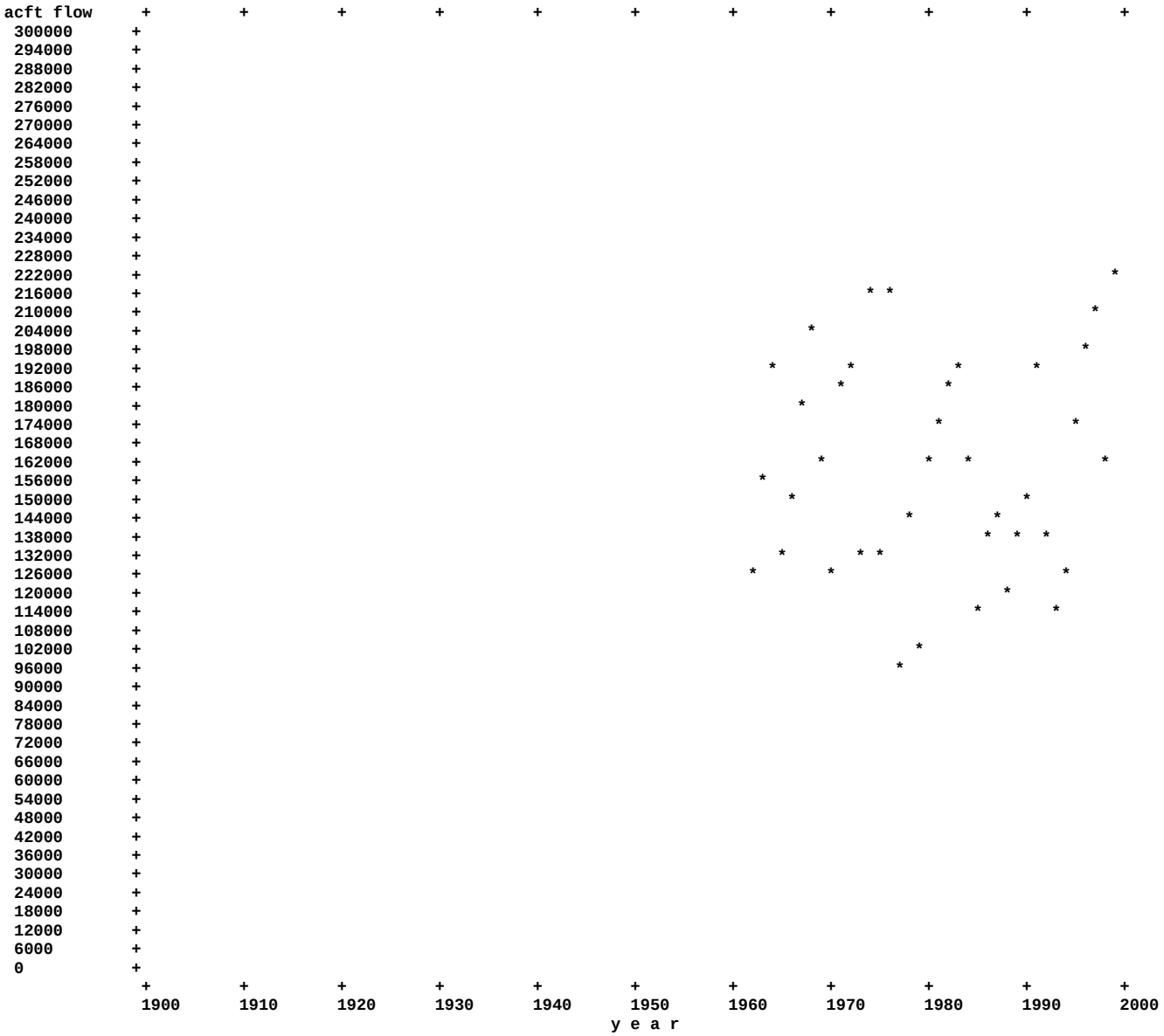
Soleduck River watershed

North Fork Soleduck River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
70660.82													1171.85
64892.62													1076.19
59595.23													988.34
54730.34		X											907.66
50262.53			X										833.56
46159.48													765.52
42391.34		9	9	X									703.03
38930.84													645.64
35752.79						X							592.93
32834.21			7	9	X								544.53
30153.85	X				9								500.08
27692.32													459.25
25431.73				7									421.76
23355.66		7	5		7	9		X	X				387.33
21449.09				5				9					355.72
19698.13			3				X						326.68
18090.13		5		3			9		9				300.01
16613.37	9				5	7				X			275.52
15257.19							7	7	7	9			253.03
14011.69		3											232.37
12867.89						5	5	5					213.40
11817.44						3		3					195.98
10852.76	7		1		3		3		5				179.98
9966.821				1				1	3		X		165.29
9153.198								0				X	151.80
8406.002						1				7			139.41
7719.793					1		1						128.03
7089.609	5		0						1		9		117.58
6510.862							0					9	107.98
5979.365		1											99.16
5491.251				0		0				5			91.07
5042.988	3				0								83.63
4631.313										3			76.81
4253.248													70.54
3906.046										1	7	7	64.78
3587.183									0				59.49
3294.353		0											54.63
3025.425												5	50.17
2778.452											5		46.08
2551.64											3		42.32
2343.343												3	38.86
2152.049	1												35.69
1976.371										0	1		32.78
1815.035													30.10
1666.869												1	27.64
1530.798											0		25.39
1405.835												0	23.31
1291.073													21.41
1185.679													19.66
1088.889													18.06
1000													16.58

North Fork Soleduck River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



North Fork Soleduck River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

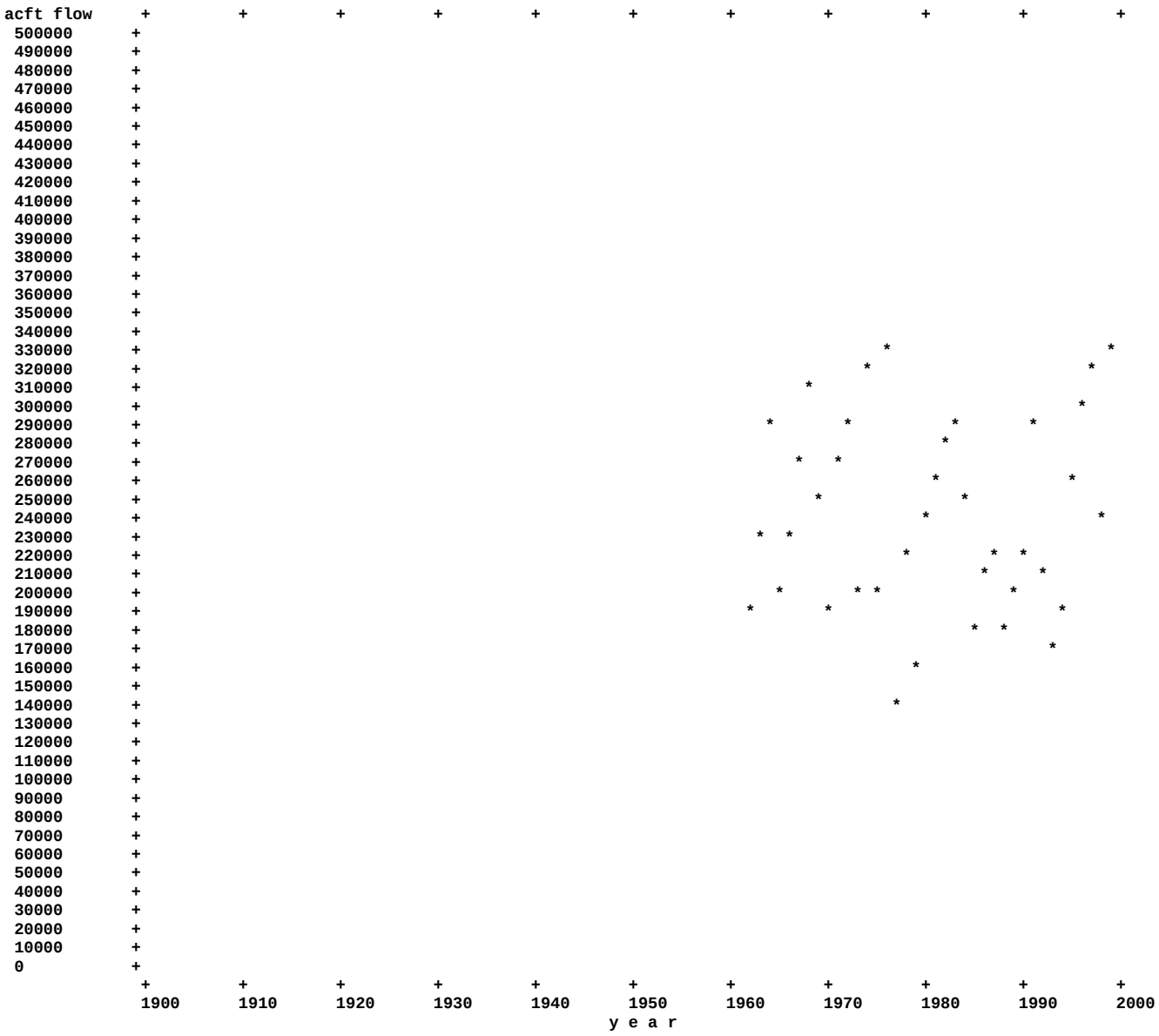
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	7755	13807	22967	18976	7570	5480	12152	10821	10025	6009	3146	2635	121341
1963	10304	26413	29386	14517	24559	9181	9696	10927	6256	5007	2829	2105	151178
1964	15495	27654	21948	25502	12206	11346	11547	13382	21564	14094	7097	5272	187107
1965	7531	14220	14449	16842	21422	9974	11651	12594	9035	4921	2761	1665	127065
1966	6961	17021	20385	23803	9022	12298	16161	15281	12908	9218	4237	2387	149681
1967	7965	15338	45382	30044	14922	14555	6114	14639	16403	7580	3143	2260	178343
1968	29544	14691	28173	38353	27939	15899	8161	11201	10731	6441	3323	6414	200871
1969	14024	18195	24739	14657	6270	13729	15664	22018	16957	6084	2992	6332	161661
1970	6847	10626	17366	18765	13524	10566	15672	8747	8623	4137	2011	3845	120729
1971	5045	16134	20948	25285	20014	16645	11885	21886	16572	14897	6955	3879	180144
1972	6431	20565	15292	20452	21806	33996	16391	16184	14017	13315	4377	4648	187473
1973	2347	13296	31365	21708	7748	10896	6555	13049	11576	5492	2508	2427	128968
1974	7060	17841	33183	37632	15486	21443	15005	16493	20995	15788	6887	3250	211064
1975	1210	13885	26227	17292	9749	12322	5993	13009	14036	8812	5367	4094	131997
1976	23077	39854	38744	25096	12440	9641	10767	19837	14487	11903	6564	3513	215924
1977	3374	5227	10466	8438	10568	10610	12532	11127	9934	4004	2728	3279	92287
1978	7023	30303	32448	14583	10232	10082	7104	8545	7797	3769	2573	7028	141485
1979	3304	8297	9483	5068	17416	16990	9177	11896	7976	5089	2218	4171	101086
1980	9082	5629	48438	16985	21760	12810	15412	9889	7318	4260	2620	3860	158064
1981	2235	28580	39307	13681	27907	7832	16251	12037	11394	4161	1839	2811	168035
1982	13942	23436	31555	18033	29302	12566	12265	12184	16746	8635	3770	2320	184753
1983	12046	13453	30291	32116	28201	21504	10649	11269	11699	13012	3804	3563	191606
1984	2136	40920	11190	23967	15175	16108	10601	14630	12082	8162	3189	2552	160713
1985	12516	23302	13131	5738	4768	6173	14753	12531	10925	4601	2011	3030	113477
1986	15114	14974	6944	24975	20672	15732	7973	15123	9263	3695	1904	1588	137956
1987	3737	23633	15461	19772	16507	22782	10555	13988	9850	3673	1764	1368	143089
1988	427	5350	22416	10738	9666	12612	15634	16826	12933	6716	2921	2425	118663
1989	7758	20584	14062	16509	9786	14142	16795	11807	10064	7202	2707	1555	132971
1990	7742	21764	19034	19145	16484	13114	13097	11365	14742	5057	2295	2017	145857
1991	9804	50472	22295	20432	32633	10942	12894	9435	6647	4544	6012	5704	191812
1992	1618	17674	19283	30123	24302	8401	13948	10487	3515	1864	1509	2295	135020
1993	4112	13408	9634	9697	6665	13662	17358	18736	10535	3576	2557	1521	111462
1994	2453	3222	23718	19757	10839	21669	12908	10285	10623	4145	1934	2831	124383
1995	4932	14029	39520	24232	29422	18438	9869	10310	8557	4321	2749	1885	168264
1996	11344	42538	37358	26653	24564	9563	18199	12682	6331	3437	1960	2394	197024
1997	10202	13568	21597	39336	15657	27720	16827	20696	16020	11793	4341	8777	206533
1998	21111	18902	18240	29104	18570	14442	7137	11658	8636	5124	2098	1374	156395
1999	4885	35524	34976	27265	23785	17307	10175	14649	19583	16478	9434	3612	217673
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	8486.7	19850.8	24247.4	21191.3	17093.6	14294.0	12250.7	13479.6	11772.5	7132.0	3503.5	3333.8	156635.6
med =	7060.0	17021.0	22295.0	19772.0	15657.0	12810.0	12152.0	12531.0	10731.0	5124.0	2761.0	2811.0	151178.0

Soleduck River above NF Soleduck - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
106239													1761.89
96773.85													1604.92
88152.09													1461.93
80298.38		X											1331.68
73144.38			X										1213.04
66627.81													1104.97
60691.76		9	9	X									1006.52
55284.61						X							916.85
50359.16				9	X								835.17
45872.52	X		7		9								760.76
41785.66													692.98
38062.86		7		7									631.24
34671.73			5		7	9		X					575.00
31582.76				5				9	X				523.77
28768.97			3	3			X						477.11
26205.89		5			5	7	9		9				434.60
23871.13	9						7			X			395.88
21744.39		3						7	7	9			360.61
19807.14						5	5	5					328.49
18042.47					3	3		3					299.22
16435.02	7		1				3		5				272.56
14970.79				1				1					248.28
13637								0	3		X	X	226.16
12422.04	5				1	1				7			206.01
11315.34			0				1						187.66
10307.23									1		9	9	170.94
9388.938						0	0						155.71
8552.451		1											141.84
7790.49	3			0	0					5			129.20
7096.421													117.69
6464.181										3			107.20
5888.27										1	7	7	97.65
5363.673		0							0				88.95
4885.809													81.03
4450.519											5	5	73.81
4054.014													67.23
3692.831	1										3	3	61.24
3363.829													55.79
3064.137										0	1		50.82
2791.146													46.29
2542.475												1	42.16
2315.96											0		38.41
2109.626												0	34.99
1921.674													31.87
1750.467													29.03
1594.514													26.44
1452.455													24.09
1323.053													21.94
1205.178													19.99
1097.806													18.21
1000													16.58

Soleduck River above NF Soleduck - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Soleduck River above NF Soleduck - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

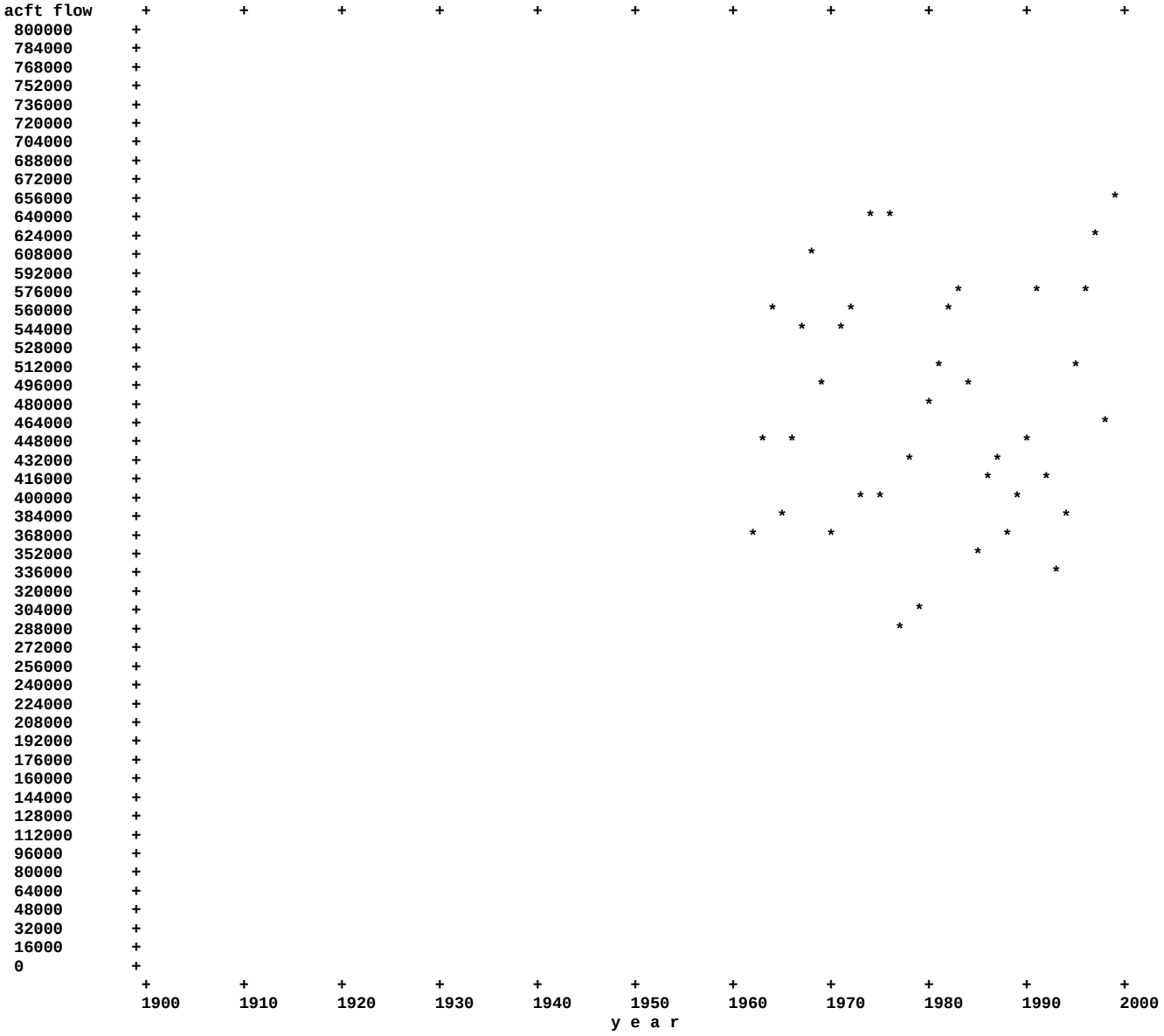
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	12143	21004	34793	28179	11586	8800	18289	15980	14612	8756	4717	3939	182797
1963	15579	39764	43852	21854	36187	13934	14732	16039	9000	7402	4145	3088	225575
1964	23498	41957	33217	38944	18492	17926	17146	19333	30900	20448	10320	7980	280161
1965	11538	21601	21982	26583	33032	14700	17111	18570	12946	7067	4043	2478	191650
1966	10790	25928	31251	36590	13896	19261	23360	21947	18508	13252	6127	3579	224488
1967	12556	23661	68371	46175	23574	22521	9412	21095	23388	10828	4528	3353	269461
1968	44630	22219	42913	57983	41749	24344	12610	16335	15569	9335	4932	9989	302608
1969	21851	27602	37771	22662	10545	20676	23557	31634	24276	8769	4355	9756	243455
1970	10576	16095	26279	28395	20280	15880	23963	12787	12349	5968	2938	5886	181396
1971	8104	24249	32163	39175	30169	25789	17712	31393	23802	21306	9972	5814	269648
1972	10404	31244	23842	31268	33207	50557	24675	23210	19969	19573	6310	6898	281156
1973	3484	19934	48046	33212	11751	16597	9685	19093	16930	7951	3652	3565	193902
1974	11448	27930	50278	56370	24551	33087	22536	24617	30293	22806	9938	4780	318634
1975	1943	21673	39541	26505	15399	18916	8937	19218	20249	12699	8089	6084	199252
1976	35283	59295	58215	37803	19174	15004	16074	28996	21114	17283	9574	5202	323017
1977	5104	8043	16025	12897	16296	16449	18559	16467	14526	5847	4034	5033	139278
1978	10695	45735	48689	21823	15376	14984	10659	12774	11364	5476	3891	10854	212319
1979	5023	12462	14609	7687	26981	25427	13712	17404	11532	7488	3265	6377	151966
1980	13708	8513	72846	25399	33054	19397	22983	14439	10703	6326	3832	5871	237071
1981	3626	43605	58394	20412	41357	12337	24271	17666	16869	6064	2781	4425	251806
1982	21160	35080	47055	28059	43940	19142	18653	17644	24007	12446	5514	3421	276121
1983	18673	20321	45053	47947	42689	32618	15758	16439	17028	18855	5828	5335	286544
1984	3410	61349	17194	36608	23297	24298	15922	21897	17599	11809	4684	3842	241908
1985	18931	35276	20067	8720	7446	9457	21999	18397	15762	6691	2989	4509	170244
1986	22659	22461	10464	37822	31382	23682	12058	22592	13503	5524	2859	2403	207408
1987	5669	35577	23324	29890	24753	34435	15803	20489	14456	5424	2648	2073	214538
1988	723	8094	33558	16385	14830	19423	23602	24879	18824	9772	4304	3664	178057
1989	11715	31373	21397	25501	14804	21610	25084	17065	14483	10459	4015	2342	199847
1990	11570	33208	28567	29190	25836	19886	19133	16602	21732	7405	3430	3009	219567
1991	15016	75885	33877	31101	49118	16428	19493	13881	9704	6626	9314	8494	288936
1992	2476	26721	29074	45681	36061	12370	20796	15383	5197	2804	2270	3503	202335
1993	6335	20226	14812	14939	9860	20562	26063	27432	15540	5309	3803	2296	167178
1994	3778	5038	35343	29579	17170	32537	19184	14927	15681	6143	2900	4210	186490
1995	7406	21334	59354	36195	43850	27819	14844	14921	12306	6283	4173	2837	251321
1996	17273	63817	54472	38859	35974	14146	26809	18783	9314	5084	2932	3579	291042
1997	15544	20628	32936	59042	23601	42736	25314	30290	23513	17524	6404	13065	310596
1998	31851	28328	27604	43719	27708	21594	10595	16847	12474	7536	3132	2072	233460
1999	7261	53506	53230	41330	37005	26666	15327	21603	28157	23646	13559	5269	326559
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	12985.1	30019.4	36591.0	32118.0	25946.8	21736.7	18326.8	19712.3	17057.3	10368.0	5163.2	5023.0	235047.1
med =	11448.0	25928.0	33558.0	29890.0	24551.0	19423.0	18289.0	18397.0	15681.0	7536.0	4145.0	4210.0	225575.0

STATION NUMBER 12041500 SOLEDUCK RIVER NEAR FAIRHOLM (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
210856.9													3496.89
189455.9													3141.97
170226.9													2823.07
152949.7		X	X										2536.55
137426													2279.10
123477.8		9	9	X									2047.78
110945.4						X							1839.94
99684.9				9	X								1653.19
89567.36	X		7		9								1485.40
80476.7				7									1334.64
72308.63		7	5		7	9							1199.18
64969.65				5				X	X				1077.47
58375.54			3	3			X	9					968.11
52450.66		5			5	7	9		9				869.85
47127.16	9	3					7	7		X			781.57
42343.94						5			7	9			702.24
38046.23					3		5	5					630.97
34184.73	7		1			3	3	3	5				566.93
30715.11				1				1					509.39
27597.67						1		0	3		X	X	457.68
24796.64	5				1					7			411.23
22279.88			0				1						369.49
20018.58									1		9	9	331.99
17986.79		1				0	0						298.30
16161.2				0	0					5			268.02
14520.92	3												240.82
13047.1										3			216.38
11722.88										1	7	7	194.41
10533.07		0							0				174.68
9464.001													156.95
8503.45											5	5	141.02
7640.391	1										3	3	126.71
6864.921													113.85
6168.165										0	1		102.29
5542.125													91.91
4979.622											0	1	82.58
4474.214												0	74.20
4020.099													66.67
3612.078													59.90
3245.469													53.82
2916.069													48.36
2620.1													43.45
2354.172													39.04
2115.233													35.08
1900.547													31.52
1707.65													28.32
1534.331	0												25.45
1378.603													22.86
1238.682													20.54
1112.961													18.46
1000													16.58

STATION NUMBER 12041500 SOLEDUCK RIVER NEAR FAIRHOLM (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12041500 SOLEDUCK RIVER NEAR FAIRHOLM (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

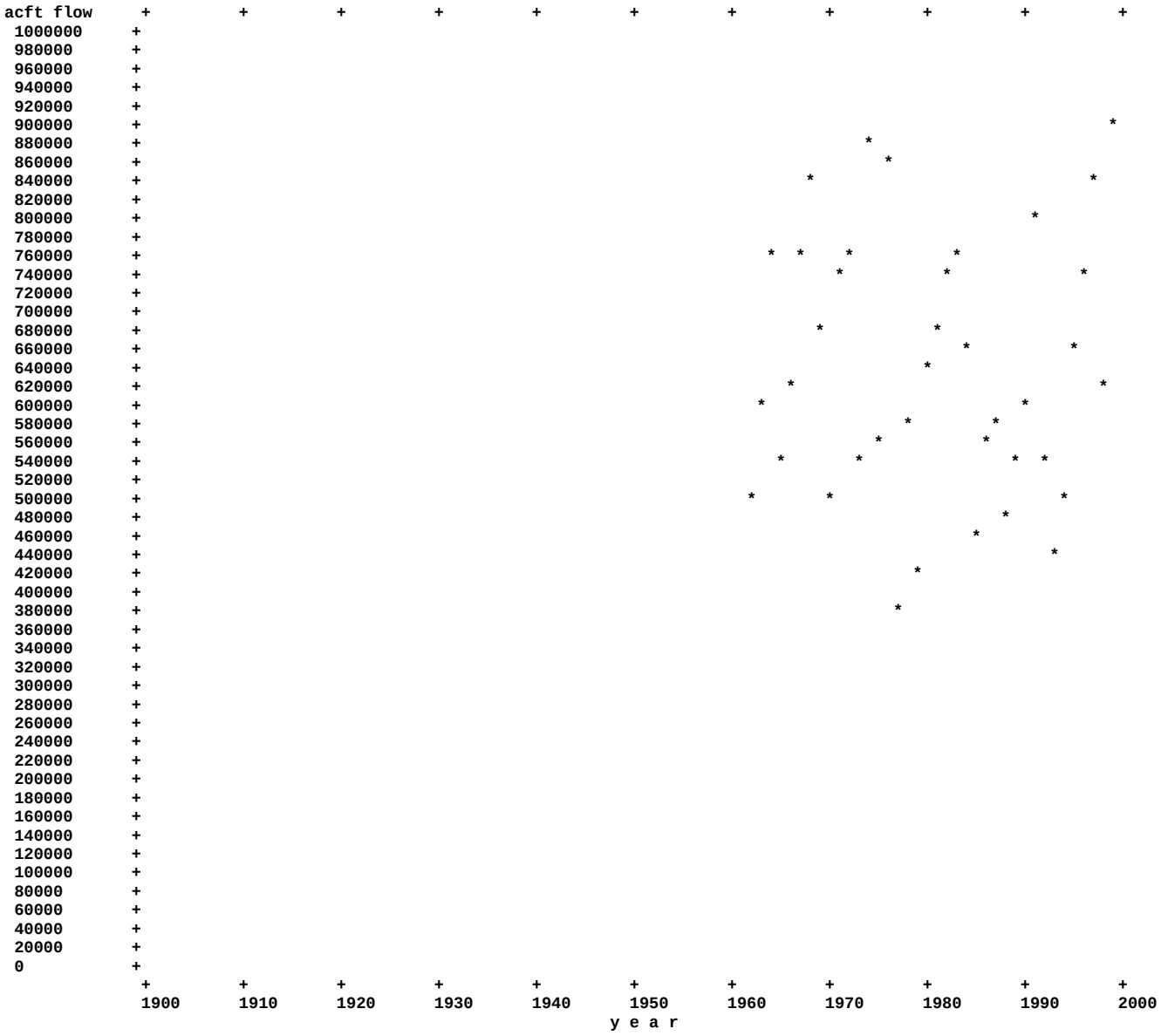
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	24508	41895	69275	55632	23167	17939	36313	31472	28612	17145	9352	7799	363109
1963	30994	78966	86757	43398	71201	27765	29369	31503	17520	14584	8136	6063	446256
1964	46808	83593	66111	77800	36819	36309	33850	37706	60046	39957	20188	15884	555071
1965	23080	43059	43845	53825	66254	28925	33618	36549	25156	13747	7934	4897	380889
1966	21689	51745	62533	73299	27860	38878	45572	42692	35974	25789	11954	7095	445080
1967	25410	47466	135814	92491	47750	45235	18865	41096	45344	21013	8822	6617	535923
1968	88756	44210	85640	115351	82643	48686	25315	31995	30422	18234	9735	20116	601103
1969	44015	54990	75451	45505	21872	41066	46760	61545	47153	17086	8523	19563	483529
1970	21227	32045	52300	56509	40205	31513	47897	25071	23990	11633	5760	11770	359920
1971	16522	48121	64399	78730	59942	51828	35022	61031	46302	41365	19382	11524	534168
1972	21269	62286	48036	62496	66263	99873	48999	45119	38701	38471	12295	13615	557422
1973	6878	39518	96109	66402	23408	33121	19079	37451	33202	15523	7146	7006	384843
1974	23423	56366	100115	111702	49795	66385	44709	48707	59050	44477	19374	9398	633501
1975	3961	43687	78569	53031	31187	37872	17675	37855	39469	24742	16072	12014	396131
1976	70521	117158	115509	75090	38452	30208	31805	56850	41343	33786	18754	10257	639733
1977	10155	16118	32051	25775	32686	33066	36595	32461	28483	11459	7950	10074	276873
1978	21342	90920	96553	43226	30510	29591	21136	25291	22253	10709	7741	21786	421058
1979	10017	24724	29290	15314	54220	50366	27142	34138	22500	14725	6420	12744	301600
1980	27251	16939	144597	50293	65889	38614	45455	28296	20989	12488	7515	11710	470036
1981	7420	87080	115303	40381	81576	24958	48035	34698	33260	11873	5533	8949	499066
1982	42163	69491	93065	56489	87110	38203	37202	34450	46661	24249	10815	6733	546631
1983	37533	40412	89006	94877	84970	64981	31063	32202	33323	36824	11659	10572	567420
1984	6935	121615	34438	73140	46645	48292	31585	43375	34451	23048	9202	7631	480357
1985	37668	70217	40102	17385	15013	18919	43509	36139	30724	13089	5903	8911	337577
1986	44917	44536	20786	75295	62540	47027	23992	44715	26443	10938	5673	4782	411642
1987	11294	70649	46357	59460	49072	68499	31308	40209	28392	10682	5251	4127	425299
1988	1504	16106	66482	32722	29685	38937	46926	49023	36838	19119	8468	7287	353098
1989	23293	62625	42684	51185	29459	43182	49644	33290	28198	20447	7923	4652	396580
1990	22903	66318	56656	58276	52166	39611	37502	32542	42767	14530	6790	5953	436012
1991	30036	150612	67538	62048	97532	32586	38779	27292	19016	12977	18719	16788	573923
1992	4951	53158	57772	90995	71168	24330	41128	30206	10242	5566	4507	6997	401020
1993	12702	40200	29674	29955	19434	40828	51698	53823	30589	10480	7513	4566	331462
1994	7575	10164	69879	58599	34815	64540	37888	29174	30878	12117	5749	8318	369695
1995	14690	42547	117747	71637	86706	55295	29468	29123	23952	12290	8316	5632	497404
1996	34466	126543	106682	76101	70591	27881	52743	37038	18312	10020	5808	7085	573269
1997	31023	41133	65762	117098	46895	85712	50254	59422	46183	34606	12606	25821	616514
1998	63310	56146	54939	86737	54814	42758	20915	32863	24327	14816	6196	4117	461939
1999	14341	106275	106190	82313	74493	53468	30445	42522	54801	45979	26384	10322	647532
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	25961.8	59727.2	72737.3	63962.2	51705.4	43348.6	36296.3	38656.2	33312.3	20278.5	10159.7	9978.3	466123.3
med =	22903.0	51745.0	66482.0	59460.0	49072.0	38937.0	36313.0	36139.0	30724.0	14816.0	8136.0	8318.0	446256.0

Soleduck River at gage near Beaver Creek (at Snider Ranger Station) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
290845.8													4823.44
259650.7													4306.10
231801.5		X											3844.24
206939.3			X										3431.92
184743.8													3063.83
164928.8		9	9	X									2735.21
147239				9	X	X							2441.84
131446.7	X		7										2179.94
117348.2					9								1946.13
104761.9		7	5	7		9							1737.39
93525.52				5	7								1551.04
83494.31				3									1384.69
74539.02	9	5	3		5	7	X	X	X				1236.17
66544.24													1103.58
59406.95		3				5	7		9				985.22
53035.18					3			7		X			879.55
47346.82	7		1			3	5	5	7				785.21
42268.54				1			3	3	5				700.99
37734.97						1		1					625.80
33687.65	5				1			0	3		X	X	558.68
30074.44							1			7			498.76
26848.77		1	0									9	445.26
23969.07				0			0		1		9		397.51
21398.23					0	0							354.87
19103.14	3									5			316.81
17054.21										3			282.83
15225.03		0										7	252.49
13592.04									0	1	7		225.41
12134.21													201.24
10832.74											5	5	179.65
9670.857	1										3	3	160.38
8633.597													143.18
7707.589										0	1		127.82
6880.901											0	1	114.11
6142.881												0	101.87
5484.019													90.95
4895.823													81.19
4370.715													72.48
3901.924													64.71
3483.418													57.77
3109.8	0												51.57
2776.254													46.04
2478.483													41.10
2212.65													36.70
1975.329													32.76
1763.463													29.25
1574.32													26.11
1405.464													23.31
1254.719													20.81
1120.142													18.58
1000													16.58

Soleduck River at gage near Beaver Creek (at Snider Ranger Station) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Soleduck River at gage near Beaver Creek (at Snider Ranger Station) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

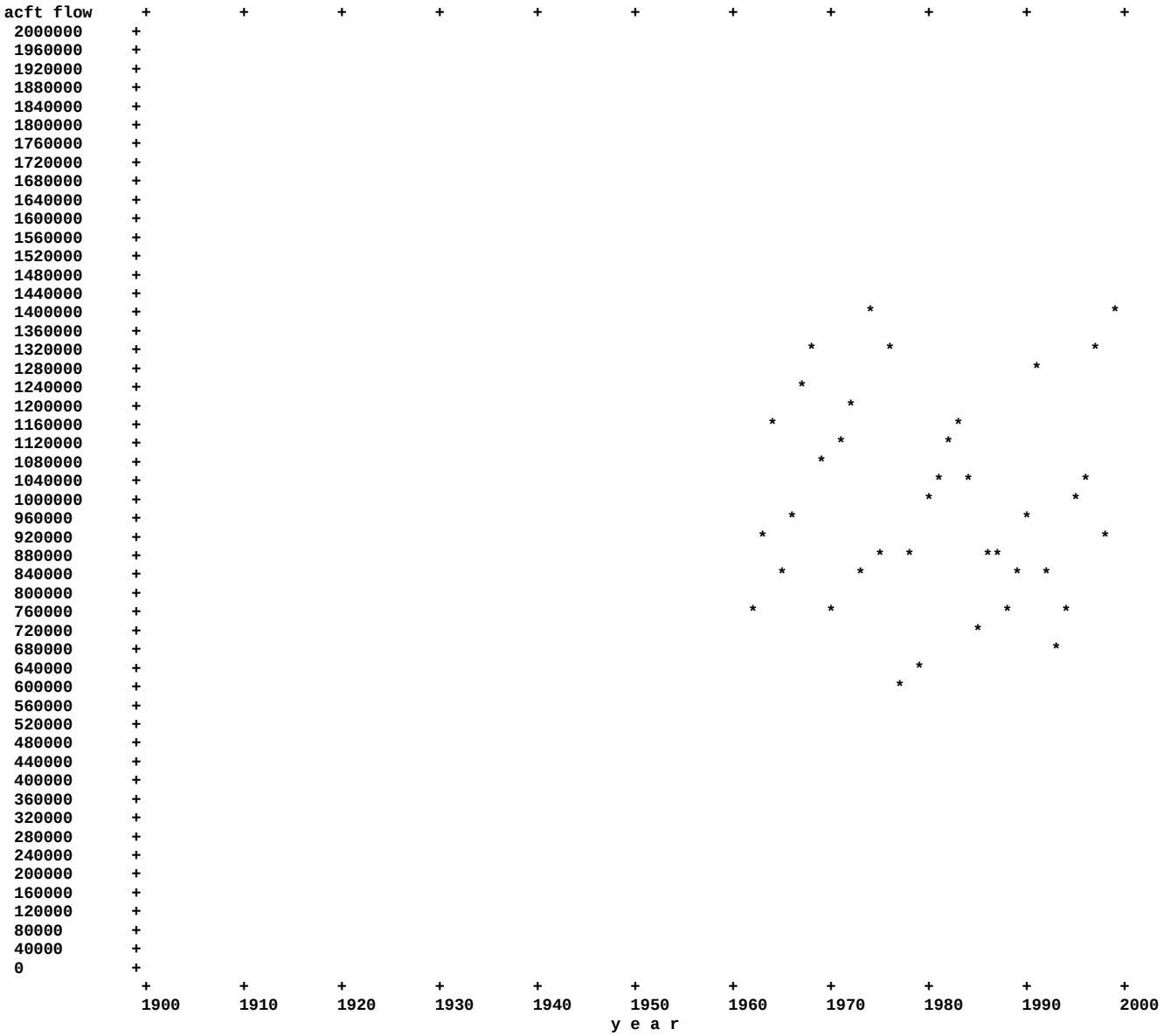
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	29064	55327	95013	78885	29047	19118	49159	44350	41041	23769	11786	9849	486407
1963	42816	109639	116995	59624	91455	38699	41164	39097	20409	17871	10040	7821	595629
1964	66012	119135	93176	113087	51456	57481	44019	44101	68572	47667	23726	21353	749785
1965	32915	60949	62380	85657	98988	36362	41911	46402	28837	16346	9825	6495	527065
1966	31993	74174	91727	108658	40696	60183	53711	48865	40924	29578	14281	8929	603720
1967	39574	70623	189996	137383	76021	67841	27067	47668	51142	24390	10989	8351	751045
1968	124806	61718	123636	163034	111906	70839	37211	38723	35960	21279	11938	29980	831029
1969	67328	77873	109567	68113	39604	56421	64127	71145	53445	19919	10507	28197	666246
1970	30942	44580	73401	79400	54400	42677	69369	30337	27563	13969	7547	16067	490252
1971	26562	65901	94956	119561	83241	78243	46193	70031	53108	46812	22500	14592	721699
1972	35209	88818	73732	90903	95282	133254	67488	51406	43858	48341	14695	16845	759832
1973	8639	53421	141384	96893	32330	46969	23751	46167	40694	18196	9044	8808	526295
1974	38977	85281	141657	150336	78889	98632	60397	65150	69555	52420	22723	11772	875791
1975	6009	65088	109031	76818	48501	54916	21608	48365	46161	28601	21427	15421	541946
1976	101455	150018	157769	103109	53511	46510	43946	67883	48792	38544	22019	12263	845818
1977	13528	23498	47174	37879	48688	51918	44028	40270	33566	13686	9807	13607	377649
1978	25993	120980	134896	60862	43861	38912	29723	33622	26879	14135	9704	26351	565918
1979	14942	33588	41894	22659	78128	71410	36948	41755	26871	18225	8980	14279	409677
1980	33049	24150	198708	74486	86945	58271	56617	36742	26601	15859	10056	13641	635125
1981	12201	122915	147349	51755	106450	38552	61361	43427	42163	14345	7412	13458	661388
1982	57771	91933	123830	85833	118344	54733	51942	40935	53628	28253	13246	8162	728611
1983	55058	54535	114276	122398	118924	93022	39745	39328	40176	43607	17478	13515	752062
1984	10594	162386	48975	103411	67614	66370	41380	58030	42153	27200	11486	10018	649617
1985	52492	97806	54856	24912	19502	23953	57131	45059	36097	15824	7807	11405	446843
1986	59262	58474	26446	103445	88289	62723	32326	59476	32275	13847	7513	6518	550593
1987	15616	95598	60920	81957	66194	95489	42156	49830	35694	13438	7088	5835	569815
1988	2926	21681	88389	44792	42574	56759	63942	63056	44851	22991	10746	9504	472211
1989	30904	89152	58979	76290	39490	61635	64563	39015	32842	24663	10206	6450	534188
1990	30540	95150	74622	79857	80555	55162	43850	40777	55409	17755	8919	7886	590481
1991	43025	207747	96674	88278	134620	43805	54018	34046	23006	15794	26638	21608	789259
1992	6377	67851	78213	124203	93125	30332	51275	38854	12911	7501	6263	9530	526434
1993	17071	54447	40439	42184	24444	53224	69043	67078	39262	13223	9649	6367	436431
1994	10521	14728	90104	77113	51467	88000	49805	33529	39832	15254	7652	10422	488426
1995	19391	56296	161672	94184	115708	76194	39247	34074	27737	14871	10814	7511	657700
1996	47946	167872	128921	91749	86202	35397	65392	48256	22965	12693	7737	9272	724402
1997	41591	56226	95754	157203	62474	128777	69097	73697	56201	44393	15749	32492	833654
1998	87513	76118	73215	118351	74102	57624	26781	38731	28392	17861	8046	5824	612558
1999	18034	145823	153833	117219	111926	79826	43339	55972	63721	52875	30458	12643	885668
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	36543.3	82144.7	100383.1	89802.1	72235.6	61321.9	48021.8	47769.7	39823.5	24368.3	12802.7	12974.8	628191.3
med =	30942.0	70623.0	94956.0	85833.0	74102.0	56759.0	44028.0	44350.0	39832.0	18196.0	10206.0	10422.0	603720.0

Soleduck River below Lake Creek - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
459460.6													7619.78
406446.2													6740.58
359549.2		X											5962.83
318063			X										5274.82
281363.9			9	X									4666.19
248899.1		9		9		X							4127.79
220180.3	X				X								3651.51
194775.1			7	7	9								3230.19
172301.3		7	5			9							2857.48
152420.5				5	7								2527.77
134833.8	9		3	3									2236.11
119276.1		5			5	7	X						1978.10
105513.7						5		X					1749.86
93339.12		3			3	3	7	9					1547.95
82569.36	7		1	1					X				1369.35
73042.19							5	7		X			1211.35
64614.29							3			9			1071.58
57158.9	5				1			3	7			X	947.93
50563.68						1	1	1	5		X		838.56
44729.49		1	0									9	741.80
39568.43				0				0	3				656.21
35002.9					0		0			7			580.49
30964.13	3					0			1		9		513.51
27391.39		0											454.26
24230.87										5			401.85
21435.04										3		7	355.48
18961.78													314.47
16773.91									0	1	7		278.18
14838.47											5	5	246.08
13126.36	1										3		217.69
11611.79										0	1	3	192.57
10271.99												1	170.35
9086.767											0	0	150.70
8038.3													133.31
7110.816													117.93
6290.343													104.32
5564.544	0												92.28
4922.485													81.64
4354.514													72.22
3852.073													63.88
3407.609													56.51
3014.426													49.99
2666.611													44.22
2358.928													39.12
2086.747													34.61
1845.971													30.61
1632.976													27.08
1444.558													23.96
1277.88													21.19
1130.433													18.75
1000													16.58

Soleduck River below Lake Creek - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Soleduck River below Lake Creek - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

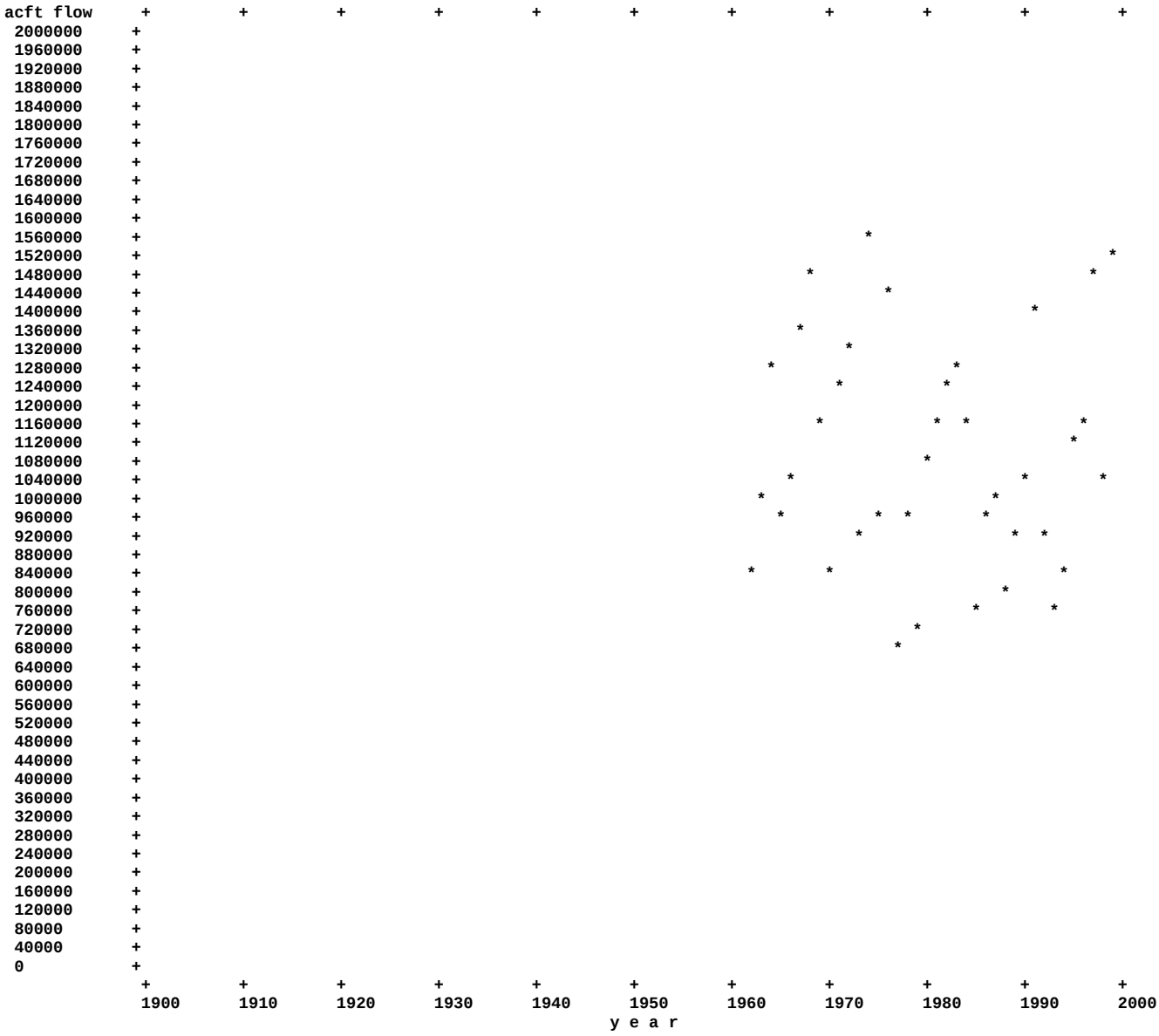
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	45375	87330	151767	123215	44097	29510	76066	66824	60910	33335	16359	13773	748563
1963	68069	173978	177791	93656	128626	62400	66826	52241	23250	23849	12878	10418	893980
1964	107456	195874	151125	190827	82943	107609	63751	52013	75877	58629	28660	33122	1147886
1965	54899	99787	102811	160739	172933	49826	56402	64436	31778	18891	12612	9180	834295
1966	55716	123276	156760	187938	69749	109925	64220	54658	44942	33115	17005	12507	929809
1967	73113	123055	303961	237932	142833	119373	45681	55071	54137	26918	13463	11319	1206855
1968	201450	99134	206709	264689	171166	120066	64362	49269	43608	25089	15982	52927	1314451
1969	121225	127294	184691	119571	84285	88679	100388	81042	58121	22889	13175	47829	1049189
1970	53137	71541	118581	128394	83634	65917	116904	38804	30369	16579	10064	25742	759666
1971	51074	102926	163294	212705	132368	138594	68410	78385	59627	50491	25185	20863	1103920
1972	69343	146396	133174	153724	158715	199049	106260	56770	46511	65855	17315	22954	1176067
1973	11704	82033	241943	164446	51631	77323	32316	60717	53047	21401	11600	11551	819712
1974	76650	156554	230004	232974	149724	172544	93726	97359	82396	62287	26054	14979	1395250
1975	10117	118204	172760	130247	90359	93811	31764	67950	54085	32600	32623	21042	855561
1976	170748	226324	247461	162247	98334	88997	66677	83837	58710	44430	26150	16232	1290148
1977	20974	40463	81221	65195	85138	95886	55949	54053	40763	16742	12627	21641	590653
1978	38605	186600	210536	96052	70892	57976	48032	48802	33765	18973	14718	42419	867369
1979	25462	52461	72524	38241	136767	112207	56134	52691	31519	23229	12706	20468	634409
1980	47531	41198	311910	120479	131774	101401	78617	49419	34570	22433	13974	20559	973865
1981	22520	207107	220327	78231	155039	71315	93930	57804	59868	17439	10644	23077	1017301
1982	94503	141671	186708	153251	184069	90281	85229	48872	59063	32087	16442	10909	1103083
1983	97254	87098	171347	188303	193380	151361	56510	49812	50330	52977	27139	19035	1144545
1984	18834	253986	83613	174825	115495	105242	64146	88284	53115	31615	14458	13983	1017595
1985	83543	158782	93425	38845	36348	41385	85405	60563	41526	18898	10508	15177	684405
1986	91700	90952	41430	169388	144531	99317	51141	89630	40351	19361	10448	9345	857594
1987	23504	151889	98271	132117	101988	153516	63394	66146	47152	17275	9872	8485	873609
1988	5461	33503	136414	75125	71854	97780	102182	89707	56373	27652	13714	13518	723283
1989	48624	148624	97840	132926	63311	103208	98259	45934	36808	29306	13370	9135	827346
1990	44784	159182	117065	135352	147608	89244	57561	52240	76561	22033	12062	10704	924396
1991	72039	328186	158388	146153	213089	67229	85805	45881	28474	19094	46412	30567	1241317
1992	9612	112625	124930	206113	136376	40861	77857	50972	16714	10444	8895	14027	809424
1993	28770	86425	70535	73337	33554	84584	107787	89470	53895	17536	12816	9079	667787
1994	16407	25399	136502	119184	99836	136996	72408	40974	54954	20253	10562	13902	747375
1995	28504	94772	253582	144042	174028	121248	60885	40317	30972	17805	16020	10487	992660
1996	79095	265225	169969	120182	116696	49595	91694	68557	30007	16428	10588	12531	1030567
1997	69648	93135	158779	247786	99809	223342	107887	98401	76614	64755	20319	47649	1308124
1998	139459	117026	120217	185594	110784	86857	37778	45461	32670	23030	10948	8408	918233
1999	24971	232535	254441	190466	202160	137410	66294	77224	72836	58818	33858	15467	1366480
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	60575.8	132698.7	160863.3	147223.5	118050.6	101101.7	72595.7	62383.9	48322.8	29856.3	16900.7	19079.2	969652.0
med =	51074.0	118204.0	156760.0	144042.0	115495.0	95886.0	66677.0	55071.0	47152.0	23030.0	13463.0	14027.0	924396.0

Soleduck River at gaging station near Quillayute - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
507840.3													8422.12
448345.3													7435.44
395820.3		X											6564.36
349448.8			X										5795.33
308509.9			9	X									5116.39
272367.1		9		9		X							4516.99
240458.5	X				X								3987.81
212288.1			7	7	9								3520.63
187417.7		7	5			9							3108.17
165461.2				5	7								2744.04
146076.9	9	5	3	3			X						2422.57
128963.6					5	7	9						2138.76
113855.1		3				5		X					1888.19
100516.7			1		3	3	7	9					1666.99
88740.84	7			1					X				1471.69
78344.59							5	7	9	X			1299.28
69166.3							3			9			1147.07
61063.27	5				1			5	7			X	1012.68
53909.52						1	1	3	5		X	9	894.05
47593.87		1	0					1					789.31
42018.11				0				0	3				696.84
37095.56					0	0	0			7			615.20
32749.68	3								1		9		543.13
28912.96		0											479.50
25525.72										5		7	423.32
22535.31										3			373.73
19895.23										1	7		329.95
17564.45									0				291.29
15506.72											5	5	257.17
13690.06	1										3	3	227.04
12086.23										0	1		200.44
10670.29												1	176.96
9420.238											0	0	156.23
8316.63													137.92
7342.313													121.77
6482.139	0												107.50
5722.732													94.91
5052.297													83.79
4460.406													73.97
3937.857													65.31
3476.525													57.66
3069.24													50.90
2709.67													44.94
2392.224													39.67
2111.968													35.03
1864.545													30.92
1646.108													27.30
1453.261													24.10
1283.007													21.28
1132.699													18.78
1000													16.58

Soleduck River at gaging station near Quillayute - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Soleduck River at gaging station near Quillayute - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

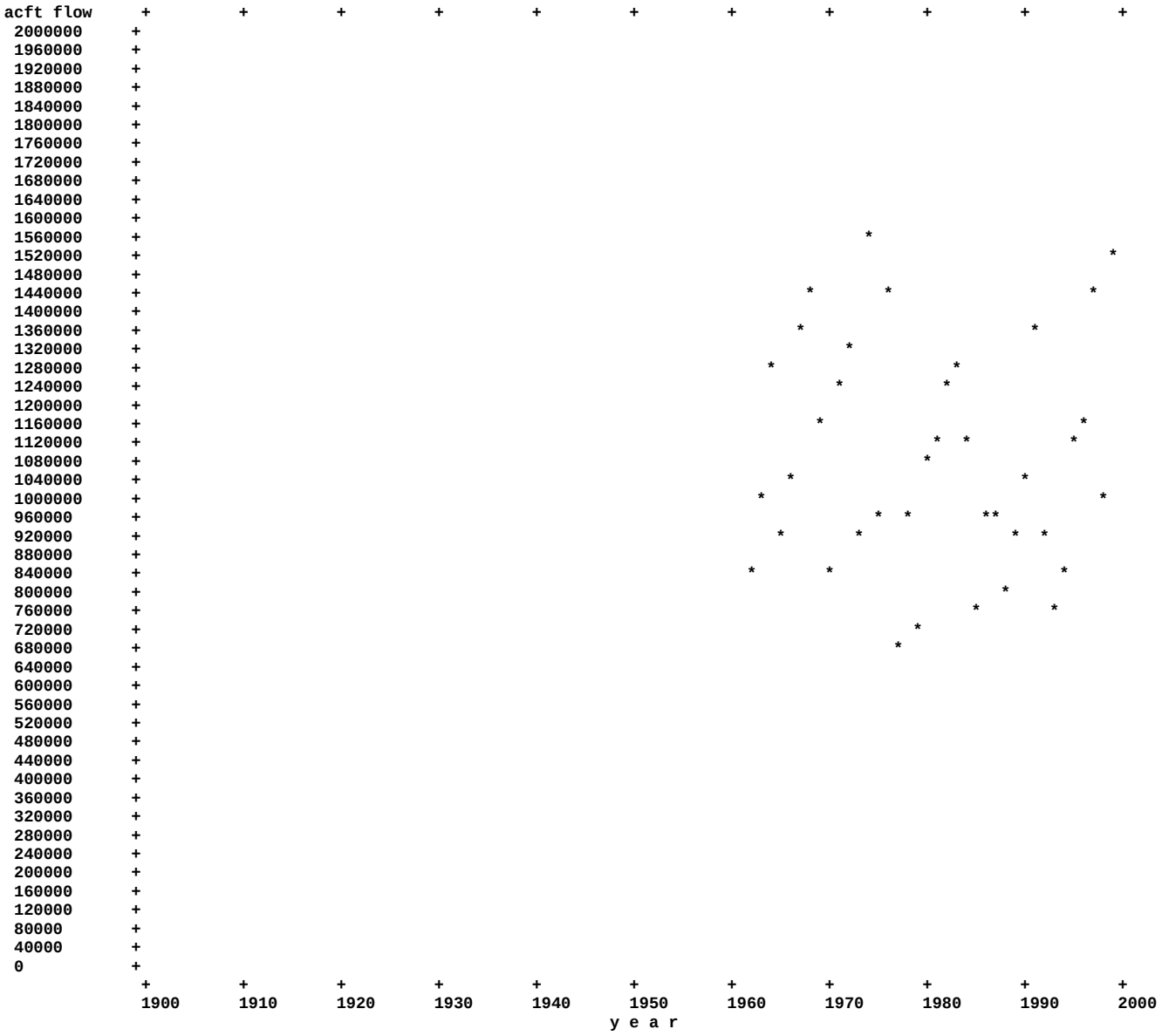
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	53009	98125	168842	134113	49779	35988	83896	71648	64404	34708	17704	14957	827173
1963	75352	192140	194979	103384	139250	69249	74220	56168	23978	25773	13594	10935	979022
1964	119242	217477	167504	212702	91960	121791	69506	54496	78213	61959	30274	36653	1261778
1965	61268	110847	114313	181855	193746	53840	60705	69724	32575	19360	13293	9778	921302
1966	62565	137188	175099	210236	78082	124003	67430	56556	46251	34217	17641	13610	1022877
1967	82686	137886	335933	266144	161651	133953	51112	57416	54987	27370	13817	12115	1335070
1968	223033	109801	230070	293229	187924	134011	72166	52477	46011	26300	17276	59560	1451856
1969	136459	141299	205839	134130	96943	97914	110737	84099	59676	23698	13762	53543	1158097
1970	59563	79298	131408	142282	92029	72642	130378	41429	31079	17116	10487	28689	836398
1971	58137	113488	182550	238851	146296	155625	74855	81013	61732	51670	25798	22866	1212880
1972	79078	162668	149949	171450	176614	217636	117308	58543	47115	71000	17863	24913	1294136
1973	12557	90255	270160	183488	57257	86021	34962	65040	56756	22336	12076	12197	903105
1974	87212	178310	254613	258026	170401	193788	103654	106272	86141	65182	26807	15579	1545984
1975	11013	134707	190656	145618	102601	105187	35954	73690	56480	33808	35933	22384	948031
1976	190790	253540	273754	179278	115400	102721	72253	88564	61661	46909	26995	18008	1429873
1977	21426	45435	90942	73046	95527	108360	59540	58158	43038	20155	18237	26274	660137
1978	43803	206975	230122	105275	77903	63757	53264	52617	35762	19789	16645	49839	955751
1979	28262	58056	82187	42389	155238	122348	61273	55446	32418	24361	13210	23871	699059
1980	53355	46554	344215	130982	145309	113276	85745	52022	36184	24464	14731	24008	1070845
1981	24962	233292	246097	87631	169297	80913	105980	61719	65517	18127	11343	25497	1130376
1982	106331	157717	205257	172251	203340	100126	95276	50951	60387	33004	17125	11880	1213643
1983	110137	97603	191164	211990	215201	166921	61591	52615	53310	55899	28615	20604	1265648
1984	21023	283496	94390	197074	129512	116654	71883	97174	55896	32615	14981	14837	1129534
1985	92185	176903	106991	41892	43839	49109	94079	65141	42757	19444	10908	15942	759189
1986	102381	102008	47246	190536	160726	111472	57081	98492	42336	20995	11018	9863	954153
1987	25283	169696	111904	147369	112502	170225	69164	70964	50006	18008	10316	8866	964301
1988	5789	36986	151628	85453	80446	109811	114080	97551	59442	28672	14167	14530	798554
1989	54511	166068	110378	148829	71257	115404	109643	48003	37588	30121	13877	9501	915179
1990	48474	177598	131620	154630	166870	99249	63627	54628	81725	22974	12589	11147	1025131
1991	80411	362743	175216	162841	235646	74116	94615	49379	29863	19681	52804	33083	1370397
1992	10678	131375	139860	233820	149088	43974	88565	53132	17465	10916	9258	14999	903129
1993	32983	96441	81654	83735	36249	96050	120163	95926	57612	18549	13423	9448	742232
1994	17892	28541	152664	133183	117073	151130	78659	44255	58733	21472	11065	14803	829470
1995	31015	109488	279909	160292	190837	134472	67732	42287	31708	18336	17591	11038	1094702
1996	88755	298255	184647	130316	127572	53875	101019	73979	31660	17112	11036	13100	1131326
1997	79838	105466	175415	276876	112519	248882	118717	105870	84170	71330	21321	53116	1453520
1998	154570	128675	137100	205392	120357	94859	40965	47234	33800	24713	11541	8753	1007958
1999	27074	258689	281393	210361	229278	152932	71078	81654	75379	60453	34660	15984	1498936
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	67713.2	148291.8	178886.0	164235.5	131724.2	112691.7	80075.7	66482.4	50626.7	31384.1	17994.2	20967.6	%1071072.6
med =	58137.0	134707.0	175099.0	160292.0	127572.0	108360.0	72253.0	58158.0	50006.0	24464.0	14167.0	14999.0	%1022877.0

Soleduck River at the Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
502762.6													8337.91
443951.8													7362.58
392020.1		X											6501.33
346163.4			X										5740.84
305670.9			9	X									5069.30
269914.7		9		9		X							4476.32
238341.4	X				X								3952.70
210461.3			7	7	9								3490.33
185842.4		7	5			9							3082.04
164103.4				5	7								2721.52
144907.4	9	5	3	3			X						2403.17
127956.7					5	7	9						2122.06
112988.9		3				5		X					1873.83
99772.02			1		3	3	7	9					1654.64
88101.08	7			1					X				1461.08
77795.43							5	7	9	X			1290.17
68695.29							3			9			1139.26
60659.58	5				1			5	7			X	1005.99
53563.91						1	1	3	5		X	9	888.31
47298.26		1	0					1					784.40
41765.5				0				0	3				692.65
36879.96					0	0	0			7			611.62
32565.92	3								1		9		540.08
28756.49		0											476.90
25392.69										5		7	421.12
22422.38										3			371.86
19799.49										1	7		328.36
17483.44									0				289.95
15438.31											5	5	256.03
13632.4	1										3	3	226.08
12037.75										0	1		199.64
10629.63												1	176.28
9386.216											0	0	155.66
8288.261													137.45
7318.739													121.38
6462.628	0												107.18
5706.655													94.64
5039.118													83.57
4449.666													73.79
3929.161													65.16
3469.546													57.54
3063.696													50.81
2705.316													44.87
2388.861													39.62
2109.423													34.98
1862.672													30.89
1644.785													27.28
1452.385													24.09
1282.491													21.27
1132.472													18.78
1000													16.58

Soleduck River at the Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Soleduck River at the Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	52479	97144	167154	132772	49281	35629	83057	70931	63760	34361	17527	14807	818901
1963	74599	190218	193029	102351	137858	68557	73478	55606	23738	25515	13458	10826	969232
1964	118050	215303	165829	210575	91040	120573	68811	53951	77431	61340	29972	36287	1249160
1965	60655	109738	113170	180036	191808	53301	60098	69027	32249	19167	13160	9680	912089
1966	61940	135817	173348	208133	77301	122763	66756	55990	45789	33875	17464	13474	1012648
1967	81860	136507	332574	263482	160034	132614	50601	56842	54437	27096	13679	11994	1321719
1968	220803	108703	227770	290297	186045	132671	71444	51952	45551	26037	17103	58964	1437337
1969	135094	139886	203781	132789	95974	96935	109630	83258	59079	23461	13624	53007	1146516
1970	58967	78505	130094	140859	91109	71916	129074	41014	30768	16944	10382	28402	828034
1971	57555	112353	180725	236462	144833	154069	74107	80203	61115	51153	25540	22637	1200751
1972	78287	161042	148450	169735	174848	215459	116135	57957	46644	70290	17684	24664	1281194
1973	12431	89352	267458	181653	56685	85161	34613	64390	56189	22113	11955	12075	894074
1974	86340	176527	252067	255446	168697	191850	102618	105210	85280	64530	26538	15423	1530524
1975	10903	133360	188749	144162	101575	104135	35595	72953	55915	33470	35574	22160	938551
1976	188882	251005	271017	177485	114246	101694	71531	87678	61044	46440	26725	17828	1415574
1977	21212	44981	90033	72315	94571	107276	58945	57576	42608	19953	18055	25352	652877
1978	42254	207653	228187	104222	77124	63119	52731	52054	35515	19591	16479	49890	948820
1979	27979	57475	81365	41965	153686	121125	60660	54892	32094	24117	13078	23632	692068
1980	52821	46089	340773	129672	143856	112143	84888	51502	35822	24219	14584	23768	1060137
1981	24713	230959	243636	86755	167604	80104	104921	61102	64862	17946	11229	25242	1119072
1982	105268	156140	203204	170528	201306	99124	94323	50441	59783	32674	16954	11761	1201507
1983	109035	96627	189252	209870	213049	165251	60975	52089	52777	55340	28328	20398	1252991
1984	20813	280661	93446	195103	128217	115487	71165	96202	55337	32289	14831	14688	1118239
1985	91263	175134	105921	41473	43401	48618	93139	64489	42329	19249	10799	15783	751597
1986	101357	100988	46773	188630	159118	110358	56510	97507	41912	20785	10908	9764	944611
1987	25030	167999	110785	145895	111377	168522	68473	70255	49506	17828	10212	8777	954658
1988	5731	36616	150112	84599	79642	108713	112939	96575	58848	28385	14025	14384	790568
1989	53966	164407	109274	147341	70544	114250	108547	47523	37212	29820	13739	9406	906027
1990	47989	175822	130304	153084	165202	98257	62991	54082	80907	22744	12463	11036	1014880
1991	79607	359116	173464	161213	233289	73374	93669	48885	29564	19484	52276	32752	1356693
1992	10571	130061	138461	231482	147597	43535	87679	52601	17291	10807	9165	14849	894098
1993	32653	95476	80837	82897	35886	95089	118962	94967	57036	18363	13289	9354	734809
1994	17714	28255	151138	131851	115902	149618	77873	43813	58146	21257	10954	14655	821176
1995	30705	108393	277110	158689	188929	133127	67054	41864	31390	18152	17415	10928	1083755
1996	87867	295272	182801	129013	126296	53336	100009	73239	31344	16941	10926	12969	1120013
1997	79040	104411	173661	274107	111394	246393	117530	104812	83328	70617	21108	52585	1438985
1998	153024	127388	135729	203338	119153	93910	40555	46762	33462	24466	11426	8665	997878
1999	26803	256102	278579	208257	226986	151402	70367	80838	74626	59849	34314	15824	1483947
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	67006.8	146881.2	177106.8	162593.0	130406.9	111564.7	79275.1	65816.6	50123.4	31070.2	17814.3	20755.0	%1060413.4
med =	57555.0	133360.0	173348.0	158689.0	126296.0	107276.0	71531.0	57576.0	49506.0	24219.0	14025.0	14849.0	%1012648.0

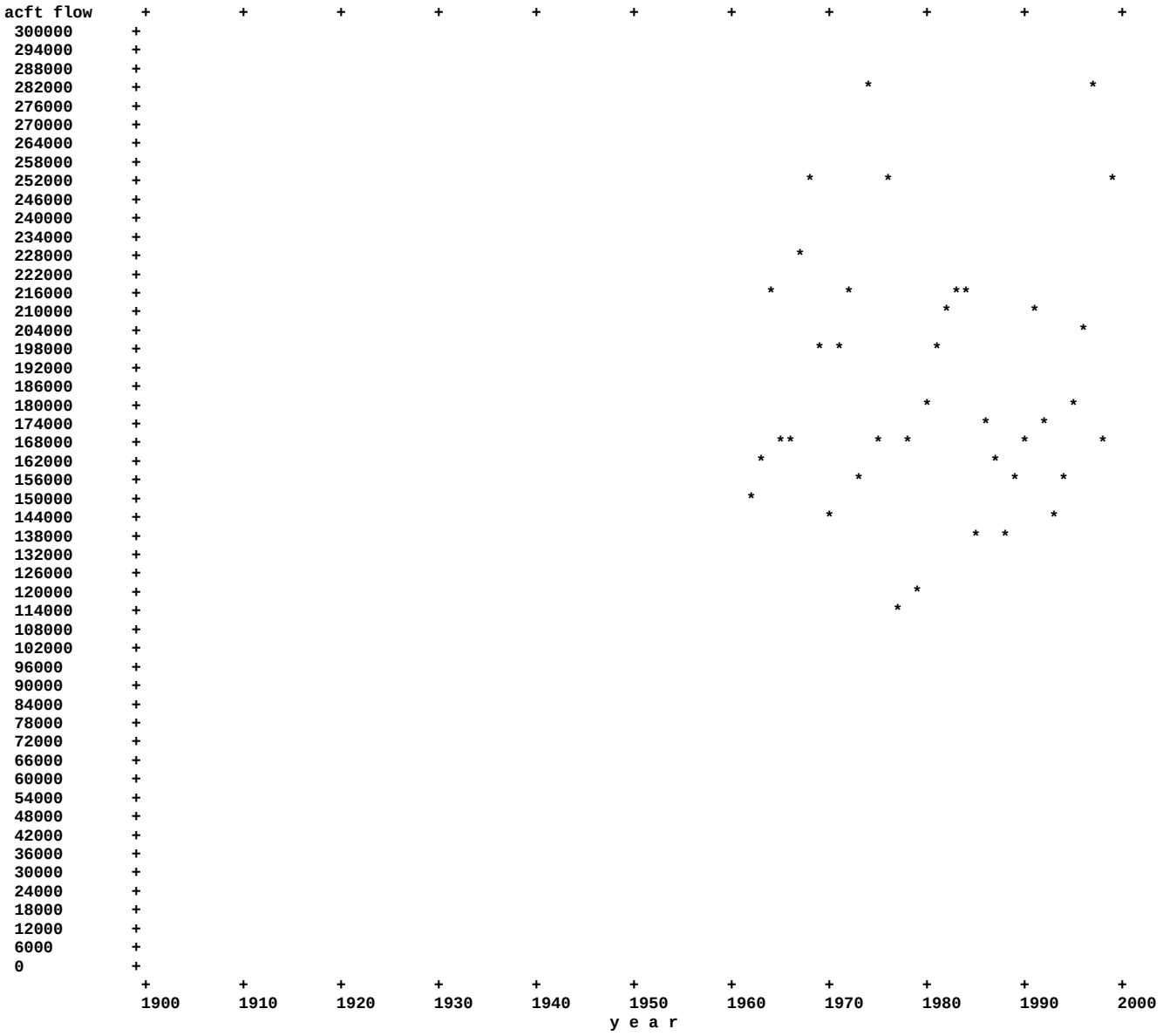
Dickey River watershed

STATION NUMBER 12043080 EAST FORK DICKEY RIVER NEAR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
92996.41													1542.27
84936.97													1408.61
77576.05													1286.54
70853		X											1175.04
64712.59													1073.21
59104.39			X	X									980.20
53982.17		9	9	9	X								895.25
49303.86						X							817.66
45031.02													746.80
41128.45	X			7									682.08
37564.09			7		9								622.97
34308.64		7											568.98
31335.34			5	5	7	9							519.67
28619.69	9	5	3										474.63
26139.39					5	7	X						433.50
23874.07				3		5							395.93
21805.05		3					9						361.62
19915.33			1		3								330.28
18189.41	7												301.66
16613.04						3		X	X			X	275.51
15173.29				1			7			X			251.64
13858.32													229.83
12657.3	5				1		5	9			X		209.91
11560.37			0			1							191.72
10558.5		1											175.10
9643.468							3						159.93
8807.726												9	146.07
8044.412								7					133.41
7347.258									9				121.85
6710.515							1						111.29
6128.954		0			0			5		9			101.64
5597.799	3												92.83
5112.671							0	3					84.79
4669.586						0			7				77.44
4264.905													70.73
3895.292													64.60
3557.71				0				1	5				59.00
3249.387											9		53.89
2967.782								0				7	49.22
2710.582													44.95
2475.673									3				41.06
2261.122										7			37.50
2065.164	1												34.25
1886.19													31.28
1722.726										5		5	28.57
1573.427													26.09
1437.068											7		23.83
1312.526													21.77
1198.778													19.88
1094.887									1	3			18.16
1000									0		5	3	16.58

STATION NUMBER 12043080 EAST FORK DICKEY RIVER NEAR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12043080 EAST FORK DICKEY RIVER NEAR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

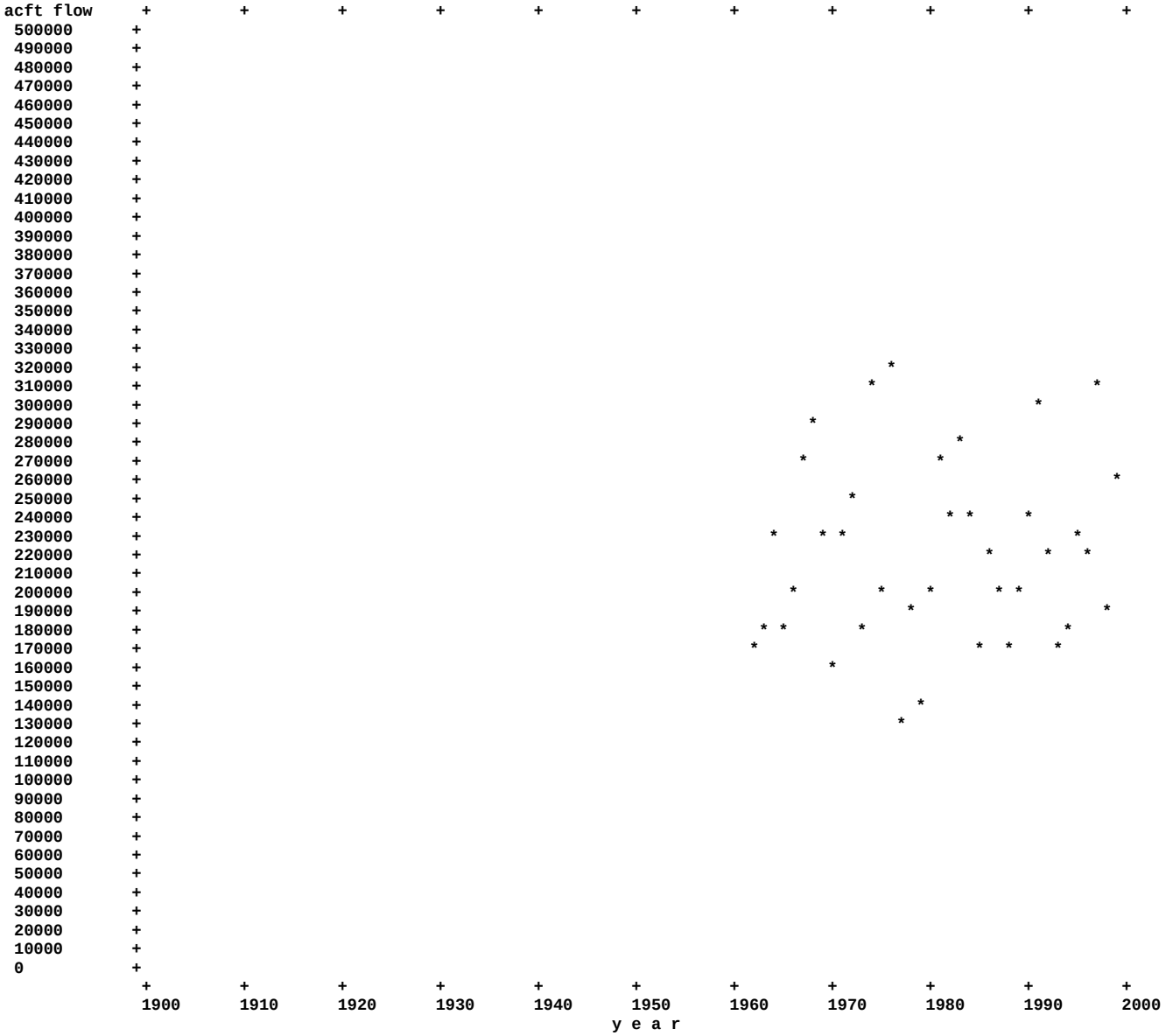
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	16394	22127	32647	17772	11538	14952	14942	7446	3787	2189	2389	2312	148496
1963	13372	32935	31162	17765	19336	12594	14519	7700	1422	3908	1136	952	156801
1964	21590	42153	30819	40253	16925	25773	10980	5052	4270	5708	3074	6611	213208
1965	12232	22489	21174	41298	37321	7267	7799	9739	1622	992	1321	1156	164410
1966	12387	24748	31958	39241	14749	24881	6147	3604	2412	2069	1105	1976	165277
1967	17496	26656	55995	50358	33558	25363	9366	4374	1486	573	378	1598	227201
1968	37571	18436	42478	52830	31135	24996	14340	5718	4336	1970	2218	11308	247336
1969	27708	25468	38333	26488	23096	16878	18881	5685	2965	1463	970	8633	196569
1970	11841	14226	23345	25254	15364	12364	24524	4969	1222	844	579	5684	140216
1971	13000	19263	34936	47353	25321	30939	11852	4913	3994	2216	1007	2829	197623
1972	17816	29551	30484	32175	32482	33664	20138	3386	940	9498	867	2525	213526
1973	1585	15053	51064	34544	10392	15924	5019	8014	6914	1749	705	895	151858
1974	20751	41549	45447	46547	38277	38376	18505	15650	7067	5859	1263	932	280222
1975	1858	32464	34323	29493	22626	20957	8856	7457	2368	412	2862	1178	164854
1976	37434	51159	41172	32518	34658	26112	8253	7111	3669	2177	1728	2267	248256
1977	4458	9223	17773	14404	18976	22739	6698	7630	4334	1574	1244	4752	113806
1978	10823	38463	34031	16160	12239	10839	9584	6557	3685	1064	3971	15891	163308
1979	4993	10405	18418	7365	35138	17268	9124	4718	1301	1855	511	7590	118687
1980	12027	10214	58813	17013	25275	21333	13684	3927	2424	3871	1133	7542	177255
1981	5472	50472	38549	13372	26263	17852	18034	6916	11577	436	947	4154	194043
1982	20356	29496	33915	37849	35519	19271	18539	3552	2474	1493	897	1553	204913
1983	23450	20155	31175	36855	40236	30825	7895	4883	5387	6345	1723	2853	211781
1984	4548	60244	20785	40197	25880	22281	15028	14325	4631	1620	766	1406	211713
1985	16741	36138	26745	3450	15913	16528	12675	5207	2048	468	487	1223	137623
1986	22404	12658	11547	41192	27972	23416	11357	11892	3327	3072	897	818	170552
1987	3584	30667	27197	22088	19700	26853	11665	10161	4717	1078	605	470	158785
1988	307	6380	29791	18830	15353	24977	16531	12411	5206	1625	573	1793	133777
1989	11173	32080	24837	26954	15462	24378	11369	5002	959	1083	683	401	154379
1990	5887	28365	18789	38378	30132	16339	8758	3723	9064	1515	744	620	162314
1991	15721	47929	30636	30254	33195	11863	14856	5499	2452	812	11786	4460	209462
1992	1990	37733	25099	55303	20425	4454	21705	2806	968	293	376	1589	172739
1993	7851	20249	22199	19676	5891	22849	23208	11523	6621	1708	935	407	143117
1994	2416	5756	30228	27715	34302	23921	11271	6862	6675	2091	737	1633	153606
1995	4020	30626	42542	30762	24923	23432	13020	3671	1027	463	3007	869	178362
1996	19288	66426	29516	21152	21529	8918	18185	9414	2760	973	601	848	199611
1997	21475	24005	29711	55819	24880	45167	19691	13386	15723	13962	1650	10623	276092
1998	28365	21438	34284	36578	16653	14793	6246	2970	2062	3272	962	353	167975
1999	3608	51055	49857	37607	52775	28728	7527	6821	4147	2758	1317	805	247005
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	13526.1	28906.7	32415.1	31127.9	24879.2	21317.5	13178.2	6965.1	4001.1	2501.5	1530.4	3250.2	183598.9
med =	12232.0	26656.0	30819.0	30762.0	24880.0	22281.0	11852.0	5718.0	3327.0	1625.0	962.0	1598.0	170552.0

West Fork Dickey River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
120572.1													1999.59
109552.4													1816.84
99539.93													1650.79
90442.44		X											1499.91
82176.42													1362.83
74665.88			X										1238.27
67841.83			9	X									1125.10
61641.4		9		9									1022.27
56007.66					X	X							928.84
50888.82													843.95
46237.86	X			7	9								766.82
42011.94		7	7		7								696.73
38172.24			5	5		9	X						633.06
34683.51		5	3										575.20
31513.6	9					7							522.63
28633.4				3	5		9						474.86
26016.44						5							431.46
23638.68		3	1					X					392.03
21478.21	7				3		7						356.20
19515.21				1		3		9				X	323.64
17731.61									X				294.06
16111.03							5						267.19
14638.56	5		0		1						X		242.77
13300.66						1				X		9	220.58
12085.06		1					3						200.42
10980.54													182.10
9976.968													165.46
9065.119								7					150.34
8236.617						0			9				136.60
7483.829							1	5		9			124.11
6799.841		0		0									112.77
6178.368									7				102.46
5613.699	3						0	3				7	93.10
5100.633					0								84.59
4634.458													76.86
4210.895									5				69.83
3826.038								1			9		63.45
3476.356										7			57.65
3158.633								0					52.38
2869.95													47.60
2607.651	1												43.25
2369.324													39.29
2152.78									3				35.70
1956.027										5		5	32.44
1777.255													29.47
1614.823													26.78
1467.235											7		24.33
1333.138									1				22.11
1211.295										3			20.09
1100.589											5		18.25
1000									0				16.58

West Fork Dickey River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



West Fork Dickey River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

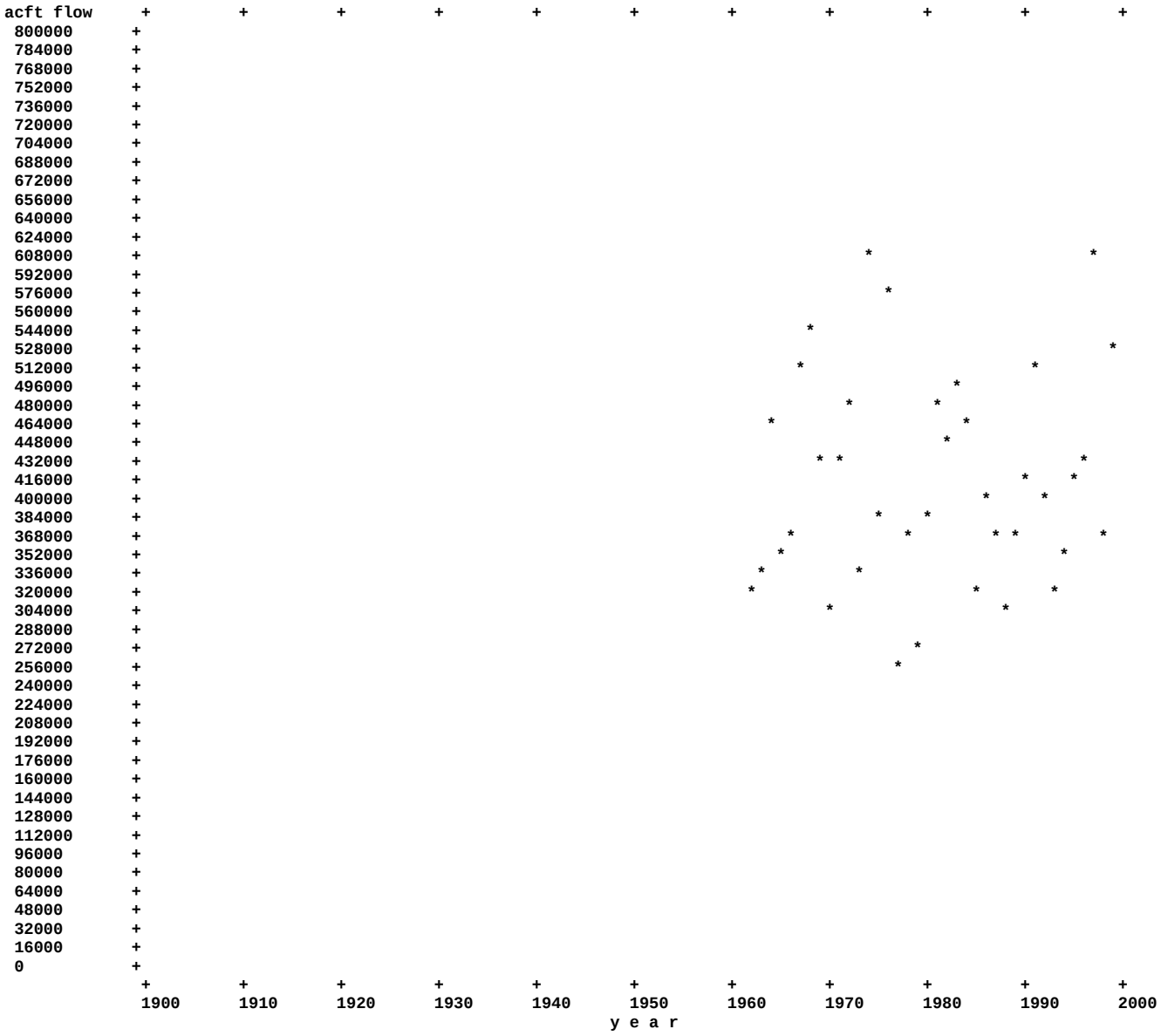
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	18495	22760	35266	21439	12967	16395	15744	8469	5898	749	2885	2386	163453
1963	15058	37270	35257	20047	21830	14175	14378	7799	1187	3919	1452	657	173030
1964	24148	41406	32593	44296	18182	29241	11560	4853	4971	7429	3484	7406	229568
1965	12719	20537	23484	40489	43137	8555	9122	10974	1296	332	1102	873	172620
1966	14399	29152	38945	46894	17724	29697	6528	4007	2792	2264	1076	2435	195914
1967	19788	30811	67194	58526	39270	31116	11945	4974	1584	612	344	1399	267562
1968	45736	22959	47757	57301	33666	29045	16118	6982	5269	2868	3023	14625	285349
1969	31336	28792	43399	29950	26099	19039	21313	6331	3243	1537	977	13723	225738
1970	13320	16028	26382	28550	17320	13913	27720	5518	1263	834	534	6099	157479
1971	14636	21747	39543	53640	28625	35004	13332	5454	4411	2392	1019	5277	225081
1972	20105	33428	34488	36408	36755	38098	22740	3720	943	10659	860	5398	243601
1973	1675	16966	57854	39097	11675	17956	5574	8975	7726	1862	676	1352	171389
1974	20129	45649	49171	53287	43069	44532	20779	18428	7398	5375	1234	822	309875
1975	1162	34169	34749	30552	25563	23777	9675	14932	6939	4235	10085	3515	199353
1976	40995	63903	61924	33948	39231	30112	11750	11316	7797	7644	2905	4074	315598
1977	4938	10348	20055	16230	21421	25693	7481	8539	4796	1663	1289	5272	127724
1978	12164	43547	38515	18224	13772	12183	10757	7321	4060	1083	4385	17918	183928
1979	5545	11690	20788	8238	39771	19482	10235	5232	1353	1982	456	8494	133266
1980	13531	11473	66652	19192	28573	24097	15413	4334	2628	4271	1162	8439	199765
1981	3215	55158	69691	26172	29695	19960	33371	7869	11386	1834	1362	4698	264411
1982	27899	36006	39109	35792	40210	18530	21468	4066	2068	1653	1313	2521	230634
1983	28128	22788	51648	63319	45568	27853	12255	5570	6220	5342	1765	3211	273667
1984	3713	60389	22706	49532	29260	22648	17192	20563	5449	1718	670	1412	235251
1985	16491	35627	30489	6711	17937	18333	21923	12646	2051	1012	406	1185	164809
1986	21628	33110	13728	45106	35174	26799	12721	22802	3735	3364	840	681	219685
1987	2516	41451	30987	38608	21652	38210	10258	8778	5562	1105	498	347	199969
1988	283	7335	31949	24208	18465	22481	31224	18327	6206	1724	470	1893	164563
1989	13143	36565	26467	34412	17424	23686	35561	3106	1325	1110	575	312	193685
1990	7743	43318	41698	42629	44915	22960	18349	3909	9385	1600	644	459	237607
1991	17008	86123	33428	34916	54445	15196	18882	8201	2583	803	14376	5209	291170
1992	2396	45566	35593	60033	29411	7730	25323	3222	1333	880	347	1639	213472
1993	10048	20263	25475	23397	4732	26102	27153	13525	6955	1818	888	315	160671
1994	3013	6634	37572	30155	38827	31163	12616	7808	7009	2252	635	1693	179378
1995	5548	33152	59690	35845	40395	28549	14746	4200	1392	1008	3240	744	228506
1996	19652	71130	32422	21577	24360	8089	21117	10925	2988	986	494	718	214457
1997	22005	27079	32626	62848	28101	51661	21955	16192	16579	12923	1680	12576	306222
1998	30862	23745	37433	41375	18911	15672	6193	3526	2070	3589	923	295	184595
1999	4740	53092	51919	38023	55243	30101	7955	7435	5384	3276	1387	665	259220
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	14997.6	33714.9	38911.7	36078.1	29299.3	24153.5	16642.8	8706.0	4611.4	2887.0	1880.6	3966.8	215849.1
med =	13531.0	33110.0	35266.0	35792.0	28573.0	23686.0	14746.0	7435.0	4060.0	1818.0	1019.0	1893.0	213472.0

STATION NUMBER 12043100 DICKEY R NR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
196001.4													3250.52
176365.6													2924.88
158697.1													2631.86
142798.4		X											2368.20
128492.7		9	X	X									2130.95
115620.1			9	9	X								1917.46
104037.1						X							1725.37
93614.4	X												1552.52
84235.97			7	7	9								1396.99
75797.08		7			7								1257.03
68203.62			3	5		9							1131.10
61370.88	9	5				7							1017.79
55222.59				3	5		X						915.82
49690.31						5	9						824.07
44712.26		3	1		3								741.52
40232.92	7					3	7						667.23
36202.29				1				X	X			X	600.39
32575.49								9					540.24
29312.03					1		5			X	X		486.12
26375.51	5		0										437.42
23733.14		1				1	3					9	393.59
21355.52													354.16
19216.09								7					318.68
17291													286.76
15558.76							1	5	9				258.03
14000.05		0											232.18
12597.5						0				9			208.92
11335.46	3			0	0		0		7				187.99
10199.86								3					169.16
9178.014												7	152.21
8258.546								1	5				136.96
7431.193													123.24
6686.725								0			9		110.89
6016.838													99.78
5414.058										7			89.79
4871.669	1								3				80.79
4383.618													72.70
3944.46												5	65.42
3549.295										5			58.86
3193.721													52.97
2873.77											7		47.66
2585.87									1	3			42.88
2326.813													38.59
2093.71									0		5	3	34.72
1883.958													31.24
1695.22													28.11
1525.39										1	3		25.30
1372.574													22.76
1235.067										0			20.48
1111.336													18.43
1000											1		16.58

STATION NUMBER 12043100 DICKEY R NR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12043100 DICKEY R NR LA PUSH (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

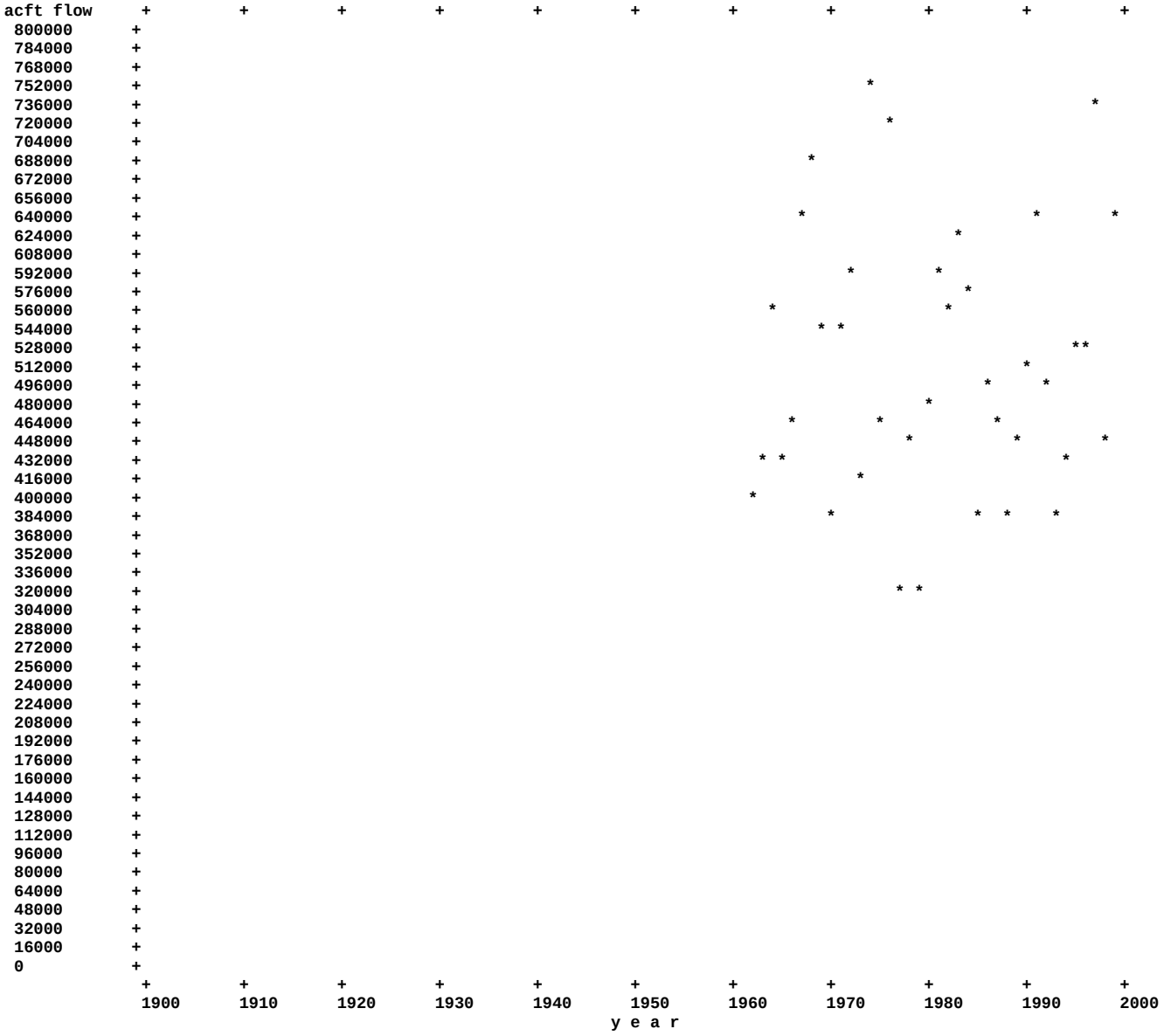
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	35525	45669	69125	39948	24950	31911	31227	16206	9888	2964	5374	4780	317567
1963	28947	71486	67630	38501	41917	27257	29391	15767	2650	7962	2638	1632	335778
1964	46568	84982	64532	86071	35732	56019	22937	10072	9412	13392	6678	14271	450666
1965	25388	43732	45465	83179	81941	16116	17234	21090	2963	1335	2461	2059	342963
1966	27281	54902	72242	87747	33082	55599	12899	7749	5300	4411	2218	4495	367925
1967	37964	58526	125498	110896	74178	57548	21721	9519	3124	1206	734	3045	503959
1968	84879	42184	91876	112100	65958	55039	31012	12940	9786	4937	5345	26436	542492
1969	60121	55250	83224	57467	50091	36571	40927	12234	6319	3053	1981	22828	430066
1970	25618	30805	50634	54785	33279	26755	53197	10677	2529	1706	1131	11992	303108
1971	28139	41758	75838	102837	54930	67146	25642	10554	8557	4691	2061	8287	430440
1972	38612	64128	66157	69834	70500	73071	43660	7234	1916	20523	1757	8108	465500
1973	3318	32602	110906	74985	22469	34498	10784	17298	14906	3675	1404	2293	329138
1974	41572	88767	96308	101666	82826	84439	39998	34711	14719	11419	2539	1782	600747
1975	3060	67807	70266	61095	49068	45551	18864	22902	9546	4793	13293	4814	371059
1976	79838	117258	105224	67633	75237	57259	20406	18816	11733	10084	4733	6481	574701
1977	9566	19926	38517	31192	41133	49315	14436	16463	9295	3295	2577	10205	245920
1978	23405	83506	73870	35010	26485	23441	20711	14130	7884	2184	8507	34425	353558
1979	10729	22497	39921	15886	76276	37420	19710	10130	2701	3905	982	16376	256533
1980	26023	22082	127755	36865	54829	46258	29627	8410	5143	8289	2335	16270	383886
1981	8798	107526	110636	40443	56978	38498	52552	15056	23355	2332	2355	9013	467542
1982	49214	66739	74368	74872	77111	38438	40744	7758	4612	3203	2256	4160	443474
1983	52544	43726	84598	102350	87371	59635	20572	10644	11821	11870	3548	6175	494854
1984	8389	122709	44272	91432	56146	45708	32811	35595	10268	3397	1459	2867	455050
1985	33799	72989	58282	10391	34466	35491	35352	18288	4169	1514	907	2448	308096
1986	44775	46906	25746	87848	64355	51137	24515	35477	7190	6551	1766	1523	397788
1987	6186	73542	59249	62022	42096	66376	22275	19240	10471	2220	1120	829	365627
1988	600	13967	62839	43870	34452	48230	48828	31367	11626	3408	1059	3751	303996
1989	24767	69901	52213	62548	33485	48877	48152	8215	2329	2231	1278	724	354721
1990	13895	73172	61920	82472	76591	40088	27738	7766	18772	3170	1410	1095	408088
1991	33313	137011	65213	66370	89511	27581	34386	13982	5124	1643	26656	9848	510639
1992	4468	84865	61916	117399	50846	12450	47898	6139	2347	1202	734	3284	393548
1993	18244	41209	48549	43878	10786	49848	51295	25513	13815	3589	1853	733	309310
1994	5533	12618	69091	58907	74464	56155	24320	14939	13925	4420	1393	3384	339149
1995	9758	64917	104283	67839	66706	52962	28273	8016	2466	1505	6358	1638	414722
1996	39615	140001	63052	43471	46726	17285	40028	20714	5851	1993	1112	1590	421439
1997	44236	52015	63459	120827	53946	98604	42400	30134	32872	27329	3387	23630	592839
1998	60287	45999	73003	79375	36214	31004	12652	6618	4203	6985	1917	658	358914
1999	8511	105972	103560	76937	109917	59864	15755	14511	9716	6146	2752	1493	515134
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	29039.1	63780.3	72664.1	68446.0	55185.5	46301.2	30392.9	15970.4	8771.1	5487.7	3475.5	7353.2	406866.8
med =	26023.0	58526.0	67630.0	67633.0	53946.0	46258.0	28273.0	14130.0	7884.0	3408.0	2061.0	3751.0	393548.0

Dickey River at Outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
242869.1													4027.79
217602.9													3608.77
194965.4													3233.34
174682.7		X	X										2896.97
156510.2		9		X									2595.59
140228.1			9	9	X								2325.57
125640						X							2083.64
112569.4	X			7	9								1866.87
100858.6		7	7										1672.66
90366.05			5	5	7	9							1498.65
80965.14	9		3										1342.74
72542.16		5		3	5	7	X						1203.05
64995.43							9						1077.90
58233.86		3	1			5							965.76
52175.66	7				3		7						865.29
46747.75				1		3		X				X	775.27
41884.48								9	X				694.62
37527.18							5			X			622.36
33623.14	5		0		1						X		557.61
30125.28		1				1						9	499.60
26991.28							3						447.63
24183.34								7					401.06
21667.49													359.34
19413.37							1	5	9				321.95
17393.77		0											288.46
15584.26						0				9			258.45
13963	3			0	0		0	3	7				231.57
12510.4													207.47
11208.93												7	185.89
10042.84								1	5				166.55
8998.066											9		149.23
8061.977								0					133.70
7223.271													119.79
6471.824										7			107.33
5798.545	1								3				96.16
5195.314													86.16
4654.834										5		5	77.20
4170.585													69.17
3736.71													61.97
3347.974									1		7		55.52
2999.677										3			49.75
2687.615											5	3	44.57
2408.018									0				39.94
2157.507													35.78
1933.058										1	3		32.06
1731.958													28.72
1551.779										0			25.73
1390.345													23.06
1245.705											1		20.66
1116.111												1	18.51
1000											0		16.58

Dickey River at Outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Dickey River at Outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	44020	56590	85654	49501	30916	39541	38694	20081	12252	3673	6658	5923	393504
1963	35869	88580	83802	47707	51940	33775	36419	19537	3284	9866	3269	2022	416070
1964	57703	105303	79963	106653	44276	69414	28422	12480	11663	16594	8275	17684	558430
1965	31459	54189	56337	103069	101535	19970	21355	26133	3672	1654	3050	2551	424973
1966	33805	68030	89517	108729	40993	68894	15983	9602	6567	5466	2748	5570	455904
1967	47042	72521	155507	137414	91916	71309	26915	11795	3871	1494	910	3773	624467
1968	105175	52271	113846	138906	81730	68200	38428	16034	12126	6118	6623	32757	672214
1969	74497	68462	103125	71209	62069	45316	50714	15159	7830	3783	2455	28287	532904
1970	31744	38171	62742	67885	41237	33153	65918	13230	3134	2114	1401	14860	375588
1971	34868	51743	93973	127428	68065	83202	31774	13078	10603	5813	2554	10269	533368
1972	47845	79462	81977	86533	87358	90544	54100	8964	2374	25431	2177	10047	576811
1973	4111	40398	137426	92916	27842	42747	13363	21434	18470	4554	1740	2841	407842
1974	51513	109993	119337	125977	102632	104630	49563	43011	18239	14149	3147	2209	744398
1975	3792	84021	87069	75704	60801	56444	23375	28379	11829	5939	16472	5965	459787
1976	98929	145297	130385	83805	93228	70951	25286	23315	14539	12495	5865	8030	712125
1977	11853	24691	47727	38651	50969	61107	17888	20400	11518	4083	3193	12645	304725
1978	29002	103474	91534	43382	32818	29046	25664	17509	9769	2706	10541	42657	438101
1979	13295	27877	49467	19685	94515	46368	24423	12552	3347	4839	1217	20292	317876
1980	32246	27362	158304	45680	67940	57319	36712	10421	6373	10271	2893	20161	475682
1981	10902	133238	137091	50114	70603	47704	65118	18656	28939	2890	2919	11168	579341
1982	60982	82698	92151	92775	95550	47629	50487	9613	5715	3969	2795	5155	549518
1983	65109	54182	104827	126824	108263	73895	25491	13189	14648	14708	4397	7652	613184
1984	10395	152051	54858	113295	69571	56637	40656	44106	12723	4209	1808	3553	563863
1985	41881	90442	72218	12876	42708	43978	43805	22661	5166	1876	1123	3034	381769
1986	55482	58122	31903	108854	79744	63365	30377	43960	8909	8118	2188	1887	492908
1987	7665	91128	73417	76853	52162	82247	27602	23841	12975	2751	1388	1028	453056
1988	744	17307	77865	54360	42690	59763	60504	38868	14406	4222	1313	4648	376688
1989	30689	86616	64699	77505	41492	60565	59666	10179	2886	2764	1584	897	439543
1990	17218	90669	76727	102193	94906	49673	34370	9623	23261	3928	1747	1357	505670
1991	41278	169774	80807	82241	110915	34176	42609	17326	6350	2035	33030	12203	632744
1992	5537	105158	76721	145472	63005	15427	59352	7606	2908	1490	910	4070	487654
1993	22606	51063	60158	54370	13365	61767	63560	31613	17118	4447	2296	908	383273
1994	6856	15635	85612	72993	92270	69583	30136	18511	17255	5477	1726	4193	420247
1995	12091	80441	129219	84061	82657	65626	35034	9933	3056	1865	7879	2029	513891
1996	49088	173478	78129	53866	57899	21419	49600	25667	7250	2470	1378	1971	522214
1997	54814	64453	78633	149719	66846	122182	52539	37340	40732	33864	4197	29281	734600
1998	74703	56998	90460	98356	44874	38417	15677	8200	5209	8655	2375	815	444738
1999	10546	131312	128324	95334	136201	74178	19523	17981	12040	7616	3410	1850	638314
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	35983.0	79031.6	90039.8	84813.0	68381.6	57372.7	37660.6	19789.1	10868.6	6799.9	4306.6	9111.6	504157.5
med =	32246.0	72521.0	83802.0	83805.0	66846.0	57319.0	35034.0	17509.0	9769.0	4222.0	2554.0	4648.0	487654.0

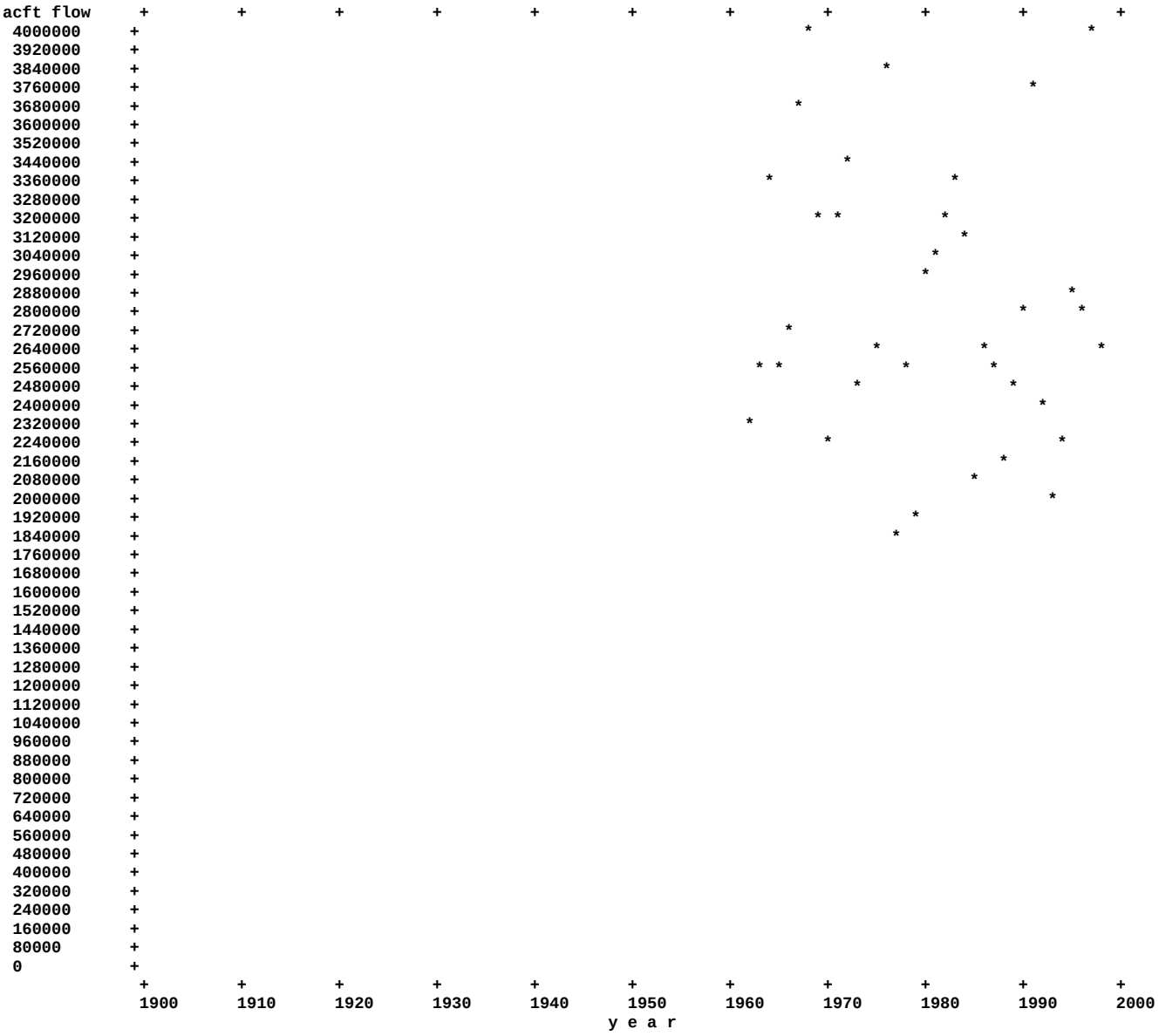
Quillayute River Watershed

Quillayute River at top just below Bogachiel and Soleduck confluence - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
1368362													22693.16
1184341													19641.34
1025069		X	X										16999.93
887215.1			9	X									14713.74
767900.5		9		9	X	X							12735.01
664631.6	X												11022.38
575249.9			7	7	9								9540.05
497889.1		7	5	5	7	9							8257.09
430931.9	9	5	3			7							7146.66
372979.2				3	5		X						6185.56
322820.2		3			3	5	9						5353.71
279406.6	7		1			3	7	X					4633.73
241831.4				1				9					4010.58
209309.4							5		X			X	3471.23
181161	5				1		3	7	9	X	X		3004.41
156798.1						1						9	2600.37
135711.5		1	0				1	5	7	9			2250.67
117460.6				0		0		3					1947.99
101664.3		0			0			1	5				1686.02
87992.25	3						0	0					1459.28
76158.87									3				1263.03
65916.85										7	9	7	1093.18
57052.21										5			946.16
49379.71									1		7		818.92
42739.02	1								0	3		5	708.79
36991.38										1			613.47
32016.7											5	3	530.97
27711										0	3		459.56
23984.36											1		397.76
20758.89												1	344.27
17967.19											0	0	297.97
15550.93													257.90
13459.6	0												223.22
11649.53													193.20
10082.87													167.22
8726.907													144.73
7553.293													125.27
6537.51													108.42
5658.327													93.84
4897.382													81.22
4238.772													70.30
3668.733													60.84
3175.354													52.66
2748.325													45.58
2378.724													39.45
2058.828													34.14
1781.952													29.55
1542.311													25.58
1334.898													22.14
1155.378													19.16
1000													16.58

Quillayute River at top just below Bogachiel and Soleduck confluence - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Quillayute River at top just below Bogachiel and Soleduck confluence - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

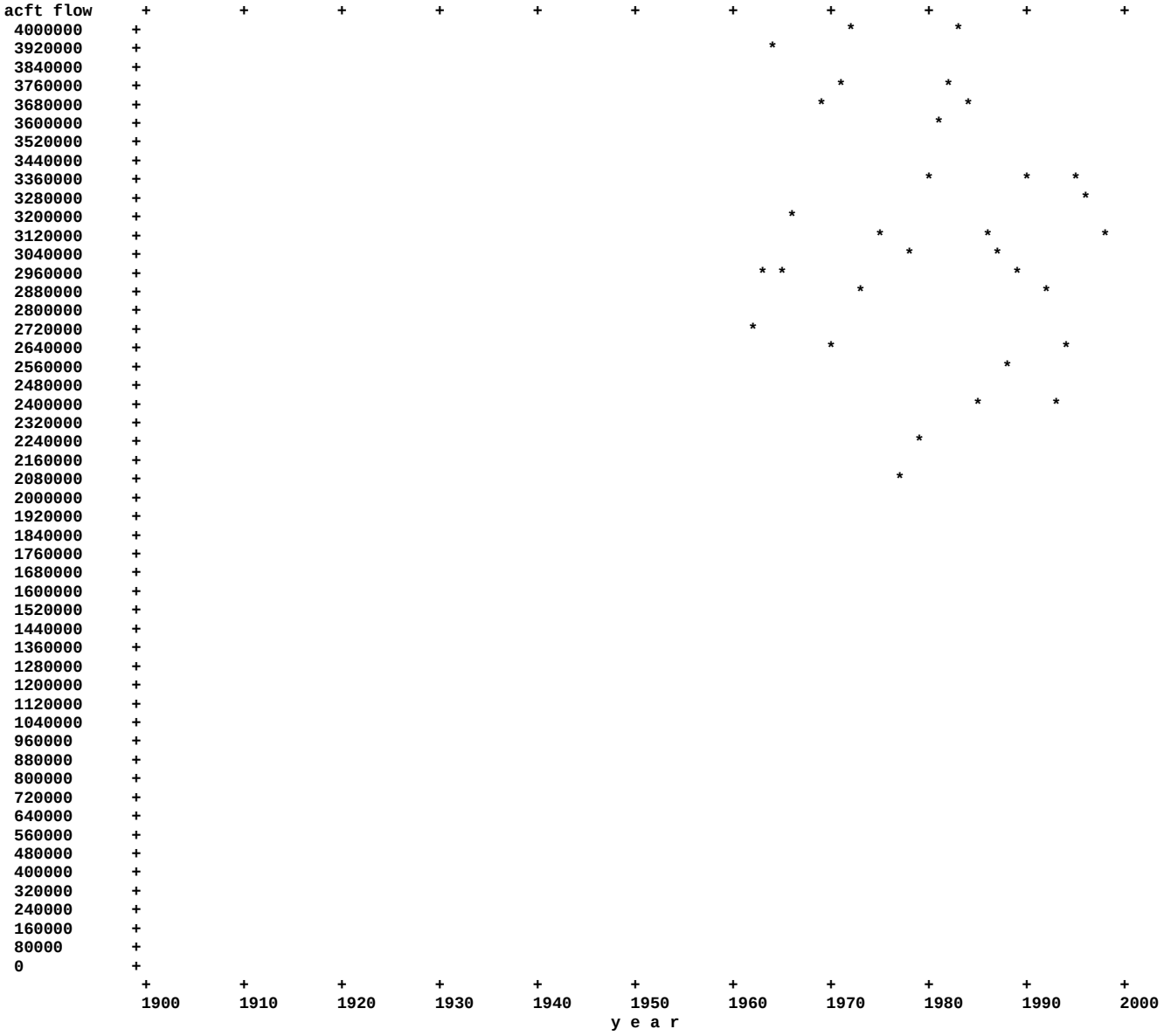
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	210484	295796	481154	311473	164933	178671	230274	156497	115676	62992	48663	38857	2295470
1963	208238	516757	502083	279314	330312	194533	209131	129479	38130	63993	27795	20766	2520531
1964	331594	603042	460835	603252	255447	376974	175197	101999	122486	124443	62629	103374	3321271
1965	178155	310423	321713	559599	565756	128756	140622	167038	48059	27808	26694	21391	2496014
1966	188024	387153	503315	608410	229690	377260	127623	93504	72197	56251	29896	36231	2709556
1967	256388	404276	904038	768732	498780	395949	151473	102381	70978	35217	19896	28177	3636286
1968	608074	302368	646771	801007	487517	384628	214448	113006	92302	50799	43715	181217	3925851
1969	410098	392800	583547	395756	325493	265146	297595	141109	90108	39679	24982	158899	3125212
1970	177510	220569	362075	391665	244392	195615	372679	91805	44610	27183	18300	85156	2231558
1971	187531	304086	527000	705167	396295	460927	192758	130436	102293	74800	37261	62590	3181144
1972	255755	454215	450823	488783	496914	549186	316492	93136	57707	165729	28128	63806	3420673
1973	29851	239566	772753	524059	160948	243972	85889	145204	126157	41152	20975	24848	2415373
1974	285278	547102	710196	683956	535504	573740	278838	276563	157417	121162	46607	34443	4250807
1975	37213	411175	521157	423364	321364	307600	93293	179170	102359	58641	98786	56858	2610981
1976	549904	647184	736546	488182	340486	309190	189131	189154	126683	89919	55873	43325	3765576
1977	60680	126122	245967	190016	269036	318564	165715	143420	97645	42263	38263	72069	1769757
1978	140637	579677	595593	266903	203689	164729	135533	140750	76027	36911	44438	164494	2549380
1979	71712	150228	242462	108999	491002	309502	167180	122040	57799	57651	27408	85161	1891145
1980	165492	120764	938679	325057	439940	299807	247393	103781	77283	60075	30621	71201	2880094
1981	83767	667433	622461	227721	421549	252327	276860	141491	161809	35845	30364	81190	3002818
1982	299164	416623	531130	521388	542182	285620	270301	97984	94058	57041	35729	24989	3176209
1983	330959	269448	487087	552204	598225	467995	151854	112622	111157	109404	84324	55013	3330288
1984	69184	754800	277156	566100	378567	313000	193879	255504	118097	60760	29297	39600	3055943
1985	254166	495067	301788	119471	135707	143898	243615	150340	76866	35096	20929	39016	2015958
1986	270188	269951	129756	536045	452701	297579	159180	256365	89952	55699	24842	22063	2564321
1987	72131	461591	301197	405370	295244	472078	183636	160243	114806	41654	21815	17904	2547667
1988	12100	103691	397569	244064	234625	317246	307558	239263	124445	58647	28470	39673	2107350
1989	151012	475979	306586	443194	198655	325865	282914	89599	62156	59997	30729	19244	2445928
1990	127490	512921	346424	441939	519176	274535	139389	119483	195720	50179	29182	23218	2779656
1991	233434	977401	497770	463913	651033	199609	259841	116025	64273	38026	159811	85252	3746387
1992	28209	358604	378595	663789	368583	104015	229571	121404	40809	24886	17899	43936	2380299
1993	98980	262337	239139	246016	89136	258996	315776	215956	138532	46054	30279	19708	1960908
1994	54556	89466	389270	345965	364956	402728	199978	88407	142151	53503	24538	35020	2190537
1995	83992	303694	758144	416299	494116	364182	184105	80473	49144	32081	50728	25436	2842393
1996	251070	801750	391047	280015	286413	132511	240677	183636	74115	39855	23617	31052	2735760
1997	228342	293023	505383	748306	301861	740421	314754	237545	193970	181146	50722	136513	3931985
1998	422589	335347	377142	558300	307115	248769	103434	87908	60861	57565	24844	16304	2600176
1999	68963	711943	801730	597024	699768	452661	194508	196277	127928	96971	53885	28065	4029721
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	197182.0	409851.9	488054.8	455284.6	370976.6	318125.9	211660.4	146605.2	97809.6	62396.8	39550.9	56212.1	%2853709.8
med =	178155.0	387153.0	481154.0	443194.0	340486.0	307600.0	194508.0	130436.0	92302.0	55699.0	29896.0	39016.0	%2709556.0

Quillayute River below Dickey River - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
1606046													26634.96
1385616													22979.31
1195439		X	X										19825.39
1031365			9	X									17104.35
889809.7		9		9	X	X							14756.77
767683	X			7	9								12731.40
662318.9		7	7										10984.02
571415.4			5	5	7	9							9476.46
492988.5	9	5	3		5	7	X						8175.81
425325.7				3			9						7053.68
366949.6		3			3	5		X					6085.56
316585.6	7		1	1		3	7	9					5250.32
273134.2													4529.71
235646.4	5						5		X	X		X	3908.00
203303.8					1	1	3	7	9		X		3371.63
175400.3			0									9	2908.87
151326.7		1					1	5	7	9			2509.63
130557.1				0		0		3					2165.18
112638.1		0			0		0	1	5				1868.01
97178.47	3							0					1611.63
83840.69									3			7	1390.43
72333.53										7	9		1199.59
62405.73										5			1034.95
53840.52									1		7		892.90
46450.89	1								0	3		5	770.35
40075.49													664.62
34575.12										1	5	3	573.40
29829.7										0	3		494.70
25735.56													426.80
22203.35											1	1	368.22
19155.93											0	0	317.69
16526.78													274.08
14258.47	0												236.47
12301.49													204.01
10613.11													176.01
9156.454													151.85
7899.728													131.01
6815.488													113.03
5880.065													97.52
5073.025													84.13
4376.75													72.58
3776.04													62.62
3257.777													54.03
2810.646													46.61
2424.884													40.21
2092.068													34.70
1804.932													29.93
1557.204													25.82
1343.478													22.28
1159.085													19.22
1000													16.58

Quillayute River below Dickey River - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Quillayute River below Dickey River - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	254504	352386	566809	360973	195850	218212	268969	176578	127928	66665	55322	44780	2688974
1963	244107	605337	585885	327021	382252	228307	245550	149017	41413	73859	31064	22788	2936601
1964	389297	708345	540798	709905	299723	446388	203619	114479	134149	141038	70904	121058	3879701
1965	209614	364612	378049	662668	667291	148726	161977	193171	51731	29462	29743	23942	2920987
1966	221829	455184	592832	717140	270683	446154	143607	103106	78765	61717	32645	41801	3165460
1967	303430	476797	1059546	906146	590695	467258	178388	114177	74849	36712	20806	31950	4260753
1968	713249	354639	760616	939912	569247	452828	252876	129040	104428	56916	50338	213974	4598065
1969	484595	461261	686672	466965	387562	310461	348308	156269	97938	43462	27436	187186	3658116
1970	209254	258740	424817	459550	285629	228767	438596	105035	47744	29297	19702	100016	2607146
1971	222399	355829	620972	832594	464360	544129	224531	143514	112896	80613	39815	72859	3714512
1972	303600	533677	532799	575316	584272	639730	370592	102099	60081	191160	30305	73853	3997484
1973	33962	279963	910179	616974	188790	286720	99252	166638	144627	45706	22714	27689	2823215
1974	336790	657096	829534	809933	638136	678370	328400	319575	175656	135311	49753	36652	4995205
1975	41005	495196	608225	499068	382165	364044	116668	207549	114188	64580	115258	62822	3070768
1976	648833	792480	866931	571987	433715	380141	214417	212469	141222	102414	61737	51355	4477701
1977	72533	150812	293694	228666	320005	379671	183603	163820	109162	46346	41456	84714	2074482
1978	169638	683151	687127	310285	236507	193775	161197	158259	85796	39617	54979	207150	2987481
1979	85007	178105	291929	128684	585517	355870	191603	134593	61146	62490	28625	105453	2209022
1980	197738	148126	1096983	370738	507880	357126	284104	114202	83656	70347	33514	91361	3355776
1981	94669	800671	759552	277834	492152	300031	341978	160147	190748	38735	33282	92358	3582159
1982	360146	499321	623281	614163	637732	333249	320788	107596	99773	61010	38524	30144	3725727
1983	396067	323630	591914	679027	706487	541890	177345	125811	125804	124112	88720	62665	3943472
1984	79578	906852	332014	679395	448138	369638	234535	299611	130820	64969	31105	43153	3619806
1985	296047	585509	374006	132347	178415	187876	287420	173001	82031	36972	22052	42050	2397727
1986	325670	328073	161658	644898	532445	360944	189557	300325	98861	63817	27030	23950	3057229
1987	79796	552719	374613	482223	347406	554325	211238	184084	127780	44405	23203	18931	3000723
1988	12843	120998	475433	298424	277315	377009	368062	278131	138851	62869	29783	44320	2484038
1989	181702	562595	371285	520699	240147	386430	342580	99778	65042	62761	32313	20140	2885471
1990	144708	603590	423151	544132	614082	324208	173759	129106	218981	54107	30929	24575	3285326
1991	274712	1147175	578577	546154	761948	233785	302450	133351	70622	40061	192841	97455	4379131
1992	33746	463762	455316	809261	431588	119442	288923	129010	43717	26376	18808	48006	2867953
1993	121586	313400	299297	300386	102501	320763	379336	247570	155651	50501	32576	20616	2344181
1994	61412	105100	474882	418958	457226	472311	230114	106917	159406	58981	26264	39213	2610784
1995	96083	384135	887363	500360	576773	429808	219139	90405	52200	33946	58607	27466	3356284
1996	300159	975228	469176	333881	344313	153930	290277	209303	81365	42325	24995	33023	3257974
1997	283156	357475	584016	898025	368707	862603	367293	274885	234702	215010	54919	165794	4666585
1998	497292	392345	467602	656655	351989	287186	119111	96108	66069	66220	27219	17119	3044914
1999	79509	843255	930054	692358	835968	526840	214030	214258	139967	104587	57295	29915	4668035
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	233164.9	488883.4	578094.3	540097.5	439358.2	375498.6	249320.8	166394.4	108678.0	69196.7	43857.4	65323.6	%3357867.8
med =	209614.0	461261.0	566809.0	544132.0	431588.0	360944.0	230114.0	149017.0	99773.0	61010.0	32313.0	43153.0	%3165460.0

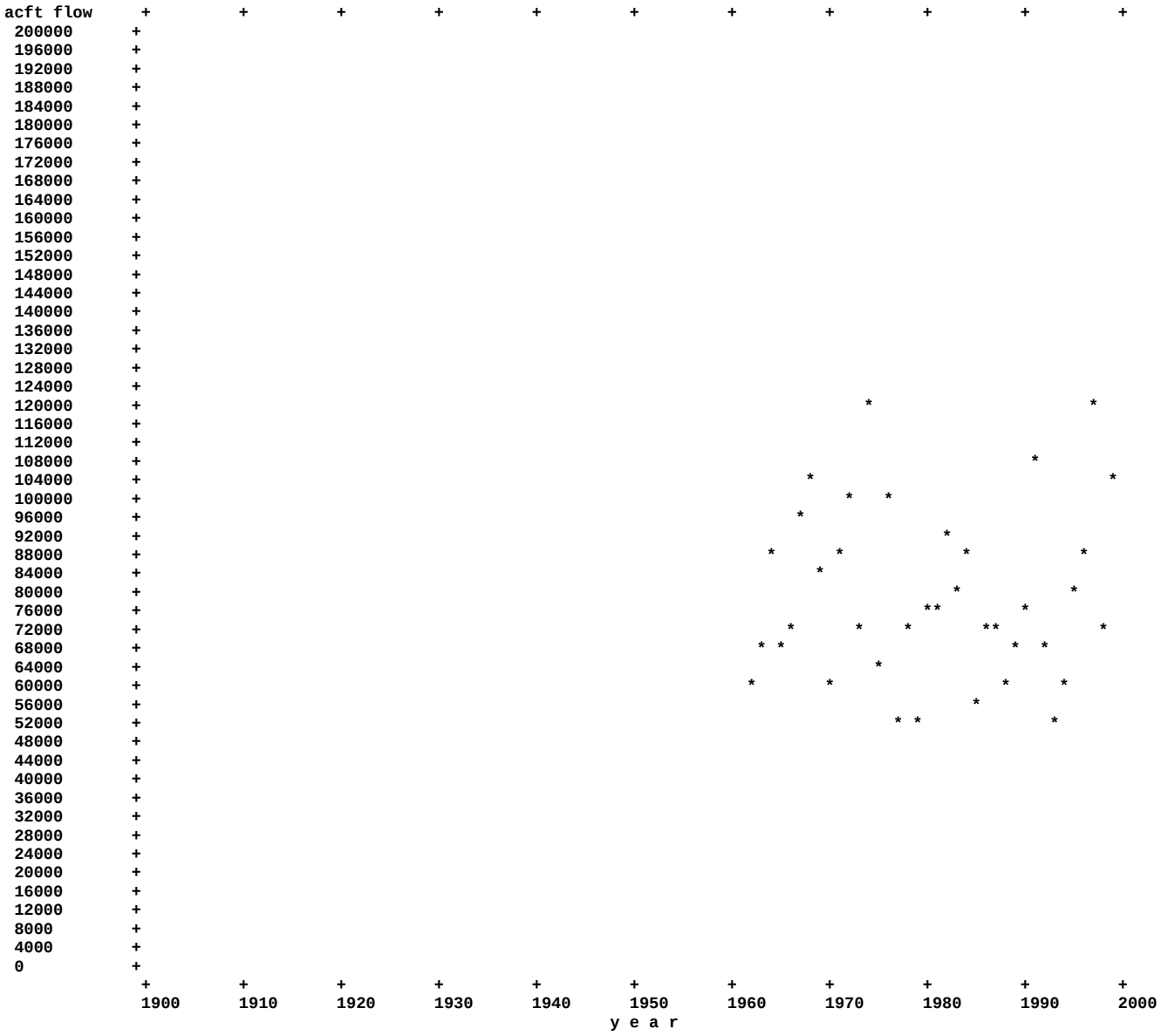
Ozette River watershed

Big River Gage 0000186997 at 27E Big River Bridge - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
39365.22													652.84
36577.2													606.60
33986.63													563.64
31579.54													523.72
29342.93		X											486.63
27264.73													452.16
25333.72			X	X									420.14
23539.47													390.38
21872.32		9	9	9	X								362.73
20323.22						X							337.04
18883.84													313.17
17546.4				7	9								290.99
16303.68	X												270.38
15148.98			7										251.23
14076.06		7				9							233.44
13079.13			5	5	7								216.91
12152.81													201.54
11292.09			3	3									187.27
10492.33	9	5			5	7	X						174.01
9749.217													161.68
9058.732							9						150.23
8417.152		3				5							139.59
7821.019			1		3								129.71
7267.098				1			7	X		X			120.52
6752.409	7					3			X			X	111.98
6274.172								9					104.05
5829.807													96.68
5416.914					1		5				X		89.84
5033.263	5												83.47
4676.784		1											77.56
4345.553						1	3						72.07
4037.781													66.96
3751.807								7				9	62.22
3486.087			0										57.81
3239.186									9				53.72
3009.772				0			1			9			49.91
2796.608													46.38
2598.539						0	0	5					43.09
2414.499													40.04
2243.493	3	0						3					37.21
2084.6													34.57
1936.959					0				7				32.12
1799.774													29.85
1672.306													27.73
1553.866											9		25.77
1443.814								1				7	23.94
1341.557									5				22.25
1246.542													20.67
1158.256										7			19.21
1076.223													17.85
1000								0	3				16.58

Big River Gage 0000186997 at 27E Big River Bridge - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Big River Gage 0000186997 at 27E Big River Bridge - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

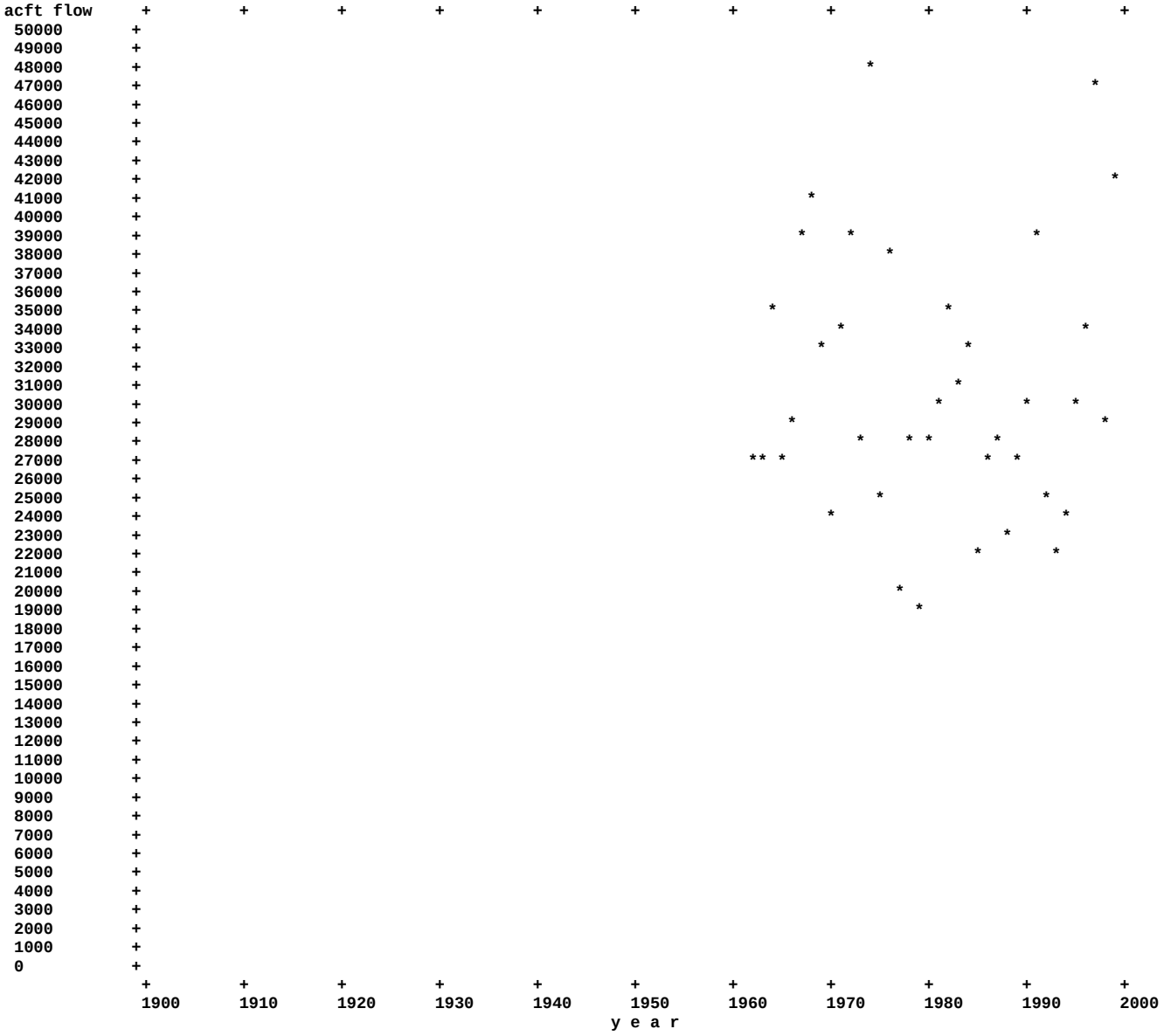
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	4583	6980	12319	10646	4981	4224	6166	2069	1299	620	1120	1106	56112
1963	5981	14773	12481	7542	8391	5398	5535	3643	661	1564	576	356	66903
1964	8247	15225	12291	16491	7157	10901	5011	2545	2179	2833	1467	2581	86926
1965	4843	8018	9066	16559	14901	3149	3421	4224	725	237	388	356	65888
1966	4612	9926	11855	18003	6413	10722	3149	1620	1195	1077	492	832	69895
1967	6484	10058	23468	21451	14655	11233	3972	2128	778	218	170	440	95056
1968	15516	8542	16755	20605	12688	9667	5608	2278	1549	985	872	5563	100627
1969	10268	9808	15230	10507	10183	8034	7704	2318	1278	628	374	3750	80082
1970	4954	5575	9776	10543	6856	5349	10435	2404	692	456	304	2557	59902
1971	5024	8357	15361	19734	11514	12771	4967	2110	1673	1061	457	1273	84302
1972	6730	13272	13324	16503	15189	15346	8730	1846	480	3351	395	1130	96296
1973	595	7134	22771	16887	5263	7060	2487	3339	2990	924	245	356	70049
1974	8156	17394	18972	20094	16404	16488	7848	6796	3020	2356	531	373	118432
1975	486	8805	13025	11659	7182	6614	2438	4676	1907	888	2697	1346	61725
1976	15543	17057	20044	13480	9323	8116	4875	3582	1866	1236	787	752	96660
1977	2198	3967	7362	7070	8448	9741	2969	3343	1871	756	523	2559	50807
1978	4712	15654	14014	7770	5675	4683	4192	2925	1615	566	1678	6471	69955
1979	1860	4470	7631	4163	14937	7481	3998	2201	664	860	209	3110	51584
1980	4756	4389	24410	8106	10899	9171	5883	1887	1114	1601	475	3090	75781
1981	1375	16269	15304	4253	10376	5778	10467	3846	4392	1015	284	1668	75026
1982	9422	12839	12718	20365	18173	6751	7035	1116	552	426	436	606	90437
1983	5645	7846	12011	14553	15781	8587	2952	966	1115	6890	741	1285	78372
1984	1617	23019	6808	19431	11044	9425	5127	6790	2023	758	238	600	86879
1985	6613	13803	8551	2848	4683	4740	6355	3478	947	242	176	512	52949
1986	8778	7262	3348	15664	12844	8141	4237	6768	1482	1311	364	319	70516
1987	1202	12844	8293	11602	9613	13207	4793	3666	2058	551	212	183	68225
1988	158	3454	11165	6798	6577	9839	8492	6000	2260	760	207	784	56494
1989	4757	13499	9416	12926	5364	9945	8151	1356	488	553	266	172	66893
1990	2640	15915	10099	12672	15926	7616	3866	1713	3825	719	294	224	75508
1991	6514	27833	14741	13176	18472	5282	7126	2401	1117	449	5151	2037	104299
1992	877	10521	10912	19212	10265	2594	5965	2470	491	220	176	687	64389
1993	3436	7159	6741	6977	1824	7015	8596	5091	2839	792	381	173	51024
1994	1079	2156	10844	10031	11223	11370	5100	1462	2861	938	233	707	58003
1995	1873	8525	21471	11534	13266	10606	4877	1377	516	315	1323	343	76025
1996	7772	28118	12011	9231	9434	3679	7720	4197	1245	511	212	333	84464
1997	8674	9918	12097	24104	10763	19453	8318	5868	6425	5290	708	4541	116158
1998	11433	8863	14094	15781	7426	6353	2715	1376	953	1386	394	164	70937
1999	1640	20995	20490	15327	21720	11586	3306	3020	1926	1240	557	313	102120
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	5290.9	11585.3	13191.3	13271.0	10679.8	8634.6	5647.0	3128.8	1712.4	1225.9	687.2	1411.9	76465.8
med =	4757.0	9918.0	12291.0	12926.0	10265.0	8116.0	5100.0	2470.0	1299.0	792.0	394.0	707.0	70937.0

Umbrella Creek at Makah Gage at Hoko-Ozette Rd Bridge - Total monthly streamflow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	avg cfs
12752.6													211.49
12119.55													200.99
11517.94													191.02
10946.18													181.53
10402.81													172.52
9886.411													163.96
9395.646		X	X										155.82
8929.243		9		X									148.08
8486.001													140.73
8064.753					X								133.75
7664.416			9	9									127.11
7283.952						X							120.80
6922.374													114.80
6578.745													109.10
6252.174	X			7									103.69
5941.814			7		9								98.54
5646.86													93.65
5366.548													89.00
5100.151		7				9							84.58
4846.978			5		7								80.38
4606.373				5									76.39
4377.71	9												72.60
4160.403		5											69.00
3953.88			3	3	5	7	X						65.57
3757.608							9						62.32
3571.079													59.22
3393.809					3			X					56.28
3225.34	7	3				5							53.49
3065.233			1										50.83
2913.073							7		X				48.31
2768.468						3							45.91
2631.04								9					43.63
2500.434												X	41.47
2376.313					1		5			X			39.41
2258.352	5			1									37.45
2146.247											X		35.59
2039.706						1							33.83
1938.455		1											32.15
1842.229							3						30.55
1750.78								7					29.04
1663.872												9	27.59
1581.277													26.22
1502.781									9				24.92
1428.183										9			23.69
1357.287													22.51
1289.911			0			0							21.39
1225.88	3						1	5					20.33
1165.027					0								19.32
1107.195				0									18.36
1052.233		0											17.45
1000								3					16.58

Umbrella Creek at Makah Gage at Hoko-Ozette Rd Bridge - Total monthly streamflow in ac-ft
hydrograph of annual recorded flows



Umbrella Creek at Makah Gage at Hoko-Ozette Rd Bridge - Total monthly streamflow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

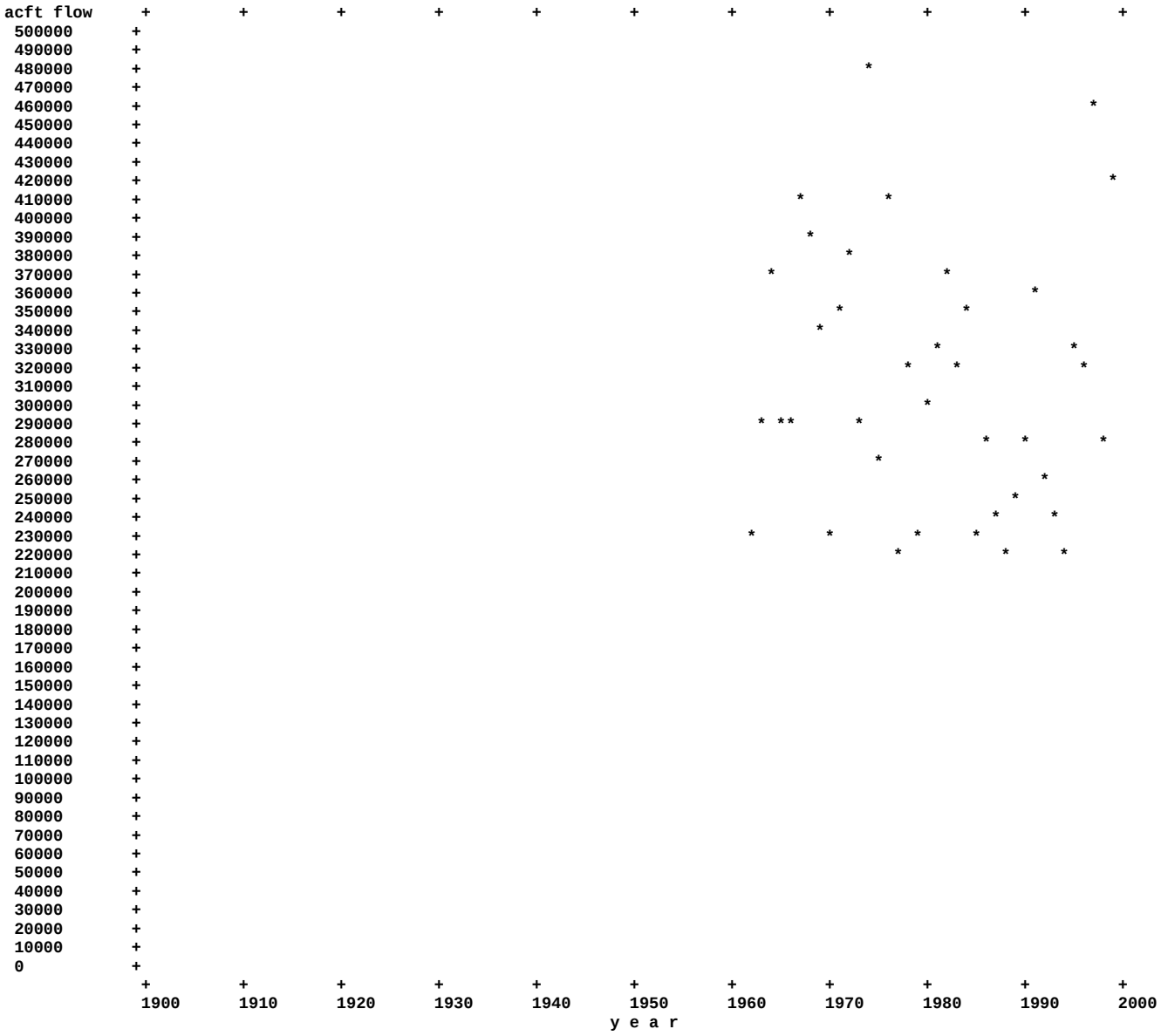
YEAR	oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	ann
1962	2730	3179	4412	3330	2505	2864	3269	1936	633	314	645	601	26416
1963	2636	5793	5075	2816	3246	2150	2309	1556	249	646	227	175	26877
1964	3386	5934	4655	6330	2783	4054	2032	974	832	1384	842	1240	34445
1965	1959	3185	3965	5973	5886	1233	1332	1685	437	213	264	250	26382
1966	1857	3975	4879	6804	2608	4024	1214	629	487	670	373	531	28050
1967	3146	4292	8514	7883	5755	4684	1830	1056	464	148	100	256	38128
1968	6025	3076	6413	7618	5140	4162	2878	854	605	580	500	2414	40264
1969	4344	4209	5935	4156	3635	2679	2987	1129	734	372	216	1605	32001
1970	2231	2477	3673	3967	2447	1985	3854	1166	417	268	182	1201	23868
1971	2259	3151	5781	7363	4218	5132	2235	1039	927	624	263	722	33714
1972	3223	4906	5058	6334	5923	5574	3856	1172	282	1482	229	558	38596
1973	350	3001	8403	5717	2354	2992	1202	1565	1443	544	186	221	27978
1974	3672	9108	6610	7077	5600	4968	3573	3243	1440	1180	311	223	47005
1975	647	3977	5078	3926	3440	2313	908	1695	745	411	1008	560	24707
1976	5831	6401	7527	4794	3746	3577	1581	885	1059	598	686	746	37428
1977	995	1740	2944	2252	3383	3269	1145	1110	805	538	397	981	19561
1978	1506	6609	6025	2789	2111	1814	1570	1211	633	272	993	1971	27504
1979	710	1891	2933	1086	4605	2876	1534	758	357	401	201	816	18167
1980	1521	1664	9108	2811	3805	3390	1898	598	425	645	338	1149	27351
1981	683	6114	5754	1593	3892	2139	3928	1450	2021	498	220	760	29051
1982	3991	4833	4788	7644	6825	2496	2601	543	276	266	279	379	34922
1983	2364	2906	4524	5473	5932	3189	1145	495	480	2340	588	1011	30447
1984	1064	8636	2517	7296	4162	2873	1934	2580	767	352	174	396	32749
1985	3108	4858	3928	1100	1938	2281	2146	1032	407	185	130	484	21597
1986	3228	2892	1286	4573	4648	3456	1607	2683	600	704	246	329	26252
1987	753	4588	3183	4147	3069	4716	2633	2299	1048	323	141	117	27018
1988	96	2237	3989	2638	2558	3469	3256	2348	1126	451	135	407	22709
1989	2622	4817	3302	4617	2804	3511	2903	699	286	310	174	102	26148
1990	1695	5139	3571	4528	5349	2936	2358	1085	1759	419	174	149	29162
1991	3156	8915	4978	4705	6130	2086	2758	1537	675	261	2146	1002	38346
1992	543	3738	3892	6353	3637	1664	2335	1582	291	154	109	382	24679
1993	1606	2770	2618	2704	1158	2718	3294	2722	1380	477	219	103	21767
1994	673	1008	3866	3544	4010	4063	2725	921	1387	535	167	398	23298
1995	1189	3790	7028	4122	4736	3772	2658	866	305	187	721	209	29583
1996	3079	9109	4928	4019	4086	2303	3073	1923	721	299	144	200	33882
1997	3191	4246	4955	8813	4529	7257	3147	2592	2817	2343	402	1976	46266
1998	4278	3461	3909	6108	3440	3106	1744	716	574	758	230	97	28420
1999	1037	7740	7582	5966	7967	4795	2138	1948	1042	700	319	185	41417
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	2299.6	4483.3	4936.5	4815.0	4054.2	3330.8	2357.6	1428.5	814.1	601.4	386.3	655.4	30162.0
med =	2231.0	3977.0	4788.0	4573.0	3805.0	3106.0	2309.0	1166.0	633.0	451.0	230.0	407.0	28050.0

OZETTE RIVER below Coal Creek - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
157147.2													2606.16
142030.1													2355.45
128367.2													2128.87
116018.8		X											1924.08
104858.1			X	X									1738.99
94771.12													1571.70
85654.42				9	X								1420.51
77414.73			9		9	X							1283.86
69967.66				7		9							1160.36
63237.04			7	5	7								1048.73
57153.83		9				7	X						947.85
51655.8													856.67
46686.67			5		5	5							774.26
42195.55	X		3	3			9						699.78
38136.51		7			3			X	X				632.46
34467.89	9					3							571.62
31152.18		5	1	1			7	9		X			516.63
28155.44					1								466.94
25446.97						1	5						422.02
22999.07							3					X	381.42
20786.63													344.73
18787.02				0				7	9				311.57
16979.76		3			0	0	1						281.60
15346.36			0					5					254.51
13870.1										9			230.02
12535.84	7							3			X		207.90
11329.93		1											187.90
10240.03									7				169.82
9254.966												9	153.49
8364.666	5						0						138.72
7560.018								1					125.38
6832.767											9		113.32
6175.475	3								5			7	102.42
5581.413										7			92.56
5044.498													83.66
4559.237								0	3	5			75.61
4120.652		0											68.34
3724.258													61.76
3365.996													55.82
3042.197										3			50.45
2749.548											7		45.60
2485.05									1				41.21
2245.997									0				37.25
2029.939											5		33.66
1834.665													30.43
1658.176										1	3	5	27.50
1498.665													24.85
1354.498	1												22.46
1224.2												3	20.30
1106.435											1		18.35
1000										0	0	1	16.58

OZETTE RIVER below Coal Creek - Total monthly flow in ac-ft
hydrograph of annual recorded flows



OZETTE RIVER below Coal Creek - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

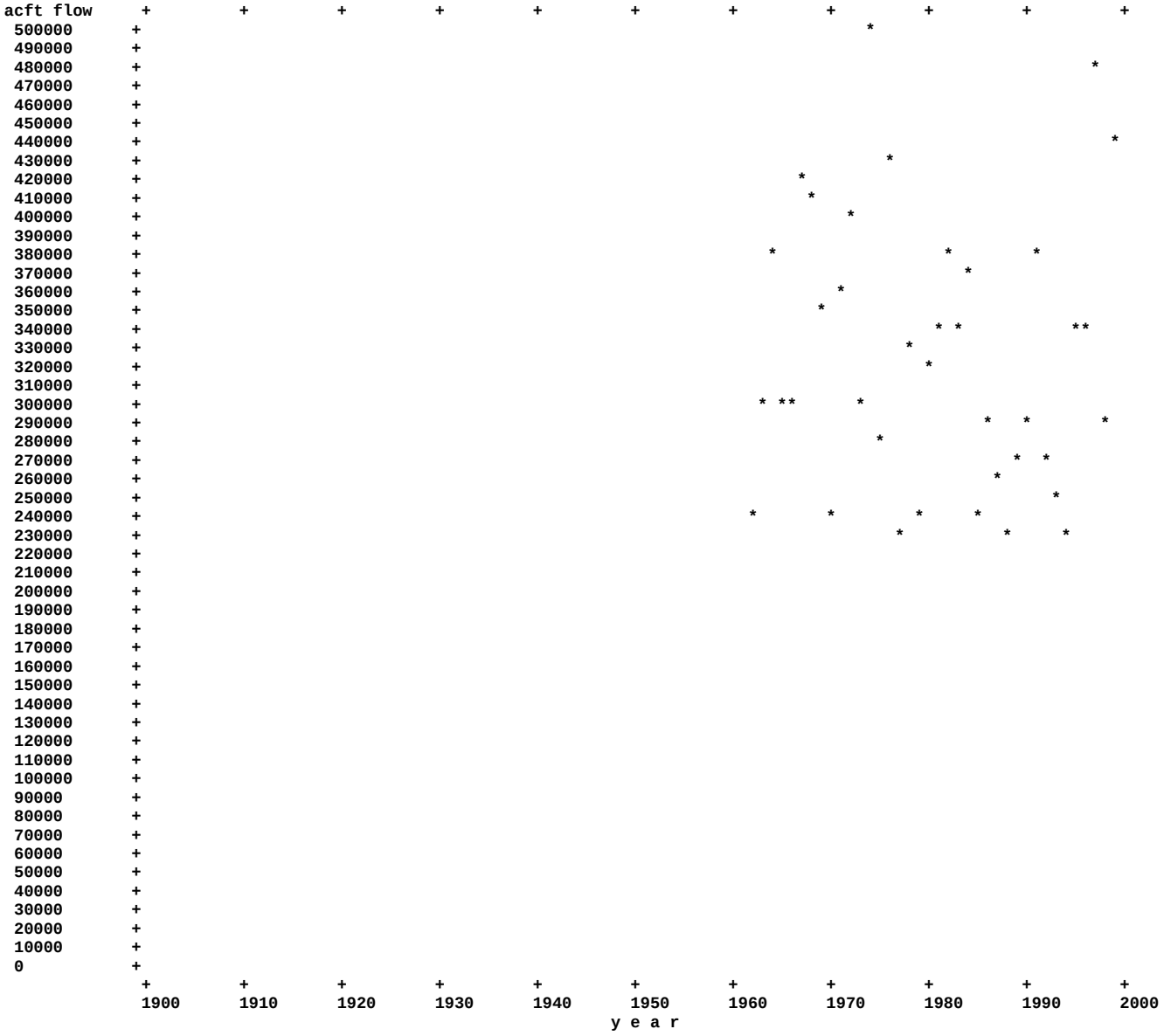
YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
1962	7594	11115	42609	62226	27921	24015	19441	10969	6029	2789	1564	5009	221282
1963	9826	37507	61883	46759	44636	30044	21092	20979	2958	7565	2610	951	286811
1964	12355	40139	69632	74346	38762	55891	34086	14831	7424	4146	6984	3594	362191
1965	8045	12165	35006	63492	80033	38824	19806	16773	3231	1578	1885	1770	282608
1966	7644	15729	39609	70348	52272	55120	18365	7911	5468	4863	2279	1307	280914
1967	10508	32153	92402	98342	69101	57243	22703	11413	3461	1386	912	1008	400633
1968	41884	26128	49668	81284	71305	50479	31107	12582	7474	4411	3882	9209	389413
1969	33087	31075	40168	61547	52771	42959	41391	12906	5914	2823	1834	6040	332516
1970	8233	9228	15282	34340	43313	29795	53876	21279	3087	2141	1731	3543	225849
1971	8349	22763	40953	77886	66273	62908	33867	11281	8242	4782	2144	1714	341163
1972	10817	29432	47468	63218	70708	71167	46211	17989	2234	14950	1912	1574	377682
1973	2686	11290	45941	86882	35343	38292	21681	19370	17514	4121	1822	951	285893
1974	12282	53891	64821	79326	74116	74339	42076	37007	17675	13215	2433	1832	473013
1975	1040	12862	46007	66910	38883	36115	13906	17156	9802	3956	12424	6290	265351
1976	42044	51648	72560	79130	55675	43345	23194	11528	9810	7120	6016	7474	409545
1977	5950	13482	25214	30534	30486	47145	24480	15013	12712	6141	3025	5802	219984
1978	11768	50898	70673	40211	29808	23153	23750	17367	12182	5570	5373	22403	313156
1979	14527	18579	28705	17332	39138	54579	21876	12883	5296	3614	1811	7202	225542
1980	13977	15276	62625	47099	50244	45608	29044	7028	4802	5812	3617	11190	296321
1981	8313	47993	67062	41229	34670	30509	34960	20887	18749	7886	2128	7208	321595
1982	35456	44804	55539	57256	77586	44833	27711	11439	2483	1500	1006	1286	360898
1983	9170	29113	45974	54738	53292	55682	24622	6618	3118	19868	7774	6367	316338
1984	5182	65160	46378	59116	47829	40401	29830	27413	14716	4666	1654	1484	343830
1985	20416	37443	52139	24040	15857	23120	26142	17140	4835	1807	951	1166	225057
1986	12802	36357	20752	34784	40213	46913	28652	29752	14792	5563	2152	1206	273939
1987	1715	18565	40182	46314	35653	43028	24141	14016	10185	3182	1201	930	239113
1988	787	6503	39522	25638	26810	29839	36698	24547	15415	3993	1362	1340	212455
1989	7668	37890	37785	58276	28975	32850	29850	8268	2854	2652	1366	1078	249511
1990	3518	44307	43418	37549	62874	35484	13711	7318	16557	5538	1569	1310	273153
1991	10437	58389	75303	48543	64100	34838	23012	10564	4311	2074	6671	19508	357748
1992	4143	26308	46866	49062	58892	25342	15356	19815	4287	1952	969	1058	254051
1993	5991	32603	35193	32529	21757	24320	29647	29384	16591	4969	1903	1107	235995
1994	1344	4034	38724	39069	37336	61476	7864	8435	7432	4938	1633	800	213086
1995	2386	12565	83129	58395	64616	54621	27390	6461	2373	924	6159	2141	321160
1996	11944	112248	60178	36232	29522	16096	23414	16755	5737	2354	1319	936	316735
1997	12668	15707	41556	95117	55299	76726	50650	32411	35183	29498	3157	7518	455490
1998	21178	32425	51274	59589	46176	33915	16324	4336	2305	1825	1060	788	271195
1999	1326	38840	96510	71305	84941	66592	29691	12298	5886	3246	1607	1166	413408
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	11554.2	31489.8	50755.5	55526.1	48873.3	43621.2	27411.0	15897.9	8766.4	5511.0	2892.1	4138.4	306437.5
med =	8349.0	29432.0	46007.0	57256.0	46176.0	42959.0	24622.0	14016.0	5914.0	4121.0	1885.0	1574.0	286811.0

OZETTE RIVER at the ocean outlet - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
164263.5													2724.18
148330.3													2459.94
133942.8													2221.33
120950.7		X											2005.87
109218.9			X	X									1811.31
98624.97													1635.61
89058.6				9	X								1476.96
80420.23			9		9	X							1333.70
72619.68				7		9							1204.34
65575.83			7	5	7								1087.52
59215.14		9				7	X						982.04
53471.43			5										886.78
48284.89	X				5	5							800.77
43601.38		7	3	3			9						723.09
39372.16					3			X	X				652.96
35553.2	9					3							589.62
32104.64		5	1	1			7	9		X			532.43
28990.6					1								480.79
26178.59						1	5						434.15
23639.33							3					X	392.04
21346.4													354.01
19275.86		3		0				7	9				319.67
17406.17			0		0	0	1						288.67
15717.81								5					260.67
14193.23	7									9	X		235.38
12816.53		1											212.55
11573.36								3	7				191.93
10450.79												9	173.32
9437.089	5						0						156.51
8521.717													141.33
7695.14								1			9		127.62
6948.731	3											7	115.24
6274.729									5				104.06
5666.097										7			93.97
5116.5													84.85
4620.218		0						0	3				76.62
4172.069										5			69.19
3767.389													62.48
3401.966													56.42
3071.984										3			50.95
2774.011									1		7		46.00
2504.94									0				41.54
2261.969													37.51
2042.565											5		33.87
1844.442													30.59
1665.536										1	3	5	27.62
1503.984	1												24.94
1358.103												3	22.52
1226.371													20.34
1107.416											1		18.37
1000										0	0	1	16.58

OZETTE RIVER at the ocean outlet - Total monthly flow in ac-ft
hydrograph of annual recorded flows



OZETTE RIVER at the ocean outlet - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
1962	8383	12328	44823	64129	28779	24742	20508	11069	6095	2824	1773	5066	230517
1963	10860	40166	64126	47120	46108	30975	22047	21151	2995	7847	2643	975	297012
1964	13800	42880	71840	77317	40007	57843	34949	15275	7529	4638	7057	4043	377178
1965	8879	13568	36604	66476	82715	38974	20397	16973	3271	1599	1910	1793	293157
1966	8438	17491	41738	73593	53383	57038	18514	7990	5688	4919	2308	1352	292453
1967	11632	33942	96641	102214	71739	59259	23387	11516	3503	1405	924	1035	417196
1968	44678	27628	52686	85002	73585	52192	32075	12692	7551	4462	3928	10169	406648
1969	34916	32815	42910	63422	54583	44365	42735	13018	5979	2858	1859	6686	346147
1970	9087	10190	17016	36223	44503	30718	55737	21394	3125	2169	1752	3988	235903
1971	9215	24229	43719	81446	68340	65203	34102	11383	8324	4836	2172	1948	354917
1972	11985	31819	49864	66191	73443	73930	47746	18079	2263	15528	1938	1632	394417
1973	2720	12530	50052	89925	36251	39520	21800	19529	17657	4169	1844	974	296971
1974	13710	57026	68242	82952	77071	77309	43447	38186	17819	13328	2464	1856	493411
1975	1070	14411	48348	69003	40132	37262	14023	17962	9895	4003	12893	6357	275359
1976	44843	54722	76177	81554	57323	44766	23428	11996	9965	7202	6107	7581	425664
1977	6480	13741	26820	31758	32334	48930	24648	15593	12825	6213	3075	6332	228750
1978	12580	54526	73979	41731	30954	24135	24598	18043	12270	5600	5922	23563	327904
1979	14889	19604	30305	17490	41660	55010	22734	12989	5340	3664	1830	7638	233154
1980	14798	16175	67357	48632	52324	47460	30142	7109	4857	5901	3658	11842	310254
1981	8408	51348	70218	42089	36799	31671	37109	21102	19859	7952	2150	7616	336322
1982	37640	47453	58162	61456	81334	46191	29127	11512	2515	1530	1037	1334	379290
1983	10456	30698	48452	57740	56546	57423	24790	6856	3181	21382	7854	6515	331894
1984	5746	69907	47748	63123	50107	41968	30879	28817	14825	4709	1677	1534	361040
1985	22113	40105	54288	24201	16908	24360	27308	17290	4887	1830	972	1229	235490
1986	14565	37934	21443	37289	42760	48802	29520	31414	14874	5659	2178	1245	287683
1987	1776	20873	41635	48397	37356	45402	24967	14648	10547	3299	1219	945	251065
1988	798	7099	41526	26818	27950	31585	38189	25584	15811	4143	1380	1382	222265
1989	8487	40318	39450	60600	29900	34616	31277	8515	2883	2684	1385	1091	261205
1990	3977	47173	45215	39826	65742	36813	14377	7623	17216	5682	1590	1328	286561
1991	11565	63420	77956	50912	67430	35748	24251	10983	4519	2101	7558	19867	376312
1992	4312	28187	48821	52527	60720	25794	16387	20246	4394	1971	982	1096	265437
1993	6584	33849	36363	33741	22081	25539	31157	30261	17083	5125	1928	1120	244831
1994	1399	4413	40666	40852	39350	63517	8742	8699	7928	5117	1654	839	223178
1995	2478	14062	87004	60465	67001	56516	28230	6712	2404	946	6401	2164	334381
1996	13301	117331	62336	37862	31190	16730	24762	17478	5966	2384	1337	958	331634
1997	14193	17468	43729	99471	57225	80235	52109	33424	36296	30410	3299	8300	476158
1998	23230	33985	53810	62431	47470	35015	16795	4586	2355	1894	1085	800	283457
1999	1406	42629	100207	74065	88862	68672	30262	12821	6227	3475	1639	1188	431452
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	12510.4	33632.7	53217.8	57895.9	50841.2	45163.9	28348.8	16329.4	8966.3	5669.9	2983.7	4352.1	319912.3
med =	9215.0	31819.0	48452.0	60465.0	47470.0	44365.0	24967.0	14648.0	6095.0	4169.0	1910.0	1632.0	297012.0

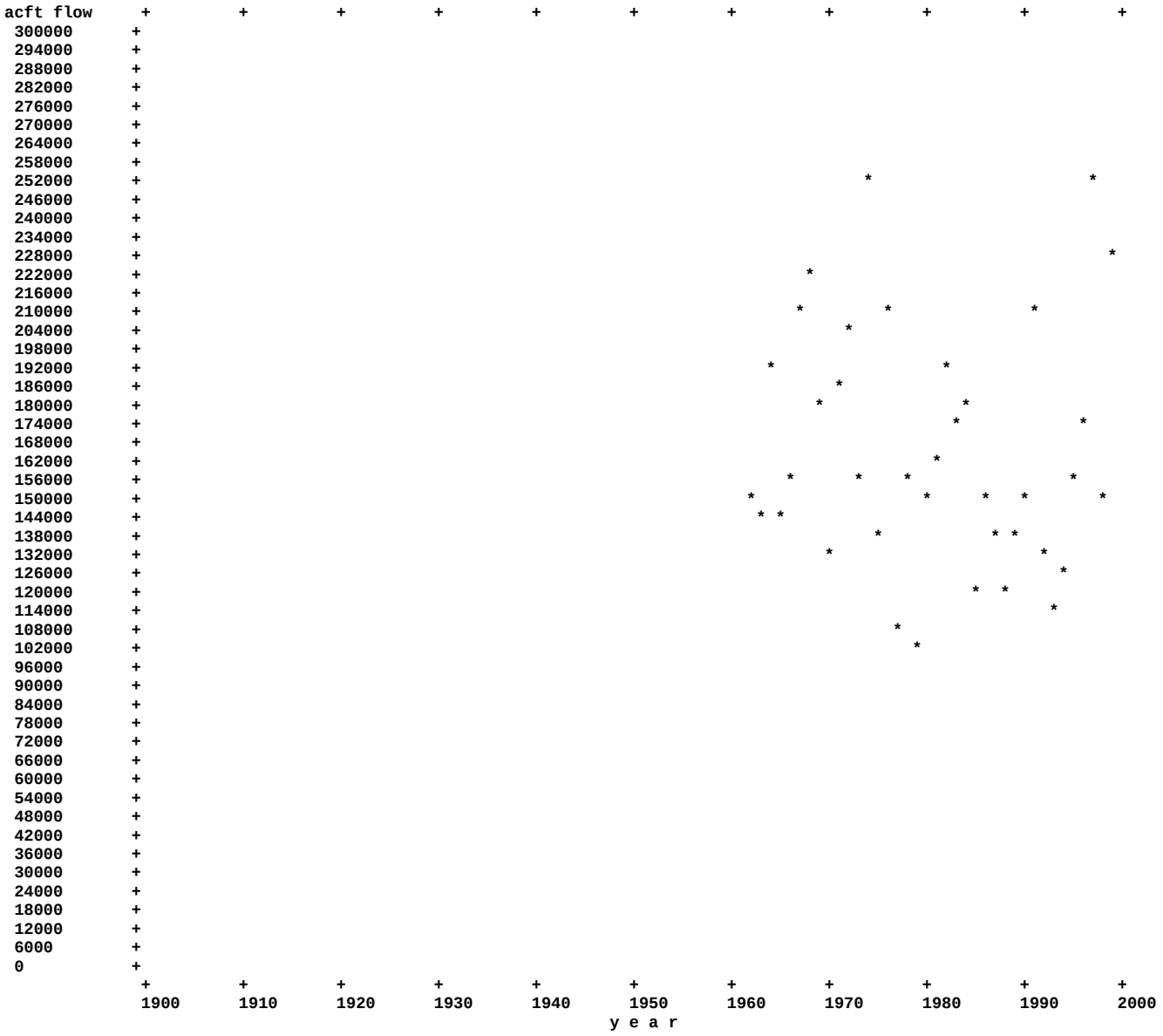
Sooes River watershed

STATION NUMBER 12043163 SOOES R BLW MILLER CR NR OZETTE (unrestricted synthetic record) - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
73075.77													1211.90
67065.32													1112.22
61549.23													1020.74
56486.79			X										936.79
51840.77		X				X							859.74
47576.89			9	X									789.02
43663.72				9									724.13
40072.4					X								664.57
36776.43													609.91
33751.58	X		7	7	9								559.74
30975.53													513.70
28427.81		7				9							471.45
26089.61			5	5	7								432.67
23943.75	9												397.09
21974.39		5	3			7	X						364.43
20167.01				3	5								334.45
18508.28		3					9						306.94
16985.97	7		1		3	5		X					281.70
15588.88						3	7		X	X			258.53
14306.7								9				X	237.27
13129.98				1							X		217.75
12050.05	5				1		5						199.84
11058.93													183.40
10149.33		1				1							168.32
9314.557							3					9	154.47
8548.439								7					141.77
7845.334										9			130.11
7200.052			0										119.41
6607.852							1		9				109.59
6064.359	3			0				5					100.57
5565.568		0				0							92.30
5107.798							0	3					84.71
4687.684					0								77.74
4302.125									7			7	71.35
3948.277											9		65.48
3623.533													60.09
3325.496	1							1	5				55.15
3051.975										7			50.61
2800.952													46.45
2570.575								0					42.63
2359.145												5	39.12
2165.107													35.91
1987.027									3	5			32.95
1823.595													30.24
1673.604													27.76
1535.951											7		25.47
1409.62													23.38
1293.679										3		3	21.45
1187.274									1				19.69
1089.621									0		5		18.07
1000													16.58

STATION NUMBER 12043163 SOOES R BLW MILLER CR NR OZETTE (unrestricted synthetic record) - Total monthly flow in ac-ft
hydrograph of annual recorded flows



STATION NUMBER 12043163 SOOES R BLW MILLER CR NR OZETTE (unrestricted synthetic record) - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

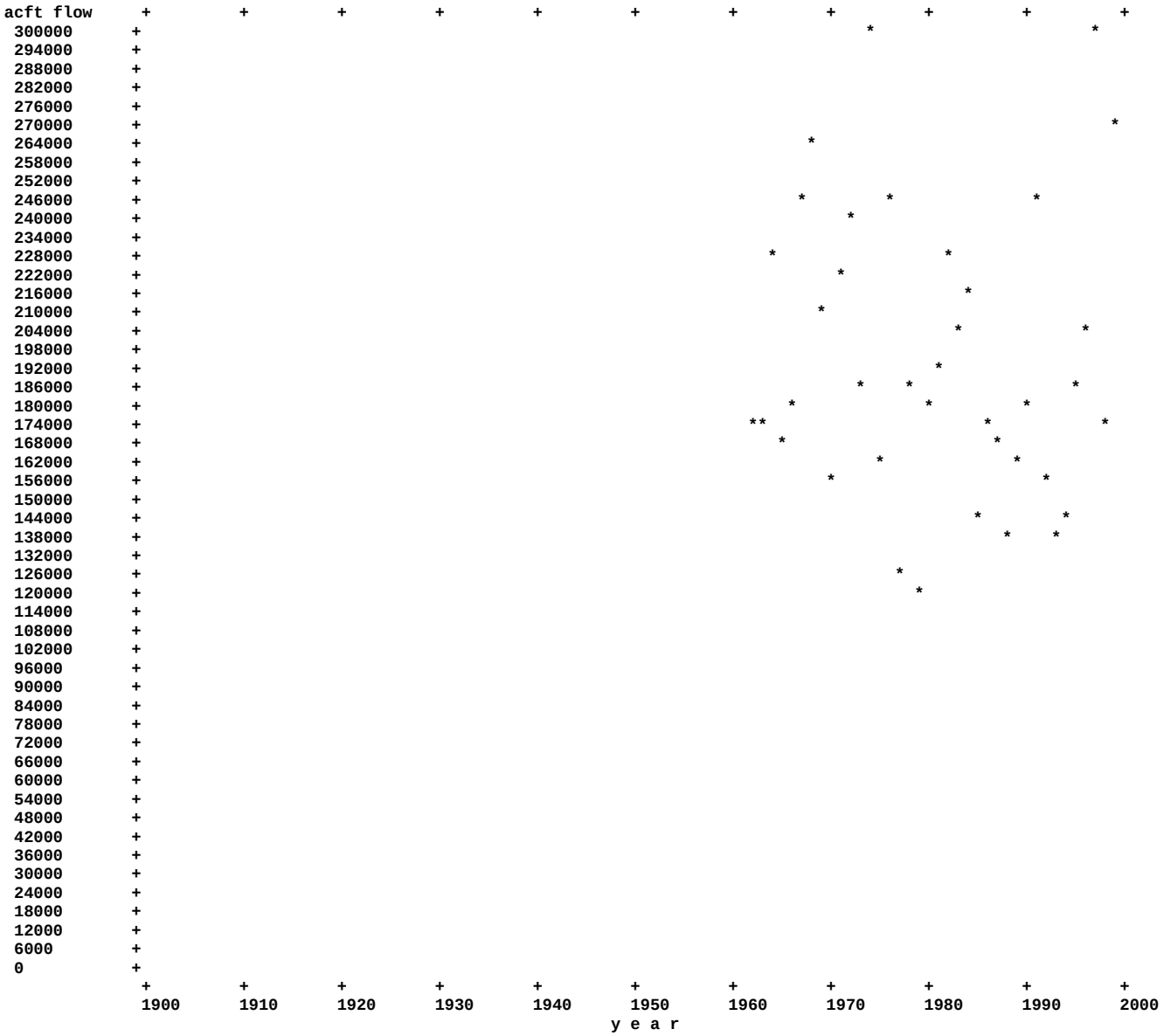
YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
1962	15000	17500	24364	18339	13750	15750	18000	10700	3200	1362	3160	3126	144251
1963	14480	28452	26936	15479	17872	11774	12661	7761	1428	4259	1373	977	143451
1964	18652	33761	25717	34189	15299	22369	11118	5162	4347	7326	2962	6724	187625
1965	10711	17536	18218	33052	32565	6674	7221	9188	1501	874	1000	1145	139684
1966	10145	21930	28750	34848	14325	22204	6568	3179	2358	3054	1208	2442	151010
1967	15556	23355	49697	43953	29511	22970	9993	5634	1564	806	624	1460	205123
1968	33720	16927	36472	44427	26278	21983	12533	4564	3038	2825	2543	13570	218881
1969	23982	22066	33069	22938	20037	14720	16433	6093	3553	1376	979	9314	174561
1970	12223	13597	20251	21883	13425	10859	21259	6300	1479	1104	876	6669	129924
1971	12379	17348	31982	40783	23285	28366	12250	5591	3285	3013	1146	3541	182969
1972	16497	27111	27955	29484	29762	30831	18597	4949	1089	8973	1026	3808	200082
1973	1849	16510	46569	31627	12909	16460	6500	8521	6190	2672	888	1237	151932
1974	17209	50496	36595	39194	30971	27457	16996	16214	6261	6184	1221	1291	250088
1975	3282	21943	28068	21658	18951	12683	4861	9243	3844	1923	5359	2783	134597
1976	32257	35432	41696	26491	20654	19713	8602	4717	5724	3009	3340	3921	205554
1977	5349	9495	16195	12341	18637	18004	6182	5845	4163	2654	1829	5340	106034
1978	8192	36589	33338	15332	11560	9905	8547	6817	3233	1115	5538	11700	151866
1979	3646	10334	16132	5810	25434	15812	8650	3900	1626	1845	708	4401	98298
1980	8275	9068	47714	15453	20983	18676	11078	2971	2031	3249	1505	6571	147574
1981	3489	33834	31829	8674	21467	11714	21671	7878	11193	2410	815	4118	159092
1982	22022	26705	26452	42349	37793	13700	14287	2676	1151	1083	1138	1766	191122
1983	12968	15983	24984	30268	32820	17558	6147	2396	2319	15261	2941	5423	169068
1984	5685	47867	13819	40409	22969	15800	10572	14166	3971	1583	843	1835	179519
1985	17105	26844	21669	5891	10596	12506	11752	5500	1900	833	766	2342	117704
1986	17776	15905	6962	25256	25676	19041	8751	16766	2977	3525	972	1453	145060
1987	3365	25344	17523	22887	16890	26052	10422	8123	4087	1253	787	731	137462
1988	637	5979	22008	14492	14046	19114	17928	12874	4524	1593	771	2322	116288
1989	11781	26618	18186	25505	11584	19346	15963	3583	1153	1255	826	676	136475
1990	6867	28407	19685	25005	29577	16150	6857	4623	8206	1523	861	913	148674
1991	15620	49419	27514	25991	33921	11416	15157	5985	2215	1094	12660	5413	206405
1992	2556	20612	21470	35164	20049	5353	12804	6142	1159	808	682	2079	128877
1993	8750	15225	14377	14855	4661	14933	18138	12527	5836	1646	991	679	112618
1994	3058	5422	21322	19534	22125	22422	11047	3827	5887	2708	856	2131	120341
1995	5014	17993	38923	22751	26167	20798	10592	3797	1197	892	3663	1214	153001
1996	16944	50502	22986	16828	17834	9316	16909	10510	3472	1190	785	1189	168465
1997	17568	17349	28032	47219	17528	49236	17320	14234	15430	12969	2133	11292	250311
1998	23619	19071	21564	29645	16708	15277	7045	3795	1923	3819	1009	656	144131
1999	4443	45352	52197	31961	38289	25889	8444	7771	3807	3458	1262	1138	224011
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	12175.6	24312.7	27400.5	26104.3	21497.6	18232.4	12101.4	7224.3	3745.3	3066.5	1895.9	3615.5	161371.8
med =	11781.0	21930.0	25717.0	25256.0	20049.0	16460.0	11078.0	5985.0	3200.0	1845.0	1009.0	2322.0	151010.0

Sooes River below the Makah Fish Hatchery - Total monthly flow in ac-ft
annually dispersed flow duration for low flow exceedence

X=100% 9=90% 7=70% 5=50% 3=30% 1=10% 0=0%

acft flow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	avg cfs
86665.57													1437.28
79266.51													1314.57
72499.14													1202.34
66309.53			X										1099.69
60648.36		X		X		X							1005.80
55470.46			9										919.93
50734.68				9									841.39
46403.21					X								769.56
42441.54	X				9								703.86
38818.1			7	7									643.77
35504						9							588.81
32472.85		7	5	5	7								538.54
29700.49	9												492.56
27164.81		5	3				X						450.51
24845.59				3	5	7							412.04
22724.4							9						376.87
20784.31	7	3	1		3	5		X					344.69
19009.85						3	7		X	X			315.26
17386.89								9				X	288.35
15902.48				1							X		263.73
14544.81	5				1								241.21
13303.05							5						220.62
12167.3		1				1							201.78
11128.51							3					9	184.56
10178.41								7					168.80
9309.433										9			154.39
8514.641			0										141.21
7787.704							1		9				129.15
7122.83	3			0				5					118.13
6514.719		0				0							108.04
5958.525					0		0	3					98.82
5449.817													90.38
4984.535									7			7	82.66
4558.98											9		75.61
4169.758													69.15
3813.765	1							1	5	7			63.25
3488.165													57.85
3190.364													52.91
2917.987								0				5	48.39
2668.863													44.26
2441.009									3				40.48
2232.608										5			37.03
2041.999													33.86
1867.664											7		30.97
1708.211													28.33
1562.373										3		3	25.91
1428.985									1				23.70
1306.986									0		5		21.68
1195.402													19.82
1093.344										1	3		18.13
1000										0			16.58

Sooes River below the Makah Fish Hatchery - Total monthly flow in ac-ft
hydrograph of annual recorded flows



Sooes River below the Makah Fish Hatchery - Total monthly flow in ac-ft

monthly summary by water year reformatted file
this is a rewritten record

YEAR	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
1962	17790	20754	28895	21750	16307	18679	21347	12690	3795	1615	3748	3707	171078
1963	17172	33744	31945	18357	21195	13963	15016	9204	1694	5051	1628	1159	170128
1964	22120	40039	30500	40547	18144	26529	13186	6122	5155	8688	3513	7974	222517
1965	12703	20797	21606	39198	38621	7915	8564	10897	1780	1037	1186	1358	165661
1966	12032	26008	34096	41329	16989	26333	7789	3770	2797	3622	1432	2896	179093
1967	18449	27698	58939	52127	34999	27242	11852	6682	1855	956	740	1731	243270
1968	39991	20075	43255	52689	31165	26072	14864	5413	3603	3350	3016	16094	259586
1969	28442	26170	39219	27204	23764	17457	19489	7226	4214	1632	1161	11046	207024
1970	14496	16126	24017	25953	15921	12878	25212	7472	1754	1309	1039	7909	154086
1971	14681	20574	37930	48368	27615	33642	14528	6631	3896	3574	1359	4200	216996
1972	19565	32153	33154	34968	35296	36565	22055	5870	1291	10641	1217	4517	237291
1973	2192	19580	55230	37509	15310	19521	7709	10106	7341	3169	1053	1467	180186
1974	20409	59887	43400	46483	36731	32563	20157	19229	7425	7334	1448	1531	296597
1975	3892	26023	33288	25685	22476	15042	5765	10962	4559	2280	6355	3301	159628
1976	38255	42021	49450	31417	24494	23380	10202	5594	6788	3569	3961	4650	243781
1977	6344	11261	19207	14636	22103	21352	7332	6932	4937	3148	2169	6333	125753
1978	9715	43393	39538	18183	13710	11747	10136	8085	3834	1322	6568	13876	180109
1979	4324	12256	19132	6890	30164	18753	10259	4625	1928	2188	840	5219	116578
1980	9814	10754	56587	18327	24885	22149	13138	3524	2409	3853	1785	7793	175018
1981	4138	40126	37748	10287	25459	13892	25701	9343	13275	2858	967	4884	188678
1982	26117	31671	31371	50225	44821	16248	16944	3174	1365	1284	1350	2094	226665
1983	15380	18955	29630	35897	38924	20823	7290	2842	2750	18099	3488	6432	200510
1984	6742	56769	16389	47924	27241	18738	12538	16800	4709	1877	1000	2176	212904
1985	20286	31836	25699	6987	12567	14832	13938	6523	2253	988	908	2778	139593
1986	21082	18863	8257	29953	30451	22582	10378	19884	3531	4181	1153	1723	172037
1987	3990	30057	20781	27143	20030	30896	12361	9633	4847	1486	933	867	163025
1988	755	7091	26101	17187	16658	22669	21262	15268	5365	1889	914	2754	137914
1989	13972	31569	21568	30248	13738	22944	18932	4249	1367	1488	980	802	161856
1990	8144	33690	23345	29656	35077	19154	8132	5482	9732	1806	1021	1083	176323
1991	18524	58609	32631	30825	40229	13539	17976	7098	2627	1297	15015	6420	244790
1992	3031	24445	25463	41703	23777	6348	15185	7285	1375	958	809	2466	152845
1993	10377	18056	17050	17618	5528	17710	21511	14857	6921	1952	1175	805	133561
1994	3627	6431	25287	23167	26240	26592	13101	4539	6982	3212	1015	2528	142721
1995	5946	21339	46161	26982	31034	24666	12562	4503	1420	1058	4345	1440	181455
1996	20096	59893	27261	19958	21150	11048	20053	12465	4118	1411	931	1410	199794
1997	20836	20575	33245	56000	20788	58392	20541	16881	18300	15381	2529	13392	296861
1998	28011	22618	25574	35158	19815	18118	8355	4501	2281	4530	1197	778	170934
1999	5269	53786	61904	37904	45410	30703	10014	9216	4515	4101	1497	1349	265670
n =	38	38	38	38	38	38	38	38	38	38	38	38	38
avg =	14439.7	28834.0	32496.1	30959.0	25495.4	21623.1	14351.9	8567.8	4441.8	3636.7	2248.6	4287.9	191382.0
med =	13972.0	26008.0	30500.0	29953.0	23777.0	19521.0	13138.0	7098.0	3795.0	2188.0	1197.0	2754.0	179093.0