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4.9 SPEELYAI CREEK CONNECTIVITY AND SPEELYAI HATCHERY PROTECTION STUDY (AQU 9)

4.9.1 Study Objectives

This study discusses the current condition of lower Speelyai Creek and the effects of potential operational changes at the upper diversion structure. The measures discussed include ways to: (1) re-connect upper and lower Speelyai Creek; (2) facilitate long-term, successful operation of the Speelyai Hatchery; and (3) ensure protection of aquatic organisms that may inhabit upper and lower Speelyai Creek and the Speelyai Diversion Canal.

4.9.2 Study Area

The study area extends from the upper Speelyai Creek Diversion at River Mile 6.0 to the mouth of the creek (RM 1.7). In this report, the section of Speelyai Creek upstream of the upper diversion is referred to as upper Speelyai Creek; the section downstream of the upper diversion is referred to as lower Speelyai Creek. Speelyai canal refers to the canal dug between the upper diversion and Yale Lake.

4.9.3 Methods

Information on hydrology, water quality, and aquatic habitat for this report was compiled from the Streamflow Study (WTS 2), the Water Quality Monitoring and Assessment Study (WAQ 1), and the Stream Channel Morphology and Aquatic Habitat Study (WTS 3). Readers are referred to those study reports for methods used to obtain streamflow, water quality, and aquatic habitat data.

For the present study, Speelyai Hatchery operators were asked to provide information on hatchery operations and water requirements. The Washington Department of Ecology was asked for groundwater withdrawal and well log information for the vicinity of Speelyai Hatchery.

Additional analysis of hydrology and hydraulic information was undertaken as described in the following sections.

4.9.3.1 Lower Speelyai Creek Hydrology Synthesis

The USGS has collected flow information in upper Speelyai Creek (USGS Gage 14219800) since 1959. However, there has been no long-term daily hydrologic data collected in lower Speelyai Creek. Collings (1971) has published a set of formulas for estimating mean monthly and annual flow at ungaged streams in western Washington. The mean monthly and annual discharges of both the upper and lower Speelyai basin were predicted using Formula 1.

$$Q_m = \alpha A^{\beta_1} S^{\beta_2} E^{\beta_3} F^{\beta_4} P^{\beta_5} T^{\beta_6} \qquad (1)$$

Where: Qm is the mean monthly or annual discharge, in cubic feet per second;
A is drainage area, in square miles (Table 4.9-1);
S is main channel slope, in feet per mile (Table 4.9-1);
E is mean basin elevation, in feet above mean sea level, divided by 1000 (Table 4.9-1);
F is forest cover, expressed as the percentage of the drainage area (Table 4.9-1);
P is mean annual precipitation in inches (Table 4.9-1);
T is minimum January air temperature in degrees Fahrenheit (Table 4.9-1);
α is the regression constant (Table 4.9-2);
$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$, and β_6 are regression coefficients for A, S, E, F, P, and T respectively (Table 4.9-2).

Table 4.9-1. Speelyai Creek watershed characteristics.

	Upper	**Lower**
A, Drainage Area (square miles)	13.49	4.10
S, Main Channel Slope (feet per mile)	455	75
E, Mean Basin Elevation (÷1000 feet)	2.1	0.35
F, Forest Cover (%)	100	95
P, Mean Annual Precipitation (inches)	102	72
T, Minimum January Temperature (°F)	28	34.3

A – drainage areas were integrated from GIS database
S – upstream of diversion (Williams and Pearson 1985), downstream rough estimate based on 7½-minutes top maps.
E – upper watershed (Williams and Pearson 1985), lower watershed rough estimate based on 7½-minutes top maps.
F – upper watershed (Williams and Pearson 1985), lower watershed estimate based on 1999 aerial photographs.
P – integrated based on PRISM spatial climate database
T – upper watershed (Williams and Pearson 1985), lower watershed estimated based on elevation difference between upper and lower watershed and temperature lapse rate of 2°C per 1000 feet, that is,
$T_l = T_u + (2.1 - 0.35) * 2.0 * 1.8 = 34.3°F$, where T_u = 28°F.

4.9.3.2 Hydraulic Analysis of Increased Flows

Cross sections and substrate size data were measured at 7 locations in lower Speelyai Creek and 3 locations in upper Speelyai Creek. At each location, the channel cross section and water surface slope was measured with a rod, tape, and hand level. A pebble count of 100 surface particles was made at the upstream end of point bars using the Wolman pebble count method to determine the grain size distribution of the armor layer (Wolman 1954). A grab sample of the sub-armor layer was also taken for later dry sieving.

Table 4.9-2. Regression coefficients for Western Washington streams (Collings 1971).

Month	α	β_1	β_2	β_3	β_4	β_5	β_6
January	6.02E-6	1.02		-0.02		1.28	2.14
February	7.76E-6	1.02		-0.02		1.20	2.10
March	2.14E-5	1.06		-0.02		1.15	1.80
April	1.03E-3	0.99			0.24	1.09	0.77
May	0.692	0.98		0.03	0.45	1.04	-0.86
June	35.5	0.97		0.06	0.58	1.00	-1.61
Month	α	β_1	β_2	β_3	β_4	β_5	β_6
July	55.0	1.07	0.14	0.07	0.37	1.09	-1.80
August	6.31	1.20	0.29	0.05		1.17	-1.55
September	11.2	1.02			0.38	1.34	-1.25
October	2.95E-4	0.99			0.26	1.73	0.85
November	2.51E-5	0.98		-0.03	0.18	1.51	1.68
December	1.26E-5	1.01		-0.02	0.09	1.38	1.80
Annual	3.24E-3	0.99			0.12	1.23	0.35

The cross section information was entered into the WINXSPRO computer program and processed to predict streamflow at various water surface elevations. Three different flow computation methods were used (Jarrett [1984], Thorne and Zevenbergen [1985], and Manning's n) for comparison with flow estimates at time of measurements and estimated bankfull flow.

4.9.3.3 Sediment Input Budget

A sediment input budget was calculated for the upper and lower Speelyai Creek watersheds. Inputs considered included: (1) soil creep and road surface erosion, which were calculated using the SEDMODL GIS program based on the existing roads and streams; and (2) landslide inputs. Landslide inputs were based on an inventory of the 1963, 1974, 1980, 1988, and 1999 aerial photographs. Landslides were classified based on age of photo, type of slide (shallow rapid, debris torrent, or small sporadic deep-seated), size, land use association, and delivery to stream. Landslide sediment inputs were annualized over the 1943-1999 period for comparison with other average annual inputs.

4.9.4 Key Questions

Results of this study address the following "key" watershed questions identified during the Lewis River Cooperative Watershed Studies meetings:

- What would be the frequency and intensity of high flows under the conditions specified in the water right?
- Given the above high flow projections, what measures would be necessary to protect the hatchery and other shoreline developments?

- What upstream threats are there to the Speelyai Creek water quality? What measures should be taken to address these threats?
- What measures will ensure the long-term availability of sufficient quantities of high quality water to sustain hatchery operation? What would be the likely water quality conditions of Speelyai Creek?
- Which alternative hatchery water sources are feasible: groundwater or treated lake water?
- How would restoration of instream flows to lower Speelyai Creek affect the stream channel and which species might benefit?
- What would be the effects on the quality of water reaching the hatchery if the water was routed through lower Speelyai Creek?
- How does the hatchery intake at Speelyai Creek affect habitat connectivity for wild salmonids (e.g., kokanee)?
- Can Speelyai Creek Hatchery be operated in a way that is compatible with restoration of instream flows to the natural stream channel?

The following key question is partially addressed in the present study and will be investigated more fully depending upon which management objective is chosen to be implemented for the hatchery and lower Speelyai Creek.

- What diversion design and/or operational criteria, and channel reconfiguration, would reconnect the creek and facilitate operation of the Speelyai Diversion within the parameters of the water right?

4.9.5 Results

Speelyai Creek, a tributary to the Lewis River, is located west of Yale Lake. The upper watershed is a steep, forested basin underlain by basalt and andesite. The watershed is dissected by numerous small streams valleys with V-shaped cross sections. The western half of the area is managed for commercial timber harvest and has many logging roads and harvest units. The eastern half of the area is owned by the Washington Department of Natural Resources (DNR), is not heavily roaded, and has not experienced much recent harvest.

Lower Speelyai Creek has a broad, U-shaped valley with steep sides. The broad valley is underlain by Quaternary volcaniclastic deposits derived from ancient eruptions of Mount St. Helens. The lower mile of Speelyai Creek has begun to incise into these deposits and flows in a more confined valley. There are numerous small woodlots, farms, and home sites in the lower valley. The land use map (Figure 8.1-3) shows that the stream passes through or abuts approximately 50 parcels between the upper and lower diversion structures. Many cabins and homes have been constructed in close proximity to the creek. During the aquatic habitat survey, 22 cabins, houses and house-trailers were counted near the streambank. Four small drivable bridges constructed of log stringers or rail cars and 10 foot bridges were counted. These 14 small bridges had very little clearance (1-2 feet) between the low flow water surface and the bottom of the bridge deck. Two large bridges, the Highway 503 bridge and the concrete bridge on Beaver Pond Road, had high clearances. One hose with a small pump that evidently was used to pump water from Speelyai Creek was observed approximately 1,500 feet downstream of the Highway 503 bridge. Future land use plans along the creek are not known, but additional development of cabins and/or home sites is likely based on the number of new structures observed and development pressures from the Vancouver/Portland metropolitan area.

There are 2 diversions on Speelyai Creek. The upper diversion is owned by the PacifiCorp and was originally built with a dual purpose: 1) to divert upper Speelyai Creek into Yale Lake for power generation; and 2) to divert upper Speelyai Creek away from the lower, spring-fed section to improve the quality of the hatchery water supply. The upper diversion is constructed across the original stream channel, diverting the flow parallel to the diversion and into the canal. The lower diversion is located at the hatchery site near Lake Merwin (approximately RM 1.8) and controls the diversion of water into the hatchery. It includes a rotating drum screen to exclude debris and fish from the intake. Neither diversion allows upstream fish passage.

Between 1979 and the present, the upper diversion on Speelyai Creek was only opened on 3 occasions to allow water to flow into lower Speelyai Creek (Manuel Farinas, pers. comm.). Each instance occurred in the month of October during severe low flows when additional water was needed at the hatchery. In each case, the intake was opened for less than 3 weeks. The reason that the upper diversion structure is normally closed is due to fish health concerns. The Speelyai Hatchery intake water is virtually free of any fish pathogens since very few fish species are present in Speelyai Creek between the 2 diversion structures. This provides a disease-free rearing environment at the hatchery, which is important to the hatchery managers.

The upper diversion structure was damaged during the 1996 flooding, and the main stream channel moved northeast and away from the diversion structure. As a result, water is not able to be diverted into lower Speelyai Creek under current conditions.

4.9.5.1 Water Rights

There are 2 Certificates of Surface Water Rights held by PacifiCorp (a.k.a. Pacific Power and Light) and one held by WDF (Washington Department of Fisheries, currently known as the Washington Department of Fish and Wildlife) on Speelyai Creek. Certificate 12057 is for the upper diversion, and includes the provision that 15 cfs (or the entire flow of upper Speelyai Creek if less than 15 cfs) should be passed into lower Speelyai Creek. The remaining water (up to an equivalent annual runoff of 70 cfs) can be diverted into Yale Lake for power production purposes. Certificate 15822 is for the Speelyai Hatchery diversion, and includes diversion rights for 15 cfs. WDF holds Certificate 7941 for an additional 15 cfs at the Speelyai Hatchery.

4.9.5.2 Hydrology

Upper Speelyai Creek

The USGS maintains a stream gage station on upper Speelyai Creek (USGS 14219800). The current location of the gage is immediately above the upper diversion. Prior to 1996 the gage was located approximately 1,000 feet upstream of this point, but the old gage location was damaged during the 1996 flood.

The daily flow records for the Speelyai Creek near Cougar gage were analyzed to provide information on flow exceedence and baseflows as part of the Streamflow Study (WTS 2). Figure 4.9-1 and Table 4.9-3 show daily flow exceedence values for the gage site. Flows are highest during the late fall and winter rainy season (November-April) and lowest in the dry late summer period (July-mid October).

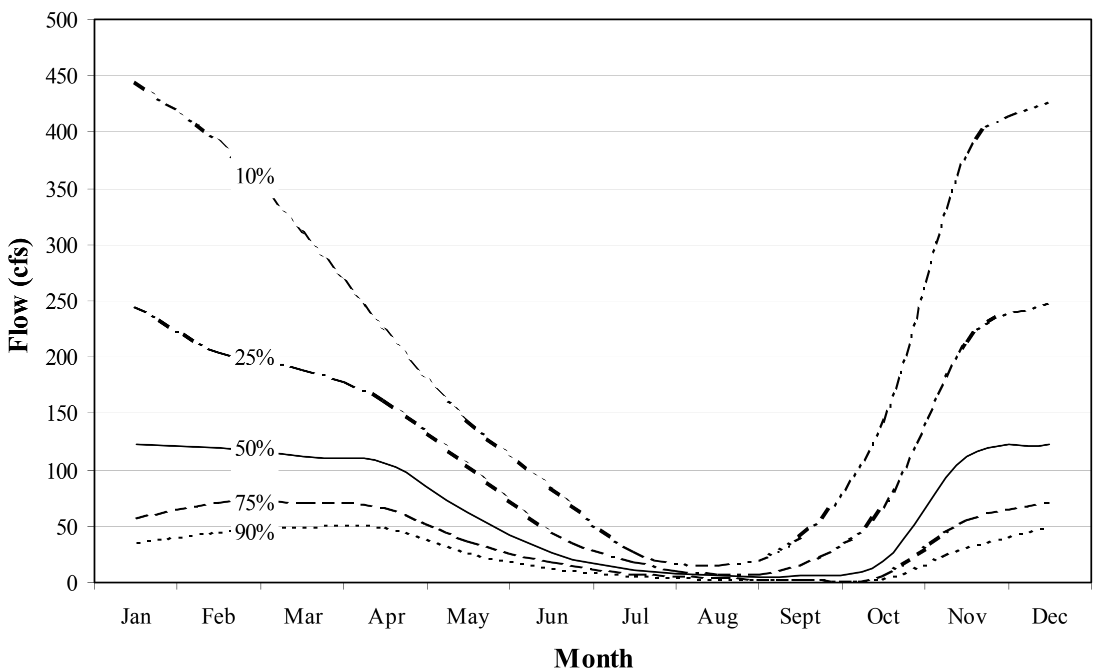


Figure 4.9-1. Daily flow exceedence curve for upper Speelyai Creek upstream of diversion near Cougar (USGS Gage 14219800, from 6/1/1959 to 9/30/1998)**.**

Table 4.9-3. Daily flow exceedence values for upper Speelyai Creek upstream of diversion.

Percent of Time Flow Exceeded	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
10%	445	391	310	224	144	83	28	15	40	143	382	427
25%	246	205	190	161	104	45	18	8	16	66	215	248
50%	122	120	112	105	62	27	11	6	6	19	112	123
75%	57	71	72	67	38	18	7	4	4	6	55	71
90%	35	45	50	49	26	12	5	3	3	3	31	50

Base flows were also analyzed, with the lowest daily (1-day), 3-day, and 10-day running means computed. Annual base flow values are shown in Figure 4.9-2. Base flows range between 1 and 16 cfs over the period of record, and between 1 and 3 cfs since the mid-1980's.

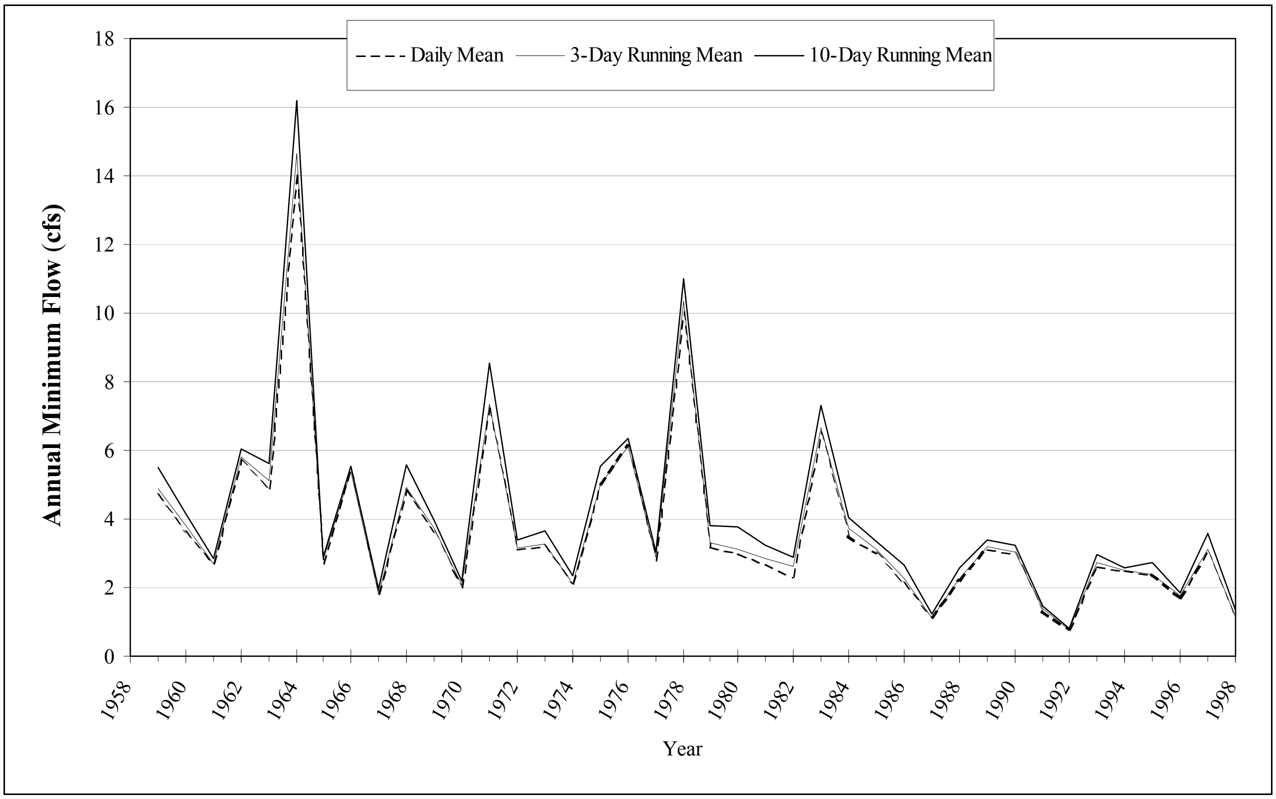


Figure 4.9-2. Baseflows for upper Speelyai Creek upstream of diversion near Cougar (USGS Gage 14219800, from 6/1/1959 to 9/30/1998)**.**

The timing of baseflows, shown in Figure 4.9-3, ranges between August and mid-November.

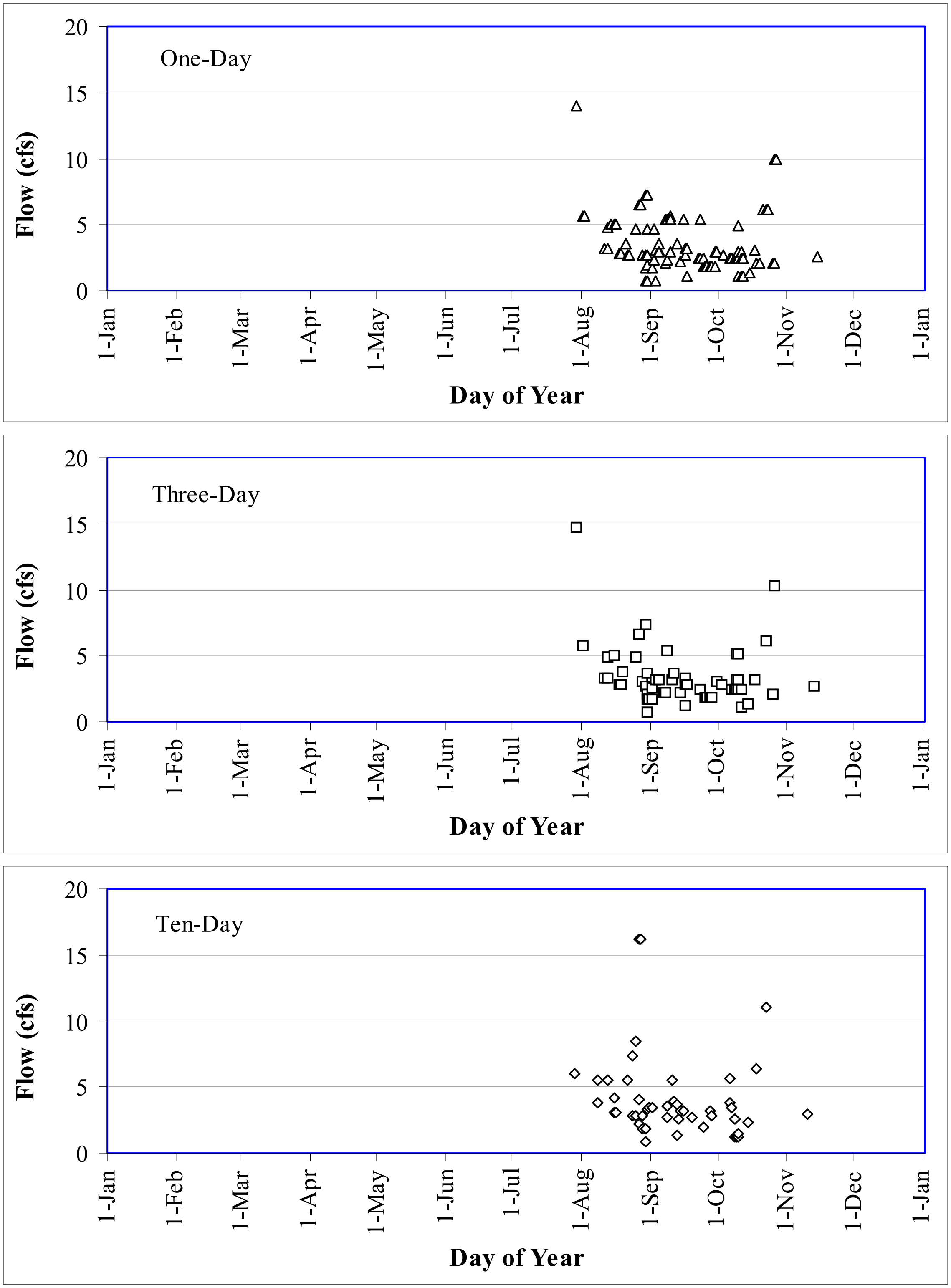


Figure 4.9-3. Base flow timing for Speelyai Creek near Cougar (USGS Gage 14219800)**.**

Peak flows were computed for the Speelyai gage for the 1960-1997 period (Table 4.9-4). The 2-year peak flow is computed as 1,680 cfs; the 10-year flow is 2,940 cfs, and the 50-year flow is 4,020 cfs.

Table 4.9-4. Peak flow frequencies for Speelyai Creek near Cougar, 1960-1997.

Chance of flow occurring in any given year	Recurrence interval (years)	Peak flow (cfs)
1%	100	4,470
2%	50	4,020
5%	20	3,410
10%	10	2,940
20%	5	2,440
50%	2	1,680
80%	1.25	1,140
90%	1.11	916
95%	1.05	764
99%	1.01	538

Peak flows in upper Speelyai Creek occur between November and March, in response to rain or rain-on-snow events (Figure 4.9-4).

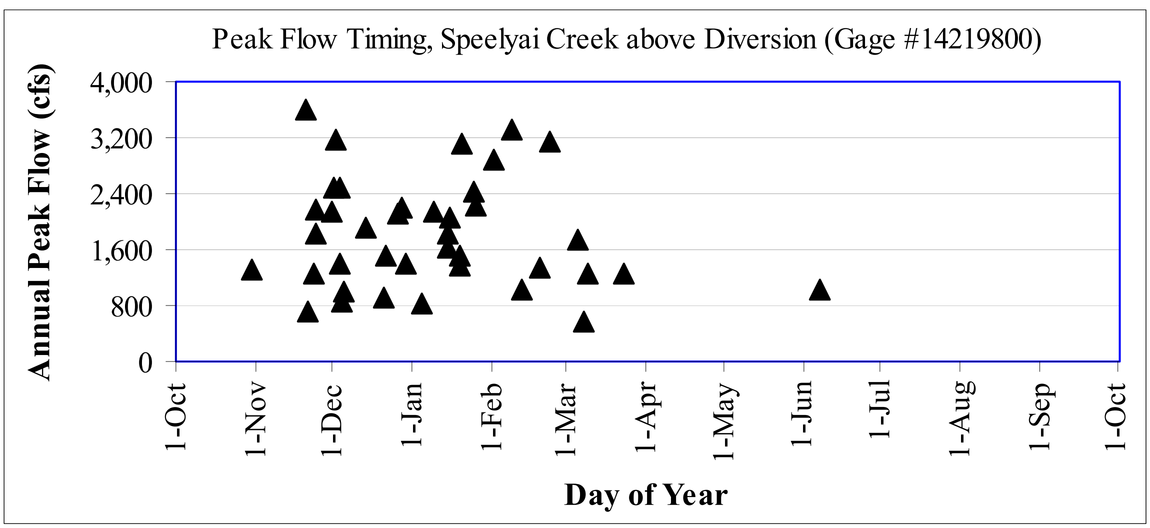


Figure 4.9-4. Peak flow timing, Speelyai Creek near Cougar.

Lower Speelyai Creek

There are no long-term gage records from lower Speelyai Creek. Occasional flow measurements were made by the WDFW, and Speelyai Hatchery personnel record average monthly flow in the stream at their intake. Monthly flows were estimated for lower Speelyai Creek as well as upper Speelyai Creek using Equation 1 (Section 4.9.3.1). Upper Speelyai estimates were made for comparison with long-term measurements in the upper basin to determine how well Equation 1 predicts flows.

Predicted flows for upper Speelyai Creek are less variable (higher in summer and lower in winter) than recorded flows (Table 4.9-5). In contrast, the lower Speelyai observed flow (based on 1997-2001 data) is much more constant throughout the year than the estimated flows based on Equation 1. This is consistent with the field indicators of stable flow conditions (see Section 4.9.5.4) and the groundwater-fed system in the lower water-shed.

Table 4.9-5. Predicted and observed Speelyai Creek mean monthly flows (cfs).

Month	Upper		Lower	
	Predicted (Eq. 1; cfs)	Recorded at Gage (1959-2001; cfs)	Predicted (Eq. 1; cfs)	Observed at Hatchery (1997-2001; cfs)
January	132	198	38	26
February	118	183	35	25
March	84	153	27	27
April	98	127	16	23
May	87	77	7.0	21
June	65	41	3.7	18
July	37	16	2.0	17
August	20	9	1.4	17
September	37	17	2.8	16
October	52	54	6.7	18
November	107	172	20	23
December	134	199	30	28

Hydraulic Modeling

Hydraulic modeling using the WINXSPRO program was performed at 7 cross sections in lower Speelyai Creek, 3 cross sections in upper Speelyai Creek, and at 3 bridges in lower Speelyai Creek. The model was used to predict the change in water surface elevation at the cross sections under different flows and to calculate the flow that could pass under the bridges without touching the bottom of the bridge deck. The computations were used to assess the effects of different flow scenarios on water levels, bridges, and structures along lower Speelyai Canal (see Section 4.9.6). Details of the computations and output files are included in the Aquatic Habitat and Stream Channel Morphology report as WTS 3 Appendix 4.

4.9.5.3 Groundwater

Hydrogeology

Speelyai Creek is located in the Cascade Range geomorphic province. In the Lewis River area, rocks of the Cascade Range can be divided into 4 groups. These are, from oldest to youngest, Western Cascade Group, intrusive rocks, High Cascade Group, and surficial deposits. Geologic formations that underlie the Speelyai Creek valley include the lower part of the Western Cascade Group, undifferentiated eruptive deposits of the High Cascade Groups, and surficial deposits.

The lower part of the Western Cascade Group consists primarily of lava flows and breccia of basaltic to andesitic composition interbedded with laharic breccia, tuffs, and volcaniclastic rocks. Individual lava flows range in thickness to as much as 100 feet.

The High Cascade Group in the vicinity of lower Speelyai Creek consists of a stratigraphic sequence of pyroclastic flow deposits, lahars, tephra, and alluvium that forms valley fill between the mouth of Swift Creek and the head of the Lake Merwin. This sequence was deposited during episodes of explosive andesitic and dacitic volcanism at an eruptive center that coincided with, but predated the modern cone of Mount St. Helens. The sequence has been divided into 2 parts, one older than the glacial drift of Fraser age and the other younger. The thickness of the older fill may be as much as 660 feet near the mouth of Swift Creek. The younger part of the sequence in the Lewis River valley is represented by a few pyroclastic flow deposits and by lahars and fluvial deposits derived from ancestral Mount St. Helens. These deposits accumulated in valleys cut in the older valley fill.

Surficial deposits in the Lewis River area consist primarily of Pleistocene glacial drift and terrace deposits and recent alluvium. Deposits of recent alluvium are mostly restricted to the floodplain and low terraces along the river and streams.

Groundwater Occurrence

Water well drillers reports were reviewed to gain information on the groundwater conditions in the vicinity of the Speelyai hatchery. Forty well driller’s reports were reviewed and only 16 contained information regarding depth to groundwater, well yield, and formation composition. Information from the well logs indicates limited water may be available for development. Depth to first water, total depth of well, and yield for the 16 wells are summarized in Table 4.9-6. All 16 wells are used for domestic purposes.

Table 4.9-6. Well log information in vicinity of lower Speelyai Creek.

Depth of well (ft)	Diameter of well (inches)	Depth to first water (ft)	Date drilled	Yield (gpm)	Drawdown (ft)
102	6	14.6	8/22/98	25	Not Available
37	6	1	8/6/96	30	Not Available
180	6	80	12/23/96	50	Not Available
180	6	80	12/24/96	50	Not Available
150	6	120	9/5/91	20	Not Available
103	6	54	6/17/98	30	Not Available
178	6	96	3/3/97	10	Not Available
190	8	67	6/14/99	20	Not Available
191	6	123	9/22/98	50	Not Available
286	6	0	1/19/66	70	Not Available
285	6	150	9/29/96	1.5	Not Available
221	6	155	6/4/71	29	66
177	6	139	11/16/91	17	Not Available
155	6	107	2/22/91	25	Not Available
154	6	115	2/5/92	18	Not Available
150	6	80	11/1/89	40	Not Available

A review of Table 4.9-6 indicates that well discharges range between 1.5 to 70 gallons per minute (gpm) with a mean yield of 30 gpm. Total depth of the wells ranged between 37 and 286 feet below the ground surface (bgs). The well driller's reports suggest that 7 of the 16 wells were completed in mostly volcanic rocks that make up the Western Cascade Group. The mean discharge for these wells is approximately 28 gpm. The remaining wells appear to be completed in valley fill material derived from the undifferentiated deposits of the High Cascade Group. The mean discharge for this group of wells is approximately 32 gpm.

No information regarding groundwater quality was found.

Based on the information developed to date, there is a high probability that there is insufficient groundwater to supply a large, constant water need such as that required for the Speelyai Hatchery. The hatchery currently uses 5,000-10,000 gpm for its operations and has a water right for 13,500 gpm from Speelyai Creek (See Section 4.9.5.6). Depending upon the management option chosen for Speelyai Creek, a totally new water source or a supplemental water source may be needed. Depending upon the management option chosen for Speelyai Creek a totally new water source or supplemental water source may be needed groundwater may be a viable alternative as part of a small supplementation program, but since the majority of flow in lower Speelyai Creek comes from groundwater sources, removal of large quantities of groundwater may reduce surface flow in the creek.

4.9.5.4 Water Quality

Water quality and water temperature monitoring at Speelyai Creek was a component of Yale relicensing studies, conducted between November 1996 and February 1998, as well more recent sampling during Lewis River relicensing studies (Study WAQ 1, May 1999 through April 2000). Monitoring during Yale relicensing was conducted at 2 locations: upstream of the diversion headgate on Speelyai Creek (SPLYU) (upper Speelyai Creek) and just above the Speelyai Creek hatchery intake (SPLYL) (lower Speelyai Creek). Elevations at these 2 sites are 520 feet and 250 feet msl, respectively. Hourly temperature data were recorded at both locations, and *in situ* data (pH, dissolved oxygen, and specific conductance) were collected on a monthly basis at each site.

Continuous temperature and *in situ* data were collected at both SPLYU and SPLYL during Lewis River relicensing. Water quality samples for nutrient, turbidity, and alkalinity measurement were also collected at SPLYU, as well at the mouth of Speelyai Creek immediately below the Speelyai Hatchery (site SPLYE, elevation 245 feet msl).

Field and laboratory methods for Yale and Lewis River monitoring programs have been described previously (PacifiCorp 1999, PacifiCorp and Cowlitz PUD 2001). A summary of previous data from both Yale and Lewis River relicensing studies for Speelyai Creek sites is presented below.

<u>Water Temperature</u>

Water temperatures in upper Speelyai Creek have a seasonal 10°C fluctuation, with median August temperatures near 15°C and January temperatures just below 5°C (Figure 4.9-5). In contrast, water temperatures in lower Speelyai Creek show only minor seasonal fluctuations, varying between 8°C and 12°C due to the groundwater-dominated flow regime (Figure 4.9-6).

On average, groundwater-dominated flows at the downstream end of Speelyai Creek are approximately 2-4°C colder during the summer months, and about 2-4°C warmer during the winter months than temperatures immediately upstream of the diversion (Figure 4.9-7). Median monthly temperatures (based on 743 hourly observations) in August 1999 were 15.2°C at the upper site, and 11.8°C at the lower site. The maximum temperature recorded at SPLYU was 18.7°C in August 1999, a violation of WDOE Class AA temperature criteria of 16°C applicable to Speelyai Creek. The maximum temperature recorded at SPLYL was 14.3°C in June 1999.

<u>pH, Dissolved Oxygen, Specific Conductance</u>

Data collected during Yale and Lewis River relicensing studies indicate that little difference exists in pH and dissolved oxygen (DO) between upper and lower reaches of Speelyai Creek. However, the dominance of groundwater inputs to the lower reach vs. surface water runoff above the diversion causes marked differences in specific conductance between SPLYU and SPLYL (Figure 4.9-8).

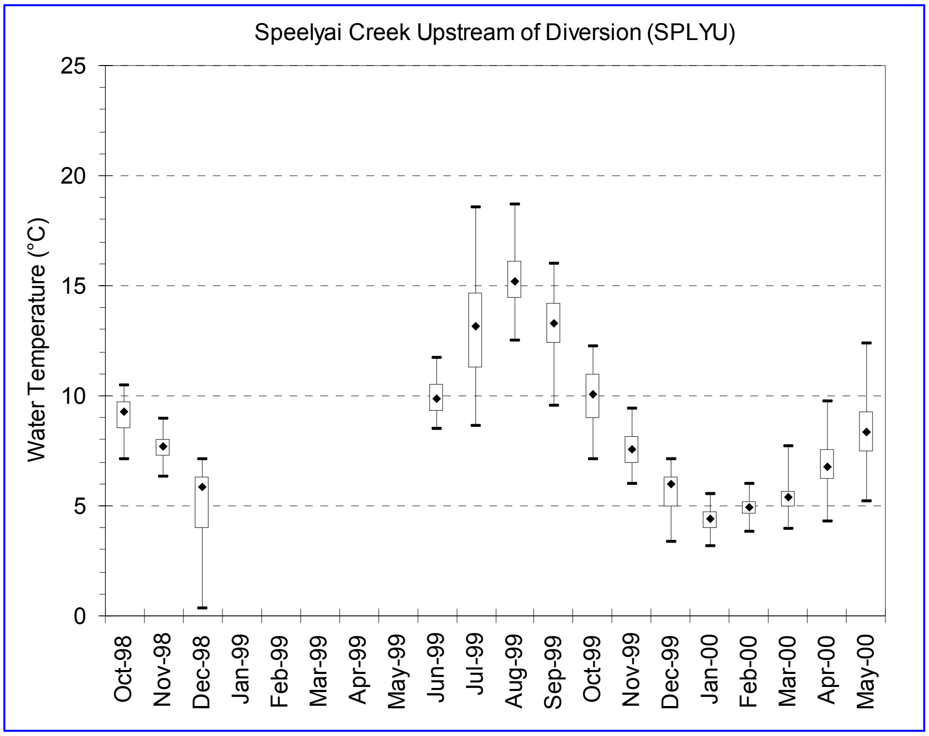


Figure 4.9-5. Percent exceedences of hourly water temperature measurements at upper Speelyai Creek. Bars indicate minimums and maximums, boxes indicate 25 and 75 percent exceedances, and diamonds indicate median values.

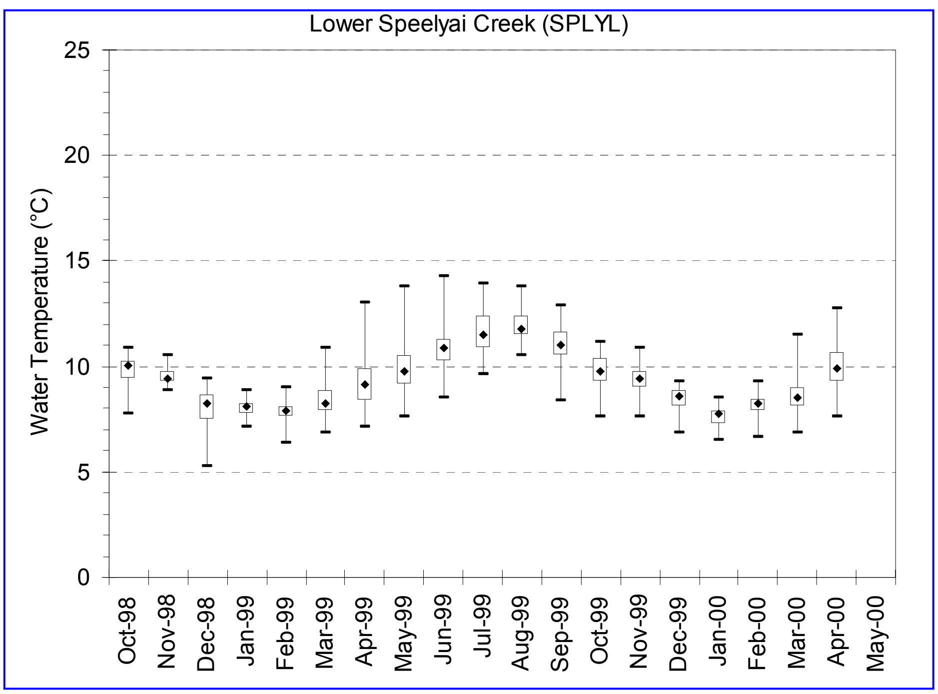


Figure 4.9-6. Percent exceedences of hourly water temperature measurements at lower Speelyai Creek. Bars indicate minimums and maximums, boxes indicate 25 and 75 percent exceedences, and diamonds indicate median values.

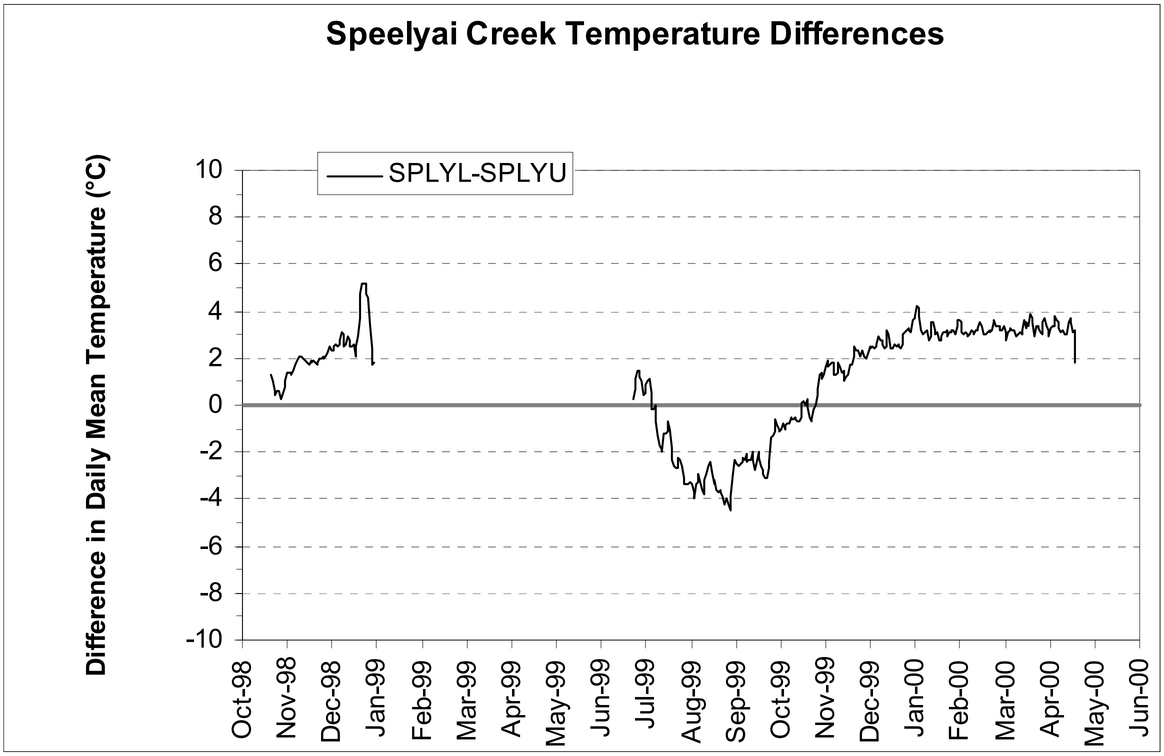


Figure 4.9-7. Difference in daily mean temperature between upper (SPLYU) and lower (SPLYL) Speelyai Creek sites, October 1998 through May 2000. Data above the zero line indicate warmer temperatures at SPLYL, and below the zero line colder at SPLYL.

The WDOE Class AA dissolved oxygen standard (applicable to feeder streams to lakes and reservoirs) of a minimum of 9.5 mg/l DO was not met twice at SPLYU during study WAQ 1 in August and September 1999 (8.4 and 9.0 mg/l respectively). Associated DO percent saturation values were 90 and 92 percent, respectively. No exceedences at this site were recorded between November 1996 through February 1998. The Class AA standard was also not met in September at SPLYL (8.6 mg/l, 81 percent saturation). Differences in DO at upper and lower sites were within a milligram per liter on most visits, and never differed by more than 2 mg/l. Measurements of pH were also similar between upper and lower Speelyai sites.

Monitoring of specific conductance during both Yale and Lewis River relicensing studies has shown consistently higher conductance at the lower site, reflecting higher dissolved solids of groundwater than the more dilute surface water of Speelyai Creek. Values at SPLYU were on average 50 percent of those measured downstream from May 1999 through April 2000.

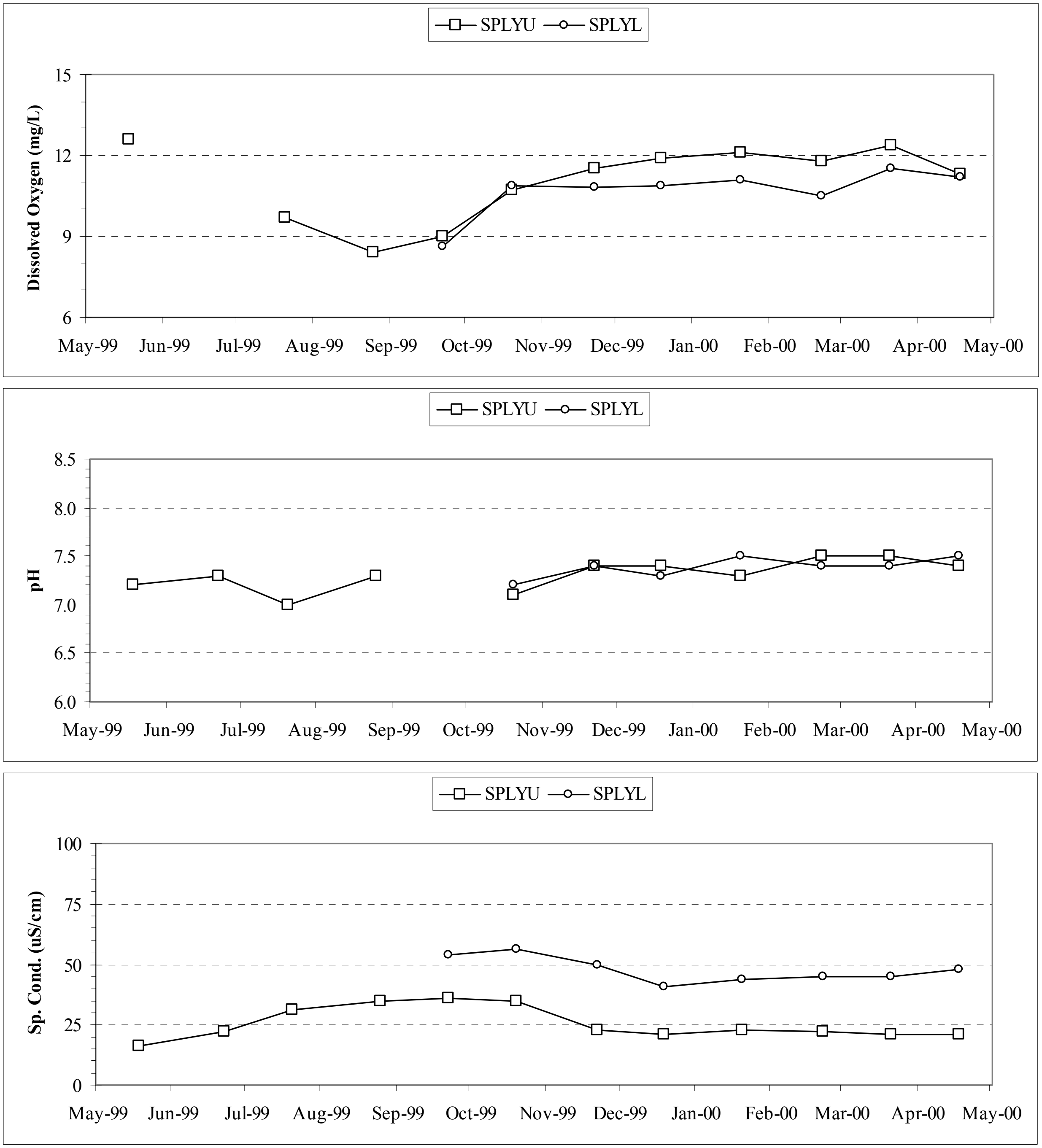


Figure 4.9-8. In situ measurements of dissolved oxygen, pH, and specific conductance at upper (SPLYU) and lower (SPLYL) Speelyai Creek sites, May 1999 through April 2000.

Nutrients/Turbidity/Alkalinity

Data collected during Study WAQ 1 provided information on nutrients, turbidity, and alkalinity for Speelyai Creek at stations SPLYU (above the diversion), and downstream of the Speelyai Hatchery (SPLYE). The latter site, at the mouth of Speelyai Creek, was established to assess potential effects of the hatchery on water quality in Lake Merwin. Data at SPLYE thus do not reflect conditions in lower Speelyai Creek itself.

Based on comparison to other sites in the North Fork Lewis River watershed, nutrient concentrations and turbidity at upper Speelyai Creek (SPLYU) are similar to other mid-elevation, surface water dominated streams in the Lewis River watershed, such as Ole and Canyon creeks (Figure 4.9-9). Turbidity was consistently less than 2 NTUs at SPLYU. Seasonal patterns of nutrient concentrations were also similar among upper Speelyai, Ole, and Canyon creeks (Figure 4.9-10). Total and ortho-phosphorus concentrations were typically below detection (<0.005 mg/l). Nitrate levels (NO_3+NO_2) were also similar among these streams, less than 0.10 mg/l nitrate during the growing season, and increasing with greater allochthonous inputs during the fall. Patterns of total persulfate nitrogen (TPN) at SPLYU were similar to nitrate; TPN is the sum of total biologically available nitrogen, including organic nitrogen, ammonia, and nitrate+nitrite. TPN at upper Speelyai Creek was below detection in June and July (less than 0.10 mg/l) and reached 0.30 mg/l in August.

Alkalinity

Monthly alkalinity at SPLYU averaged 15 mg/l from May 1999 through April 2000. Similar results were obtained for the same period in Ole and Canyon creeks, where alkalinity averaged 16 mg/l and 12 mg/l respectively.

Land Use Influences on Water Quality

Current and future land use in the Speelyai Creek watershed will continue to have an effect on water quality in the stream. The upper watershed is managed for commercial timber production, and roads and harvest units have resulted in large increases in sediment supplied to the upper watershed compared to unmanaged conditions (Section 4.9.5.5 and Table 4.9-11). As a result, turbidity levels in the upper watershed are high during large runoff events. Recent changes to Washington Forest Practice rules are aimed at reducing sediment inputs from harvest practices and roads and should result in decreasing sediment inputs to the upper watershed in the future. Regulation or alteration of land use practices in the upper basin are not within the control of the licensees or FERC. Based on discussions with Speelyai Hatchery personnel, water quality (temperature and turbidity) and supply at the hatchery intake has declined slightly over the past few years. There is general belief that residential housing affects groundwater supply, reducing the spring water flow into lower Speelyai Creek, and that development decreases water quality. No specific analyses of these assumptions have been made, but development of wells along lower Speelyai Creek could decrease flow in the channel since the majority of flow comes from groundwater (collectively, domestic wells potentially could remove 486 gpm from the water

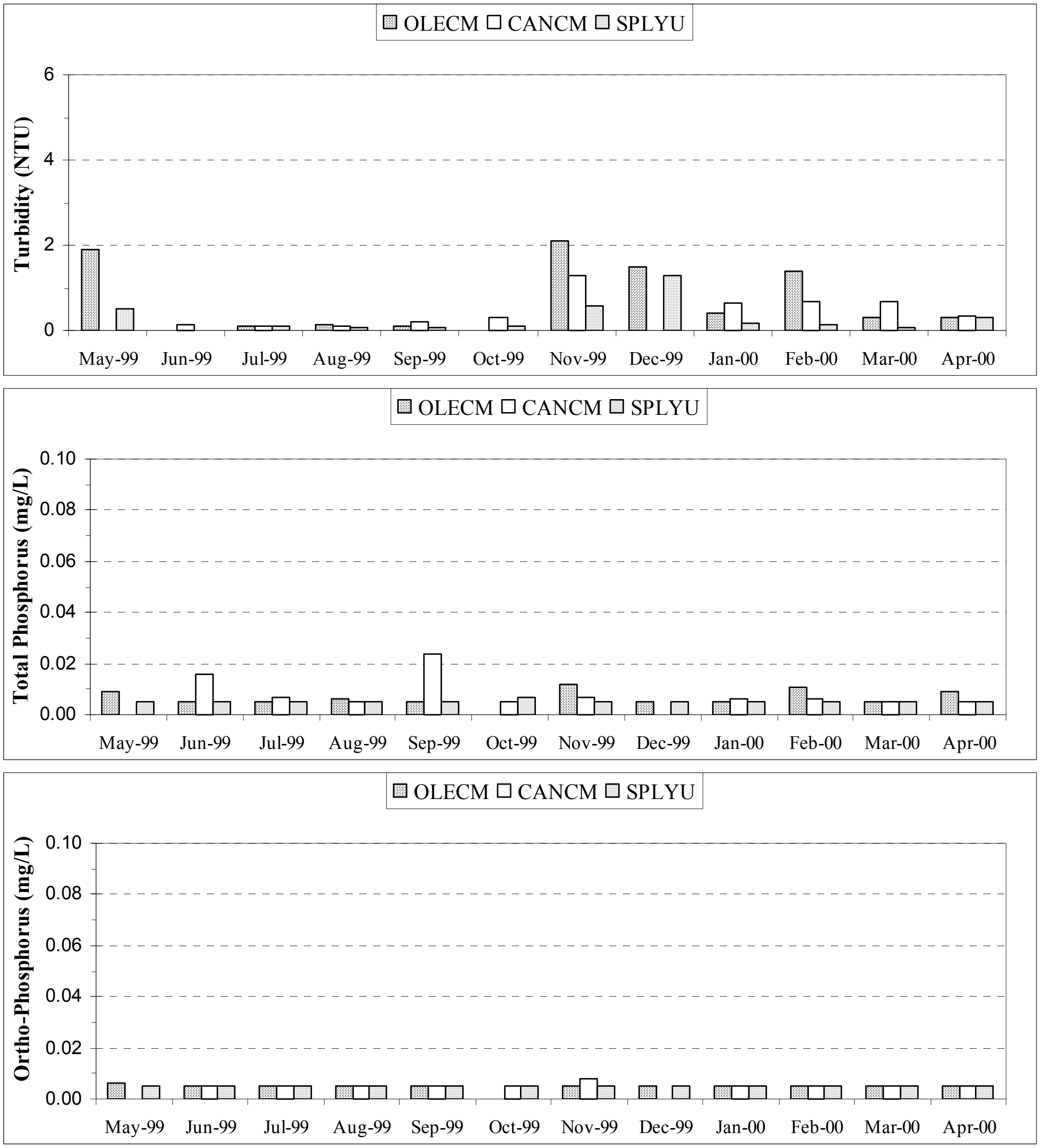
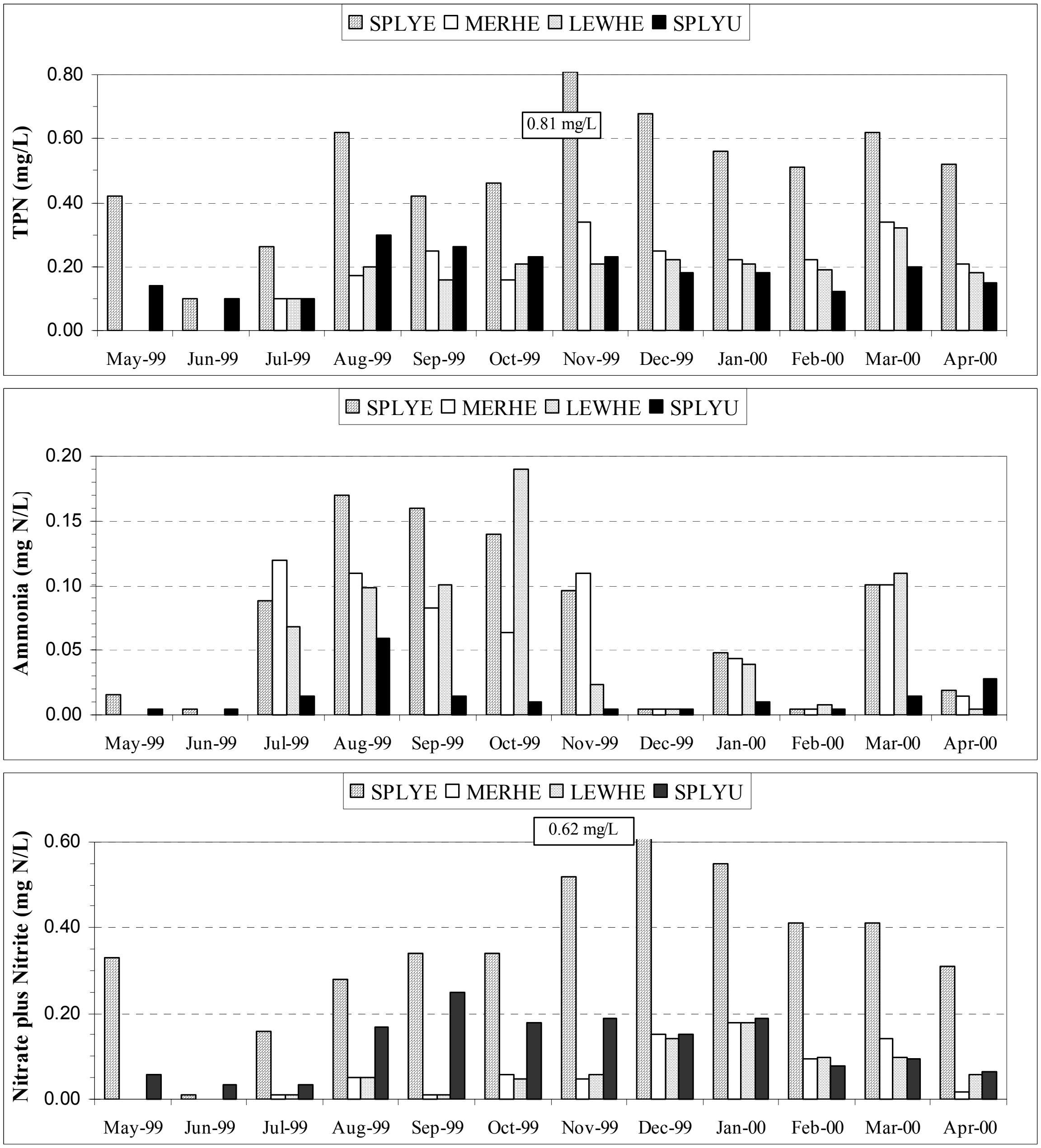


Figure 4.9-9. Turbidity, ortho-phosphorus, and total phosphorus concentrations at Ole Creek, Canyon Creek, and upper Speelyai Creek (SPLYU); May 1999 through April 2000.



SPLYE: downstream of Speelyai Hatchery
MERHE: Merwin Hatchery effluent
LEWHE: Lewis River Hatchery effluent
SPLYU: upper Speelyai Creek

Figure 4.9-10. TPN, ammonia, and nitrate+nitrite at hatchery effluent monitoring stations, and at upper Speelyai Creek (SPLYU) May 1999 through April 2000.

table). The land use map of lower Speelyai Creek (Figure 8.1-3) shows 40-60 lots bordering lower Speelyai Creek. The majority of landowners have left forested buffers along the creek, based on observations of the 1999 aerial photographs and during the 2000 field survey. These buffers provide shade during the summer, limit water temperature increases, and help to filter sediment and other pollutants from runoff. Encouraging local residents to retain buffers and protect streambanks will help to ensure good water quality in lower Speelyai Creek.

4.9.5.5 Aquatic Habitat Quality and Connectivity

Aquatic habitat in lower Speelyai Creek, the Speelyai canal (flows into Yale Lake), and the lower 0.5 mile of upper Speelyai Creek was mapped during September 2000. Large woody debris was counted and gravel samples were taken. This information is included in the Stream Channel and Aquatic Habitat Report (WTS 3) and is summarized below. Complete data are included in WTS 3 Appendix 1 of the 2000 Technical Report (PacifiCorp and Cowlitz PUD 2001).

Lower Speelyai Creek has the characteristics of a spring-fed system. Flow increased gradually from only a trickle just below the upper diversion to an estimated 15-20 cfs at the Hatchery diversion during the September survey. The stability of streamside vegetation close to the September water level, along with instream decorative statuary and low bridges built by residents indicates that flows in the lower creek do not vary dramatically, even during winter rains (Figures 4.9-11 and 4.9-12). In general, aquatic habitat appears to be in good condition, with a mix of riffle, glide, and pool habitat, abundant woody debris and cover, many active beaver dams, and cobble/gravel substrate. The riparian zone consisted of a diversity of riparian species and habitats (Riparian Synthesis Report).

Lower Speelyai was divided into 2 reaches for summary statistics: the reach from the hatchery (confluence with Lake Merwin) to the Highway 503 bridge, and from the highway bridge to the upper diversion. The highway bridge marks the approximate boundary between the upper wide, unconfined valley and the lower slightly more confined valley where the stream has begun incising into the underlying flat volcaniclastic deposits. Summary information for aquatic habitat unit lengths, widths, total area, substrate, and spawning gravel availability is shown in Table 4.9-7.

Lower Speelyai Creek is dominated by glides and riffles, with abundant pools in the lowest reach, and fewer pools in the upstream portion. Wetted channel width is close to 30 feet in the lowest reach, and approximately 20 feet in the upstream portion where there is less flow. The ratio of bankfull:wetted width is 1.5, indicating a stream system with few peak flows. Substrate is dominantly cobble gravel, with sand and silt in habitat types with slower moving water.

Figure 4.9-11. Typical lower Speelyai Creek view showing stable channel characteristics. (Habitat Unit 259, approximately 350 feet upstream from Highway 503 bridge)

Figure 4.9-12. Typical low clearance log stringer bridge in lower Speelyai Creek. (Habitat Unit 32, approximately 0.8 mile upstream from Speelyai Hatchery intake)

Table 4.9-7. Summary of aquatic habitat in lower Speelyai Creek.

Hatchery (Lake Merwin) to Highway 503 bridge	Riffle	Glide	Pool	Beaver Complex	Cascade
Average length (ft)	166	182	173	213	25
Average wetted width (ft)	27	28	31	50	24
Average bankfull width (ft)	43	45	50	100	42
Total wetted area (sq ft)	133,609	169,974	81,208	10,650	1,242
Dominant Substrate	CO	CO	SA	CO	BO/CO
Subdominant substrate	GR	SA	SI	GR	CO/GR
Spawning Gravel Area (sq ft)	8,850	9,300	550	500	0
Average length (ft)	93	219	77	703	203
Average wetted width (ft)	15	19	24	25	18
Average bankfull width (ft)	25	28	31	45	25
Total wetted area (sq ft)	30,891	116,524	7,587	17,575	15,887
Dominant Substrate	CO	GR	GR	SI	CO/GR
Subdominant substrate	GR	CO	SA	CO	CO
Spawning Gravel Area (sq ft)	100	400	0	0	500

BO: boulder SA: sand
CO: cobble SI: silt
GR: gravel

Upper Speelyai Creek, upstream of the PacifiCorp diversion, is typical of a high energy stream with large peak flow events (Figure 4.9-13). The reach is dominated by riffles and glides, with a few pools and cascades (Table 4.9-8). Average wetted width is 23 feet, and the bankfull:wetted width ratio is 3, indicating large peak flows. Dominant substrate is cobble and boulder, with minor gravel in pools. The riparian zone is dominated by upland species, likely due to the flashy nature of the streamflow.

Figure 4.9-13. Typical upper Speelyai Creek view showing wide active channel. (Habitat Unit 36, approximately 0.5 mile upstream from upper diversion)

Table 4.9-8. Summary of aquatic habitat in Upper Speelyai Creek.

Stream Reach	Riffle	Glide	Pool	Cascade	Riffle/Glide
Average length (ft)	145	115	61	50	159
Average wetted width (ft)	23	27	19	21	25
Average bankfull width (ft)	69	70	61	62	70
Total wetted area (sq ft)	38,770	29,142	2,257	3,107	8,810
Dominant Substrate	CO	CO/BO	CO	BO	CO
Subdominant substrate	BO	CO/BO	GR	CO	GR/BO
Spawning Gravel Area (sq ft)	0	50	0	0	0

BO: boulder CO/BO: cobble/boulder
CO: cobble GR: gravel

The canal reach of Speelyai Creek, a constructed channel between the upper diversion and Yale Lake, is a straight channel with very high, near-vertical walls. The reach is dominated by riffles and glides, with a few pools (Table 4.9-9). Average wetted width is 20 feet, and the bankfull:wetted width ratio is 1.5 due to the completely confined, dug channel. Dominant substrate is cobble and sand, with minor gravel in pools. The length of the canal reach that is riverine varies with the level of the Yale Lake pool.

Table 4.9-9. Summary of aquatic habitat in the canal reach of Speelyai Creek.

Canal Reach	Riffle	Glide	Pool
Average length (ft)	152	95	221
Average wetted width (ft)	21	24	14
Average bankfull width (ft)	37	35	18
Total wetted area (sq ft)	17,315	9,973	3,094
Dominant Substrate	CO	SA	CO
Subdominant substrate	SA	CO	GR
Spawning Gravel Area (sq ft)	0	0	0

CO: cobble
GR: gravel
SA: sand

Woody debris was counted in all surveyed stream reaches (Table 4.9-10). There was abundant wood of all sizes in the stream reaches but very little wood in the canal reach (likely was flushed through to Yale Lake due to the confined channel). The reach between the Highway 503 bridge and the upper diversion had less wood, but many beaver dams provide good cover. There were no beaver dams in upper Speelyai Creek, likely because they are washed out by high flows.

Table 4.9-10. Large woody debris summary, Speelyai Creek.

Reach	Class 4			Class 3			Class 2		Class 1		Instream LWD/mi*	Root wad or jams	Beaver Dams
	Wet	Bnk	Pot	Wet	Bnk	Pot	Wet	Bnk	Wet	Bnk			
Hatchery to Highway 503 bridge	15	5	16	27	4	65	112	40	175	44	160.5	12 RW, 8 Jams	28
Highway 503 bridge to upper diversion	4	4	11	2	3	8	16	1	9	5	26.0	5 RW, 1 Jam	20
Total Lower Reach	**19**	**9**	**27**	**29**	**7**	**73**	**128**	**41**	**184**	**49**	**107.9**	**17 RW, 9 Jams**	**48**
Upper Speelyai	0	2	5	3	10	7	1	15	4	16	76.6	8 RW, 2 Jams	none
Canal reach	0	0	0	0	0	0	0	0	0	0	0.0	1 Jam	none
Total Upper Reach	**0**	**2**	**5**	**3**	**10**	**7**	**1**	**15**	**4**	**16**	**76.6**	**8 RW, 3 Jams**	**none**

Class 4 = >36"diam, >50' long
Class 2 = >12" diam, >25' long
Class 3 = >24"diam, >50' long
Class 1 = >6" diam, >25' long

Wet = within wetted channel
Bnk = within bankfull channel (exclusive of those counted in wetted channel)
Pot = potential; standing but leaning over bankfull channel
* Instream LWD/mile includes wetted and bankfull

During the field survey, pebble counts and sub-armor samples were made at 10 locations, approximately every half mile to mile. No samples were taken in the canal reach due to a lack of representative sample locations. Results of the substrate sampling are included in WTS 3 Appendix 2 of the 2000 Technical Report (PacifiCorp and Cowlitz PUD 2001) and summarized in Figures 4.9-11 and 4.9-12.

Sediment Input

A sediment input budget was prepared for the Speelyai Creek watershed. Estimated average annual sediment input from soil creep, landslides, and road surface erosion were calculated. Average total sediment input to lower Speelyai Creek (downstream of the PacifiCorp diversion) was 242 tons/year, primarily from natural sources (Table 4.9-11). Average annual sediment input to upper Speelyai Creek was 9,800 tons/year, with 95 percent of the sediment coming from management-related landslides (originating in roads and recent clearcuts).

Table 4.9-11. Sediment inputs (average tons/year).

Source	Upper Speelyai Creek	Lower Speelyai Creek
Soil creep	145	20
"Background" landslides (clearcuts >50 years old)	370	220
Management-related landslides (road and recent clearcuts)	9,250	0
Road surface erosion	35	2
TOTAL	**9,800**	**242**

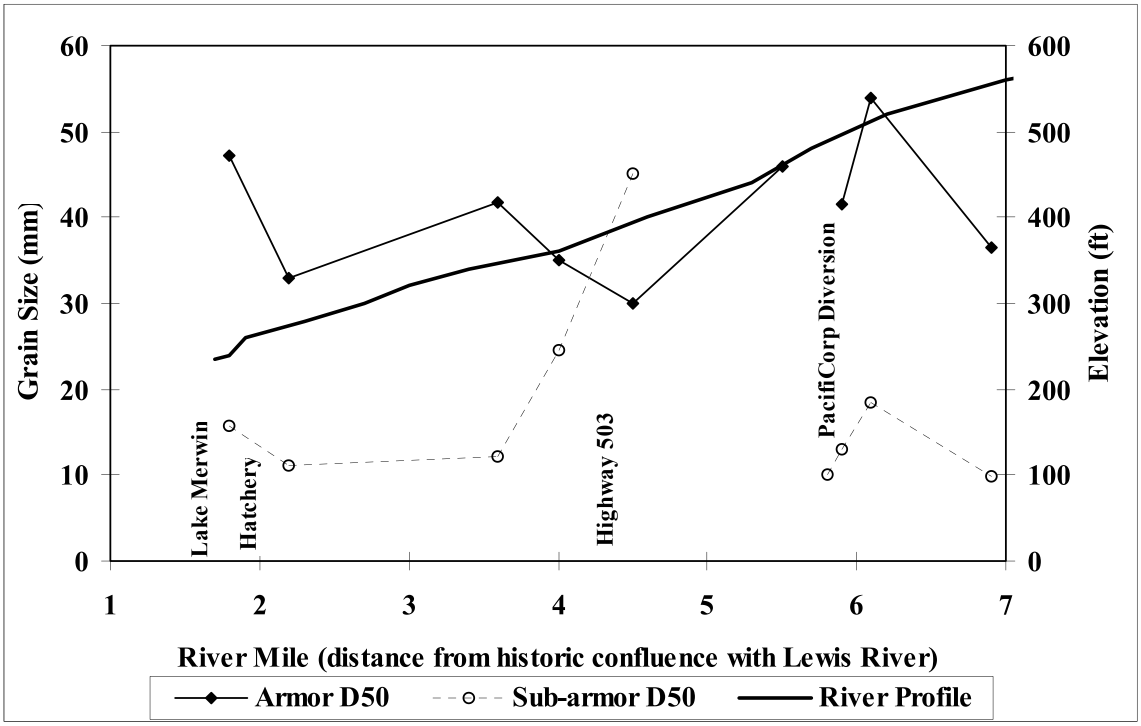


Figure 4.9-14. Change in median (D50) surface armor and sub-armor gravel samples in Speelyai Creek.

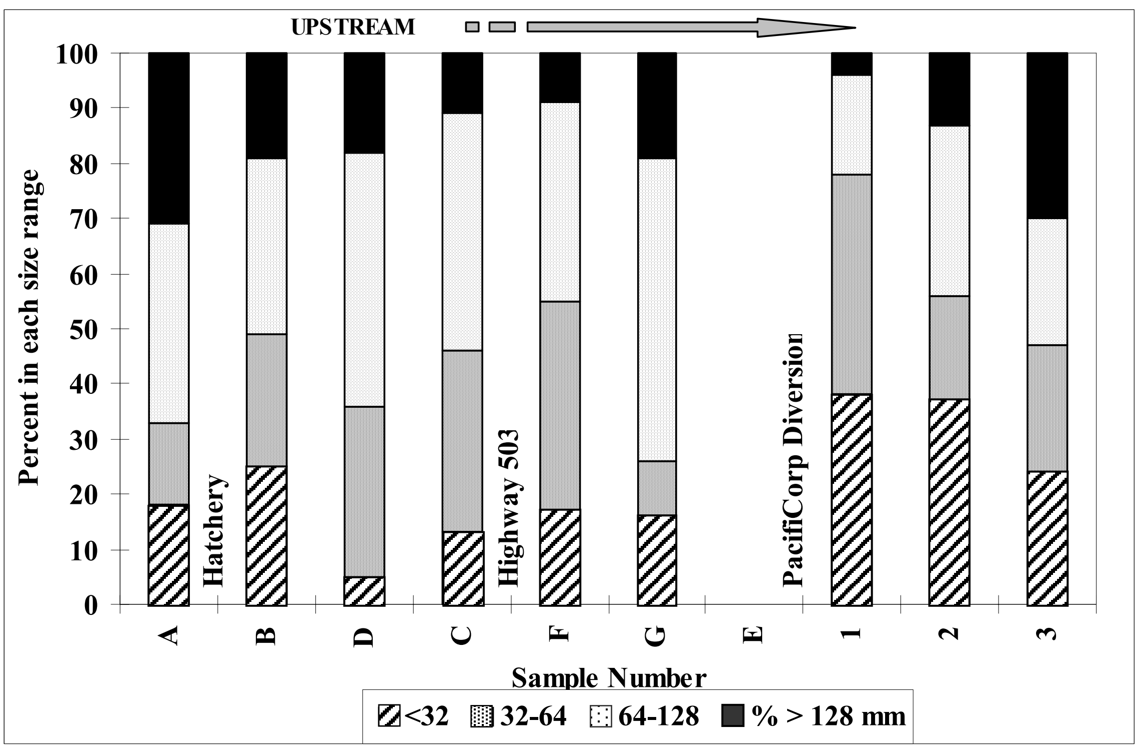


Figure 4.9-15. Change in grain size distribution of surface (armor) gravel samples in Speelyai Creek.

Aquatic Habitat Connectivity

The current diversion structures in Speelyai Creek do not provide upstream passage for fish or aquatic organisms. As a result, the stream is divided into 3 sections from an accessibility standpoint. Fish from Lake Merwin can access the lower 400 feet of Speelyai Creek, up to the hatchery diversion. Kokanee were seen spawning in this reach during the September 2000 survey, and resident fish and aquatic organisms undoubtedly use the reach.

Fish and aquatic organisms in the reach between the 2 diversions are limited to resident species, either descendents of those present prior to construction of the hatchery diversion, or those that moved into the reach from upstream. Currently the upper diversion structure is not passing water to the lower stream reach, precluding downstream passage into lower Speelyai. Prior to the 1996 flood, water, fish and other organisms that could fit through the trashrack screen could pass from upper to lower Speelyai Creek during the few times the diversion was open.

Upstream of the upper diversion, fish and aquatic organisms can move from Yale Lake into and out of upper Speelyai Creek through the canal reach.

4.9.5.6 Speelyai Hatchery

Hatchery production on the Lewis River is provided through the Lewis River Hatchery Complex. The Complex includes the Lewis River Salmon Hatchery, Merwin Trout and Steelhead Hatchery and Speelyai Hatchery. The Speelyai Hatchery is owned and funded by PacifiCorp and Cowlitz PUD. The Washington Department of Fish and Wildlife (WDFW) operates the facility to produce 90,000–100,000 kokanee for stocking into Lake Merwin. The hatchery also serves as a satellite to Merwin and Lewis River hatcheries. Speelyai Hatchery operations depend on Speelyai Creek flows (about 25 to 30 cfs of spring-fed water) for successful rearing conditions.

Speelyai Hatchery has been in operation since the 1950's and, during that time, it has evolved into a key link in quality fish production at the Lewis River hatchery complex. A portion of the fish produced at all 3 hatcheries are cultured at Speelyai. Production goals have evolved greatly over the years due to water quality limitations at the Merwin and Lewis River hatcheries. Even though the water quality at Speelyai has declined, it still remains far superior to that available at the Lewis and Merwin hatcheries. All spring Chinook and early coho adults are held at Speelyai. Temperature and disease problems in the Lewis River prohibit holding of adults until November. All incubation of spring Chinook and early coho is done at Speelyai for the same reasons.

Late fall, winter and spring temperatures at Speelyai are much more conducive to proper incubation and early rearing of all fish stocks. Water temperatures at the Lewis and Merwin hatcheries are very cold from late December until mid-April and thus do not provide the proper temperatures to give the needed growth rates. Speelyai is especially important in the growth schedule of spring Chinook.

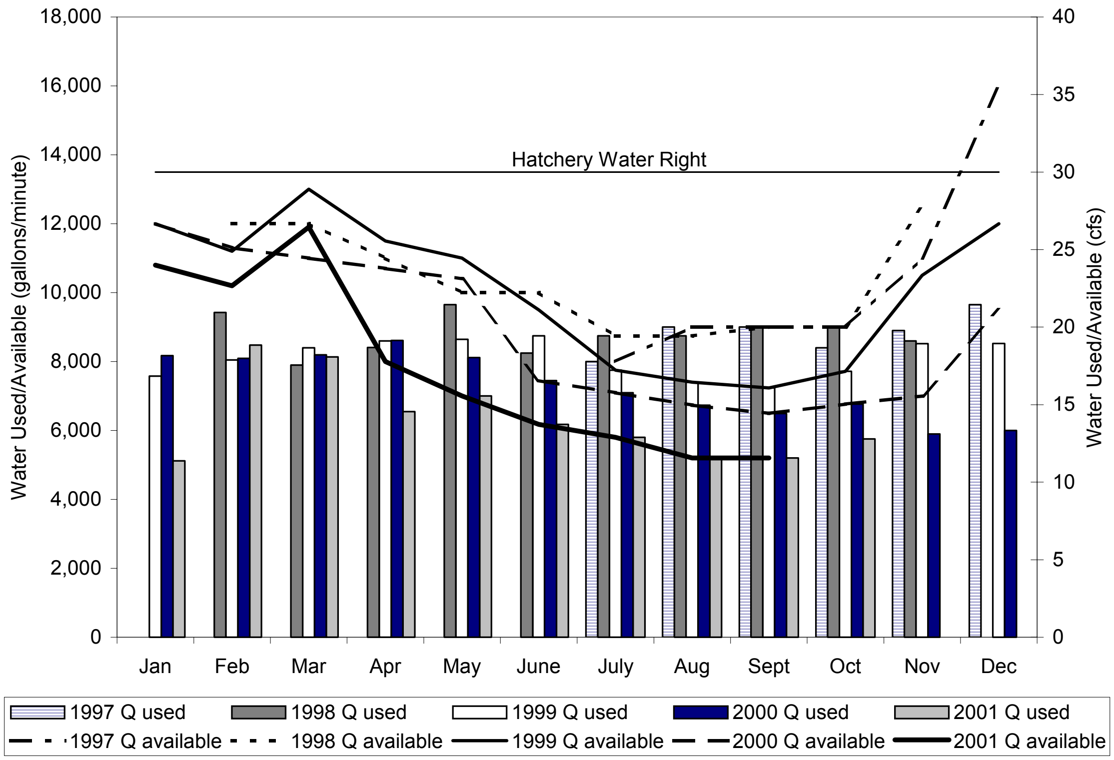
Historically, disease problems have been far lower at Speelyai than at Lewis and Merwin hatcheries. In 2000, WDFW transferred its rainbow program to Speelyai in an effort to avoid the losses that occurred at Merwin in 1999. In 1999, the Merwin program lost over 1 million rainbow due to infectious haematopoietic necrosis virus (IHNV) virus. Fish present in Speelyai Creek do not carry the IHNV virus. WDFW will move the Speelyai coho program to Merwin because they are not susceptible to the virus, and once the rainbow are released, the coho will be returned to Speelyai for rearing. While Speelyai Creek is not totally pathogen free, it is affected far less than water from Lake Merwin or the Lewis River. Dissolved oxygen levels are very good at all 3 sites.

The primary programs at Speelyai involve: 1) 1.3 million spring Chinook are incubated and held through early rearing, 70 percent of which are transferred to rear at Lewis River hatchery; 2) 3 million early coho are incubated to the eyed stage and then shipped to the Lewis, Merwin, Washougal, and Hagerman, Idaho hatcheries as mentioned previously, 1 million coho fry shipped to Merwin will be returned for later rearing; 3) 300,000 kokanee eggs are incubated and reared at Speelyai, all but 60,000 of which are planted after marking; and 4) 500,000 rainbow trout are incubated and reared to release.

The quality of the surface flow in lower Speelyai Creek is influenced by substantial groundwater inflow, coupled with somewhat limited development in the watershed. The creek is the only water source supplying the hatchery and is diverted via a gravity flow system. During low flow, 20.5 cfs (9,200 gpm) is the maximum diversion normally possible, and generally the hatchery takes all the flow. WDFW reports that 25 cfs would be beneficial. Water temperatures normally range from 6.7°C to 14.4°C.

According to the Lewis River Hatchery complex manager, Robin Nicolay, water supply to the hatchery in 2001 was down significantly due to the dryer-than-normal winter and fall. Normally, the late summer and fall are the months when water supply declines. This year, the creek above the diversion went totally dry, although there was flow observed upstream of the highway bridge. Frank Shrier (PacifiCorp) and Robin Nicolay (WDFW) estimated the flow to be approximately 1,500 to 2,500 gpm at a point several thousand feet above the upper diversion. The flow disappeared into the stream bed before the channel reached the highway bridge and upper diversion structure. Due to the lack of adequate water supply, a significant portion of the spring Chinook population was moved out of the Speelyai Hatchery in June 2001. Spring Chinook normally remain at the hatchery until January.

The amount of water available at the Speelyai Hatchery intake and the amount of water used by the hatchery are recorded monthly. Water available and used from 1997-2001 is displayed in Figure 4.9-16. Generally, the hatchery uses all available water during August, September, and October.



Source: WDFW Lewis River hatchery personnel.

Figure 4.9-16. Amount of water available for diversion and the amount diverted and used by the Speelyai Hatchery, 1997-2001.

Hatchery Water Quality and Quantity Requirements and Potential Alternative Water Sources

WDFW operates the Speelyai Hatchery with the following water quality criteria: for incubation, rearing and adult holding/spawning programs, all water at Speelyai needs to be pathogen free; temperature ranges from 8.8°C-14.4°C (48°F-58°F) are optimum; and dissolved oxygen requirements range from 10 mg/l minimum to saturation. Depending upon the season and year, a continuous flow of 15-20 cfs is required to meet current loading demands.

Additional water could be used to increase hatchery capacity. Alternatively, hatchery production could be decreased so that additional water is not needed. Five potential sources have been identified in the vicinity of the Speelyai Hatchery:

- Speelyai Creek surface water (existing source)
- Other tributaries (i.e. Brooks Creek)
- Groundwater wells in vicinity of hatchery
- Ranney collector installed in shallow groundwater near Speelyai Creek
- Treated water from Lake Merwin

Surface water from Speelyai Creek is the existing source of water for Speelyai Hatchery. Water quality, temperature, and quantity have been discussed in detail in previous sections, and are good. An additional 5-10 cfs during the summer (July-October) is desired to maintain production levels.

There are a few small tributaries near Speelyai Hatchery (i.e. Brooks Creek), but the drainage area of these streams is small, and it is likely that they have very low flow during the critical summer months.

Existing groundwater information suggests that there is not sufficient groundwater in the vicinity of the hatchery to provide the entire water supply. The majority of wells in the area have a capacity of 30 gpm. The hatchery uses 7,000-9,000 gpm, so an extremely large well field would need to be developed to supply the entire amount. It may be possible to develop a large well field to augment the current surface water supply by 1,000-2,000 gpm, but this may be counter-productive by potentially decreasing the surface flow in Speelyai Creek.

Ranney collectors (radial collector wells) have been used to supply water to hatcheries in no other locations. This type of collector consists of a vertical caisson installed through the depth of the near-stream aquifer. Screened lateral pipes extend from the caisson at various depths into the most permeable sections of the aquifer and transfer water in a vertical caisson where it can be pumped to the hatchery. The advantage of this type of collector is that it removes the majority of the turbidity. The capacity of each collector well, the maximum capacity of the aquifer under Speelyai Creek, and the effects of the collector on Speelyai Creek surface water flows would need to be determined through hydrogeologic testing.

Water from Lake Merwin could be treated (to remove potential pathogens) and pumped to the hatchery. The most likely treatment system would be ozone, which kills most potential aquatic pathogens. Figure 4.9-17 shows water temperature profiles in Lake Merwin measured in 1999/2000. Preferred hatchery water temperatures are 8.8°C-14.4°C. In order to get cool water during the summer months, the intake would need to be located deeper than 20 meters (65 feet) in the lake. This would require an intake in the main body of the lake, approximately 4,000-5,000 feet from the hatchery, since the inlet where the hatchery is located is not deep enough. During winter and early spring months (January–April), lake temperatures are colder than optimal at all depths.

4.9.6 Discussion

Four potential management scenarios for lower Speelyai Creek were investigated to provide information on the range of options for operating the upper diversion structure, and the effects on the creek and hatchery.

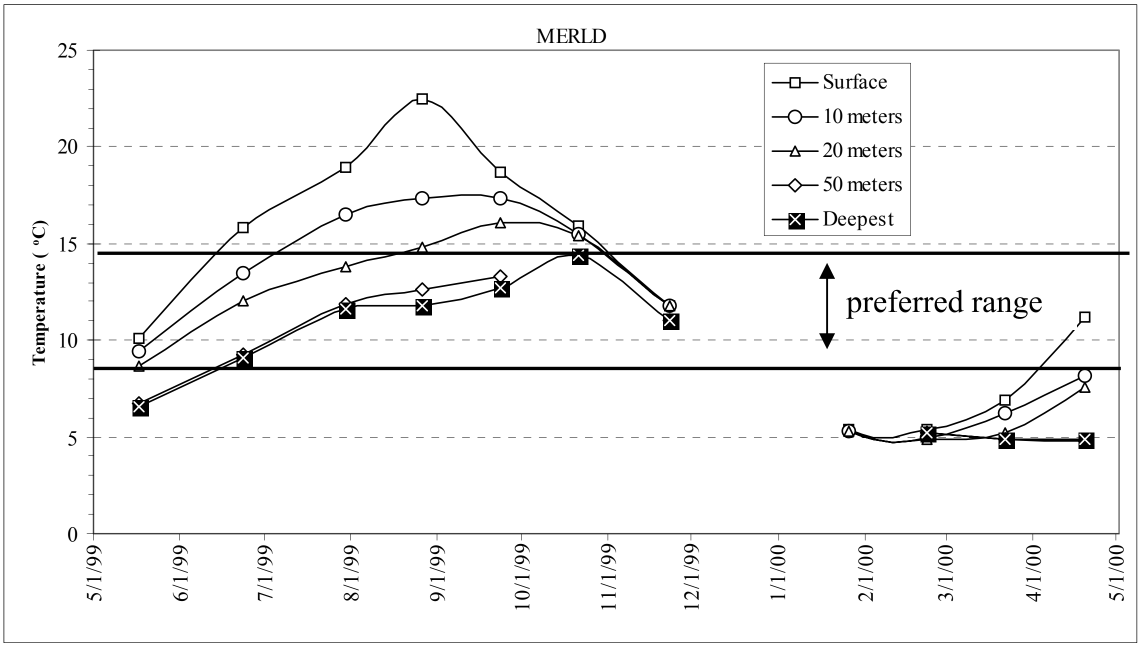


Figure 4.9-17. Lake Merwin monthly temperature profiles.

4.9.6.1 Operate PacifiCorp (Upper) Diversion with No Water Releases into Lower Speelyai

Under this scenario, the upper diversion would continue to be operated as at present, with no release of water into lower Speelyai Creek. All water from upper Speelyai Creek would be diverted into Yale Lake. The diversion has essentially been operated in this manner since 1979. The upper diversion gates have only been opened 3 times since 1979, always during October in extremely dry water years. Each time, the gates were closed within 3 weeks, as soon as the rains started and flows in lower Speelyai increased.

Hydrology

If the upper diversion is operated under current conditions, no water from upper Speelyai Creek would be added to lower Speelyai Creek. Under this scenario, groundwater flow and runoff from the lower Speelyai watershed would supply the creek, and flows would continue as during the past 20 years, varying between 15 cfs in the summer and 30 cfs during the winter and spring (Figure 4.9-16). During dry years, summer flows would be less than 15 cfs. High flows would continue to be muted, with runoff from only the lower Speelyai watershed.

Water Quality

No measurable change in water quality or water temperature would be expected with this action, as no changes in flow or in the ratio of surface to groundwater would occur.

Aquatic Habitat Condition and Connectivity

Aquatic habitat would remain as at present, with a good mix of riffle, glide, and pool units, beaver dams, abundant large woody debris, and spring-fed flow conditions. The amount of aquatic habitat increases gradually downstream from the upper diversion as flows increase from groundwater input.

Land Use and Streamside Structures

Existing stream-side homes, cabins, bridges, and instream structures would continue to be stable since high flows would continue to be muted. Development of stream-side homes would likely continue since the stream would be seen as a stable system. This could negatively affect riparian habitat and water quality in the stream.

Speelyai Hatchery Water Supply

The hatchery water supply would continue to be below desired/permitted levels in the summer and early fall (June-October) during dry years. Water quality would be good, with a water supply of cool, consistent temperature, low turbidity, and essentially free of fish-borne pathogens.

An additional 5-10 cfs would be required during the summer and early fall during dry years to obtain the 20 cfs used by the hatchery during the majority of the year; 15-20 cfs of additional flow would be required to meet the 30 cfs water right. Based on existing wells in the area, it is unlikely that groundwater or a Ranney collector could be used to supply this volume of water. Treated water from Lake Merwin would be the most feasible source of this large volume of water.

4.9.6.2 Operate PacifiCorp (Upper) Diversion According to Water Right

Under this scenario, the upper diversion structure would be repaired and the stream channel routed to its former position to release water according to the water right. A flow of 15 cfs (or inflow if less than 15 cfs) would be released into lower Speelyai Creek. The remaining flow from upper Speelyai Creek would be diverted into Yale Lake through the canal.

The existing diversion structure does not have any fish passage facilities, and none would be added under this scenario. An upstream-facing rock groin would be placed in Speelyai Creek deflect flow toward the intake structure.

Hydrology

This action assumes that 15 cfs (if available) would be added to lower Speelyai Creek from the upper watershed. Review of the Speelyai Creek USGS gage data shows median flows in excess of 15 cfs during all but the months of July (11 cfs), August (6 cfs), and September (6 cfs; Table 4.9-3). The additional flows would result in higher flows at the hatchery intake than under current conditions. Estimated average flows at the Speelyai Hatchery were calculated for both predicted flows (based on Equation 1) and estimated monthly flows recorded by hatchery personnel (Figure 4.9-18 and Table 4.9-12).

Estimated average monthly flows between 7 and 53 cfs (based on predicted flows) and 23 and 43 cfs (based on estimates by hatchery personnel) would be expected at the hatchery intake site under this scenario.

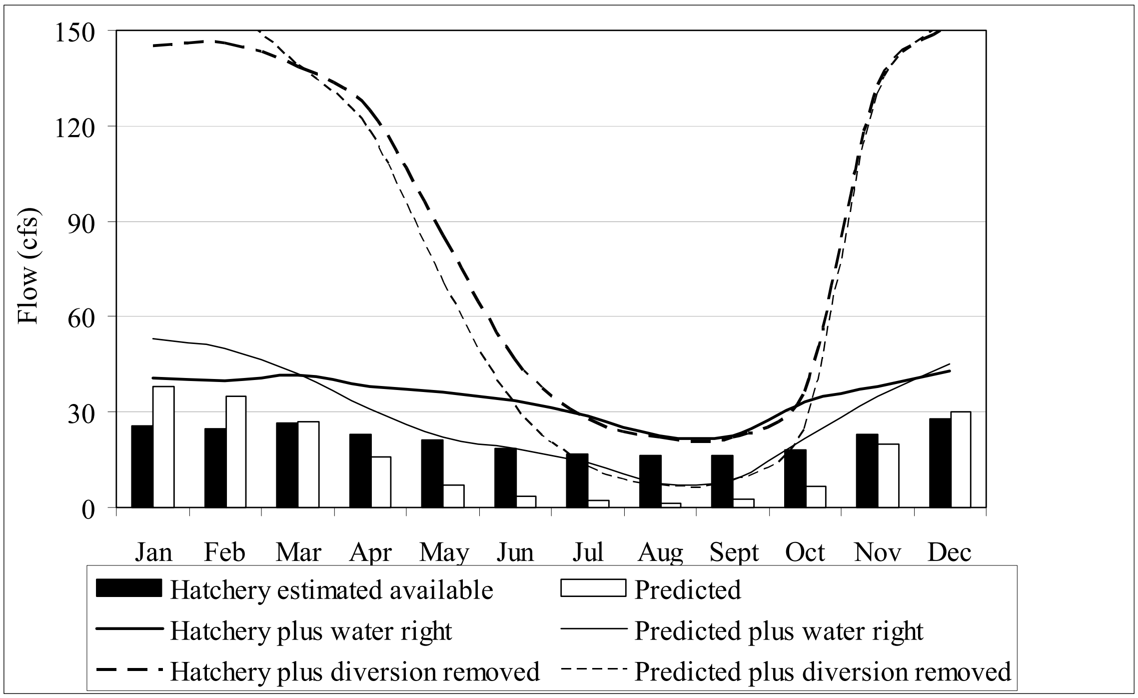


Figure 4.9-18. Estimated changes to mean monthly flows at the Speelyai Hatchery intake under different management scenarios.

Table 4.9-12. Estimated flow at Speelyai Hatchery intake under different scenarios (in cfs).

Inflows / Scenarios	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Current conditions (no inflow) - predicted using Equation 1	38	35	27	16	7	4	2	1.4	3	7	20	30
Hatchery estimate of available water (1997–2001)	26	25	27	23	21	19	17	17	17	18	23	28
Inflow to lower Speelyai if operated according to water right	15	15	15	15	15	15	12	6	6	15	15	15
Inflow to lower Speelyai if upper diversion removed	120	121	112	102	64	28	12	6	6	18	110	124
Flow at hatchery intake assuming the following scenarios:												
Predicted flow plus water right	53	50	42	31	22	19	14	7	9	22	35	45
Hatchery estimated flow plus water right	41	40	42	38	36	34	29	23	23	33	38	43
Predicted flow plus diversion removed	158	156	139	118	71	32	14	7	9	25	130	154
Hatchery estimated flow plus diversion removed	146	146	139	125	85	47	29	23	23	36	133	152

Water Quality

Changes to water temperatures in lower Speelyai Creek are expected if flows from upper Speelyai are added to the lower reach. Peak water temperatures in both upper and lower Speelyai Creek occur during July, August, and September. The moderating influence of groundwater on summer water temperatures in lower Speelyai Creek would be slightly decreased by this action, resulting in warmer summer flows at the downstream end of Speelyai Creek. There is likely to be a greater influence of this action in terms of temperature during the winter months, when the full 15 cfs inflow would be added to lower Speelyai. In the winter months, temperatures at the downstream end of Speelyai Creek would be expected to be cooler than under existing conditions. Median temperatures at SPLYU and SPLYL in January were 4.4°C and 7.8°C, respectively.

With the exception of a probable decrease in specific conductance, particularly during the winter months, and a slight increase in turbidity during peak flows, effects on the quality of water reaching the hatchery likely would be minimal. No significant changes in dissolved oxygen would be expected. pH may be slightly lower at the hatchery intake due to greater influence of precipitation influenced flows, which would tend to depress pH relative to groundwater.

Aquatic Habitat Condition and Connectivity

The area of aquatic habitat would increase in lower Speelyai Creek with the addition of flow from the upper watershed. The change in water surface elevation (stage) and wetted width at the 7 measured stream transects in lower Speelyai was computed by comparing stage/width under current (no release) average monthly flows reported by hatchery personnel, and these flows with the addition of up to 15 cfs (the second and sixth rows in Table 4.9-12). The increased stage varied between 0.1 feet in the summer and 0.3 feet in winter (Table 4.9-13). Increased widths averaged between 2 and 5 feet between summer and winter, but varied greatly between transects, depending upon the cross section configuration (range 0.4 to 20 feet increase).

Table 4.9-13. Estimated changes in water surface elevation and channel width if upper diversion operated according to water right (average increased stage/width in feet).

Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stage	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2
Width	5	5	5	4	4	5	4	2	2	4	5	5

No estimate was made of the total increase in habitat or types of different habitat created, but the total wetted area would be greater than under current conditions. The addition of 6-15 cfs would not result in any appreciable channel changes, transport of gravel, or larger particles on the streambed since peak flows from the upper watershed would not be added to the lower channel. The net flow increase may result in slight flushing of surficial sand and silt particles during higher flows.

Continual operation of the upper diversion structure would allow aquatic organisms from the upper watershed to pass downstream into lower Speelyai Creek. There are no upstream passage facilities at the structure. Terrestrial species that are dependent upon riparian corridors for migration (e.g. shrews and voles) may be able to cross the 30-40 foot diversion structure and road that separates the upper and lower creek riparian zones, but conditions and cover are not ideal.

Land Use and Streamside Structures

An increase of up to 15 cfs to lower Speelyai Creek is predicted to increase water levels 0.1 to 0.3 cfs at most locations modeled (Table 4.9-13). This is not anticipated to have negative effects on any streamside houses, trailers, or bridges.

Speelyai Hatchery Water Supply

The hatchery water supply would continue to be below permitted levels (30 cfs) during July, August, and September, particularly during dry years. The increased flows would be more than the 20 cfs used by the hatchery during the majority of the year, so a supplemental water source may not be needed under this scenario. If the hatchery operations change and the entire permitted 30 cfs is needed, 7 cfs of additional flow would be required on average during August and September (more during dry years). Based on existing wells in the area, it is possible that groundwater from wells or a Ranney collector could be used to supply this volume of water, but additional hydrogeologic testing would be needed to make a final determination and to determine the effects on surface flows. Treated water from Lake Merwin would be the another possible source of water, but the intake would need to be far out in the lake to get cool water during July and August.

The quality of water provided to the hatchery would be changed under this scenario. Water temperatures would be warmer during the summer and colder during the winter. Specific conductance would decrease, and turbidity during high flow events would increase as more turbid water is supplied from the upper watershed. There would also be the potential for pathogen-carrying fish, or water with fish pathogens to be transported into lower Speelyai Creek from the upper watershed and Yale Lake system. Lower Speelyai Creek water is essentially free of fish pathogens under current conditions.

4.9.6.3 Construct New Upper Diversion to Re-connect Upper and Lower Speelyai

Under this scenario, the existing upper diversion structure would be redesigned to allow for upstream and downstream passage of aquatic organisms and riparian-dependent species. A design for this type of structure has not been developed pending the outcome of settlement and aquatic management discussions, but would likely entail a flow control structure at the upstream end with a small fish ladder designed for upstream and downstream passage. To facilitate migration of riparian-dependent species, a riparian vegetation corridor would be planted along the margins of the facility/channel to provide cover. The facility would be designed not to pass the large quantities of wood or sediment from the upper watershed into lower Speelyai Creek.

The amount of water directed into lower Speelyai Creek would be the amount permitted under the existing water right (up to 15 cfs) as discussed in Section 4.9.6.2, so the effects on hydrology, water quality, aquatic habitat condition, land use, and the hatchery water supply would be identical to that discussed in that section. The only differences would be the effects on aquatic habitat connectivity.

Aquatic Habitat Connectivity

Under this scenario, the upper diversion would be redesigned to allow for upstream and downstream passage of fish, other aquatic organisms, and riparian-dependent species (e.g., shrews and voles). Fish would be able to freely migrate between upper and lower Speelyai Creek and the Yale Lake system. The lower diversion would not be changed under this scenario, so no fish could migrate upstream from Lake Merwin into Speelyai Creek.

4.9.6.4 Remove PacifiCorp (Upper) Diversion Structure

Under this scenario, the upper diversion structure would be removed and the flow of upper Speelyai Creek would be directed into the lower reach of the stream. No flow would go into the Speelyai canal reach or Yale Lake from the upper Speelyai watershed.

Hydrology

If the upper diversion structure was removed, the entire flow of upper Speelyai Creek would be directed into lower Speelyai Creek. This would result in much higher flows during the winter and spring months. Predicted mean monthly flows are shown in Figure 4.9-18 and Table 4.9-12. Peak flows would be similar to those at the upper diversion, with a 1.25-year peak flow of 1,140 cfs, a 5-year peak flow of 2,440 cfs, and a 10-year peak of 2,940 (Table 4.9-4).

Water Quality

Removal of the diversion structure and full reconnection of upper and lower Speelyai Creek would result in surface water-dominated turbidity, nutrients, alkalinity, and cation/anion concentrations during much of the year. The influence of groundwater would be substantially reduced via dilution by surface water between November and June, and water quality would be expected to closely approximate conditions upstream of the current diversion during these months.

Aquatic Habitat Condition and Connectivity

The area of aquatic habitat would increase in lower Speelyai Creek with the addition of flow from the upper watershed. The change in water surface elevation (stage) and wetted width at the 7 measured transects in lower Speelyai was computed by comparing stage/width under current (no release) average monthly flows reported by hatchery personnel with those measured at the upper Speelyai gage and added to the lower creek flows (Table 4.9-12). The increased stage varied between 0.1 feet in the summer and 1.2 feet in winter (Table 4.9-14). Increased widths averaged between 2 and 13 feet between summer and winter, but varied greatly between transects depending upon the cross section configuration (range 0.4 to 30-foot increase). No estimates were made of the total increase in habitat or types of different habitat created, but the total wetted area would be greater than under current conditions.

Table 4.9-14. Estimated changes in water surface elevation and channel width if upper diversion removed (average increased stage/width in feet).

Variable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Stage	0.8-1.2	0.8-1.2	0.8-1.1	0.6-1.0	0.5-0.8	0.3	0.2	0.1	0.1	0.2	0.8-1.2	0.8-1.2
Width	13	13	12	12	10	6	4	2	2	5	12	13

The addition of peak flows, sediment, and large woody debris from the upper watershed would result in major channel changes in the lower stream reach. The channel would be changed from spring-fed characteristics (stable flows and channel) to one with active channel processes. The width of the active stream channel would be similar to that upstream of the upper diversion structure, approximately 60 feet wide compared to the current 20-30 feet. Large woody debris transport would be greater, resulting in less in-channel wood, and high flows would destroy the existing beaver dam complexes and still-water habitat. The existing high sediment load in the upper watershed that is a result of timber harvest activities would be transported into the lower stream system (Table 4.9-11), resulting in higher turbidity during peak flows and more channel migration. The existing beaver dams in the lower watershed would likely be washed out during peak flow events.

Fish, aquatic organisms, and riparian-dependent species would be able to freely migrate between upper and lower Speelyai Creek (upstream of the lower diversion). The lower diversion would not be changed under this scenario, so no fish could migrate upstream from Lake Merwin into Speelyai Creek.

Land Use and Streamside Structures

Returning upper Speelyai Creek flows to lower Speelyai Creek is predicted to increase average monthly water levels 0.1 to 1.2 cfs at most locations modeled along the creek (Table 4.9-13). Under high flow and flood conditions, water levels would be much higher. Peak flows of approximately 1,140 (1.25-year flow), 1,680 (2-year flow) and 2,440 (5-year flow) are much larger than the capacity of the 3 small bridges that were measured during field work (estimated capacity below bridge deck of 85-275 cfs depending upon the bridge). It is likely that the other 2 low-clearance road bridges and 9 foot bridges have similar small underflow capacities. These 14 bridges would need to be replaced with larger structures or abandoned. The Highway 503 bridge and the concrete bridge at Beaver Pond Road would likely not need to be replaced.

High flows would also affect at least some of the 22 cabins, houses, and trailers located in close proximity to the stream. Cross sections were located at 2 of these cabins to make a rough estimate of the flow that would reach the base of the structures. In both cases, the 2-year to 5-year peak flow was estimated to reach the foundation of the cabins. In order to accurately assess the effect of peak flows on the structures, a more detailed hydraulic model with multiple cross sections would be needed, but geomorphic evidence based on channel cross sections supports the hydraulic modeling that 2-year flows would be near historic bankfull conditions. The cabins closest to the stream that would be in most jeopardy are new cabins constructed just at the top edge of the old bankfull channel. Most older homes are farther away from the channel or on stilts.

The peak flows would likely fill the hatchery diversion impoundment with sediment, damage the intake structure and probably render the intake unusable after flood events. The diversion structure would be overtopped during peak flow events. This would result in major repair costs and loss of the hatchery water supply (or redesign of the structure to handle large flow and sediment supplies).

Speelyai Hatchery Water Supply

Depending on flows, summer water temperatures at the Speelyai Hatchery intake would be expected to increase by up to 2-3°C. Winter temperatures at the intake would be cooler by approximately the same amount. On a seasonal basis, water temperatures are currently at both the upper and lower limits for good fish culture. If the Speelyai Creek diversion were removed, temperature records show that both temperature extremes would be adversely altered. These changes in temperature would increase disease incidence and adversely impact the spring Chinook program at Speelyai Hatchery.

pH would be slightly lower at the hatchery due to precipitation-dominated surface flows, which would tend to depress pH relative to groundwater. During the majority of the year, turbidity would remain low (based on data collected at SPLYU), although in contrast to existing conditions, the hatchery would be subject to high turbidity and storm-caused erosion during peak flows.

Disease problems could increase due to the probability of kokanee from Yale Reservoir entering the system or spawning above the lower diversion and hatchery intake structure.

The stability of the lower diversion and hatchery intake structure would be at risk as discussed in the previous section. It would need to be redesigned, or an alternate water source for the entire hatchery water supply would be required. It is likely that a constant 20-30 cfs could not be supplied from wells (groundwater) sources; a Ranney type collector under the stream channel or treated lake water would be the most feasible alternatives.

4.9.7 Schedule

This study is complete.

4.9.8 References

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4.9.9 Comments and Responses on Draft Report

This section presents stakeholder comments provided on the draft report, followed by the Licensees' responses. The final column presents any follow-up comment offered by the stakeholder and in some cases, in italics, a response from the Licensees.

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
WDFW – CURT LEIGH	1	AQU 09	Hatchery water supply.	There is no assessment of hatchery water supply alternatives. This is objective #2 of the study.	Objective 2 states: "…facilitate long-term successful operation of the Speelyai Hatchery." The report includes an initial assessment of hatchery water supply alternatives. Additional assessments would be provided if needed based on management decisions for the reach. In order to provide the most cost-effective approach to this study, the decision was made to wait until settlement discussions indicated a need for detailed water supply information.	
WDFW – JIM BYRNE	1	AQU 09	Speelyai Connectivity.	There seems to be an emphasis on protecting the hatchery, when the real reason for the diversion canal to Yale is to pass additional water through Yale Dame for power generation. The hatchery is only looking for a source of pathogen free water not additional water from the creek. Additional creek flows would bring potential silt problems in incubation and rearing water.	The original water right application for the Yale diversion stated the purpose of the diversion was "to divert flood water away from State Fisheries rearing ponds" as well as power production. Some members of the ARG indicated that the hatchery was interested in additional water from the	

Commenter	Volume	Page/ Paragraph	Statement	Comment	Response	Response to Responses
					creek.	
WDFW – KAREN KLOEMPKEN	1	AQU 09	Management Scenarios.	Why were only four potential management scenarios for Lower Speelyai Creek investigated when five were identified?	Five potential water supply sources were noted; the 4 management scenarios, having to do with the disposition of the upper diversion, were investigated.	
WDFW – JIM BYRNE	1	AQU 09-12 para 3	Groundwater availability.	It states that groundwater is insufficient to supply whole hatchery. This may be true but groundwater is only needed to fit part of the overall hatchery need i.e.: incubation and indoor juvenile rearing. May need additional flows in late summer in very dry years, but that can be provided now if repairs to the valves are made.	Appropriate source(s) of water for the hatchery that meet all stated objectives depends upon the management options chosen for lower Speelyai Creek, as stated in the report.	Ground water input is needed for specific times and specific locations, not on a hatchery wide year round basis. This is not clear in the text. **Licensees' Response**: *The following statement will be added to the text. "Depending upon the management option chosen for Speelyai Creek, a totally new water source or a supplemental water source may be needed."*
WDFW – KAREN KLOEMPKEN	1	AQU 09-20 para 2, third sentence	Incorrect word.	Should change the word "event" to "even" between "vary dramatically" and "during winter rains."	This change will be made.	
WDFW – KAREN KLOEMPKEN	1	AQU 09-27 para 1, third sentence	Use of acronyms.	IHN should be spelled out before the acronym is used and not in bold. Also should be IHNV, for proper use.	This change will be made.	
WDFW – KAREN KLOEMPKEN	1	AQU 09-34	4.9.6.3 Construct New Upper Diver. to Reconnect Upper & Lower Speelyai.	There were no "design for this type of structure pending the outcome of settlement" discussions. Why? Wouldn't a design and cost estimate be useful during settlement discussions?	In order to provide the most cost-effective approach to this study, the decision was made to wait until settlement discussions indicated a need for design information.	