Final Report

Valsetz Water Storage Concept Analysis

Appendix C
Aquatic Resources/Fisheries

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Aquatic Resources/Fisheries

1 Introduction

This Valsetz Water Storage Concept Analysis is funded by a Senate Bill 1069 [2008] Water Conservation, Reuse, and Storage Grant Program grant awarded by the Oregon Water Resources Commission on November 20, 2008. The grant provides funding for developing information needed to evaluate development of a water conservation, reuse, or storage project in the South Fork Siletz Basin. The funded planning study includes collection of streamflow and environmental information, completion of hydrologic, streamflow, and water demand analyses, development of baseline environmental impacts assessments and completion of a storage concept and alternative analysis.

The purpose of this study is to conduct an appraisal level assessment of potential environmental effects and potential benefits of the Valsetz water storage project. The assessment focuses on three storage concept alternatives determined by dam height and reservoir storage. This analysis serves as a preliminary, concept-level review of the resources that may be affected if a project were developed. This initial investigation relies on existing information, an extremely limited amount of field data and some preliminary modeling and analysis. This is a first step in understanding potential effects in the area that would be inundated by a project and the Siletz and Luckiamute Rivers. Further investigation and technical studies will be required to definitively evaluate the magnitude and type of impacts and feasibility of project development.

This appendix documents the existing aquatic and riparian habitat in the vicinity of the historic Valsetz Lake and provides an initial evaluation of potential effects related to three different water storage scenarios. Information provided in this report is developed from a 2010 habitat survey as well as a review of publicly available literature and contact with resource management agencies. Potential impacts to these resources from the three dam options under consideration for the Valsetz Water Storage Concept are evaluated. Direct and indirect impacts of dam construction and operation and inundation are estimated. The following information includes:

1. Field Methods
2. Results of the 2010 Habitat Survey
3. Aquatic Resources/ Fisheries
4. Project Effects on Biological Resources

This document is based on limited data and relies upon many assumptions. The document provides a preliminary assessment of potential project impacts and does not constitute a feasibility analysis for the project. A feasibility analysis would include an assessment of a continuum of data and a broader range of alternatives.

2 Aquatic Resources/ Fisheries

2.1 Siletz River Fish Species

In terms of anadromous salmonids, the Siletz Basin is one of the most productive anadromous fisheries in Oregon. The Siletz River supports viable runs of seven species of anadromous salmonids (spring and fall Chinook salmon, coho salmon, chum salmon, summer and winter steelhead, and sea-run cutthroat trout) and Pacific lamprey. The Siletz is unique in that it includes the only native summer steelhead run in the Oregon Coast Range north of the Umpqua River (BLM 1996).

Siletz Falls, at River Mile 64.5, creates a partial barrier to upstream fish migration. A fish ladder has been in operation at this location since the mid-1950s. Since the fall of 1994, only summer steelhead and spring Chinook salmon have been passed upstream to the North and South Forks of the Siletz River (Buckman 1995). By limiting the species that pass the falls, the upper Siletz basin, above the falls, is being basically managed as a summer steelhead refuge.

The S.F. Siletz basin historically provided habitat for more than 40 species of fish, including anadromous, resident, and game species (Smith and Lauman 1972). Many of the species that formerly occupied Lake Valsetz, such as bullhead, carp, goldfish, bluegill, and bass, are no longer present in the basin.

Fish species currently known to be present in the SF Siletz include:

- Summer steelhead trout (*Oncorhynchus mykiss*)
- Spring Chinook salmon (*O. tshawytscha*)
- Resident cutthroat trout (*O. clarki clarki*)
- Pacific lamprey (*Lampetra tridentata*)
- Dace (*Rhinichthys sp*.) and sculpins (*Corridae sp.)*

Summer steelhead are found in the mainstem Siletz River up to Callahan Creek. They are also found in several of the lower portions of all the tributaries to the SF Siletz (Wilson 2008b). Summer steelhead are present in the river as early as late March and hold in the river until the following winter (Wilson 2008b). At the Siletz Falls fish trap, steelhead counts peak between late June and Mid-July (Wilson 2008b). Spawning begins in January and extends through May (Wilson 2008b). Juvenile fish will remain in the river for nearly a year. The relative use of the mainstem, including the north and south forks of the Siletz River, is largely unknown. Spawning surveys conducted in the 1980s indicate that an average of 903 spring steelhead spawned in the North Fork and 601 spring steelhead spawned in the South Fork between 1980 and 1985 (Stream net data, http://www.streamnet.org/). Surveys were discontinued in 1985.

Spring Chinook enter the river between May and August and spawn in September and October (Wilson 2008a). Spring Chinook use the SF Siletz in relatively small numbers (Wilson 2008a, b). Fall Chinook (which are not present in the South Fork) enter the river in September and October and spawn in late October through December (Wilson 2008b). Chinook juveniles migrate to salt water after a few months of freshwater residence (Wilson 2008a, b).

As mentioned previously, coho and fall Chinook salmon are not passed over the Siletz Falls, so are only found below the falls. Peak spawning of coho salmon occurs between mid-November and mid-December in the mainstem Siletz and its tributaries (ODFW 2011). Juvenile coho salmon typically spend roughly 18 months in freshwater before migrating to salt water.

Distribution of the four anadromous salmonids found in the S.F. Siletz watershed is presented in Figure 1.

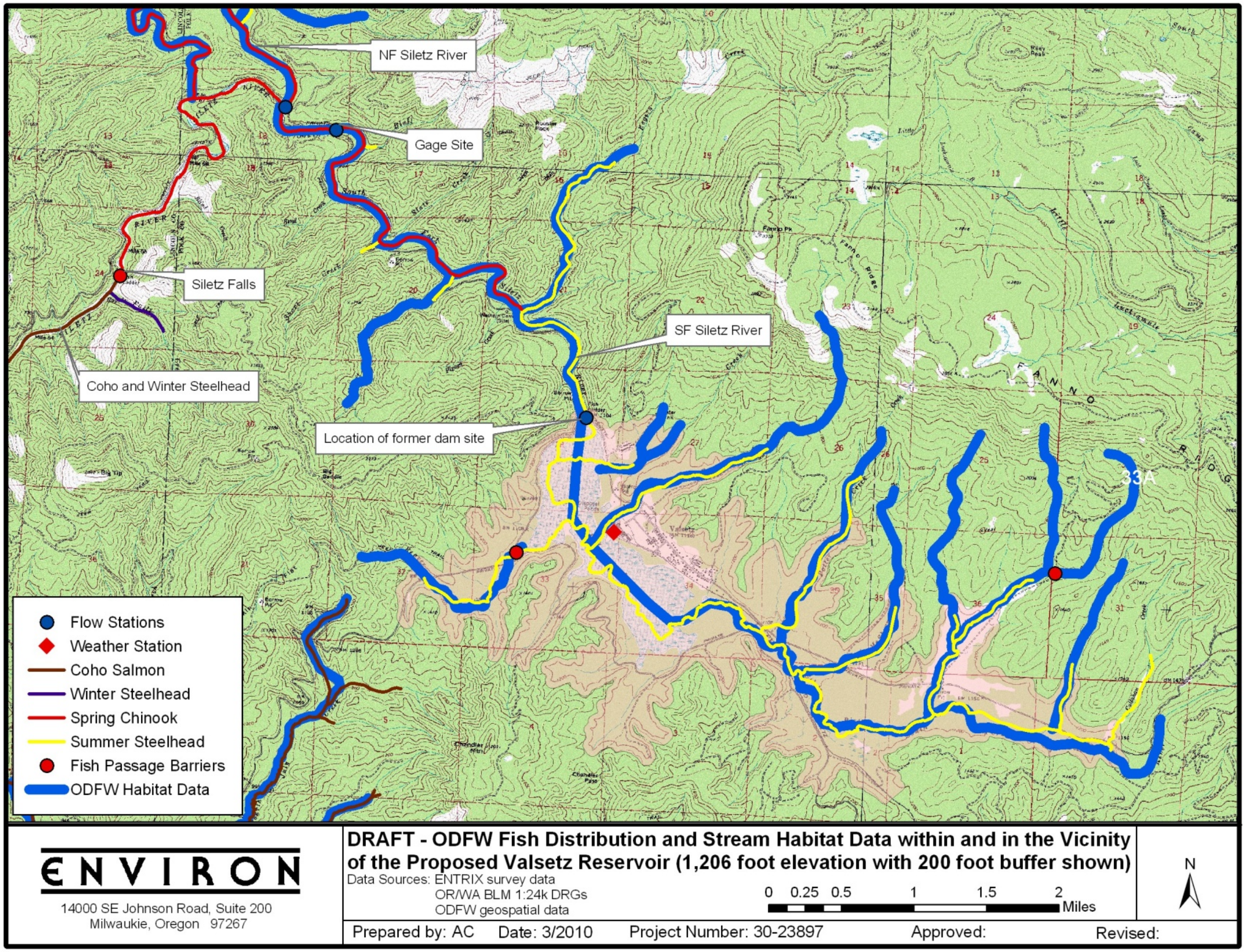

Figure 1. Anadromous Fish Distribution and Stream Habitat Data within the Vicinity of the Proposed Valsetz Reservoir. (Source: Oregon GeoSpatial Data, http://www.oregonexplorer.info/).

Pacific lamprey are present in the Siletz basin (Altman et al., 1997). Western brook lamprey may be present but are not documented. Both lamprey species are thought to be in decline and of regional concern (Kostow 2002, Van de Wettering 2008). Lamprey are anadromous. The young spend 4 to 6 years as larvae living in the mud in freshwater. After they emerge as adults, they migrate to seawater where they live for 2 to 3 years before returning to spawn (BPA 2005). Pacific lamprey along the coast of Oregon usually begin to spawn in May, when water temperatures reach 10ºC to 15ºC, and continue to spawn through July (Confederated Tribes of the Umatilla Indian Reservation, 2004).

Populations of small, resident cutthroat trout are found in many streams in the SF Siletz basin (Smith and Lauman 1972). Life history requirement of cutthroat trout vary; some populations migrate between streams and rivers in a basin during different seasons while some are non-migratory and will not move far from a home pool. Exact movement patterns of cutthroat trout in the SF Siletz basin are unknown.

2.2 Luckiamute River Fish Species

The Luckiamute system provides habitat for fewer and less diverse species and races of salmonids than the Siletz River. Winter steelhead, coho salmon, and, potentially, spring Chinook juveniles occur in the mainstem Luckiamute and many of its tributaries (Garano et al. 2004; Bio-Surveys, LLC 2009) but are not found in the Little Luckiamute above the falls at Fall City (Bio-Surveys, LLC 2009). Cutthroat trout in the Luckiamute are resident (non-andromous).

Pacific lamprey are present in the Luckiamute systems (Altman et al., 1997). Western brook lamprey may be present but are not documented. Both lamprey species are thought to be in decline and of regional concern (Kostow 2002, Van de Wettering 2008).

2.3 Endangered Species Status

The following stocks are protected under the Endangered Species Act (ESA). None of them occupy habitats within the South Fork Siletz River.

- The Oregon Coast Steelhead DPS was listed by the National Marine Fisheries Service as a species on concern on April 15, 2004 (FR 69:19975-19979). No critical habitat has been defined for this species.
- Coho salmon in the Siletz are listed as Threatened under the ESA and identified as a distinct, independent population in the Oregon Coast Coho Salmon Evolutionarily Significant Unit ESU (Ford et al. 2004, Wainwright et al. 2008).
- Luckiamute Winter steelhead are part of Upper Willamette ESUs that are listed as Threatened under the ESA (Meyers et al. 2006). Critical habitat extends into the headwaters of the Luckiamute River.
- Luckiamute spring Chinook salmon are part of Upper Willamette ESUs that are listed as Threatened under the ESA (Meyers et al. 2006). Critical habitat is limited to the lower few miles of the mainstem Luckiamute River.
- Oregon chub (ESA Endangered) were historically present in the Luckiamute River, but are considered extirpated (USFWS 2010, USFWS 1998, USFWS 1993).

The federal (ESA) and Oregon status of primary fish species in the Project area is presented in Table 1.The presence of ESA - listed salmonids in the South Fork of the Siletz River and in the Luckiamute River system will be a prominent consideration in future analysis of Project effects and development of operational parameters (e.g. instream flow releases).

Table 1. Species protected under the Endangered Species Act that are present in the Siletz and Luckiamute Rivers

Species	Basins where Present	ESA Listing Status	Critical Habitat	Notes
Oregon Coast Steelhead	Siletz River including the South Fork	Species of Concern	None	
Coastal Coho	Siletz River downstream of falls	Threatened	Yes, extends throughout most of the South and North Forks of the Siletz River	Coastal coho are not present in the South and North Forks of the Siletz River; they are not passed upstream of Siletz Falls
Upper Willamette River Steelhead	Luckiamute	Threatened	Yes, extends to headwaters of Luckiamute and Little Luckiamute	Not observed above the falls at Fall City
Upper Willamette Spring Chinook	Luckiamute	Threatened	Yes, extends from mouth to a point about 5 miles upstream on the mainstem Luckiamute	
Oregon chub	None	Endangered		Historically present in the Luckiamute basin

2.4 Habitat Requirements of Salmonids and Lamprey in the Siletz Basin

General biological requirements of fish in the Siletz Basin include (1) rearing habitat preferences, (2) spawning conditions, (3) conditions supporting egg incubation, (4) food, and (5) passage. Each is briefly discussed below.

2.4.1 Rearing Habitat Preferences

Streams that support a higher diversity of spawning and rearing habitat for salmonids tend to have a pool-to-riffle area ratio of approximately 1:1 (Groot and Margolis 1991). This ratio is thought to provide optimum food, cover and spawning habitat for trout, salmon, and char species. Platts et al. (1983 *as cited in* SCPWD 2002) also reported that a ratio of 0.4:1 supported a high biomass of salmonids. Another measurement of habitat quality is pool frequency, where Chinook redd frequency increased with decreasing pool spacing (Montgomery et al. 1999 *as cited in* SCPWD 2002). Finally, deep pools (>1.0 m) with overhanging banks and vegetation provide provides refugia from predators (Smith and Lauman 1972).

Optimal water temperatures for juvenile spring Chinook salmon ranges from 12.2 to 12.8ºCentigrade (C) and optimal rearing temperatures for fall Chinook range from 15 to 17.8ºC (Wydoski and Whitney 2003). Water temperatures that exceed 22.8ºC are lethal to most Chinook salmon juveniles and smolts. McCullough (1999) reported that the lethal temperature for adult Chinook salmon and steelhead was 21 to 22ºC in the Columbia River, which indicates that adults have less tolerance for high water temperatures than juveniles of the same species.

Larval lampreys rear buried in mud or fine substrates where they filter micro-organisms from the water. They tend to be associated with patchy fluvial features, such as backwaters, eddies, insides of bends and the downstream end of sand bars, where fine sediments (sand and silt) tend to accumulate. Emergent larvae of size 7-10 millimeters (mm) prefer mud that is 0.004 centimeters (cm-) in diameter over sand (0.005 cm) and gravel (l-O.5 cm) substrate (Close et al 1995). The water velocity over ammocoete (larval lamprey) beds in Oregon streams ranges from 0.1 to 0.5 meters per second (m/s) (Close et al 1995). Larval sea lamprey preferred a summer temperature of 20.8^0 C and ranged from 17.8 to 21.8ºC (Close et al 1995).

2.4.2 Spawning Conditions

Certain species, such as salmonids, require clean gravels (2 1/2 to 6 inches in diameter) that are well oxygenated, which typically means that the gravels are located at the tail end of riffles or pools and only contain a small proportion of sand and silts (Smith and Lauman 1972). The most sensitive salmonid life stages are eggs and fry. The optimal temperature range is 5.6 to 12.8ºC (42 to 55ºF) for salmonid egg survival and 18.3ºC (<65ºF) for fry survival. The optimal dissolved oxygen requirement is >8 ppm for eggs and >5 ppm for fry (Smith and Lauman 1972). Minimum water depth for spawning ranges from 0.8 ft for Chinook salmon to 0.6 ft for steelhead, and cutthroat.

Spawning of the Pacific lamprey on the coast of Oregon usually occurs in May with temperatures between 1O’C to 15°C (Close et al 1995). Spawning sites of *L. tridentata* generally occur in low gradient stream sections where gravel is deposited (Close et al 1995). Spawning occurs in lotic habitat with velocities ranging from 0.5 to 1.0 meter per second and depths ranging from 0.4 to 1.0 meter (Close et al 1995).

2.4.3 Egg Incubation

Optimal temperature requirements for salmonids vary by life stage. Eggs are the most sensitive stage, and Reiser and Bjornn (1979) defined optimal temperatures for salmon and steelhead egg incubation as 4.4 to 14.4ºC. Similarly, Hicks (2000) reported that a 7-day average of the daily maximum temperatures should not exceed 9 to 12ºC to support the pre-emergent stages of coho development. Optimal temperature for the early life stages of lamprey (egg to yolk sac absorption) is roughly 18 ºC (Meeuwig et al 2001).

2.4.4 Food

The majority of aquatic invertebrates are found in clean, well-oxygenated riffle habitat (Merritt and Cummins 1996). An indication of quality macroinvertebrate habitat is provided by the same riffle-to-pool ratio that supports a high biomass of salmonids (Groot and Margolis 1991).

Another indication of quality invertebrate habitat is an allochthonous (terrestrial) energy source, or organic matter produced outside the stream and falls into the channel (Cushing and Allan 2001). This material is colonized by microbes, which is then digested by shredding invertebrates. Other sources of energy can also be utilized by invertebrates (e.g., autochthonous (instream) energy and dissolved organic matter), but typically an allochthonous energy sources supports the diversity of invertebrates that are most commonly used by salmonids. The most common taxa utilized are the *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies), which are also the premise for the EPT Index, a common indicator for water quality in a stream, river, or lake.

Larval lampreys process nutrients by filter feeding on detritus, diatoms, and algae suspended above and within the substrate (Confederated Tribes of the Umatilla Indian Reservation 2004).

2.4.5 Passage

Salmonids require minimum stream depths during upstream migration. Chinook salmon require a minimum of 0.8 ft and steelhead and coho require 0.6 ft for reasonable passage conditions (Smith and Lauman 1972). Comparatively, most juvenile salmonids require a minimum depth of 0.2 ft for intra-stream movement during rearing.

3 Field Studies Conducted in 2010

3.1 Field Methods

A full description of the methods used for data collection can be found in the Aquatic Resources/ Fisheries Study Plan for the Valsetz Water Storage Instream Habitat Assessment (ENVIRON 2010). The section below provides an overview of the approaches used for the 2010 field studies and the logic that was used to select those approaches.

ODFW collected data in the South Fork Siletz in 1994 using the ODFW protocols for stream habitat surveys (Moore et al 2006). This data were collected six years after the old Valsetz Dam was removed in 1988. The ODFW data covered the entire South Fork Siletz and its tributaries. At the time the ODFW data were collected, the South Fork Siletz River had not re-established a stable channel through the old lake bed. We assumed that the ODFW data would not be very representative of current conditions within the footprint of the old lake bed; substantial changes in channel morphology and overall habitat quality were expected to have developed between 1994 and 2010. Therefore, re-sampling of the habitat conditions within the reach formerly occupied by Lake Valsetz was identified as a priority data collection effort. Habitat data were collected in this reach using the ODFW protocols (Moore et al 2006) to maximize comparability of the datasets. This information was used to estimate the effects of the proposed reservoir alternatives on the habitats within this reach. Data were also collected in the lower reaches of the major tributaries where they cross the old lakebed. Habitat within those reaches was also expected to have changed significantly since 1994. Although the intent was to sample the entire length of the old lakebed, only portions of the habitat could be assessed due to dangerously high accumulations of soft sediment in the stream. Data reported herein are extrapolated from the portion of the lakebed reach that could be accessed safely.

Downstream of the former dam site, habitat was not expected to have changed significantly since ODFW collected their data in 1994. Two reaches were randomly selected within the reach that extends from the former dam site downstream to the confluence with the North Fork Siletz River. Within these reaches, habitat data were collected following the ODFW protocols (Moore et al 2006). This data are used to characterize the typical habitat conditions available downstream of the proposed dam site.

Since the ODFW data were collected (and for several decades prior to the collection of that data), the timberlands along the major tributaries of the South Fork Siletz River have been managed under Oregon's Forest Practices Rules (http://www.oregon.gov/ODF/lawsrules.shtml) which have limited harvesting in riparian areas for almost 40 years. We therefore assumed that the data collected by ODFW in 1994 was likely reasonably representative of the habitat in the tributaries.

The proposed project would divert water into the Luckiamute River. Several potential discharge points have been identified. The scope of the study that was conducted did not address the effects of increased flow on fish habitats downstream of the discharge points. This is an issue that should be addressed in the future. The discharge of large quantities of water into the headwater channels has the potential to cause significant downcutting of the channel downstream of the discharge point. At the discharge points that were accessible (some were behind locked gates with no landowner permission to cross), cross-section and pebble count data were collected to support the analysis of the potential for significant downcutting in the Luckiamute.

3.2 Results of the 2010 Habitat Survey

A habitat survey was completed on August 25 through August 27, 2010. A total of eight reaches were surveyed, which included five reaches in the S.F. Siletz River and three in the portions of the tributary reaches that cross the old Lake Valsetz bottom (Beaver Creek, Fanno Creek, and Handy Creek) (Figure 2).

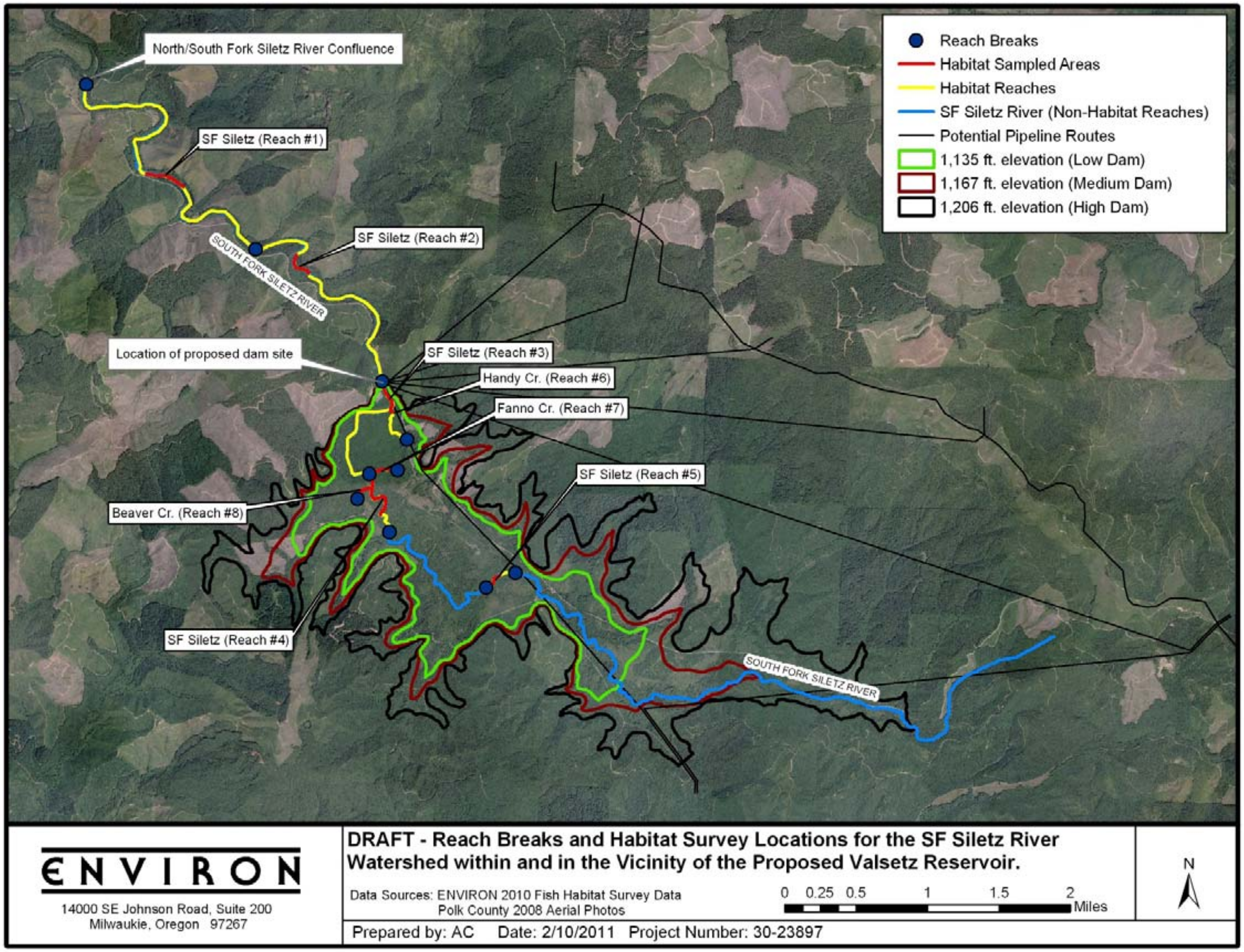

Figure 2. Reach Breaks and Habitat Survey Locations for the S.F. Siletz River Watershed within and in the Vicinity of the Proposed Valsetz Reservoir.

A comparison of the area sampled by ODFW and in the 2010 survey is provided in Table 1.

Table 2. A comparison of the total, primary, and secondary stream habitat surveyed by Oregon Department of Fish and Wildlife (ODFW) in 1993 and 1994 (ODFW 2004) with the 2010 survey.

Stream		Stream Length Sampled by ODFW	Primary Stream Length (m) - 2010 Survey	
Name	**Reach**	**ODFW**	**2010**	**% Sampled**
Beaver Creek	8	3,541	208	6%
Fanno Creek	7	4,281	207	5%
S. Fork Siletz	1	4,146	458	11%
S. Fork Siletz	2	2,947	321	11%
S. Fork Siletz	3	1,647	302	18%
S. Fork Siletz	4	939	647	69%
S. Fork Siletz	5	381	221	58%

3.2.1 Physical Habitat

The majority of habitat that was surveyed in 2010 was within the primary channel of each of the three streams for which data were collected (Table 2). Within the S.F. Siletz River (Reaches 1-5), the gradient ranged from 0 to 5.0% from the confluence with the North Fork Siletz River to the old Lake Valsetz, and then decreased to nearly zero throughout the old lakebed habitat. The only significant portion of the stream that contained eroding banks was Reach 5, which is located in the old lakebed and is continuing to adjust its channel.

Table 3. Stream length, gradient, and eroding and undercut banks identified during the 2010 habitat survey.

Stream		Stream Length Sampled (m)					
Name	**Reach**	**Total**	**Primary Channel**	**Secondary Channel**	**Gradient (%)**	**Eroding Banks (%)**	**Undercut Banks (%)**
Beaver Creek	8	208	208	0	2.62	0	0
Fanno Creek	7	229	207	22	3.68	0	2
Handy Creek	6	NR	NR	NR	NR	NR	NR
S. Fork Siletz	1	458	458	0	4.05	0	0
S. Fork Siletz	2	321	321	0	7.53	0	0
S. Fork Siletz	3	302	302	0	0.70	2	0
S. Fork Siletz	4	647	647	0	0.64	0	5
S. Fork Siletz	5	221	221	0	0.18	49	0
NR = Not Reported							

Fanno and Beaver Creeks (Reach 7 and Reach 8, respectively) are tributaries to the old Valsetz Lake. These creeks primarily had steady gradient changes that ranged from 0 to 2% throughout the surveyed habitat. A couple of exceptions were noted within Fanno Creek, which contained two high gradient riffles with a 5-10% gradient. Fanno Creek was also one of two reaches that contained undercut banks. No data were collected for Handy Creek in terms of physical habitat attributes.

Based on the shape of the valley form, the majority of streams were identified as a wide active floodplain, with the exception of Reach 1 (moderate V-shaped valley with side slopes > 30%) and Reach 2 (multiple terraces). An indication of valley form can be gained by comparing the valley width index (VWI), which is the ratio of active channel to valley floor where a lower value indicates a more constrained valley (Table 3). Reach 1 and Reach 2 on the S.F. Siletz (downstream of the old dam location) have VWI values that are at least an order of magnitude lower than the other reaches upstream of the old dam location.

Table 4. Channel width, height, and valley width index for the 2010 habitat survey.

Stream		Channel Width (m)			Channel Height (m)		
Name	Reach	Average Channel	Active/ Bankfull	Floodprone	Active Channel	Floodprone	Valley Width Index (VWI)
Beaver Creek	8	2.0	7.3	331.3	0.6	1.7	86.4
Fanno Creek	7	1.4	3.0	155.3	0.3	0.9	185.9
Handy Creek	6	NR	NR	NR	NR	NR	NR
S. Fork Siletz	1	8.1	17.6	27.9	1.1	3.1	2.4
S. Fork Siletz	2	9.0	19.0	34.4	0.7	1.7	3.8
S. Fork Siletz	3	9.0	13.7	NR	NR	NR	18.0
S. Fork Siletz	4	6.1	10.0	434.3	0.9	2.6	77.5
S. Fork Siletz	5	7.6	6.4	12.6	0.5	1.3	56.2

NR = Not Reported

Another way to look at valley form is by taking a cross section of the habitat. For example, a cross section of Reach 2 was surveyed, which showed the banks on either side of the channel create a constrained valley floor (Figure 2).

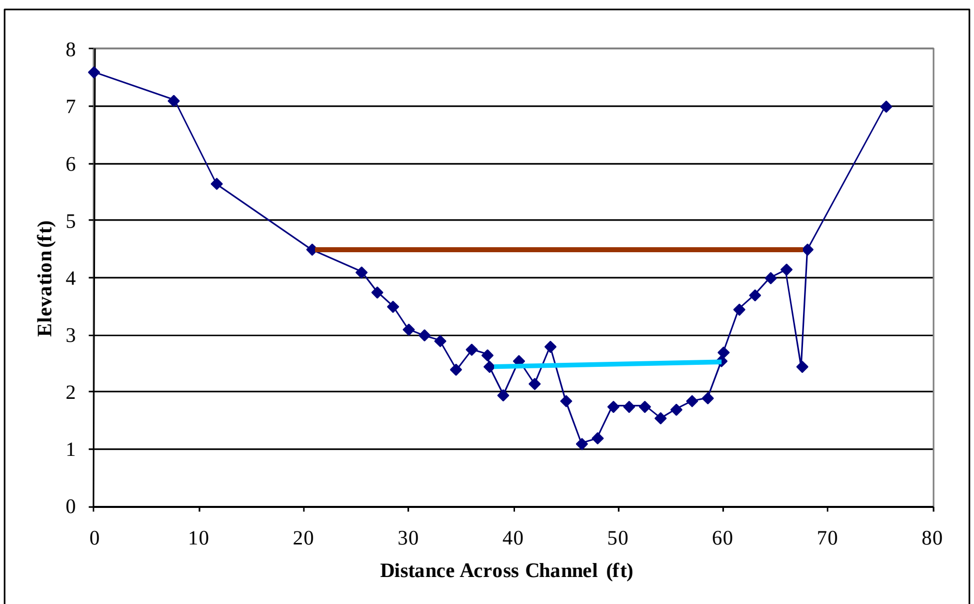

Figure 3. Cross Section of S.F. Siletz Reach 2 approximately 2.8 RM from the Mouth.
Note: red line is the floodprone height and blue line is the depth of the water during the survey.

3.2.2 Habitat Units

Habitats within the S.F. Siletz River were dominated by scour pool habitat (Figure 3), even within the lower reaches that have steeper slopes. However, the diversity of habitat units was greater within the lower S.F. Siletz River than in the surveyed habitats upstream of the old dam site. Although the two tributary streams (Beaver and Fanno creeks) contained a more even distribution of pool and riffle habitat, they still only contained three different types of habitat units. Table 4 summarizes the variety of stream habitat found within the S.F. Siletz River and the tributary streams.

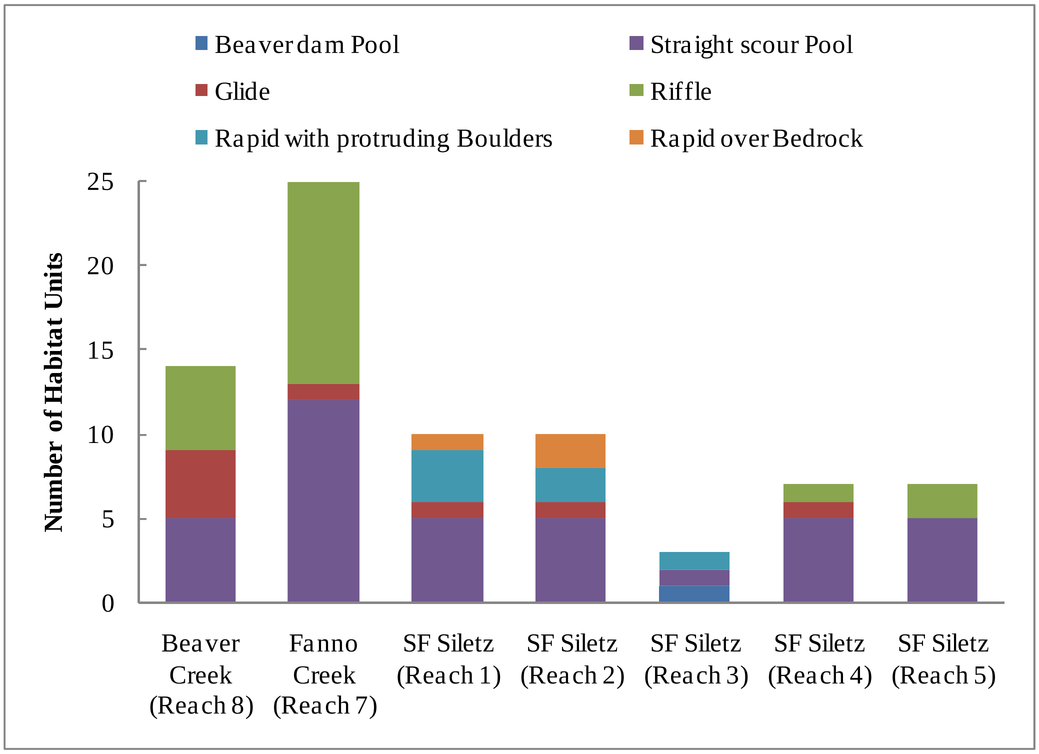

Figure 4. Composition of Habitat Units by Sample Reach.

Pool habitat, which was abundant in all stream reaches, overwhelmed the amount of available habitat in the reaches within the footprint of the old lake (Reaches 3 through 5). Based on the total area within a reach, the percent of pools within the old lakebed was greater than 97% (Table 4). Although they were not included in the survey due to safety concerns, two pools within Reach 4 and the final pool in Reach 3 extended at least another 1000 feet past the end of the surveyed area. The pool in Reach 3 was over 4 feet and was not wadable. Therefore, the values on average depth should be interpreted with some caution, as it is likely the depths within the upper S.F. Siletz River were underestimated.

Table 5. Description of pool habitat from the 2010 habitat survey.

Stream		Number	% of Pools	Average	Pools/ km	Pools with
Name	Reach	of Pools	(by Area)	Depth (m)		>3 LWD/ km
Beaver Creek	8	5	55.3	0.57	24.1	19.2
Fanno Creek	7	11	44.8	0.44	48.1	0.0
Handy Creek	6	NR[1]	NR	NR	NR	NR
S. Fork Siletz	1	5	36.6	1.10	10.9	0.0
S. Fork Siletz	2	5	40.3	1.17	15.6	0.0
S. Fork Siletz	3	2	97.6	1.19	6.6	6.6
S. Fork Siletz	4	5	99.3	0.90	7.7	1.5
S. Fork Siletz	5	5	99.2	0.85	22.6	4.5

[1]NR = Not Reported

3.2.3 Substrate

Substrate within the S.F. Siletz River was more complex in the lower river downstream of the former damsite (Reach 1 and Reach 2) and was less complex in the upper reaches within the former lakebed (Figure 5). The portion of the river downstream of the old lakebed contained a variety of larger substrate sizes, while the portion of the river within the old lakebed was dominated by either silt and organics or gravel and sand. Within the tributary reaches (also within the old lakebed), sand was predominant in Beaver Creek and bedrock was predominant in Fanno Creek. It should be noted that the bedrock in Fanno Creek was made up of a clay substrate that most likely buried larger substrate below its surface (Figure 6). The predominance of fine particles upstream of the old dam site is not unexpected since fine particles would have settled out in the bottom of the old lake. The current abundance of silt and sand suggest that the river is still adjusting to the removal of the historic dam.

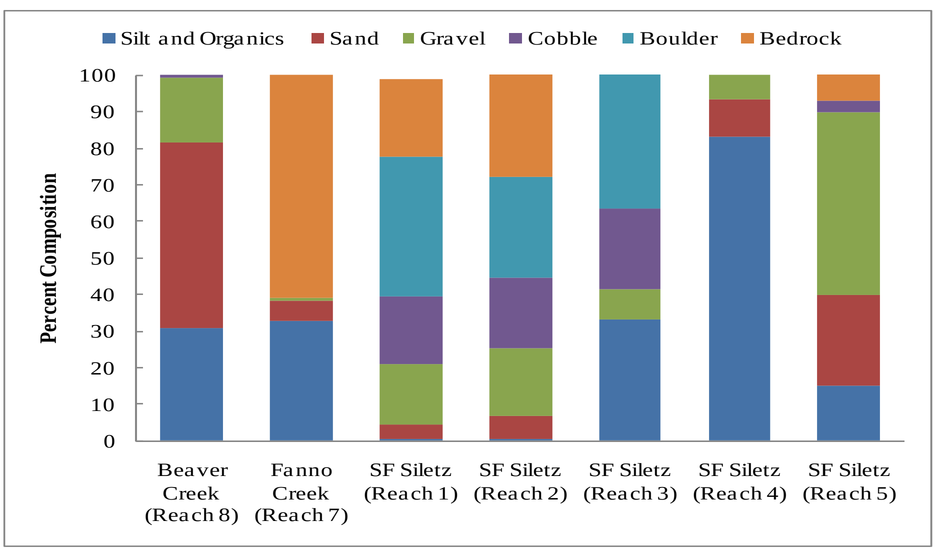

Figure 5. Percent Composition of Substrate by Sample Reach.

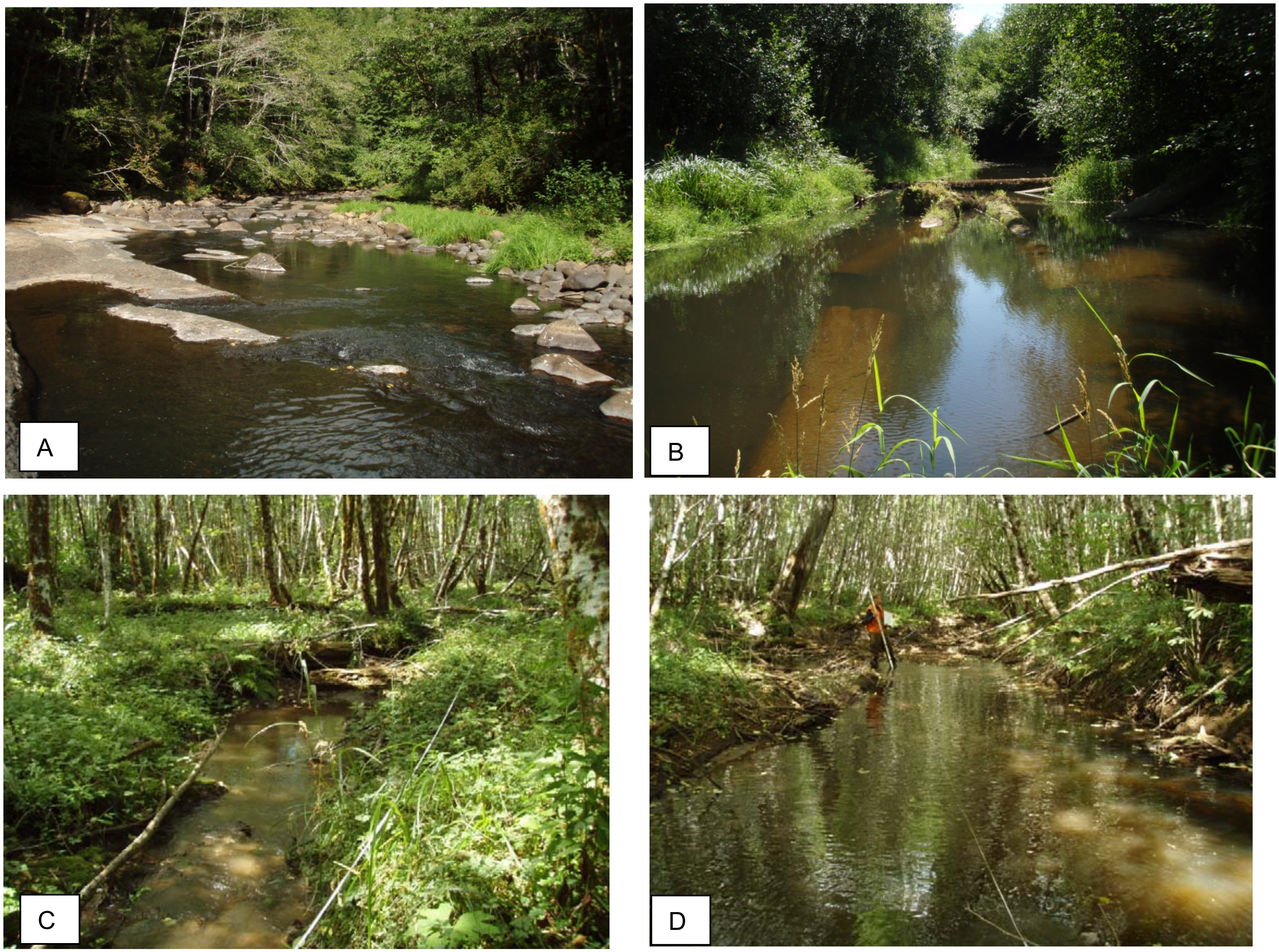

Figure 6. Typical Habitat within Reach 2 of the S.F. Siletz (A), Reach 4 of the S.F. Siletz (B), Fanno Creek (C), and Beaver Creek (D).

3.2.4 Large Woody Debris (LWD)

Large woody debris (LWD) is a good indication of the habitat complexity found within a stream, and is typically associated with fish habitat. There was a wide range in LWD present in the surveyed reaches with no apparent pattern from upstream to downstream. Within the S.F. Siletz River, there was an accumulation of LWD in Reach 3 (Table 5), which is just upstream of the mouth of the old Valsetz Lake (please refer to Figure 1). Conversely, further downstream in Reach 2 there was no identified LWD.

Figure 7. Clay Bedrock Substrate that Dominated the Habitat in Fanno Creek.

Within the tributary reaches, Handy Creek contained more LWD than all other reaches surveyed, although it was primarily composed of smaller pieces, which is reflected in the lower total volume and the few pieces of key LWD identified. This was most likely a product of the debris jams noted within Handy Creek. Some examples of LWD found within the different surveyed reaches are presented in the photos in Figure 7.

Table 6. Large Woody Debris (LWD) identified during the 2010 habitat surveys.

Stream						
Name	Reach	Total LWD	Key LWD[1]	LWD/ 100m	Volume (m^3)	Debris Jams
Beaver Creek	8	44.0	0.0	6.5	30.6	2
Fanno Creek	7	15.0	0.0	2.2	12.3	0
Handy Creek	6	91.0	4.0	NR	93.8	8
S. Fork Siletz	1	10.0	0.0	0.7	12.9	1
S. Fork Siletz	2	0.0	0.0	0.0	0.0	0
S. Fork Siletz	3	63.0	11.0	6.4	138.6	0
S. Fork Siletz	4	34.0	4.0	1.6	44.8	0
S. Fork Siletz	5	15.0	0.0	2.1	15.5	0

[1] Key LWD are pieces that are ≥0.60 m in diameter and ≥12 m long.

Figure 8. Large Woody Debris (LWD) Identified within S.F. Siletz River Reach 3 (A) and Fanno Creek (B).

3.2.5 Riparian Habitat

Forest composition within the riparian zone for all surveyed streams included young trees and second growth timber. The dominant trees within the riparian zone downstream of the old lakebed (Reach 1 and Reach 2) were deciduous, including young alder (*Alnus rubra*), willow (*Salix* sp.), big leaf maple (*Acer macrophyllum*), and vine maple (*Acer circinatum*) (Table 6). The riparian zone was also comprised of conifers in the downstream reaches, although conifers represented 15% and 23% of the total riparian habitat in Reach 1 and Reach 2, respectively. Further, the conifers in the riparian zone were primarily less than 50 cm in diameter and composed of yew (*Taxus brevifolia*), Douglas fir (*Pseudotsuga menziesii*), and white fir (*Abies concolor*).

Based on the habitat surveys by ODFW (2004) and observations in the field, the habitat downstream of the old Valsetz Dam and in the tributaries to the old lakebed were also primarily comprised of hardwoods; however conifers represented a lesser proportion of the total riparian habitat in the S.F. Siletz and a similar proportion in the tributaries. For example, in the S.F.

Siletz River, the riparian zone associated with the old lake bed contained approximately 8% conifers. In the tributaries, conifers represented 13%, 29%, and 16% of the riparian zone in Beaver, Fanno, and Handy creeks, respectively. Among these sites, the only location that contained many trees that were greater than 50 cm in diameter was in Handy Creek (ODFW 2004).

Table 7. Riparian Survey Results in Reach 1 and Reach 2 Downstream of the old Valsetz Dam.

Stream		Riparian Habitat (100 ft zone/ 1000 ft of stream)				
Name	Reach	Total Hardwoods	Total Conifers	Conifers ≥50 cm	Conifers ≥50 and <90 cm	Conifers ≥90 cm
S. Fork Siletz	1	13.0	2.3	0.3	0.3	0.0
S. Fork Siletz	2	12.4	3.8	0.0	0.0	0.0

3.2.6 Snorkel Surveys

Snorkel surveys were completed in Beaver Creek, Handy Creek, and Reaches 1, 2, and 5 of the S.F. Siletz River. No fish were observed in the portion of Handy Creek that crosses the old lakebed and snorkeling was not possible in Fanno Creek due to lack of flow available for snorkeling. An unknown salmonid fry (*Oncorhynchus* spp.) was observed in Beaver Creek In the mainstem of the S.F. Siletz upstream of the old dam site, only one fish was observed, an unknown species of sculpin, Deep sediments limited the area that could be snorkeled upstream of the old dam site, so additional fish may occupy areas that were not surveyed. Habitat conditions in the unsurveyed reach were generally similar to the reach upstream of the old dam site that could be sampled; therefore, fish may be sparse in the unsurveyed area. This should be verified.

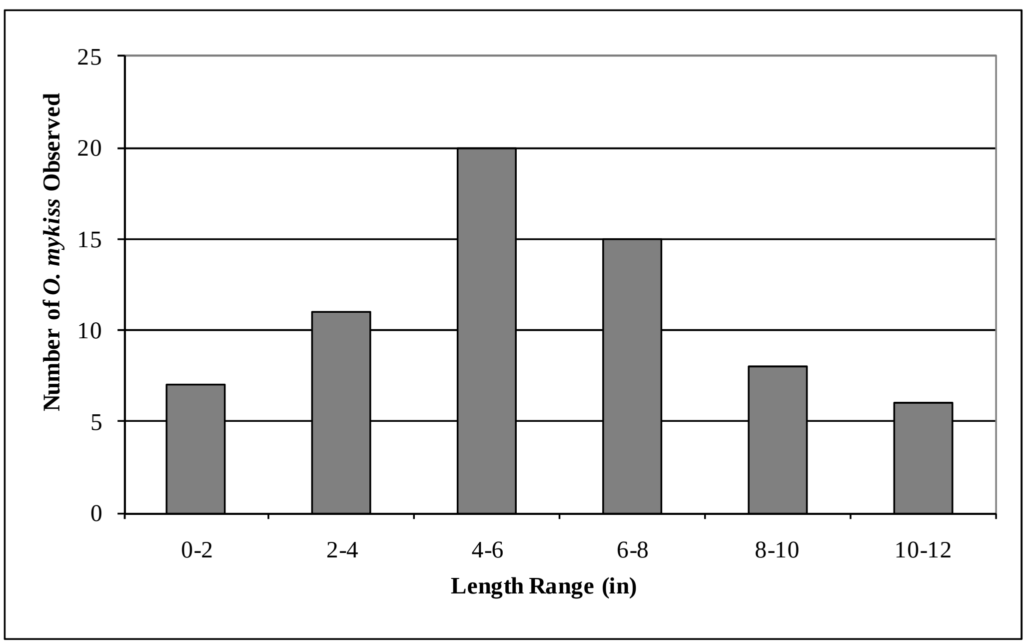

Figure 9. Number and Length Range of Steelhead (*Oncorhynchus mykiss*) Observed in Reach 1 and Reach 2 of the S.F. Siletz River.

Downstream of the old dam site, the dominant species observed in Reach 1 and Reach 2 of the S.F. Siletz River was steelhead (*Oncorhynchus mykiss*). The fish observed were distributed in a typical bell-curve with the majority of fish in the 4 to 6-inch size range (Figure 8).

To provide an understanding of fish density in the S.F. Siletz River, the observed number of steelhead was expanded to the entire width of the stream (based on the observable width during the survey), assuming that fish density was equal across the river. Based on this estimation, 9.1 steelhead/100 feet and 1.3 steelhead/100 feet of stream were present in Reach 1 and Reach 2, respectively. Expanded to the entire reach length, this resulted in 750 and 91 steelhead in the two reaches. Overall, the abundance steelhead was negligible upstream of the old dam site within the footprint of the old lakebed and was highest in the reach located furthest downstream from the old dam site.

4 Existing Aquatic Habitat Quality and Quantity

The following information is based on a comparison of previous studies within the Siletz River Watershed and the 2010 habitat survey. The information is presented according to the habitat components that most influence the quality and quantity of salmonid and fish habitat, including: (1) Amount of Spawning and Rearing Habitat, (2) Water and Substrate Quality, (3) Riparian Habitat, (4) Large Woody Debris, and (5) Migration Barriers.

4.1 Amount of Spawning and Rearing Habitat

According to the most recent survey, the pool-to-riffle ratio in the S.F. Siletz River downstream of the old dam and in Fanno Creek was typical of streams that support a high biomass of salmonids (Table 7). On the other hand, habitats in the old Valsetz Lake area, including Beaver Creek, were dominated by pool habitat. Another way to look at this is pool frequency. The frequency of pools in the old lakebed was much higher than in the reaches downstream of the former dam site. Reach 5 contained mostly pool habitat with only two other units between the pools. Overall, it is evident that downstream of the former dam site and Fanno Creek contain the best available habitat to support the highest biomass of salmonids during spawning and rearing activities. The former lakebed primarily consists of pool habitat, and may offer some deep holding pools during summer months, but contains negligible spawning habitat.

Similar results of pool frequency were reported by ODFW (2004) during the surveys completed in 1993 and 1994 in the S.F. Siletz and Valsetz Lake tributaries. During those surveys, pool frequency occurred at 15.5 pool/km in the S.F. Siletz River downstream of the dam, 7.6 pools/km in the area of the former lakebed, 45.0 pools/km in Beaver Creek, and 40.3 pool/km in Fanno Creek. The higher frequency of pools found in Beaver Creek during the previous survey reflects the fact that the ODFW survey extended upstream into the upper reaches of the creek and was not limited to the area formerly occupied by the lake.

Table 8. Estimated quantity of Spawning and Rearing Habitat Available in the S.F. Siletz Watershed Surveyed in 2010.

Stream		Pool : Riffle Ratio	Pool Frequency	Pools >1m Frequency
Name	Reach		(pools/km)	(pools/km)
Beaver Creek	8	1.0 : 0.29	24.1	0.0
Fanno Creek	7	0.83 : 1.0	48.1	0.0
S. Fork Siletz	1	0.74 : 1.0	10.9	8.7
S. Fork Siletz	2	0.85 : 1.0	15.6	9.3
S. Fork Siletz	3	1.0 : 0.024	6.6	3.3
S. Fork Siletz	4	1.0 : 0.003	7.7	3.1
S. Fork Siletz	5	1.0 : 0.008	22.6	4.5

During the 2010 survey, the presence of sand, silt, and organics varied widely by habitat type and location within the Project area (Table 8). For example, riffle habitat in the middle of the old lakebed (Reach 4) contained only silt and organics, whereas riffle habitat in the reaches upstream and downstream contained larger substrate materials such as cobble and gravel. Habitat downstream from the old dam in the S.F. Siletz contained only a small proportion of fine material within the different habitat types, and an abundance of gravel, cobble, and boulders. These results represent a change from the ODFW (2004) surveys in the S.F. Siletz River. In those surveys, sand, silt and organics present in riffle habitat increased from downstream (16%) to upstream (27%), with the highest percentage occurring within the old Valsetz Lake.

4.2 Water and Substrate Quality

Warm stream temperatures during the summer and sedimentation are the most detrimental water quality factors affecting fish in the S.F. Siletz River (Smith and Lauman 1972, BLM 1996). Stream temperatures in portions of the S.F. Siletz basin have been documented in the lethal range for salmonids from July to September (BLM 1996). The maximum temperature recorded in the South Fork Siletz in 2010 was 20ºC, which occurred in August (Figure 10).

Water temperature at the former dam site was consistently higher than temperatures recorded in the S.F. Siletz River just upstream of the confluence with the N.F. Siletz River and in the N.F. Siletz River near its mouth (Figure 11). High water temperatures can potentially impact egg survival, juvenile rearing, and successful salmonid holding prior to spawning activities. Water temperature also influences the dissolved oxygen (DO) content because DO decreases as water temperature increases.

Table 9. Estimated Percent Composition of Substrate by Unit Type Present in the S.F. Siletz River and Old Valsetz Lake Tributaries within the footprint of the historic Lake Valsetz, as Surveyed in August 2010.

		Beaver Creek	Fanno Creek	South Fork Siletz River				
Substrate	**Unit**	**Reach 8**	**Reach 7**	**Reach 1**	**Reach 2**	**Reach 3**	**Reach 4**	**Reach 5**
Silt and Organics	Glides	36.3	20.0	0.0	0.0	NA	50.0	NA
	Riffles/ Rapids	29.0	36.7	0.0	0.0	0.0	100.0	5.0
	Pools	28.0	30.4	1.0	1.0	50.0	100.0	19.0
Sand	Glides	48.8	0.0	5.0	5.0	NA	30.0	NA
	Riffles/ Rapids	51.0	5.8	4.2	6.3	0.0	0.0	22.5
	Pools	53.0	5.0	4.0	7.0	0.0	0.0	26.0
Gravel	Glides	15.0	0.0	20.0	30.0	NA	20.0	NA
	Riffles/ Rapids	20.0	1.3	15.8	15.0	10.0	0.0	60.0
	Pools	17.0	0.8	16.0	19.0	7.5	0.0	46.0
Cobble	Glides	0.0	0.0	25.0	25.0	NA	0.0	NA
	Riffles/ Rapids	0.0	0.0	19.2	17.5	40.0	0.0	7.5
	Pools	2.0	0.0	17.0	19.0	12.5	0.0	1.0
Boulder	Glides	0.0	0.0	30.0	40.0	NA	0.0	NA
	Riffles/ Rapids	0.0	0.0	36.7	25.0	50.0	0.0	0.0
	Pools	0.0	0.0	36.0	27.0	35.0	0.0	0.0
Bedrock	Glides	0.0	80.0	15.0	0.0	NA	0.0	NA
	Riffles/ Rapids	0.0	56.3	21.7	36.3	0.0	0.0	5.0
	Pools	0.0	63.8	26.0	29.0	0.0	0.0	9.0

NA = does not apply

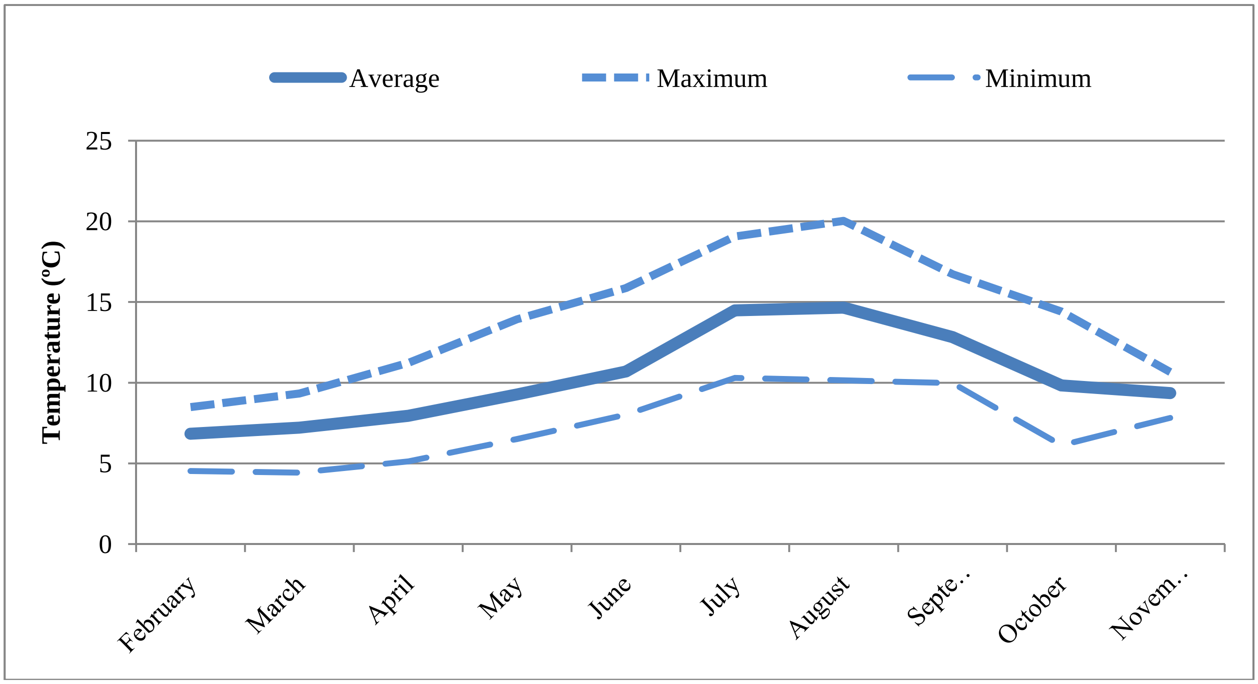

Figure 10. Average, Maximum, and Minimum Water Temperature in the S.F. Siletz River Measured in 2010.

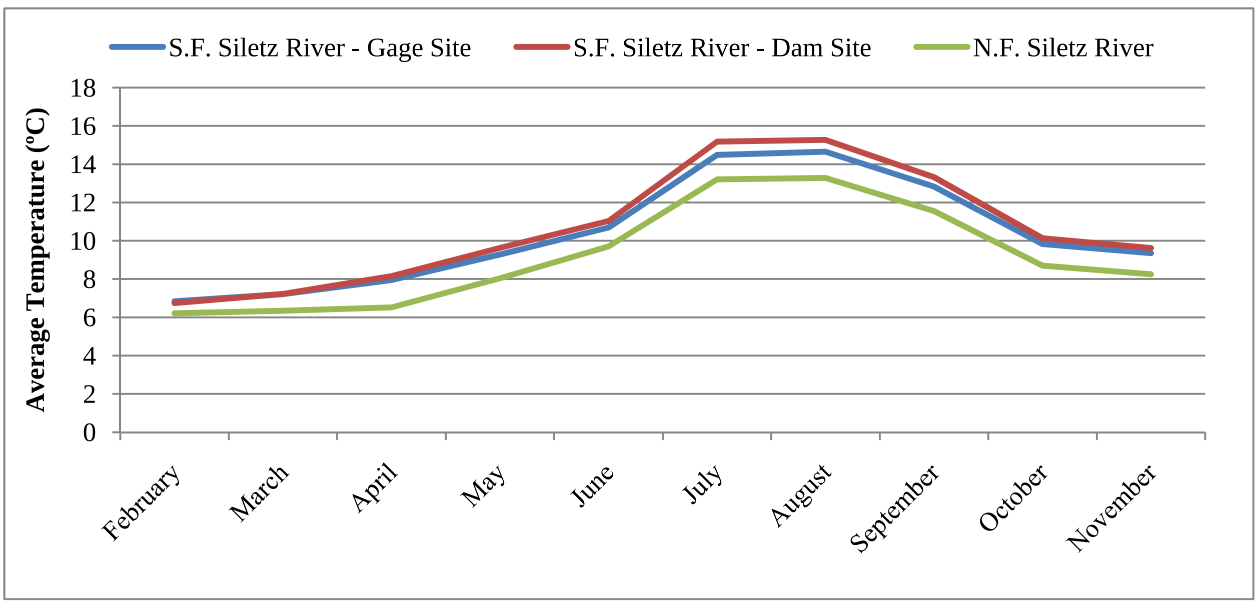

Figure 11. Average Water Temperatures in the Upper Siletz Basin Measured in 2010.

Mass wasting and soil surface erosion are a concern in the Upper Siletz watershed. In a survey of the watershed, BLM (1996) identified 6,800 acres of moderate to severe landslide potential areas. Much of the landslide potential was attributed to accelerated soil surface erosion from clearcutting/burning and road construction on hillslopes steeper than 60%.

During the 2010 survey, 49% of Reach 5 contained eroding banks. Reach 5 is at the lower end of the former Valsetz Lake, this observation is likely an indication that the river is continuing to develop a channel within the old lakebed sediments. During the ODFW surveys in the 1990s, tributary streams to old Valsetz Lake also contained bank erosion values of greater than 40%, including McFall Creek, Sand Creek, and Handy Creek. The extent to which former inundation contributed to this erosion is unknown.

4.3 Riparian Habitat

The predominant vegetation in the project area consists of young trees and second growth timber. According to a survey by BLM (1996), in 1988 the S.F. Siletz Watershed (total of 5,689.4 acres) was a mixture of young conifers with a small portion of mature hardwoods or mixed stands (Table 10). The Coast Range in general (Oregon and Washington) has been managed as Douglas fir plantations for many decades (Herger et al. 2003), with active timber harvest beginning in the watershed in the 1880s.

Table 10. Composition of the S.F. Siletz Watershed Riparian Habitat in 1988.

Vegetation Category	Seral Stage	Percent Composition
Open-recent clearcut	NA	8.2
Grass/forb-recent clearcut	NA	15.2
Shrub/open sapling-clearcut	NA	9.2
Conifer	10-40 year	15.7
Conifer	50-70 year	28.4
Conifer	80-120 year	0.0
Conifer	130-190 year	0.2
Mixed	10-40 year	0.6
Mixed	50+ year	7.2
Hardwood	10-40 year	4.0
Hardwood	50+ year	11.4

Source: BLM 1996, NA = does not apply

4.4 Large Woody Debris (LWD)

Large woody debris (LWD) is largely absent or in low abundance in the S.F. Siletz watershed. In unmanaged forests of Oregon, typical LWD loading occurs at 0.057 m^3/m^2 (Harmon et al. 1986 *as cited in* Lassettre and Harris 2001). Comparatively, the amount of LWD loading in the S.F. Siletz River was 0.006 m^3/m^2 in the old Valsetz Lake area, 0.0004 m^3/m^2 downstream of the old dam, and 0.029 m^3/m^2 in the tributary streams. Although LWD appears to be abundant in the tributary streams, it apparently is not being transported to downstream locations. The peak flows in the S.F Siletz at the former dam site exceed 2,000 cfs in a typical winter. It is possible that wood which recruits to the river is swept downstream until it gets tangled on the side of the river in a log jam.

4.5 Migration Barriers

Siletz Falls at River Mile 64.5 creates a partial barrier to upstream fish migration. A fish ladder has been in operation at this location since the mid-1950s. Since the fall of 1994, only summer steelhead and spring chinook salmon have been passed upstream to the North and South Forks of the Siletz River (Buckman 1995). By limiting the species that pass the falls, the upper Siletz basin above the falls is being managed as a summer steelhead refuge. No other barriers to upstream migration are known.

5 Potential Project Effects on Biological Resources

There are a number of interrelated effects associated with habitat quality. These include, (1) direct inundation of existing aquatic habitat, (2) temperature, (3) instream flow, (4) stream maintenance flows, (5 passage needs and requirements, (6) potential effects from inter-basin water transfer, and (7) potential development of reservoir fisheries. These are discussed below.

5.1 Inundation of Habitat

The three dam alternatives would create three different inundation areas that affect the S.F. Siletz and surrounding tributaries. Based on a review of salmonid distribution in the basin and the inundation zones, there would be approximately 32 acres, 36 acres, and 40 acres of fish habitat inundated under the low, medium and high dam alternatives, respectively. Table 10 provides a description of the length of habitat available in the S. F. Siletz River that would be inundated under each alternative and the proportion of fish habitat that would be inundated relative to the total length of available fish habitat. The largest of the reservoirs would inundate 84 to 100 percent of the available habitat in the tributaries to the proposed reservoir and 100 percent of the available habitat in the S.F. Siletz River upstream of the former dam site. The other two alternatives would have proportionately smaller, effects on available fish habitat.

The Siletz River basin contains roughly 326 miles of fish habitat; 62.9 miles of that habitat is located upstream of Siletz Falls. The inundated area under the three alternatives represents 2.2 to 4.3 percent of the length of the existing habitat in the entire Siletz River basin and 11.3 to 22.1 percent of the length of the existing habitat upstream of Siletz Falls (Table 11).

Inundation of potential spawning (i.e., riffles) and rearing (pools and glides) habitat upstream of the dam by alternative can be calculated based on the ODFW (2004) data on tributary streams upstream of the proposed dam (Table 12). This data suggests that a minimum of 70 percent of glides and 42 percent of pools located upstream of the dam location would be inundated by the three alternatives. However, only eight to 54 percent of riffles would be inundated. Therefore, much of the rearing habitat would be inundated by the reservoir but much of the spawning habitat in the tributaries would remain available under the alternatives.

Table 11. Inundation of Fish Habitat upstream of the confluence with the North Fork Siletz River for each of the Proposed Dam Alternatives.

Waterway	Fish Habitat Use	Total Length (ft.) of Fish Distribution	Length (ft.) of Fish Distribution Inundation			Proportion (%) of Fish Distribution Inundation[1]		
			Low Dam	Medium Dam	High Dam	Low Dam	Medium Dam	High Dam
Beaver Creek	Spawning and rearing	7754	3,981	5,897	7,754	51	76	100
Callahan Creek	Spawning and rearing	3830	0	0	680	0	0	18
Fanno Creek	Spawning and rearing	8034	3,240	5,069	6,805	40	63	85
Handy Creek	Spawning and rearing	2947	2,751	2,947	2,947	93	100	100
McFall Creek	Spawning and rearing	2586	0	0	2,232	0	0	86
McSherry Creek	Spawning and rearing	4848	2,026	3,520	4,848	42	73	100
Potter Creek	Spawning and rearing	7868	1,706	3,597	5,717	22	46	73
Sand Creek	Spawning and rearing	7062	0	744	5,199	0	11	74
South Fork Siletz River (middle reach)[2]	Rearing	16911	16,911	16,911	16,911	100	100	100
South Fork Siletz River (upper reach)[3]	Spawning and rearing	19364	6,792	13,042	1,9364	35	67	100
Unnamed Tributary to Sand Creek	Spawning and rearing	1115	0	0	1,115	0	0	100

[1] The percent of length for the tributaries is based on the distance from the confluence with the South Fork to the upper end of the fish distribution, as defined by ODFW. The percent length for the S.F. Siletz is based on the total length of the mainstem upstream of the confluence with the North Fork Siletz River.
[2] The middle reach of the S.F. Siletz River is within the footprint of the former lake, and extends from just above the proposed dam site to below the mouth of Potter Creek. ODFW identified this as only a rearing reach with no spawning habitat available.
[3] The upper reach of the S.F. Siletz is upstream of the former lake, and extends from the termination of the middle reach to the point where the mainstem terminates.
Source: ODFW 2004

Table 12. Percent of the total length of available habitat in the portion of the river upstream of Siletz Falls and the entire South Fork Siletz River that would be inundated by the three dam alternatives.

Portion of Occupied Habitat	Low Dam (%)	Medium Dam (%)	High Dam (%)
Percent of total length of fish distribution in the Siletz River inundated	2.2	3.0	4.3
Percent of total length of fish distribution upstream of Siletz Falls inundated	11.3	15.6	23.1

Table 13. Inundation of Spawning and Rearing Habitat in the entire length of the Tributary Streams potentially occupied by salmonids for each of the Proposed Dam Alternatives.

Stream	Area of Glides (m2)				Area of Pools (m^2)				Area of Spawning Habitat (m^2)			
	Low Dam	Med Dam	High Dam	Total	Low Dam	Med Dam	High Dam	Total	Low Dam	Med Dam	High Dam	Total
Beaver Creek	1,415.4	1,442.9	1,442.9	1,442.9	4,319.0	5,715.4	6,927.3	7,036.5	614.0	853.3	1,498.7	1,786.9
Fanno Creek	4,082.4	4,247.0	4,398.0	4,398.0	239.0	2,300.3	2,855.1	3,854.7	55.2	643.1	1,830.1	2,508.0
Handy Creek	608.9	724.7	756.2	756.2	933.4	1,619.1	1,804.7	2,033.2	165.3	426.6	694.7	777.3
McFall Creek			802.9	802.9			3,779.6	4,041.2			446.0	2,198.6
McSherry Creek	705.9	705.9	705.9	705.9	9798.9	10040.0	10,312.2	12,217.6	490.9	1,396.6	2,492.9	4,062.6
Potter Creek			133.6	133.6	210.7	493.8	805.0	3,314.4	264.6	488.2	574.0	2,852.5
Sand Creek		54.5	698.7	854.5		291.9	2,385.2	3,180.5		404.6	2,755.0	4,687.0
Handy Creek Tributary 1			16.5	16.5		72.0	247.0	263.9		79.8	324.4	364.8
Sand Creek Tributary 1			284.3	687.9			327.1	1,207.3			177.0	853.1
Total Inundated	6,812.6	7,175.0	9,239.0	9,798.4	15,501.0	20,532.5	29,443.2	37,149.3	1,590.0	4,292.2	10,792.8	2,0090.8
% of Total Habitat	70%	73%	94%		42%	55%	79%		8%	21%	54%	

The data collected in 2010 suggest that few anadromous fish utilize the habitat formerly occupied by the old reservoir (Reach 5). That reach contained negligible spawning habitat. Usage of habitats in the tributaries is unknown and should be evaluated. The highest quality habitat in the South Fork Siletz is located downstream of the proposed dam site and would not be inundated.

This assessment used three distinct dam height scenarios and therefore areas of inundation. Potential effects on other resources such as downstream fisheries and other sensitive natural resources need to be balanced with the effects of inundation.

5.2 Temperature

5.2.1 Reservoir Temperature

Vertical temperature stratification is expected within the reservoir under all three alternative reservoir sizes. This stratification is similar between small and medium reservoirs (Appendix B – Water Quality and Quantity and Sediment Transport) and may be weak in the small reservoir. The large reservoir is the deepest (over 100 feet deep), so the stratification is significantly different than the other two reservoirs. The largest reservoir is expected to become strongly stratified. The temperature at the bottom of the large reservoir stays significantly colder throughout the year and its stratification is only interrupted briefly during winter when the temperature of the surface water cools and approaches the temperature of the bottom of the reservoir. In strongly stratified reservoirs, the bottom layer of water often contains low dissolved oxygen levels. The expected dissolved oxygen levels for the three alternatives remain unknown.

Temperature of the reservoir and the S.F. Siletz extending 50 kilometers (km) downstream of the reservoir was modeled using the CEQUAL-W2 and US EPA QUAL-2K model (see the Hydrology Report, Appendix B, for details). In general, the surface of the reservoir is expected to be warmer under all three alternatives than the temperature of the river at the same location with no reservoir in place (Figure 12). There is no substantial difference in the surface temperature between the alternatives before summer. In the summer season, the medium and the large reservoirs stay warmer than the smaller reservoir. By early August, surface temperature under all three alternatives is expected to be similar. Surface temperatures in the reservoir under all three alternatives reach 23^{o}C for at least a portion of the summer.

The water near the bottom of the reservoir is substantially cooler than the temperature of the river at the same location in the absence of the reservoir during much of the year for all three reservoir alternatives (Figure 13, Appendix B). The model results indicate that bottom temperatures of the low dam alternative will tend to rise to approximately 20^{o}C. Bottom temperature of the medium reservoir reaches 19^{o}C. The largest reservoir, however, should have bottom temperatures that remain cool, in the 4 to 7^{o}C range (Figure 13). The large reservoir is cooler than the river water during the entire year; as a result potential exists to provide cooler water downstream in the summer. A multi-level water intake in the reservoir could be used to adjust water temperature and oxygen levels for water released downstream to avoid, minimize or potentially enhance water quality downstream.

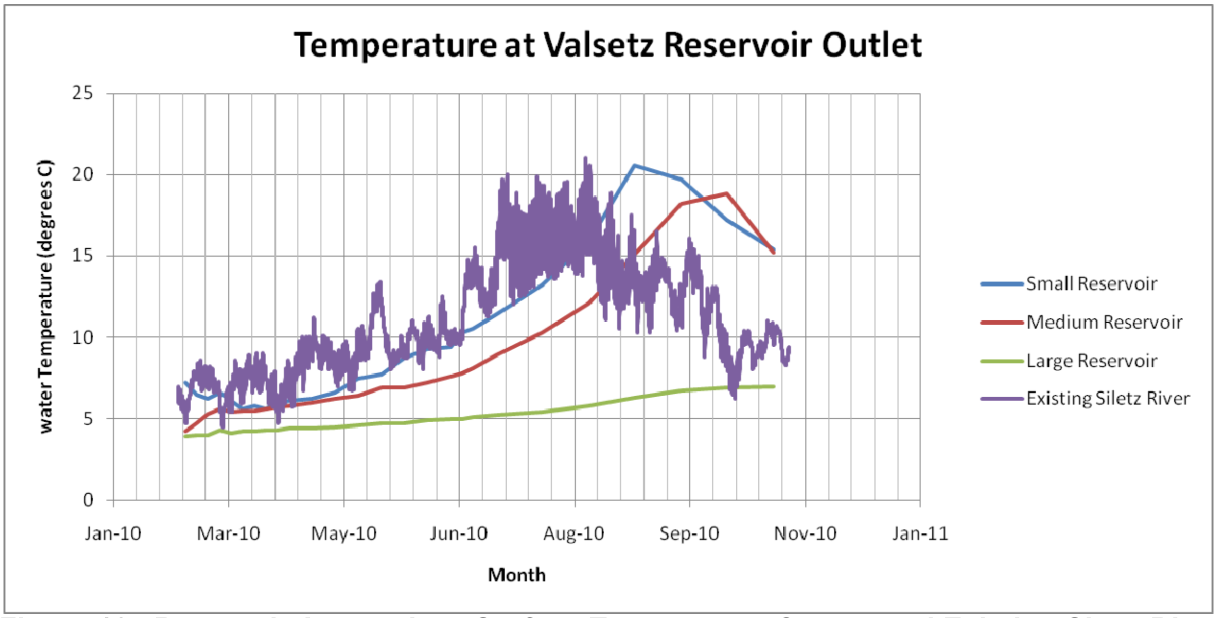

Figure 12. Reservoir Alternatives Surface Temperature Curves and Existing Siletz River Temperature

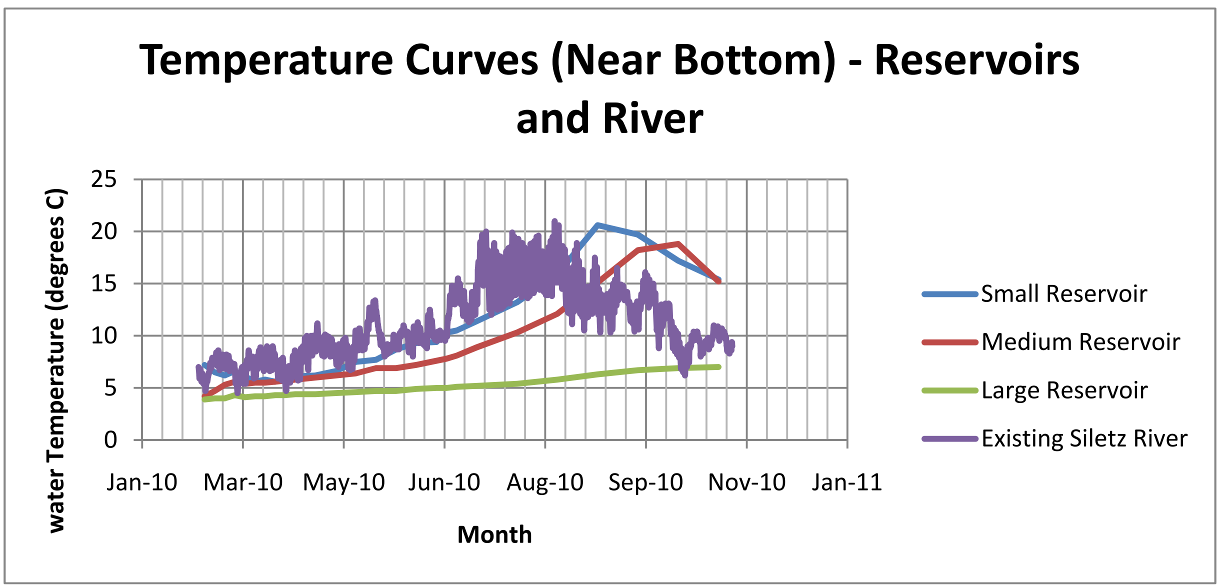

Figure 13. Reservoir Alternatives Bottom Temperature Curves and Existing Siletz River Temperature

High water temperatures can cause mortality in juvenile salmonids. Bell (1986) reported the upper lethal temperature for steelhead as 23.9°C (73.4°F). Lee and Rinne (1980) reported an upper lethal temperature of 29.4°C (84.9°F) for *O. mykiss* and Charlon et al. (1970) reported an upper lethal temperature of 25.0°C (77°F) for *O. mykiss.* Therefore, the predicted surface water temperature in the reservoir of 23°C or greater approaches and may exceed lethal temperatures for juvenile salmonids. The cooler waters in the bottom of the reservoirs may, however, support cold water fish populations, provided that dissolved oxygen levels remain sufficiently high.

5.2.2 River Temperature Downstream of the Dam

The effects of releases on water temperature downstream of the reservoir were modeled (See Appendix B) The modeling assumed water would be withdrawn from the deeper cooler waters in the reservoir. Water temperature was modeled from the proposed dam downstream to the USGS gage, approximately 50 km downstream of the proposed dam site. In all cases, the effects on temperature in the river were most pronounced in the first 1 to 2 km downstream of the dam. The differences between natural river temperature and temperatures associated with the alternatives were small or negligible at the confluence with the North Fork Siletz River, which mixes with the Siletz River and eliminates the remaining effects of water releases from the dam. A series of plots depicting the expected effects on temperature is provided in Appendix B (Water Quality, Quantity and Sediment Transport) report. The discussion below summarizes the modeled results.

5.2.2.1 Smallest Dam Alternative

The smallest dam alternative generally releases water that is warmer than current conditions in June through September. In June and July, waters that are released are warmer than the natural stream temperature, but temperatures are well within the preferred range for salmonids and spawning lampreys. By August, the temperature of the water released increase to 22^{o}C. These warmer waters cool rapidly as they move downstream. Water temperatures in excess of 20^{o}C extend less than 2 km downstream of the reservoir and temperatures cool to the natural temperature situation by the time they reach the confluence of the North Fork Siletz River. These predicted temperatures are not within a lethal range to salmonids and lamprey, but can cause stress and affect growth. By September, water released from the smallest dam alternative is predicted to have cooled somewhat to less than 20^{o}C. The water cools rapidly downstream of the dam and approaches natural temperatures within a couple of miles of the dam. In October and November, the temperature of the release water is similar to the natural river temperature.

Overall, the smallest alternative is likely to increase temperature in the reach downstream of the dam during the summer months. The effects are greatest within the first 2 km of the river downstream of the dam. The greatest effect occurs in August when the predicted temperature of the release water is significantly greater than the temperatures preferred by salmonids and lamprey and may cause stress and possibly mortality in fish rearing downstream of the dam.

5.2.2.2 Medium Dam Alternative

In February, the medium dam alternative releases water that is significantly cooler than the natural stream temperature. These cooler waters persist downstream for roughly 15 km, but the greatest difference in water temperature occurs in the first 3 km downstream of the proposed dam. There is little predicted difference in temperature downstream of the proposed dam under the medium dam alternative in March. In April through August, the release water is predicted to be 1 to 3 degrees cooler than the natural temperature of the river. In September through November, the predicted water temperatures downstream of the proposed dam are expected to be similar to natural conditions.

Overall, the medium dam alternative is not expected to negatively affect salmonids or lamprey due to changes in water temperature, with the possible exception of February. In February, the release water is 6 degrees cooler than the natural water temperature, which could significantly reduce winter growth. These cooler waters persist for a short distance and could be mitigated by releasing a mix of surface and bottom waters using a multi-level water intake in the reservoir. Throughout the year, the predicted stream temperature in the South Fork Siletz River very nearly reaches (<1^oC difference) natural river temperatures when the waters mix with the North Fork.

5.2.2.3 High Dam Alternative

The high dam alternative is predicted to release water that is cooler than the natural river temperature in all months except for a short period in March when the temperature of the released water is very similar to the natural water temperature. Results from modeling with an intake at the bottom of the reservoir predict effects of the highest dam alternative on temperatures downstream of the reservoir would be are very similar to the effects predicted for the medium dam from February through July. In August and September, the high dam alternative is predicted to continue to release water that is significantly cooler than the natural river temperature. These cooler waters are predicted to persist downstream to the confluence with the North Fork, where waters mix and temperatures approach natural river temperatures. In October and November, the temperature of the released water is predicted to be less than the natural river temperature, but the difference in temperature decreases to 1 to 3 ^oC.

Overall, the highest dam will tend to discharge water that is cooler than the natural river temperature if all water was taken from the bottom. If the South Fork Siletz River tended to become excessively warm in summer, this would be a benefit to salmonids and lamprey, but, the river is typically not excessively warm. Cold water releases could potentially reduce growth and productivity of fish in August and September between the dam and the confluence with the N.F. Siletz River. A multi-level intake could be used to mix surface and bottom water so the temperature of the release water is closer to the natural temperature of the river or closer to the optimum temperature for salmonid growth. A multi-level intake may also help balance dissolved oxygen and temperature within the reservoir. This should be evaluated further.

5.2.3 Summary of Temperature Effects

Water temperature in the South Fork Siletz River is naturally within the range that is well tolerated by salmonids and lamprey. The smallest reservoir would tend to warm the river downstream of the dam during the summer months. The greatest predicted effect would occur in August when water temperatures are predicted to increase roughly 4 to 5 degrees above the natural water temperature. Predicted water temperatures are not expected to be lethal, but are in the range that can cause significant stress to salmonids and lamprey, affecting growth and possibly survival. The effects are greatest within the first 2 km of the river downstream of the proposed dam and dissipate when the waters of the South Fork Siletz mix with the North Fork.

The medium dam alternative is not expected to negatively affect fish due to changes in water temperature, with the possible exception of February. In February, the release water is 6 degrees cooler than the natural water temperature, which could significantly reduce winter growth. These cooler waters persist for a short distance and could be mitigated by releasing a mix of surface and bottom waters.

The highest dam would tend to discharge water that is cooler than the natural river temperature throughout most of the year, if only taken from the bottom of the reservoir. If only cold water was released, it could potentially reduce growth and productivity of salmonids and lamprey in August and September between the dam and the confluence with the N.F. Siletz River. A multi-level intake could be used to mix surface and bottom water so the temperature of the release water is closer to the natural temperature of the river or closer to the optimum temperature for fish growth. Further modeling would be needed to predict how to use the multi-level intake to optimize temperature and oxygen levels throughout the year.

The potential effect of the alternatives on dissolved oxygen was not evaluated. A drop in dissolved oxygen in the deeper waters of reservoirs commonly occurs in stratified reservoirs. The release of waters with low dissolved oxygen can cause mortality or avoidance of the affected waters. Low oxygen levels can be mitigated through project design such as spillways that incorporate features that that reintroduce oxygen into the water as it falls from the dam and the use of a multi-level intake in the reservoir as described above.

5.3 Instream Flow Requirements and Channel Maintenance Flows

The provision for the application for instream water rights is authorized under ORS 537.332 to 537.360 which were approved by the Oregon legislature in 1987. As a result of this legislation, ODFW has evaluated the minimum instream flows for most of the fish bearing rivers in Oregon, including the S.F. Siletz and has applied for and attained water rights to protect those flows. A water right was issued for the S.F. Siletz with a priority date of July 12, 1966. That right protected flows at the confluence of the North and South Forks of the Siletz River ranging from 8 to 45 cfs (Table 13) and indicated that the right "*shall not affect waters to be legally stored or legally released from storage*". A second right was issued with a priority date of Mar 26, 1974. The flows protected under this right include the flows protected under the earlier right. With the second right, the total flows protected range from 10 to 60 cfs, as measured in the South Fork Siletz River above the confluence with the North Fork. The second right "*shall not have priority over the right to use water for human consumption or the use of waters legally released from storage*". The instream water rights are limited to the natural flows occurring in the South Fork Siletz River at any given time.

If the project is approved, the Oregon Department of Water Resources will issue two permits: 1) a permit to authorize storage of the higher stream flows that occur during the winter months and 2) a permit to authorize the use of water for the stated purposes (e.g. municipal, agriculture, and instream flows). The project will be required to pass the natural flows entering the reservoir downstream, except in cases where the natural flows exceed the instream flow rights. The project will not be required to meet the instream flow rights when natural flows are less than the instream flow right. However, the release of additional water may be implemented as a means of mitigating downstream impacts. Recommendations for additional releases cannot be developed at this time. Additional modeling of reservoir alternatives will provide further insight into the extent of downstream impacts and the potential benefit of additional releases.

ODFW evaluated the suitability of the instream right assessment process and determined that the assessment methods do not adequately address the flows required to maintain a channel. Therefore, ODFW developed a guidance document for assessing instream flow requirements for fish and required channel maintenance flows for storage projects in 2007 (Robison 2007). The guidance generally recommends that the full flow in storm flow events of a magnitude equivalent to the 2-year event and larger be released downstream to assure the maintenance of the channel. The guidance document provides a procedure for estimating the size of that event and for fine-tuning the recommendation by evaluating the actual trigger point at which the substrate in the river starts to move.

Table 14. Instream Flow rights for the S.F. Siletz River.

Period	Flows (cfs) protected under the right issued on July 12, 1966	Flows (cfs) protected under the right issued on March 26, 1974
October 1 – October 15	30	30
October 16 – October 31	40	40
November 1 – May 31	45	60
June 1 – June 15	30	30
June 16-June 30	12	30
July 1 – July 15	10	10
July 16 – September 30	8	10

Dams tend to accumulate the bedload (sediment) transported into the reservoir and will hold that bedload within the reservoir. Since bedload is not carried downstream of the dam, the substrate in rivers below dams tend to become coarser in time and sometimes contain reduced quantities of spawning gravel. If the recommendations in the guidance were followed, the substrate in the river downstream of the dam could potentially become coarser over time. At present, the substrate in the river downstream of the dam is relatively coarse and the likely change in substrate is unknown. The guidance document did not consider the loss of bedload transport below dams. The need for downstream maintenance flows should be discussed further with ODFW to determine the exact goals they would want to attain regarding bedload movement.

5.4 Passage Needs and Requirements

5.4.1 South Fork Siletz

Passage over the dam may be required under project permits. OAR 635-412-0005 prohibits the construction of any artificial obstruction across any waters of the state that are inhabited, or were historically inhabited, by native migratory fish without providing passage for native migratory fish. Exemptions from this requirement are possible if a) ODFW finds that the impacts to fish have been adequately mitigated or b) there is no appreciable value in providing passage. The second situation is likely to occur only in cases where no suitable habitat would remain upstream of the facility.

Substantial habitat would remain upstream of the reservoir under the low and moderate dam alternatives. A fish ladder may be required for either of these alternatives. Very little habitat would remain upstream of the highest dam alternative. Only 1.66 miles of tributary habitat would remain. If the high dam alternative is selected as the preferred alternative, discussions with ODFW will determine if the remaining habitat has sufficient value to support the construction of a fish ladder or if other mitigation can be provided for a passage waiver.

OAR 635-412-0005 also defines specific design requirements for upstream and downstream fish passage. These requirements would have to be incorporated into the engineering design of the project.

5.4.2 Luckiamute River

One of the potential impacts of transporting South Fork Siletz River water to the Luckiamute River is the potential to disrupt olfactory cues associated with upstream migration of salmonids to natal streams. The importance of olfactory cues during salmonid migration, as well as straying behavior when the olfactory cues are disrupted, has been studied in a variety of experiments (Johnsen and Hasler 1980, Dodson 1988, Dittman et al. 1996, Courtenay et al. 1997, Scholz et al. 2000). Salmonid migration is generally considered to be accomplished through olfactory imprinting and spatial learning (Dodson 1988). Imprinting is considered an olfactory process that occurs in the early stages of development, and is hypothesized to be responsible for identifying specific chemical cues from the water chemistry of natal streams.

Courtenay et al. (1997) reported that, near the spawning grounds of origin, salmonids appear to be clearly aided by chemical traces of bile and feces. Additionally, salmonids tend to follow higher concentrations of a chemical odor at the end of migration than conspecific odors. This finding supports the hypothesis that there are different forms of chemical imprinting used by adult salmonids migrating to their natal stream. Most researchers agree that homing behavior is triggered by a series of olfactory waypoints, to which a smolt is exposed during their parr to smolt transformation and seaward migration.

Creating a false signature of water not typically found in the basin could potentially result in migration delays of adults to upstream spawning grounds within the Luckiamute River. At present, the majority of the water withdrawals from the reservoir are expected to occur in summer, extending potentially into early fall. The species most likely to be affected in the Luckiamute are winter steelhead, which tend to migrate into rivers in winter and early spring. During the time of upstream migration of adults, the transfer of water into to the Luckiamute would be reduced or even discontinued, which would reduce the potential for disruption of olfactory clues. Additionally, the water released into the Luckiamute would be diluted substantially by the flows within the Luckiamute itself. This project did not evaluate the potential effects associated with olfactory clues. This should be addressed in the future if water releases are expected during adult migration periods.

5.5 Potential Recreational Fisheries

The old Valsetz Lake used to provide a warmwater fishery with stocked largemouth bass, yellow bullhead, brown bullhead, and other sunfishes (Smith and Lauman 1972). The potential to support these fish is likely but access to the fishery in the reservoir is not known. If a fishery were developed, access to the lake would be controlled by the owners of the surrounding land and permission would have to be attained to access the lake.

The development of a fishery may not be in the best interest of the water purveyors. Maintaining the quality of the water in the reservoir would be a high priority. Recreational use of reservoirs can result in pollution of waters. Boat access would need to be controlled. Runoff from parking areas could pollute waters. Septic systems would need to be constructed to control human wastes. These potential pollutant sources should be given careful consideration prior to deciding to support development of recreational uses on the lake. This study did not fully address this aspect of the project.

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