U.S. Army Corps
of Engineers
Seattle District

Centralia Flood Damage Reduction Project
Chehalis River, Washington

FINAL ENVIRONMENTAL IMPACT STATEMENT

Appendix A:

Fish, Riparian, and Wildlife Habitat Study

June 2003

Pre-Decisional Document

Fish, Riparian, and Wildlife Habitat Study

Centralia, WA General Reevaluation Report and Environmental Impact Statement

Prepared by:

Pacific International Engineering PLLC
2111 North 30th
Tacoma, Washington 98403

and

GeoEngineers, Inc.
1101 Fawcett Ave., Suite 200
Tacoma, Washington 98402

Prepared for:

Lewis County
Chehalis, Washington

November 2001

PACIFIC INTERNATIONAL ENGINEERING PLLC

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY 4
2 STUDY AREA OVERVIEW 7
2.1 Climate 7
2.2 Physiography 8
2.3 Fish Resources 10
2.3.1 Introduction 10
2.3.2 Fish Distribution and Habitat Use 10
2.3.3 Stock Status and Population Trends 14
2.4 Wildlife Resources 16
2.4.1 Introduction 16
2.4.2 Priority Habitats and Species 21
3 STUDY METHODS 26
3.1 Pre-Field Analyses 26
3.1.1 Channel Segment (Reach) Classification 26
3.1.2 Riparian Condition Determination 26
3.1.3 Selection of Field Survey Reaches 29
3.2 Field Survey Methods 29
3.2.1 Fish Habitat Surveys 29
3.2.2 Riparian Condition Surveys 32
3.2.3 Wildlife Habitat Surveys 33
3.3 Habitat Analysis 35
3.3.1 Fish Habitat 36
3.3.2 Riparian Assessment 37
3.3.3 Wildlife Habitat Typing 39
4 RESULTS AND DISCUSSION 40
4.1 Instream Habitat Conditions 40
4.1.1 Spawning Habitat Conditions 47
4.1.2 Rearing Habitat Conditions 51
4.2 Riparian Function Assessment 52
4.2.1 Riparian Vegetation Conditions 52
4.2.2 Near-Term LWD Recruitment 54
4.2.3 Riparian Shade Assessment 56
4.3 Wildlife Habitat Conditions 57
4.3.1 Wildlife Species of Concern 57
4.3.2 Channel and Riparian Wildlife Habitat Conditions 59
4.3.3 Skookumchuck Reservoir Habitat Conditions 67
5 REFERENCES 75

TABLES

Table A. Amphibians and Reptiles with Habitat in the Study Area 20
Table B. Priority Habitats in the Study Area 25
Table C. Riparian Condition Unit Classifications 26
Table D. Large Woody Debris Functions Recorded During Surveys 31
Table E. Canopy Closure Estimates from Aerial Photos 37
Table F. Coding Rational for Near-Term Riparian Recruitment Potential 39
Table G. Habitat Limiting Factors 42
Table H. 1999 WDFW Salmonid Escapement Estimates - Mid Chehalis River Basin .. 49
Table I. Habitat Types in the Skookumchuck Reservoir 69
Table J. Frequency of Habitat Edge Types 71
Table K. Habitat Descriptions along the Skookumchuck Reservoir 73

FIGURES

Figure 1. Sample of Gradient Confinement Codes 27
Figure 2. Example of Riparian Condition Unit Classification 28
Figure 3. Channel Cross Section (Schematic) 30
Figure 4. Stream Survey Overview (Schematic) 30
Figure 5. Large Woody Debris Classifications 32
Figure 6. Skookumchuck Reservoir Survey (Schematic) 34
Figure 7. Typical Glide Reach 41
Figure 8. Typical Pool 41
Figure 9. Typical Incised Channel 43
Figure 10. Skookumchuck Reservoir Talus Slope 68
Figure 11. Skookumchuck Reservoir Cliffs 68
Figure 12. Typical Aquatic Edge on the North Side of the Skookumchuck Reservoir ... 69

MAPS

Map 1.	Study Area
Map 2A-2D.	Riparian Condition Units and Channel Migration Zones
Map 3A-3D.	Wetlands Associated with RCUs
Map 4A-4D.	Reaches with Bank Armoring
Map 5A-5D.	Spawning Habitat
Map 6A-6D.	Documented Rearing/Holding Habitat
Map 7A-7D.	Large Woody Debris per Channel Width
Map 8A-8D.	Near-Term Large Woody Debris Recruitment Hazard Calls
Map 9A-9D.	Stream Canopy Coverage
Map 10A-10D.	Shading Hazard Calls
Map 11A-11D.	Wildlife Habitat Types
Map 12.	Skookumchuck Reservoir Habitat

ATTACHMENTS

Attachment A: Plant Species Observed in the Study Area
Attachment B: Wildlife Species Which May Occur in the Study Area
Attachment C: Chehalis Basin Escapement Estimates
Attachment D: Substrate Characterization Charts

1 EXECUTIVE SUMMARY

This report presents results of the fish, riparian, and wildlife habitat evaluations conducted by Pacific International Engineering (PI Engineering) on behalf of Lewis County in support of the Centralia General Reevaluation Report (GRR) and Supplemental Environmental Impact Statement (EIS). The purpose of the investigations was to provide a baseline assessment of existing resource conditions for evaluating the environmental impacts of project alternatives and to support the identification of potential habitat restoration actions.

PI Engineering developed a Study Plan in cooperation with the U.S. Army Corps of Engineers (Corps) biologists and environmental planning staff. The Corps distributed the Study Plan to state and federal resource agency staff for additional review and comment. Agency comments were reviewed by members of the Corps/Lewis County project team, and modifications to the study were made as appropriate.

For the purposes of these investigations, the Study Area is defined as the portion of the Chehalis River basin above the Grand Mound gauging station at river mile (RM) 60 to Doty at RM 102 (Map 1). The Study Area also includes the Skookumchuck, Newaukum, and South Fork Chehalis rivers upstream of the Grand Mound gauge. The communities of Centralia, Chehalis, and Bucoda are located within the Study Area, and Interstate 5 and several state highways traverse the area. Land uses in the Study Area include timber production, agriculture, and residential, commercial, and industrial development.

Within the Study Area, the Chehalis River and its tributaries support spring and fall chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and fall chum salmon (*O. keta*), as well as summer and winter steelhead (*O. mykiss*), rainbow (*O. mykiss*), and both sea-run and resident cutthroat trout (*O. clarki clarki*). Brook trout (*Salvelinus fontinalis*) have been introduced into some lakes and streams within the Chehalis watershed. Resident fish species in the area include largemouth bass (*Micropterus salmoides*), perch (*Perca flavescens*), catfish (*Ictalurus punctatus*), and others.

A native stock of bull trout/Dolly Varden trout (*Salvelinus confluentus* or *S. malma*) has been identified in the Chehalis River/Grays Harbor system. Although a few native char have been collected in the Chehalis River during monitoring studies in recent decades, they have not been collected within the Study Area and it is not known if these fish are native to the Chehalis basin or are migrants from other watersheds (U.S. Army Corps of Engineers 2001).

Of the eight salmonid stocks known to occur in the Study Area, five (Chehalis River spring chinook, Chehalis River fall chinook, Chehalis River coho, Chehalis River fall chum, and Chehalis river winter steelhead) are considered healthy. One stock (Skookumchuck/Newaukum River winter steelhead) is considered depressed. The status of two stocks (Chehalis River summer steelhead and Chehalis River coastal cutthroat trout) is unknown.

Low-gradient glide habitat composed of fairly deep, slow-moving water is the most prevalent instream habitat type in the Study Area. Riffles, which provide spawning habitat for anadromous and resident fish, are not common in the Centralia reach of the Chehalis, but are more prevalent on the tributaries. Similarly, pools are uncommon on the mainstem Chehalis but occur more frequently on the tributary streams. Side channels, although rare, are present on the mainstem Chehalis and on the Skookumchuck and Newaukum rivers. Cascade habitat is the least abundant instream habitat type in the Study Area, and is present only on one reach of the Skookumchuck.

The mainstem Chehalis provides transportation, rearing, and some spawning habitat for a variety of anadromous and resident fish. Gravels suitable for anadromous fish spawning are rare in the mainstem in the lower portion of the Study Area, but occur more frequently upstream of the Newaukum River confluence. There are few areas on the mainstem Chehalis in the Study Area that provide suitable spawning habitat for resident fish.

The South Fork Chehalis is used primarily for upstream access and rearing, as there are few areas that provide spawning gravels suitable for either anadromous or resident fish species. The Skookumchuck River provides rearing habitat, abundant spawning habitat for anadromous species, and more limited spawning habitat for resident species. The Newaukum River provides transportation and rearing habitat, as well as an abundance of spawning habitat for both anadromous and resident fish species.

There are currently no dams or other man-made structures that block the movement of anadromous fish in the mainstem Chehalis, although the combination of high water temperatures and low dissolved oxygen levels are thought to form a temporary block to fish migration in the Centralia reach during summer low flow periods. Upstream of the confluence with the South Fork Chehalis, there are numerous culverts on tributaries that are known to block passage of cutthroat trout, steelhead, or both. On the Skookumchuck River, a dam built in 1970 blocks natural passage to all anadromous fish above RM 21.9.

Wildlife populations in the Study Area consist primarily of species associated with open forest canopies and young vegetation. Climax forests associated with pre-settlement conditions were mostly removed in the 19th century, converting the floodplain and lowland habitat in the Study Area to agriculture and timber production. With increasing development, forested habitat along the mainstem Chehalis and many tributaries has been reduced to narrow strips. In the vicinity of the cities of Centralia and Chehalis, wildlife populations are characterized by species most tolerant of human activity.

A number of wildlife species and habitat types present in the Study Area are listed in the Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species Database. Priority species that occur in the Study Area include the bald eagle (*Haliaeetus leucocephalus*), which is also federally listed as threatened. Others include the Eastern wild turkey, great blue heron (*Ardea herodias*), mink (*Mustela vison*), wolverine (*Gulo gulo*), Mardon skipper (*Polites mardon*), and whulge checkerspot (*Euphydryas editha*). Priority habitats in the Study Area include cliffs, talus, freshwater

wetlands, fresh deepwater, instream habitats, mature forest, riparian areas, and rural natural open space.

Game animals occurring in the Study Area include deer, elk, cougar, and black bear. The area also provides habitat for upland game birds and migratory waterfowl.

In the lower elevations of the Study Area, the riparian vegetation community typically consists of a sparse canopy dominated by big-leaf maple (*Acer macrophyllum*), black cottonwood (*Populus balsamifera* var. *trichocarpa*), Oregon ash (*Fraxinus latifolia*), and red alder (*Alnus rubra*). Where present, the secondary canopy or shrub understory is generally dominated by red-osier dogwood (*Cornus stolonifera*) and willows (*Salix* spp.). Reed canarygrass (*Phalaris arundinacea*) is the dominant groundcover in many areas. Many of the same species occur along higher elevation reaches, along with Western red cedar (*Thuja plicata*) in the overstory and vine maple (*Acer circinatum*) and snowberry (*Symphoricarpos albus*) in the shrub layer.

Most of the wetland and riparian areas in the Study Area have been altered by human activity including draining, ditching, and removal of vegetation. In the vicinity of Centralia and Chehalis, many stream reaches have either no riparian vegetation or sparse riparian coverage. As a result, the amount of large woody debris (LWD) present in many stream channel reaches is low, and only limited recruitment of LWD can be expected in the near term.

The existing riparian canopy coverage within the Study Area is, in most cases, insufficient to provide adequate stream shading. Alteration and removal of riparian growth have increased stream temperatures throughout the Study Area. Several reaches on the Chehalis River and its tributaries are identified on the State 303(d) list of impaired water bodies because they fail to meet established standards for instream temperatures. Nearly every reach analyzed during this study received a “high hazard” designation for stream shading, indicating that there is a high hazard of negative habitat impact based on shading levels. In the entire Study Area, only two reaches on the Skookumchuck River currently achieve target shading levels.

During the course of the investigations, a number of habitat restoration opportunities were identified, including several sites that appear to be suitable for riparian restoration. The goal of riparian restoration would be to increase the extent of riparian area for species dependent on this habitat, improve stream shading and habitat connectivity, and, in the longer term, improve conditions for recruitment of LWD. Other restoration opportunities identified include reconnecting abandoned oxbows and creating side channels to offset the lack of suitable fish rearing habitat, and reconnecting the Chehalis River floodplain to the stream to increase the area and quality of fish and wildlife habitat and to improve hydrologic function.

2 STUDY AREA OVERVIEW

2.1 Climate

The Centralia-Chehalis area has a predominantly marine climate characterized by mild summer and winter temperatures. Extreme temperatures in the area are uncommon, since prevailing westerly winds bring maritime air over the basin and provide a moderating influence throughout the year. Precipitation throughout the area varies depending on distance from the Pacific Ocean, elevation, and seasonal conditions.

During spring and summer, high-pressure systems predominate over the northeastern Pacific and send northwesterly flows of dry, warm air over the Chehalis River basin. The dry season extends from late spring to midsummer, with precipitation limited to light showers. Average summer temperatures range between 50 deg F and 60 deg F, but occasionally hot, dry, easterly winds cross the Cascade Mountains and raise daytime temperatures into the 90s.

During the winter, the Aleutian low-pressure system tends to dominate. This influence causes counterclockwise circulation of cool, moist air over the basin, with southwesterly winds prevailing. Winter storms accompanied by strong winds and heavy precipitation are common throughout the Chehalis basin. Heavy orographic rainfall is commonly produced when warm, saturated marine air rises over the west slopes of the Olympic and Cascade Mountains. The western slopes of the Black and Willapa Hills also receive the full force of winter storms. Occasionally, short periods of cold weather occur when arctic air descends and interrupts normal weather patterns.

Monthly rainfall totals between October and March typically range from five to eight inches. November is typically the wettest month with an average rainfall of 7.7 inches. During the remainder of the year, monthly rainfall totals range between 0.8 and 2.0 inches. Annual precipitation averages 41.6 inches, with annual records of 28 to 60 inches.

The region does not receive significant snowfall, although there is potential for large amounts on occasion. On average, annual snowfall is approximately nine inches. Most snowfall occurs in January.

Winds in the region typically do not exceed 30 mph. Winds of this magnitude are usually associated with rainstorms that pass through the area in fall and winter. On rare occasions, winter fronts out of the south and southwest will produce winds in excess of 70 mph. However, 90 percent of the time, wind speeds in the area range between 0 and 15 mph.

2.2 Physiography

Bedrock in the Chehalis River basin is composed primarily of igneous and sedimentary rocks of the Tertiary Period. Surficial deposits include unconsolidated glacial sediments of the Pleistocene Period. Following formation of the bedrock seven to 55 million years ago, the area underwent uplift and deformation in the form of faulting and folding. Landslides, erosion, glaciation, glaciofluvial deposition, and volcanic activity followed these processes. The most recent 10,000 years have been a period of relative quiescence, with erosion being the dominant geologic process (ENSR 1994).

Within the Study Area, the Chehalis River valley is characterized by a broad, well-developed floodplain and low terraces surrounded by highly dissected uplands of low to moderate relief. The valley bottom is at an elevation of about 150 feet, and upland elevations average 300 to 600 feet. Higher elevations in the basin range from about 1,000 feet in the lowland hills to 3,800 feet in the Cascade foothills east of Centralia and Chehalis.

Soils in the floodplain are dominated by silty clay loam (SCS 1987). These soils are generally very deep and range from poorly- to well-drained. Soils on plains, terraces, and uplands tend to be very deep and range from well-drained gravelly sand to poorly drained silty clay. Soils on high terraces and mountains also tend to be very deep and are predominantly well-drained silt loam.

Wetlands in the Study Area range from forested wetland complexes to prior converted agricultural wetlands. Most of the wetlands within the Study Area have been altered by human activity, including draining, ditching and mowing. Fragmentation of wetland systems has resulted in reduced habitat functions throughout the Study Area. A detailed wetland assessment is being prepared under separate cover by the Corps.

Chehalis River. The slope of the Chehalis River from its source to the City of Chehalis is steep, falling an average of 16 feet per mile. The slope flattens to about three feet per mile in the valley surrounding Centralia and Chehalis, where the river occupies a meandering channel. Downstream of Chehalis, the average width of the floodplain is one and one-half to two miles. The floodplain shows little relief, either longitudinally or perpendicular to the direction of flow, which has resulted in a pronounced sinuous river course with numerous oxbow lakes and abandoned channels.

In addition to the mainstem Chehalis River, there are also numerous perennial streams in the Study Area. The main tributaries include the Skookumchuck, Newaukum, and South Fork Chehalis rivers; smaller sub-drainages include China and Salzer creeks (Map 1).

South Fork Chehalis River. The South Fork of the Chehalis River joins the mainstem at RM 88. It drains approximately 130 square miles, most of which is farmland and managed forest lands.

Skookumchuck River. The Skookumchuck River joins the Chehalis River at RM 67 near Centralia. The Skookumchuck originates in the Mt. Baker-Snoqualmie National Forest, northeast of Centralia. The river is approximately 41 miles in length and drains an area of 181 square miles. Elevations within the drainage range from 150 feet above sea level at the mouth to over 3,000 feet at the headwaters. The slope of the river from its source to the town of Bucoda is steep, falling an average of 19 feet per mile. Below Bucoda, the slope flattens to about five feet per mile. With the exception of the upper reach, the Skookumchuck flows in a meandering channel through a floodplain that varies in width from a few hundred feet to one-half mile. The Skookumchuck has 44 tributaries that provide an additional 185 miles of stream length. The largest tributary is Hanaford Creek, which drains an area of 58.4 square miles.

The Skookumchuck dam, located at RM 21.9, controls water levels in the river. The dam was completed in 1971 and built to supply water for the Centralia Steam Electric Plant. It also supplements flows for fish resources. At a normal pool elevation of 400 feet, the dam impounds 31,000 acre-feet of water. At this capacity, the reservoir extends approximately three miles up the valley and covers an area of approximately 640 acres. The dam is equipped with a multi-level intake and outlet system that allows water temperature below the dam to be maintained at less than 60°F. A portion of the water supplies a WDFW fish rearing facility approximately one-half mile below the dam. Authority has also been granted to the Centralia Steam Electric Plant to divert up to 54 cubic feet per second (cfs) of water from the Skookumchuck River.

Newaukum River. The Newaukum River comprises the north, middle, and south forks. Upstream sections of the south fork are steep, averaging 188 feet per mile above the town of Onalaska. The north and middle forks have slopes of 83 feet per mile. Elevations in the Newaukum River drainage range from 3,000 feet at the headwaters to 180 feet at the mouth where the Newaukum River joins the Chehalis River at RM 75. The river drains 175 miles of lowland and foothills southeast of Chehalis.

China Creek. China Creek is a small, short stream that flows through the City of Centralia to the Chehalis River. The watershed extends about five miles east of the Chehalis River at Centralia. It drains an area of approximately six square miles. Elevations in this small basin range from 180 to 570 feet, and much of the basin is moderately steep. As it runs through Centralia, the stream is diverted through pipes and culverts.

Salzer Creek. Salzer Creek joins the Chehalis River just south of the Centralia city limits. Salzer Creek originates in the low-lying hills east of Centralia and Chehalis and drains approximately 24.5 square miles. Elevations in the basin range from approximately 180 to 600 feet.

2.3 Fish Resources

2.3.1 Introduction

The Chehalis River and its tributaries support many species of salmonids, including spring and fall chinook, coho, and chum salmon, as well as steelhead, rainbow, and both sea-run and resident cutthroat trout (WDF 1975). Although sockeye salmon (*O. nerka*) and pink salmon (*O. gorbuscha*) have been observed in streams in the lower Chehalis basin, it is thought that these fish are strays from other river systems and are not indigenous to the Chehalis basin (WDF 1975; WSCC 2001). Brook trout have been introduced into some lakes and streams within the Chehalis watershed (Envirovision 2000). Little is known about the distribution and status of brook trout, but populations appear to be small.

The Lower Columbia River Evolutionarily Significant Unit (ESU) of coho salmon has been designated as a candidate for listing under the Endangered Species Act due to habitat degradation, population declines caused by drought, and other concerns (NMFS 1995). In August 2001, the Department of the Interior announced its intention to issue a listing decision on the Southwestern Washington/Columbia River ESU of coastal cutthroat trout. This species has been proposed for listing as threatened primarily due to habitat modification and destruction and overfishing (NMFS 1999).

The Chehalis and Columbia rivers probably represent the southern end of the range of anadromous char (bull trout/Dolly Varden trout) on the west coast. In its final rule for determination of bull trout as a threatened species, the U.S. Fish and Wildlife Service (USFWS) noted that a subpopulation of native char was reported to occur in the Chehalis River/Grays Harbor basin (USFWS 1999). However, data confirming the presence of such a subpopulation are limited; very few native char have been collected during monitoring studies over the past 30 years. Single fish were captured in the Chehalis River at RM 50 in 1997 and near Oakville in 1973 (U.S. Army Corps of Engineers 2001). During the 11-year period that WDFW has operated a smolt trap in the Chehalis River, only one char has been observed (in 1997) (WDFW 1998).

The Chehalis River system also supports American shad (*Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), and green sturgeon (*A. medirostris*) (Hiss and Knudsen 1993). Several exotic warmwater species, including largemouth bass, perch, catfish, sunfish (*Lepomis cyanellus*), and many other resident fishes are present.

2.3.2 Fish Distribution and Habitat Use

Chehalis River. The mainstem Chehalis provides spawning and rearing habitat for salmonids as well as access to upriver habitat. In the reach near the cities of Centralia and Chehalis, the mainstem generally lacks suitable riffles for spawning, while low flows coupled with high water temperatures during the summer and early fall limit the availability of rearing habitat. High sediment loads in this reach of the Chehalis River also decrease the area and quality of spawning and rearing habitat. In the upper portion

of the Study Area (upstream of the confluence with the South Fork Chehalis), the mainstem provides spawning and rearing habitat for spring and fall chinook, coho, and steelhead.

The timing of the Chehalis River spring chinook run is not known with precision. The Washington Department of Fisheries (1975) states that fish enter the river in March through mid-August, but chinook catches in the Chehalis Tribe reservation fishery have been reported as early as February. Chinook spawn in the mainstem and in the tributaries in late August through September, with spawning in the upper basin occurring slightly later. Fry emerge late the following winter. Juvenile spring chinook generally remain in the river for over a year, with seaward migration taking place the second spring after emergence.

Adult fall chinook begin entering the Chehalis River in August, with the run peaking in September and tapering off through November (WDF 1975). Spawning generally occurs during October through mid-December. Within the Study Area, fall chinook salmon spawn in suitable riffles in the reach between the mouth of the Skookumchuck River and the mouth of the Black River, as well as in areas upstream of the cities of Centralia and Chehalis. Fall chinook fry emerge in late winter through early spring, and remain in fresh water for three to five months before beginning their seaward migration.

The Chehalis and nearby drainages produce more coho smolts than any other system along the Washington coast, and in 1999 was the third largest producer in Washington state (WSCC 2001). Coho salmon begin entering the Chehalis in September and continue through November, with spawning occurring over the period from October through January (WDF 1975). "Late-run" coho, which enter the river in mid-November through February, are not found in significant numbers within the Study Area and upper portions of the basin. Coho tend to seek out smaller tributary streams, and the mainstem Chehalis within the Study Area provides little suitable coho spawning habitat. Coho fry emerge from the gravel in late spring. They typically migrate seaward during April, May, and June of their second year, although some fry and fingerlings migrate downstream in their first year during periods of flooding and heavy runoff.

Chum salmon enter the Chehalis system in early October through mid-December and spawning peaks in mid-November. Within the Study Area, chum salmon spawn in suitable riffles in the reach between the mouth of the Skookumchuck River and the mouth of the Black River. Chum fry begin their seaward migration shortly after emergence in early spring.

Wild summer steelhead in the Chehalis River system are a distinct stock based on the geographical isolation of the spawning population. Specific spawning locations are unknown, but it is thought that wild summer steelhead may spawn in the upper reaches of the Chehalis. Run timing is generally from May through October, and spawning is believed to occur from February through April. Wild winter steelhead are distinct from wild summer steelhead based on run timing. Run timing for winter steelhead in the

mainstem Chehalis is December through May, with spawning occurring from mid-February through early June.

American shad have been observed in the Chehalis River as far upstream as Rainbow Falls (RM 97), but the largest concentration of shad spawning is thought to be near Rochester (Hiss and Knudsen 1993). Within the Study Area reach there is likely little shad spawning, as there are few areas of suitably sized gravels.

Sturgeon are known to be present in the Chehalis as far upstream as the mouth of the Newaukum River. A few juveniles, apparently months old, were seined from the mainstem Chehalis during summer in the early 1970s (Hiss and Knudsen 1993). Within the Study Area, there are a few locations in the mainstem Chehalis that contain larger cobble substrates that could be used for spawning. However, use of these areas by sturgeon is considered unlikely.

The Olympic mudminnow (*Novumbra hubbsi*), which is listed by Washington State as a sensitive species, is not known to occur in the mainstem Chehalis, although suitable habitat occurs in some off-channel ponds. This species is known to be present in China Creek, which enters the Chehalis near Mellen Street (City of Centralia 1999).

There are currently no dams or other man-made structures that block the upstream or downstream movement of anadromous fish in the mainstem Chehalis. During the dry season, water quality in the Centralia reach (approximately RM 66 to RM 76) frequently fails to meet Class A water quality criteria for temperature and dissolved oxygen. The combination of low flows, high water temperatures, and low dissolved oxygen levels in late summer and early fall may form a block to fish migration in the Centralia reach. Upstream of the South Fork confluence, there are numerous culverts on tributaries that are known to block passage of cutthroat trout, and several culverts that block passage for both cutthroat and steelhead (WSCC 2001). In addition, one culvert on a tributary to the East Fork Chehalis is known to block migrating coho. A natural barrier to salmon migration occurs at RM 97, where Rainbow Falls occasionally hinders passage of adult fish at low flows.

South Fork Chehalis. The South Fork Chehalis River supports runs of spring and fall chinook and coho salmon, as well as steelhead trout. Coho are the most abundant salmonid in this stream (WSCC 2001). The coho stock in the South Fork Chehalis basin is classified as part of the much larger population of coho found throughout the Chehalis system upstream of the Satsop River confluence. Similarly, spring chinook and fall chinook salmon in the South Fork Chehalis are components of the Chehalis River chinook stocks. Winter steelhead in the South Fork Chehalis are part of a larger population found throughout the Chehalis basin upstream of the Satsop River (WSCC 2001). This stock does not include spawners in the Skookumchuck and Newaukum river basins.

Although the South Fork Chehalis is used primarily for upstream access and rearing, there are some suitable riffles that provide limited spawning for chinook. Coho and steelhead spawning is confined primarily to tributary streams containing suitable spawning gravels. Low flows, high water temperatures, high silt loads, and concentrations of predatory fish are factors that limit successful salmon spawning and rearing in the South Fork Chehalis.

There are several culverts on South Fork tributaries that are known to be barriers to migrating salmon, steelhead, or both (WSCC 2001). The length of stream habitats blocked by these culverts has not been determined.

Skookumchuck River. The Skookumchuck River provides spawning and rearing habitat for spring and fall chinook and coho salmon, and supports winter steelhead and resident cutthroat trout. Chum salmon used this stream historically, but have not been found in the Skookumchuck for many years (WDF 1975). The Olympic mudminnow is reported to occur in Hanaford Creek (WDFW 1999).

The spring chinook and fall chinook stocks in the Skookumchuck are considered components of the larger Chehalis River chinook stocks. Chinook use the mainstem Skookumchuck for spawning and rearing from the mouth up to the Skookumchuck dam at RM 21.9.

The coho stock in the Skookumchuck River is classified as part of the much larger population of coho found throughout the Chehalis system upstream of the Satsop River confluence. Coho use the mainstem Skookumchuck up to the dam for spawning and rearing, and spawn in the accessible reaches of tributaries. Wild winter steelhead in the Skookumchuck basin are considered to be part of a larger population that includes Newaukum River winter steelhead.

Prior to construction of the Skookumchuck dam, coho and steelhead utilized the Skookumchuck River up to an impassible falls near RM 28.9. The dam, which was built in 1970, blocks natural passage to all anadromous fish. It is estimated that 3.6 miles of spring and fall chinook mainstem habitat and 7 miles of coho mainstem habitat were lost when the dam was constructed (WSCC 2001). WDFW traps returning steelhead at a collection facility at the base of the dam, and transports them to stream reaches upstream of the dam for spawning. Steelhead smolts are transported downstream by allowing water over the spillway from March 15 to June 1 (USFWS 1982). Following dam construction, cutthroat were planted above the reservoir by the Washington Department of Game, but this practice was discontinued in 1980.

There are two culverts on Skookumchuck tributaries in the upper basin that are known to be barriers to steelhead (WSCC 2001).

Newaukum River. The Newaukum River, including its North and South forks, supports runs of spring and fall chinook and coho salmon as well as steelhead. American shad use the lower Newaukum for spawning (WDF 1975).

The spring and fall chinook stocks in the Newaukum are considered components of the Chehalis River chinook stocks; this drainage contributes an estimated 34 percent of the spawning population of Chehalis River spring chinook and an estimated 6 percent of the total spawning population of Chehalis River fall chinook (WSCC 2001). Spring and fall chinook spawn up to RM 12.5 on the North Fork and up to RM 31 on the South Fork Newaukum.

The coho spawning in the Newaukum are considered part of the Chehalis River population found upstream of the Satsop River. Coho salmon use the mainstem Newaukum for rearing and transportation, and use tributary streams for spawning and rearing. Winter steelhead in the Newaukum basin are considered to be part of a larger population that includes Skookumchuck winter steelhead. Steelhead use the mainstem Newaukum for rearing and transportation, and use tributary streams for spawning and rearing. Coho and steelhead have been documented as far upstream as RM 18.5 on the North Fork and up to RM 32.2 on the South Fork Newaukum. Tributaries producing coho and steelhead include Allen and Taylor creeks (mainstem tributaries), Lucas, Bear, Mitchell, and Johns Fork creeks (North Fork tributaries), and Bearnier, Beaver, Frase, Gheer, Kearney, and Lost creeks (South Fork tributaries).

The South Fork Newaukum contains a number of deep pools with cool water temperatures, which provide excellent rearing habitat for juvenile salmonids, as well as adult resting and maturation habitat. The area and quality of rearing and maturation habitat on the North Fork is limited by low flows, high water temperatures, high silt loads, and large concentrations of predatory fish (WDF 1975).

A diversion dam was built in 1918 at RM 12.5 on the North Fork Newaukum to provide water for the cities of Centralia and Chehalis. This dam blocked access for anadromous fish until 1970, when a fish ladder was constructed. On the South Fork, a series of falls upstream of RM 31 apparently block salmon from utilizing some potential upstream production areas (WDF 1975).

2.3.3 Stock Status and Population Trends

Many Chehalis River basin wild salmon and steelhead populations have been extensively influenced by hatchery releases of non-native stocks (Hiss and Knudsen 1993; WSCC 2001). Many hatcheries developed brood stocks from outside strains, and most Chehalis basin salmonid populations have had considerable non-native influence. Stocks occurring in the Study Area that are considered to be of mixed origin include Chehalis River fall chinook, Chehalis River coho, and Skookumchuck/Newaukum winter steelhead (Envirovision 2000).

Reports developed by WDFW and Western Washington Treaty Indian Tribes summarize the most recent information available on the status of salmonid stocks in the Chehalis basin and Study Area (WDFW and WWTIT 1994; WDFW 1998, 2000).

Escapement estimates for years 1986-1996 for coho and fall and spring chinook within the Study Area are presented in Attachment D. Steelhead redd count summaries for years 1989-1996 are also presented in Attachment D.

Spring Chinook. There is one stock of spring chinook found in the Chehalis River basin and the Study Area. The Chehalis River stock of spring chinook is considered a native stock and is maintained by wild production. The stock is considered healthy. From 1982 through 1991, escapement ranged from 610 to 3,488. With the exception of 1988 and 1989 (two strong return years), average escapement during the 1982-1991 period was approximately 1,400 (WDFW and WWTIT 1994). Since 1991, the average escapement has increased to 2,379 (WSCC 2001). The population trend is considered stable or possibly positive (Envirovision 2000).

Fall Chinook. There are seven stocks of fall chinook in the Chehalis basin, one of which (the Chehalis River stock) is found in the Study Area. The Chehalis River stock of fall chinook salmon is of mixed origin, and is maintained by wild production. The stock is considered healthy. From 1985 through 1990, escapement ranged from 2,971 to 7,837 (WDFW and WWTIT 1994). Estimates indicate that recent escapement levels have been stable (WSSC 2001). There is no recent population trend reported for Chehalis River fall chinook (Envirovision 2000).

Coho. Of the seven stocks of coho in the Chehalis basin, one (the Chehalis River stock) occurs in the Study Area. The Chehalis River coho stock is of mixed origin, with composite production of hatchery and wild fish. The stock is considered healthy. Between 1984 and 1991, escapement averaged 18,510, and then declined to an average of 14,625 between 1992 and 1998. However, a portion of the population has recently increased its level of returns, resulting in numbers similar to the 1984-1991 period (WSCC 2001). No recent population trend has been reported for this stock (Envirovision 2000).

Fall Chum. There are two stocks of fall chum in the Chehalis basin, one of which (the Chehalis River stock) is found in the Study Area. The Chehalis River fall chum stock is considered native, and is maintained by wild production. The stock is considered healthy. Escapement levels and population trend for this stock are unknown (WDFW and WWTIT 1994).

Summer Steelhead. There are two stocks of summer steelhead in the Chehalis basin. One, the Chehalis River stock, occurs in the Study Area. The origin of the stock is unknown; a native stock originally returned to the Wynoochee and possibly other rivers, but there is uncertainty about the contribution by hatchery summer steelhead spawning in the wild (WDFW and WWTIT 1994). The stock is maintained by wild production. The status of the stock and population trends are unknown. Escapement is not monitored for this stock, nor has an escapement goal been identified.

Winter Steelhead. Of the eight stocks of winter steelhead in the Chehalis basin, two (the Chehalis River and the Skookumchuck/Newaukum stocks) occur in the Study Area. The

Chehalis River stock is native and is maintained by wild production. This stock is considered healthy. From 1984 through 1992, escapement ranged from 2,540 to 4,156.

The Skookumchuck/Newaukum winter steelhead stock is of mixed origin and is maintained by composite production. Production is partially sustained by hatchery production at the Skookumchuck dam. The stock is considered depressed, with a negative population trend. From 1984 through 1992, escapement ranged from 644 to 1,202 (WDFW and WWTIT 1994). From 1996 to 1999, wild escapement ranged from only 193 to 473, below the wild escapement goal of 766 (WSCC 2001).

Coastal Cutthroat. The Chehalis River stock complex of coastal cutthroat trout includes fish in the Skookumchuck and Newaukum rivers, the smaller tributaries and headwaters of the Chehalis River, and tributaries downstream of the Study Area. The stock complex is considered native and is maintained by wild production. The status of the stock complex and population trend are unknown. Some researchers believe that that stock complex may be depressed (Envirovision 2000). However, WDFW (2000) indicates that cutthroat are relatively abundant and widely distributed in the basin, based on juvenile density sampling at over 80 sites in the upper basin and returns to a trap operated by the Quinault Indian Nation on the West Branch Hoquiam River.

Bull Trout/Dolly Varden. A native, wild-producing stock of bull trout/Dolly Varden trout has been identified in the Chehalis River/Grays Harbor system. However, most information on this stock consists of anecdotal accounts by sport fishers, and the stock status and population trend are unknown (WDFW 1998).

2.4 Wildlife Resources

2.4.1 Introduction

Existing documentation of wildlife populations and distribution within the Chehalis basin is sparse. In a literature review conducted by the Seattle District of the Corps of Engineers, no information was found pertaining to wildlife population studies conducted in the Chehalis River basin.

The literature review conducted by the Corps evaluated the Washington Game Status and Trend Reports (WDFW1996a, 1998, 1999) and found wildlife populations within the Study Area are composed mostly of species associated with open forest canopies and young vegetation. Climax forests associated with pre-settlement conditions were largely removed from the area in the 1800s, converting the floodplain and lowland habitat within the Study Area to agricultural and forestry land uses. Urbanization and population growth has reduced forested habitat along the mainstem Chehalis River to narrow strips of riparian forest (USFWS 1982). The predominant current land use adjacent to the mainstem Chehalis, South Fork Chehalis, Newaukum, and Skookumchuck rivers is agriculture. The land use adjacent to the Chehalis and Skookumchuck rivers in the vicinity of the cities of Centralia and Chehalis is largely industrial and high density residential. Wildlife populations within these areas are characterized by those species

most tolerant of human activity, such as agricultural development, forest management and residential development.

Wildlife habitats currently found in the Study Area include (Centralia 1999):

> *Coniferous Forests*: The coniferous forests are second and third growth forests with a moderately open to closed canopy. The forest overstory is dominated by Douglas fir, western hemlock, and western red cedar.
>
> *Mixed Coniferous-Deciduous Forests*: Mixed coniferous-deciduous forests are dominated by a mix of Douglas fir and red alder, with bigleaf maple and vine maple in the understory.
>
> *Riparian Woodlands*: Riparian woodlands occur in narrow, almost continuous corridors along the Skookumchuck and Chehalis rivers. The tree canopy is composed almost entirely of bigleaf maple, black cottonwood, Oregon ash, and red alder.
>
> *Forested Wetlands*: Forested wetlands are dominated by red alder, willow species, balsam poplar, with a forb layer.
>
> *Scrub-Shrub Wetlands*: Scrub-shrub wetlands found in the Study Area are dominated by red-osier dogwood, Sitka willow, Scouler willow, and red alder. Groundcover consists of reed canarygrass, sedges, and cattails.
>
> *Emergent Wetland*: Emergent wetlands in the Study Area are dominated by reed canarygrass, sedges, and cattails.
>
> *Agricultural Lands*: Agricultural lands are found throughout the Study Area. Along the Chehalis River there is typically a narrow band of riparian habitat that separates agricultural lands from the river.

The Washington Game Status and Trend Reports (WDFW1996a, 1998, 1999) provide general information regarding game species within the Chehalis basin. While the reports are based on harvest reporting and methods for species evaluation vary between biologists, population trends that should be considered are evident.

Within the Chehalis basin, deer populations are considered stable and are expected to remain so in the lower elevations along the I-5 corridor units. However, urbanization is causing in a loss of quality deer habitat and an increase in deer/human conflicts (WDFW 1996a, 1998, 1999). A pre-season survey over the Skookumchuck drainage area revealed that there were a lower number of bucks and does than the previous year (WDFW 1999). Contributing factors may be hairslip (loss), a condition that has recently afflicted lower elevation deer populations, the slow loss of quality habitat from development, increased cougar populations, and finally the gradual shift from early successional forests to older-aged forests in the higher elevations (WDFW 1996a, 1998, 1999)

Elk populations in the area are represented by three herds: the Willapa Hills herd, the Mt. Rainier herd, and the St. Helens herd. According to WDFW's Environmental Impact Statement (EIS) for Elk Management (1996), the herd geographic range encompasses the surrounding Centralia/Chehalis area, but animals are present in low densities. Elk are considered absent in the lowland areas along the Chehalis River and the lower reaches of its tributaries and are now mostly limited to forested uplands. In 1996, the estimated population numbers for each herd were: Willapa Hills – 6,000; Mt. Rainier – 4,000; St. Helens –12,200 (WDFW 1996b).

Population modeling indicates that most elk populations in the area are declining (WDFW 1996a, 1998, 1999). Since 1994, the Mt. Rainier herd has declined approximately 30 percent, the St. Helens herd declined nearly 20 percent, and the southern portion of the Willapa Hills elk herd has declined approximately 16 percent (WDFW 1999). This decline can be attributed to habitat loss through urbanization, timber harvest, agriculture and domestic livestock, road management, and hydroelectric development (WDFW 1996b).

Based on population modeling, the cougar population has increased about 1.5 percent per year since 1989 in cougar management units 2 and 3, which include the Chehalis basin (WDFW 1999). This increase can be attributed to restrictions in hunting techniques in 1996, as well as the adaptability of sub-adults forced into marginal habitats. An increase in human/lion interactions is likely because of residential expansion into habitats occupied by cougars.

Harvest data suggest that historic bear harvest levels are within acceptable limits (WDFW1996a, 1998, 1999). However, high hunting pressure in some localities has resulted in negative trends in harvest demographics. More females and sub-females were harvested in the last few years than previously, which may suggest that a declining bear population may be imminent in the Chehalis basin. However, in 1996, changes in hunting regulations made it more difficult to harvest bears, and it is believed that within a few years harvest levels will increase as more hunters develop new hunting techniques (WDFW1999).

Increased residential development poses the greatest threat to black bear habitat and, consequently, black bear populations. Increasing development is likely to reduce suitable habitat and lead to an increase in bear/human encounters and conflicts (WDFW1996a; 1998; 1999).

Furbearers, including beaver, muskrat, raccoon, mink, river otter, and opossum are found throughout the Study Area (USFWS 1982).

Waterfowl populations in Western Washington have been on the rise in the last three years (WDFW 1999). Unfortunately, most breeding and brood surveys done by WDFW occurred in Eastern Washington and do not necessarily correlate with duck production in Western Washington. Statewide information shows the overall duck population increased from 6,607,263 in 1997-98 to 7,047,864 in 1998-99 (WDFW 1999). The

Chehalis basin and more specifically, the Study Area, contains several oxbow lakes, flooded lowlands, ponds, and slackwater reaches which provide valuable stopover habitat for migratory waterfowl (USFWS 1982).

Upland birds in the Chehalis basin are forest grouse, primarily blue and ruffed grouse. The species of forest grouse found in the Study Area would likely be ruffed grouse because of the lower elevation and a higher percentage of deciduous trees in the riparian areas and surrounding forests. Based on long-term harvest trends statewide, forest grouse populations have remained stable over the past 30 years (WDFW 1996a, 1998, 1999). Timber harvest is the most significant issue for influencing habitat condition and population trends, and in general timber harvest is beneficial for most grouse.

Several of the above wildlife species, or groups of species, can be considered as broad indicators for the Chehalis basin's habitat health. Many of them occupy unique and/or multiple habitats, that when modified may exhibit beneficial or adverse effects.

Rural development is a common theme found in all of the above species habitat conditions and trends. It has been found that when rural development expands into areas that were previously remote, wildlife species suffer through the loss of available habitat that inherently exerts stress on the species' viability and their population numbers.

Amphibian and reptilian populations and distribution within the Study Area are poorly documented. The Washington State Gap Analysis Project (Dvornich et al. 1997) identified suitable habitat for amphibians and reptiles, then cross referenced these habitats with museum records and documented sightings. The results of the gap analysis indicate habitat and recorded presence of amphibians and reptiles. Those with habitat or occurrence within the Study Area are listed in Table A.

Table A. Amphibians and Reptiles with Habitat in the Study Area

Species	Habitat
Northwestern salamander *Ambystoma gracile*	Underground burrows, rotting logs, moist crevices in riparian areas, lowland forests. Habitat occurs throughout Study Area.
Long-toed salamander *Ambystoma macrodactylum*	Underground burrows woody debris in moist open areas of lowland forest and riparian habitats. Habitat occurs in lowland portions of the Study Area.
Pacific giant salamander *Dicamptodon tenebrosus*	Clear streams and small lakes in moist coniferous forests and coniferous riparian areas. Habitat occurs in some riparian areas of Study Area.
Roughskin newt *Taricha granulosa*	Common species found in moist coniferous or mixed forests, in vegetated fringes of lakes, beaver ponds, slow moving streams. Riparian floodplain pools also offer good breeding habitat. Habitat can be found throughout the Study Area.
Western redback salamander *Plethodon vehiculum*	Rocky substrates in moist coniferous forests or closed-canopy coniferous riparian areas. Also found under downed logs or coarse woody debris. Habitat is infrequent in the Study Area.
Ensatina *Ensatina eschxcholtzii*	Found in woody debris in moist coniferous forests or hardwood riparian areas with closed canopy and abundant woody debris. Also found in rock piles and at the entrances to rodent burrows. Habitat is found throughout the Study Area.
Western toad *Bufo boreas*	Terrestrial species found near ponds, lakes and streams. Outside of the breeding season, Western toads are found far from aquatic habitats in woody debris, loose soils, and detritus anywhere there is a closed canopy, including hardwoods. Western toad habitat is abundant within the Study Area.
Pacific treefrog *Hyla regilla*	Common frog, found anywhere there are suitable breeding waters, typically small ponds. Outside of the breeding season, they are found in woodlands, pastures, riparian areas, and suburban habitats, including gardens and parks. Habitat is found throughout the Study Area.
Red-legged frog *Rana aurora*	Pond breeding species needs quiet waters with aquatic vegetation for egg attachment. Otherwise found in open- and closed-canopy forests, parklands, low-density development, golf courses, and pastures. Habitat is found throughout the Study Area.
Bullfrog *Rana catesbeiana*	Introduced species found in lakes, reservoirs, and other slow-moving waters. Highly aquatic, nearly always found in or around the wetted fringe. Habitat is found in the lowland portions of the Study Area.
Painted turtle *Chrysemys picta*	Marshy ponds, small lakes, slow moving streams, and rivers with abundant aquatic vegetation. Habitat is present, though sparse, in the Study Area.
Northern alligator lizard *Elgaria coerulea*	Margins of coniferous forests, in clearcuts, under logs, on moist talus slopes. Habitat is found throughout the Study Area.
Rubber boa *Charina bottae*	Drier forests with open vegetation, under bark, logs and rocks. Excluded from moist forests and habitats. Habitat is found in disturbed portions of the Study Area.
Terrestrial garter snake *Thamnophis elegans*	Depends heavily on amphibians that breed in permanent waters. Abundant around edges of small ponds and lakes. Habitat is abundant in the Study Area.
Northwestern garter snake *Thamnophis ordinoides*	Found in meadows and along edges of forests, talus slopes and thick brushy areas. Habitat is abundant in the Study Area.
Common garter snake *Thamnophis sirtalis*	Common in wet meadows, watercourses, deep coniferous forests. Also found in open valleys in riparian thickets. Habitat is abundant in the Study Area.

The USFWS (1982) states that modifications of wetlands and timbered lands have had a negative influence on amphibian populations, and to a lesser extent, reptile populations in the Chehalis basin. Species such as the Pacific giant salamander, tailed frog, and the long-toed salamander have been especially affected. The Washington State Gap Analysis did not indicate the presence of tailed frog habitat in the Study Area (Table A).

2.4.2 Priority Habitats and Species

The WDFW Priority Habitats and Species (PHS) Database and PHS Polygon maps were consulted to determine the presence and extent of priority species and habitats within the Study Area. The PHS Database was accessed via WDFW's PHS website and the PHS Polygon maps were requested and received from WDFW. Priority species are defined by WDFW as species that require protective measures for their perpetuation due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. Priority species include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable (WDFW 2001). The Priority Species identified within the Study Area are described below.

Bald eagles (*Haliaeetus leucocephalus*) are closely associated with lakes and large rivers in open areas, forests, and mountains and along seacoasts. They need large trees adjacent to water, preferably snags, but also nest in trees or on boulders that provide good visibility for perching. Bald eagles winter in coastal habitats and inland where ice-free waters allow access to fish. Bald eagle nesting and roosting habitat has been documented in the Skookumchuck, Newaukum and South Fork Chehalis basins.

Eastern wild turkeys (*Meleagris gallopavo*) prefer a mixture of woodland and open clearings and are usually found near mature oak or other mature hardwood forests, also in mountain forests and wooded swamps. Sightings of Eastern wild turkey have been documented in the Skookumchuck watershed.

Great blue herons (*Ardea herodias*) inhabit a wide variety of freshwater and saltwater habitats including ponds, lakes, streams, rivers, marshes, wet meadows, tidal flats, sandbars, and shallow bays, or wherever shallow water or marsh vegetation is present. Great blue herons are known to be present in the Study Area along the Chehalis, Skookumchuck, and Newaukum rivers.

Harlequin ducks (*Histrionicus histrionicus*) prefer cold, shallow, rapidly flowing mountain streams in forested regions, but also inhabit ponds and lakes along rocky Arctic shores and in tundra. They loaf in shallows, or on rocks or logs in streams or ashore. They winter on marine waters, usually 6 to 12 feet deep, in heavy surf along rocky coasts. Harlequin duck breeding areas are known to occur throughout the Skookumchuck River basin.

Hooded mergansers (*Lophodytes cucullatus*) inhabit wooded, clear freshwater habitats, preferably water with sandy, gravelly, or cobbled bottoms. They prefer fast-flowing

water, but also use standing water as long as it is clear, small fish and invertebrates are abundant, and nest sites are available. Hooded mergansers are easily disturbed and thus avoid areas of human activity. Several areas of hooded merganser breeding and nesting activity have been documented on the Skookumchuck and Chehalis rivers.

Mardon skippers (*Polites mardon*) are butterflies that prefer grasslands at low elevations in the Cascades as well as alpine areas, especially on serpentine soil. Mardon skippers are uncommon throughout their range, which includes the Chehalis basin.

Mink (*Mustela vison*) frequent forested areas that are in close proximity to water. Streams, ponds and lakes, with brushy or rocky cover nearby are considered optimal territory. Mink habitat is located throughout the middle Chehalis basin.

Olympic mudminnow (*Novumbra hubbsi*) prefer slow-moving lowland streams, wetlands, and ponds. They are generally found in areas with soft mud substrate, little to no water flow, and dense aquatic vegetation. The Olympic mudminnow has historically been observed in ponds and wetlands in the Skookumchuck basin.

Osprey (*Pandion haliaetus*) occupy a wide range of habitats in association with water, primarily near lakes, rivers, and along coastal waters with adequate supplies of fish. Osprey have been documented by WDFW in the Skookumchuck watershed.

Pileated woodpeckers (*Dyocopus pileatus*) are generally limited to mature coniferous, deciduous, and mixed forests with large, dead trees. They prefer woodlands near water and large, dead trees for nesting and feeding. Pileated woodpeckers are documented as occurring throughout the Chehalis basin.

Western gray squirrels (*Sciurus griseus*) typically use dreys during the summer. Dreys are round conspicuous twig and leaf nests built in trees between 25 and 45 cm in diameter. Dreys are generally built in the upper one-third of the canopy and seldom in isolated trees. In the winter, western gray squirrels will often use dens in hollow trees. Within the Study Area, Western gray squirrel populations are limited to the northern edge of the Skookumchuck basin.

Whulge (Edith's) checkerspots (*Euphydryas editha*) are butterflies with habitat ranging from sea level to the treeline through diverse vegetative communities including coastal chaparral, meadows, fields, foothills, open woods, and alpine fellfields. Whulge checkerspots have been recorded near Rock Prairie and Violet Prairie in the Skookumchuck watershed.

Wolverines (*Gulo gulo*) inhabit boreal forests, mountains or open plains and brushlands. They construct rough beds of grass or leaves in caves or rock crevices, in burrows made by other animals, or under fallen trees. They occasionally construct their dens under snow. An historic sighting (1994) was recorded in the Skookumchuck watershed.

Wood duck (*Aix sponsa*) inhabit woodlands near shallow, quiet inland lakes, swamps,

river bottoms, ponds, marshes, and streams where nest sites are available. Important forest types for the wood duck are central and southern floodplain forests, red maple swamps, temporarily flooded oak forests, and northern bottomland hardwoods. They also prefer areas with many perching sites. Wood duck breeding and nesting areas have historically been located throughout the Chehalis and Skookumchuck basins.

The PHS list defines priority habitats as those habitat types or elements with unique or significant value to a diverse assemblage of species. A priority habitat may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element. They also may contain comparatively high fish and wildlife densities and species diversity with important breeding habitat, seasonal ranges, or migration corridors. Also they may have limited and/or declining availability, be vulnerable to human disturbance, or contain dependent or priority species (WDFW 2001). The PHS list was examined for habitats known to occur within the WDFW Region that contains the Study Area. These priority habitats and their observed presence or absence in the Study Area are presented in Table B. The WDFW Priority Habitats are as follows (WDFW 2001):

Pure aspen stands greater than two acres in size are considered a priority habitat. Mixed stands greater than two acres in size may be considered as well.

Naturally occurring caves in soils, rock, ice, or other geological formations and are large enough to contain a human are a priority habitat. Abandoned mine shafts with actual or suspected occurrences of priority species are also considered a priority habitat.

Cliffs are a priority habitat if they are greater than 25 feet high and occur below 5,000 feet. They must also contain high densities of wildlife breeding and nesting areas to be classified as a priority habitat.

Freshwater wetlands must support, at least periodically, mostly hydrophytic plants, the substrate must be predominantly undrained hydric soils, and/or the substrate must be saturated with or covered by shallow water at some point during the growing season to be a priority habitat.

Fresh deepwater habitats include environments where hydrophytes are the dominant plants; however, the water in these areas is too deep to support emergent vegetation. This environment also includes all underwater structures and features such as caverns, woody debris, and rock piles.

Instream habitat consists of the physical, biological, and chemical processes and conditions that interact to provide life history requirements for fish, wildlife, and invertebrate resources.

Juniper savannah habitat includes woodlands consisting of predominantly juniper species. Mixed stands of juniper species may also be considered a priority habitat.

Old-growth forest is also categorized as a priority habitat. This habitat consists of stands of at least two tree species forming a multi-layered canopy with occasional small openings. It also must have at least eight trees per acre greater than 32 inches dbh, four snags per acre over 20 inches in diameter and 15 feet tall, and four downed logs per acre greater than 24 inches in diameter and greater than 50 feet long to be classified as old-growth forest habitat. Mature forests are stands with average diameters exceeding 21 inches dbh. The density of trees, number of snags, and quantity of large downed logs is generally less than that of old-growth forests.

Oregon white oak woodlands are stands of pure oak or an oak/conifer mix where canopy coverage of the oak component is 25 percent, or where total canopy coverage is less than 25 percent, but oak accounts for at least 50 percent of the canopy coverage present. Priority oak habitat consists of stands at least one acre in size.

Prairies and steppe are relatively undisturbed areas where native grasses and/or forbs form the natural climax plant community. These areas should contain a variety of habitat features such as varied topography and plant communities.

Riparian habitat includes the area beginning at the ordinary high water mark and extends to the terrestrial areas that are influenced by, or directly influence, the aquatic ecosystem. These areas include the entire floodplain and riparian areas of wetlands that are directly connected to stream courses.

Rural and urban natural open space is open space that functions as a corridor connecting other priority habitats (especially areas that would otherwise be isolated), is an isolated remnant of natural habitat larger than 10 acres and surrounded by agricultural or urban developments, or is providing habitat for a priority species. The habitat must also contain unique species assemblages in agricultural or urban areas to be classified as a priority habitat.

Large tracts of shrub-steppe are tracts greater than 640 acres. These tracts should contain a variety of habitat features such as riparian areas, canyons, and habitat edges. Small tracts of shrub-steppe are tracts less than 640 acres; however, they have the same habitat requirements as large tracts to be considered priority habitats.

Snags and logs are also considered a priority habitat. Snags must be greater than 20 inches dbh and 6.5 feet tall and logs must be greater than 12 inches in diameter at the largest end and 20 feet long in order to be classified as a priority habitat. This habitat may consist of single snags or logs, or groups of snags or logs of exceptional value to wildlife due to their scarcity or location within the landscape. Areas with abundant and well-distributed snags and logs are considered priority snag and log habitat.

Talus slopes are a priority habitat if the rock rubble is homogenous, averages 0.5 to 6.5 feet in size, and is composed of basalt, andesite, and/or sedimentary rock. Mine tailings and riprap may also be included.

Table B. Priority Habitats in the Study Area

Priority Habitat	Observed in Study Area
Aspen Stands	No
Caves	No
Cliffs	Yes
Freshwater Wetlands	Yes
Fresh Deepwater	Yes
Instream	Yes
Juniper Savannah	No
Old-Growth Forest	No
Mature Forest	Yes
Oregon White Oak Woodlands	No
Prairies and Steppe	No
Riparian	Yes
Rural Natural Open Space	Yes
Urban Natural Open Space	No
Shrub-Steppe	No
Snags and Logs	Yes
Talus	Yes

3 STUDY METHODS

3.1 Pre-Field Analyses

3.1.1 Channel Segment (Reach) Classification

Prior to beginning the field investigations, streams were divided into segments (reaches) using the methods described in the Stream Channel Assessment module of the Watershed Analysis Appendices, Version 4.0 (WFPB 1997). Briefly, channel gradient, confinement, riparian condition, and confluences of tributaries were used to designate reaches as discrete units. Confinement, according to the Watershed Analysis Appendices, is defined as the ratio between the channel width and the valley width, without consideration to bank armoring, channel incision, or levee construction. Once reaches were established, they were numbered according to stream. Reach breaks and numbers were transferred to mylar overlays using the U.S. Geological Survey (USGS) 7.5-minute quadrangles as base maps. The overlays were used for digitization into GIS shapefiles. Each reach was then given a gradient-confinement code based on channel gradient (percent slope) and channel confinement (Figure 1). The gradient-confinement codes were later used for survey reach selection (see Section 3.1.3) and to determine channel sensitivity for use in other riparian analyses (see Section 3.3.2).

3.1.2 Riparian Condition Determination

After stream reaches were delineated and numbered, riparian conditions were examined for each reach. Reaches were divided into Riparian Condition Units (RCUs), which are habitat units designated by canopy type, size classification, and density (Figure 2). Stereoscopic aerial photographs were examined to delineate RCUs and determine the vegetation types and densities. Size was estimated for later field verification. Both infrared and standard 1:24000-scale photos were used.

In order to determine the extent of RCUs, each stream reach was first divided into left and right bank. Then, if vegetation type, canopy type, or topography changed within the reach, a separate RCU was defined (Table C). Since RCUs are divided by both physical characteristics and reach boundaries, each reach has at least two RCUs and several have more than three.

Table C. Riparian Condition Unit Classifications

Composition	Size	Density
H = Hardwood Greater than 70% hardwood species	S = Small Less than 12 inches DBH	S = Sparse More than 1/3 of ground exposed.
C = Conifer Greater than 70% coniferous species	M = Medium 12-20 inches DBH	D = Dense Less than 1/3 of ground exposed
M = Mixed All other cases	L = Large Greater than 20 inches DBH	N = None No riparian vegetation.

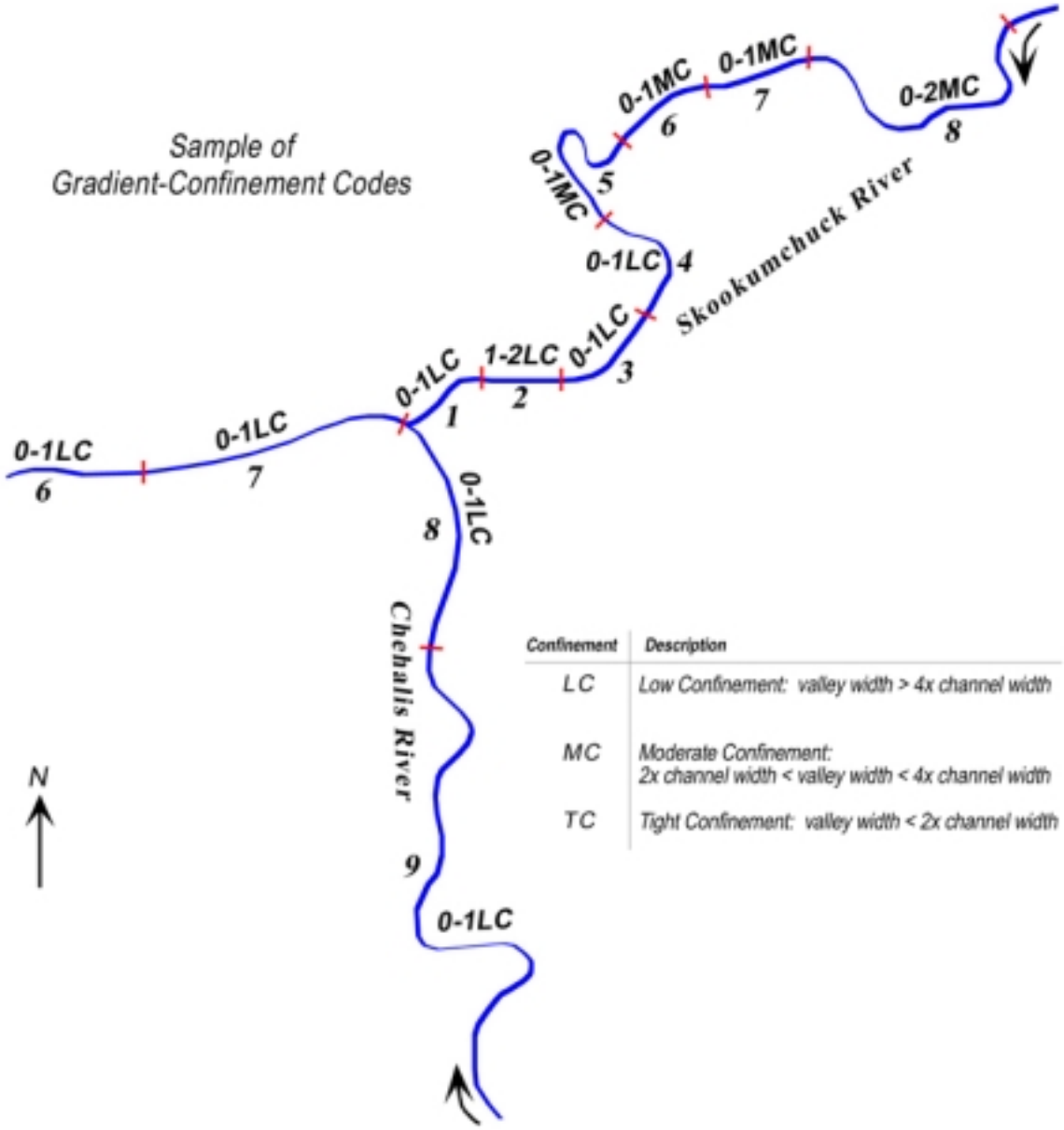


Figure 1. Sample of Gradient Confinement Codes

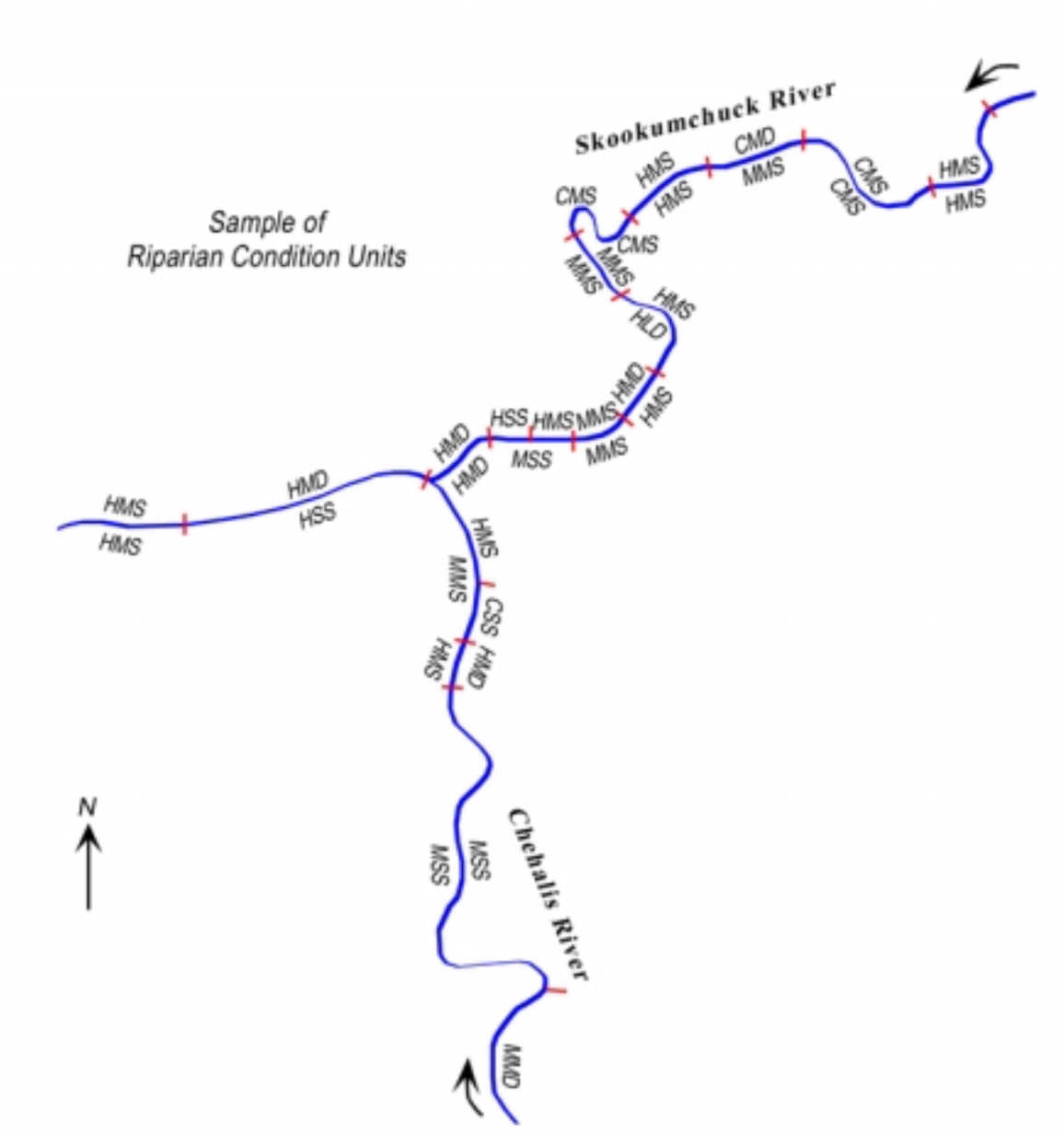


Figure 2. Example of Riparian Condition Unit Classification

3.1.3 Selection of Field Survey Reaches

Because of the large size of the Study Area, specific reaches were targeted for field surveying. Selection of reaches was based on gradient-confinement codes, unique or representative morphology, and riparian characteristics. Reaches were sorted initially according to gradient-confinement codes. Those reaches with unique gradient-confinement codes were chosen for field surveying. Aerial photographs were then reviewed to locate reaches with unique morphological characteristics (falls, dams, etc.), which were also chosen for surveying. Aerial photographs were also used to compare the riparian characteristics of the reaches. Using these riparian characteristic comparisons, and comparisons of the gradient-confinement codes, the reaches that best represented the characteristics of the subbasin were chosen. Although much emphasis was placed on surveying reaches that were representative of the subbasin, every effort was made to also survey reaches with unique characteristics.

In addition to surveying selected reaches, the locations of preliminary project alternatives were also surveyed for habitat conditions. These locations include upland areas. In upland areas where surveying of full transects was not possible due to the presence of roads and buildings or restrictions on access, visual assessments of riparian habitat conditions were made and wildlife observations were recorded. Where possible, these visual surveys were supported with instream habitat surveys in adjacent stream reaches.

3.2 Field Survey Methods

3.2.1 Fish Habitat Surveys

Fish habitat surveys were conducted to quantify physical stream and habitat parameters. Individual surveys were repeated for each reach as follows: the upstream end of each reach to be surveyed was located in the field. Wetted width, wetted depth, channel width and depth, bankslope, and substrate composition were measured along a cross-sectional transect (Figure 3) at the beginning and end of each reach. Lengths of habitat types (glide, riffle, pool and cascade) were recorded at the beginning of each habitat type using a hip chain. The physical habitat parameters surveyed varied, depending on the type of habitat. In riffle and cascade habitats, bankfull width, wetted channel width and depth (mean and maximum), gradient, bank slope (left and right), substrate material (channel and bank), channel embeddedness, and presence of spawning gravels were recorded. Measurements of pools included length, width, maximum depth, riffle crest depth, residual depth, percent woody cover, and formation feature (Figure 4). Glides were noted on data sheets but no measurements were recorded.

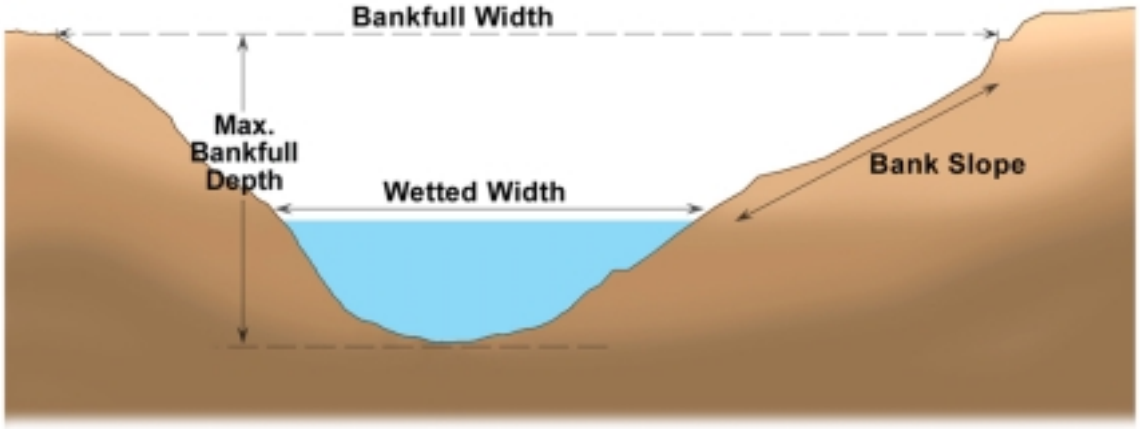


Figure 3. Channel Cross Section (Schematic)

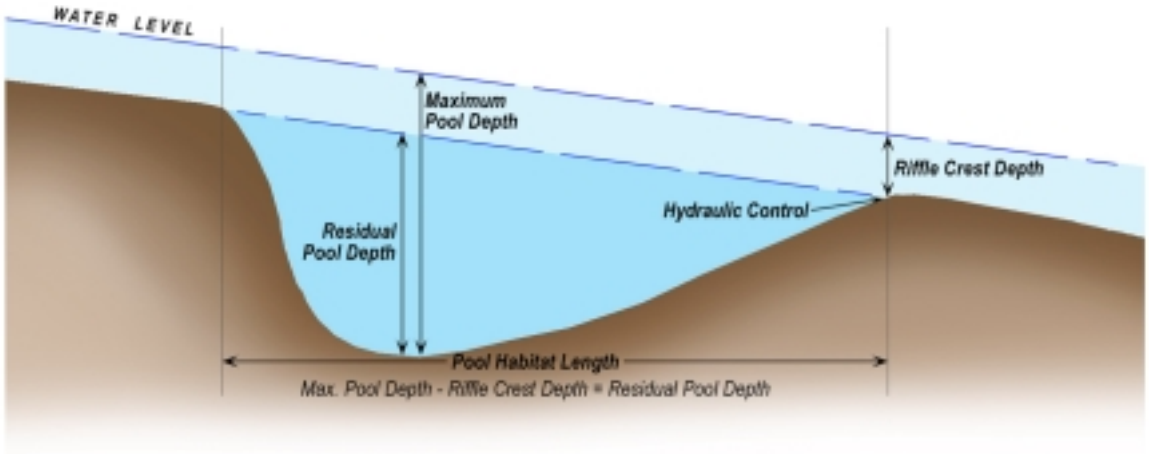


Figure 4. Stream Survey Overview (Schematic)

The survey continued to the next habitat type or to one-third of the total reach distance, whichever came first. At one-third of the total reach distance, a Wolman pebble count was conducted as described in the Stream Inventory Handbook, Version 9.9 (USFS 1999). Beginning on one bank at bankfull height, the transect was walked heel-to-toe. At each step, the first piece of substrate encountered off the toe was measured for size along the intermediate axis. This process was repeated until 100 counts were made. If the opposite bankfull height was reached before 100 counts were made, the process was repeated on a new, adjacent transect. This new transect was completed regardless of when the 100 count mark was reached. Pebble counts were also conducted at two-thirds of the total reach distance. At the end of each reach, the total length of the reach was recorded. Photographs were taken within reaches and organized in a photo log.

Percent bank erosion and large woody debris (LWD) were also recorded throughout the entire reach and within each habitat type. LWD was classified and tallied as either functional or non-functional for each reach. Functional LWD was defined as any piece that was large enough to provide a function and was within the bankfull channel (Figure 5). Non-functional LWD was defined as any piece that was either too small to provide any type of function or was not within the bankfull channel.

Functional LWD was then subdivided into functioning and non-functioning LWD. Functioning LWD was defined as any piece that was providing a function at the time of the survey. Non-functioning LWD was defined as any piece that was large enough to provide a function, yet was not performing a function at the time of the survey. Functioning LWD was examined for distance within the reach, observed function (Table D), number of functioning pieces, height, length, and width.

Table D. Large Woody Debris Functions Recorded During Surveys

Function	Definition
Pool Scour	Debris causes increased velocities, resulting in pool scour.
Bank Stability	Debris either protects the bank from erosion, or is integral to the bank structure.
Bar Stability	Debris either creates eddy for bar deposition, armors apex of a bar, or is otherwise integral to bar structure.
Sediment Storage	Debris accumulates sediment, interferes with sediment migration.
Step or Terracette Former	Debris spans wetted channel and has either backfilled to form a terracette or forms a step overfall.
Channel Creator	Debris has caused flow to change course completely and initiate new channel formation. This usually requires a very large amount of LWD.
Fish Habitat	Debris provides fish habitat.

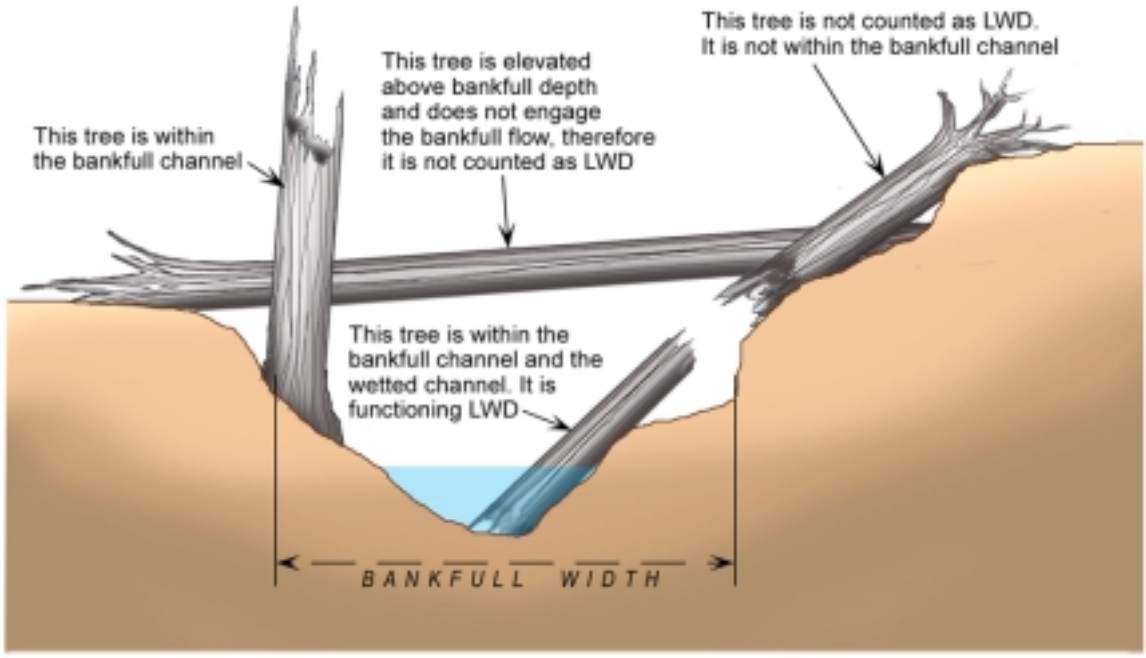


Figure 5. Large Woody Debris Classifications

3.2.2 Riparian Condition Surveys

Riparian condition information was collected within each reach, concurrent with the fish habitat survey. Riparian conditions were recorded to facilitate the Riparian Function Assessment in accordance with the Watershed Analysis Manual, Version 4.0 (WFPB 1997). This information was collected along a transect perpendicular to the channel in the same location (one-third and two-thirds reach length) that pebble counts were conducted. Canopy closure, riparian composition and size, bank vegetation cover, stream channel cover, and active riparian recruitment processes were evaluated at each location. Canopy closure was determined along a sectional transect which extended 100 feet beyond the bankfull width. This was measured to help determine the extent and density of riparian habitat outside the channel. Within the bankfull channel, bank vegetation coverage was visually estimated at each transect location. Canopy closure was measured from mid-channel and bankfull width outward, in 20-foot increments using a densiometer. Riparian vegetation recorded included the dominant and secondary canopy species and ground cover, if present. Active Riparian Recruitment Processes (ARRP's) are observable processes that contribute to addition of large woody debris to the stream channel. These processes, which were also documented, include: bankcutting, windthrow, floodplain interaction, jams, upstream sources, and beaver activity.

3.2.3 Wildlife Habitat Surveys

Channel and Riparian Wildlife Surveys. Wildlife habitat and presence were documented within the stream channel and riparian areas of surveyed reaches. This information was collected to help in determining the type of wildlife populations that could be affected by large wildlife habitat features, such as riparian canopy type, age and density. Areas surveyed for wildlife habitat and presence were first assessed through aerial photo interpretation concurrent with riparian condition unit designation. In brief, each stream reach surveyed was considered one transect for purposes of determining wildlife presence and habitat condition. The locations of wildlife presence, sign, and habitat features were noted along each transect (left and right bank) and recorded. For each reach surveyed, wildlife habitat information was also recorded in the riparian survey, including dominant and sub-dominant vegetation species, and ground cover, if no canopy was present (Section 3.2.2).

To determine wildlife species use and record habitat feature condition within the bankfull width of the channel, each surveyed reach was considered a belt transect along its length and through bankfull width. The distance and location of wildlife observations, sign, tracks, and habitat features were noted along each transect (left and right bank) and recorded onto data sheets. Habitat features, including snags, burrows, roosts, nests, and wetlands were noted with condition and type of use.

Information on habitat function, plant species composition, and riparian and stream canopy coverage was recorded and is discussed in Section 4.3.2.

Skookumchuck Reservoir Habitat and Wildlife Surveys. Wildlife habitat within the Skookumchuck reservoir was surveyed using different methods than those employed for in-channel and terrestrial habitat surveys. Some of the alternatives considered for the GRR/EIS could result in temporary pool fluctuations; therefore existing conditions and potential new shoreline conditions were determined by surveying along transects extending away from the existing shoreline to an elevation 15 feet (vertical distance) above the high water mark (approximately 477 foot elevation). That location was determined using a clinometer to measure slope and calculating the slope distance necessary to reach 15 feet above the high water mark. The transects were located every 1,000 feet along the shoreline of the reservoir (Figure 6).

Four types of surveys were conducted within the reservoir: soils, vegetation, physical features and wildlife. The soil survey was conducted to determine the soil characteristics at the current high water mark and the upper elevation of the potential increased high water mark. This information can be used to determine the potential effects of inundation on burrowing animals, amphibians, and invertebrates. At each location, a soil pit was excavated to 20 inches or bedrock and soils were examined for texture (type), depth, and slope.

Background map was supplied by USGS GRDS Data Center
The background map is 1:24 K VAIL WA USGS
Vertical Datum is NAD 29
Horizontal Datum is NAD 27
Contour interval 40 feet

GPS Points were collected by
Pacific International Engineering Staff

0 1,000 2,000 4,000
Feet

Legend

GPS Points

PACIFIC INTERNATIONAL ENGINEERING

Skookumchuck Reservoir GPS Points

Figure 6

Vegetation was also surveyed at the existing and potential high water mark. Vegetation plots were established, and canopy coverage and species composition within a 10-foot radius was measured using densitometers. Ground coverage by species was estimated by surveying a circle-plot with a 10-foot radius.

Physical habitat features were documented at each transect location and at any location along the perimeter of the reservoir where important wildlife habitat features were noted. The presence of nests, burrows, roosts, cliffs, talus, and slides were noted, along with location, elevation above high water, species use (if known), and condition. Snags within the 15-foot elevation band around the reservoir were counted and located relative to the nearest survey location.

Belt transect surveys for wildlife presence were conducted perpendicular to the shoreline and extending from the shoreline to a distance up to a 15-foot elevation increase above the existing high water mark. The belt transect was 30 feet wide (15 feet on either side of the location). At each transect, the surveyor(s) conducted timed surveys, allowing 10 minutes to observe the presence of fauna that would otherwise be disturbed by movement, especially bird species. All species determined to be present, either through direct observation or through observation of tracks or sign, were recorded onto data sheets.

3.3 Habitat Analysis

Owing to the volume and complexity of the field data, Geographic Information System (GIS) software was utilized for the analysis portion of the Study. ArcInfo 8.0 and ArcView 3.2a were used to develop the spatial data components and Microsoft Access was used to store the detailed information about habitat, riparian conditions, and LWD.

For visual depiction of stream reaches, the stream reaches shapefile was generated based on the Lewis County 24K hydrography (stream) GIS layer. The streams for the Study Area were selected from the Lewis County data, and combined to create a single line for all reaches. The stream reach boundaries were digitized from mylar overlays with USGS 24K quadrangle base maps. A unique identifier was generated for each stream reach (e.g., SK1 for Skookumchuck reach one) and included in the shapefile attribute table and the Access database so that the two information sets could be linked. The RCU shapefile was generated by designating a 100-foot buffer on either side of the stream. Attributes were added based on mylar overlays with USGS 24K quadrangle base maps and queries from the Access database. In some cases, where riparian conditions changed within the reach, the buffers were further divided between stream reach boundaries and attributed. Attribute codes indicated hardwood vs. conifer vs. mixed wood, small vs. large vs. medium, and sparse vs. dense. Channel migration zones (CMZs) were digitized from the same mylars as the RCUs. CMZs were matched to the stream reach theme. CMZs were attributed using the same codes as the RCUs. A wildlife polygon shapefile was also digitized from mylar overlays with USGS 24K quadrangle base maps. These wildlife polygons were defined for the area surrounding the Skookumchuck reservoir only. Attribute codes for the polygons solely reflect vegetative cover. To supplement field

data, existing GIS data were gathered from sources as listed on the appropriate maps. Most of these GIS data were obtained from the Washington Department of Transportation, Washington Department of Ecology, Lewis County and Sure!Maps Raster for the digital USGS quadrangles.

In order to store and manipulate data for descriptive statistics, a relational database design was implemented to organize the data based on rivers, reaches and distances. Look-up tables and data tables were created to store data on stream habitat, riparian conditions, wildlife habitat and LWD. Forms were created to facilitate data entry. Queries from this database were exported in text format and linked to the stream reach shapefile within ArcView to geographically display database information for visual interpretation. Once entered into the database, 100 percent of the electronic data were verified against the original data sheets before descriptive analyses were performed.

3.3.1 Fish Habitat

Fish habitat data were queried from the database according to river, gradient-confinement code, and habitat type for the purpose of extrapolating the data to reaches that were not surveyed. Attributes were chosen based on their ability to be effectively extrapolated to unsurveyed reaches. Some attributes could not be extrapolated due to the nature of the attribute or the unique nature of the reach within the watershed. For example, channel embeddedness cannot be inferred through extrapolation or determined with aerial photographs. Frequency percentages were calculated for each habitat type within each reach. Averages were calculated for each attribute, and then extrapolated to the reaches that were not field surveyed, again according to river, gradient-confinement, and habitat type. Once the data were extrapolated, summary analyses were developed for the major rivers in the Study Area to identify habitat areas of special concern (see Section 4.1).

In order to prevent any single habitat type from representing the entire river length, data were not included in the habitat percentages and extrapolations unless three or more habitats of the same habitat type were present in a particular river. As a result, side channel data were extrapolated to non-surveyed reaches only for the South Fork Newaukum. Off-channel habitat and side channel habitat data were combined in the database, and were therefore combined for the purposes of data analysis.

Quality spawning gravel for anadromous and resident fish is defined as gravel located in water less than 18 cm deep with a velocity between 0.3 and 1.0 cubic meters per second. Patches of gravel suitable for anadromous salmon should be at least 1.5 m^2, and patches suitable for resident fish spawning should be at least 0.1 m^2 (WFPB 1997). Areas of quality spawning gravels were determined by examining the percent of spawning gravels within each reach that were suitably sized for anadromous and/or resident fish. The lengths of habitat units with anadromous fish spawning gravels were used to determine the percent of anadromous fish spawning gravel present within each reach. Similarly, the lengths of habitat units with resident fish spawning gravels were used to calculate percent of resident fish spawning gravel within each reach. Dominant and subdominant channel

substrate types were used to identify reaches with areas of concern due to high content of fine sediments.

Quality rearing habitat abundance was determined by examining the percent of off-channel and side channel habitat within each river. Quality holding habitat abundance was determined by examining pool frequencies (channel widths per pool), percent of pools with greater than five percent woody cover, and percent of pools with greater than three feet of residual depth. LWD functioning as fish habitat was also considered in determining quality holding habitat abundance.

3.3.2 Riparian Assessment

Target Shading Determination. Stream shading within the Study Area was estimated by averaging mid-channel and bank canopy coverage data. Shading of unsurveyed reaches was estimated by studying stereoscopic aerial photographs and applying the closure estimate criteria from the Watershed Analysis Manual (WFPB 1997). A summary of the canopy coverage estimating criteria is presented below in Table E.

Table E. Stream canopy closure estimates from aerial photos

Stream Surface Visibility	Percent Shading
Stream surface not visible	>90%
Stream surface slightly visible or visible in patches	70-90%
Stream surface visible but banks are not visible	40-70%
Stream surface visible and banks visible at times	20-40%
Stream surface and banks visible	0-20%

The canopy coverage values were then compared to Department of Ecology target shade values for non-glacial streams in western Washington to develop riparian shade hazard calls for each reach (WFPB 1997). Reaches that met or exceeded the target shade level for that reach received a low hazard call, whereas reaches that did not meet the target shade level received a high hazard call. Using aerial photos and RCUs derived from field surveys, reaches with high riparian shade hazard calls were then evaluated to identify potential activities (e.g., logging, agriculture, urban development, natural processes) that may be contributing to the high shading hazard. The results of the target shading determination are presented in Section 4.4.3.

LWD Near-Term Recruitment Potential. Near-term recruitment potential (NRP) hazard calls were developed to assess the capacity of the riparian area to contribute LWD to the stream channel. Hazard calls are a useful tool in evaluating areas of concern for environmental impact assessment and site management. Near-term recruitment involves existing conditions including tree canopy presence, size, composition and density. Long-term recruitment was not assessed as it involves consideration of land use practices, management strategies, and demographic forecasts beyond the scope of the riparian studies.

Determining the riparian capacity for LWD recruitment involved three stages. First, the NRP was categorized based on riparian stand characteristics. The NRP assesses the probability that a particular riparian community contains suitable material for LWD recruitment. Then, channel characteristics were considered using Channel Sensitivity Ratings (CSR) to study the potential interaction of various channel types with various riparian communities. The CSR characterizes the degree to which LWD influences channel form and fluvial processes (WFPB 1997). This indicates whether or not the LWD will be introduced into the channel, will actually stay within the channel, and whether channel configuration will allow LWD to provide function (Channel Response). Finally, a hazard call was determined, based on the NRP, the CSR and existing LWD levels within the reaches themselves. Each step is further explained below.

The NRP was divided into four classes: Low Recruitment Potential, Moderate Recruitment Potential, High Recruitment Potential, and Non-Forested Land Use/Low Recruitment Potential. The NRP designation code was determined for each RCU using riparian condition (RC) and riparian size and density (RS). The RC is a composition designation for the tree canopy (hardwood, coniferous, mixed or agriculture/development). RS designations are stand maturity and density estimates. Both RC and RS were identified on aerial photographs and verified during field investigations.

The CSRs were developed for each RCU and categorized into three classes: high, moderate, and low channel sensitivity. CSRs were developed by examining ARRPs, as well as the Channel Response Matrix from the Stream Channel Assessment section of the Watershed Analysis Appendices. The ARRPs are those that were identified during field investigations or detectable in aerial photographs. These attributes were sorted using Microsoft Excel™, and then classes were designated based on the combination of attributes that met criteria for each NRP code (Table F). For example, reaches with medium or large dense riparian vegetation and active recruitment processes were given a “high” ARRP rating, whereas reaches with sparse vegetation, or without active recruitment processes (upstream sources or windthrow) were considered “moderate”. Within the Channel Response Matrix, “high” designations were given to unconfined and moderately confined reaches with a gradient of less than one degree. “Moderate” designations were given to unconfined and moderately confined reaches with gradients between one and four degrees. “Low” designations were given to confined reaches with a gradient greater than one degree. The ARRP ratings were then compared to the ratings from the Channel Response Matrix to develop the channel sensitivity rating for each RCU.

Table F. Coding rationale for near-term riparian recruitment potential

Active Recruitment Process Present	Riparian Size and Density	Riparian Composition	Near-Term Recruitment Potential (NRP)
Yes	Large/Medium/Dense	Hardwood, Conifer, Mixed	High
Yes	Large/Medium/Sparse	Hardwood, Conifer, Mixed	Moderate
Yes	Large/Medium/Dense	½ Agricultural	Moderate
Yes	Small/Dense	Hardwood, Conifer, Mixed	Moderate
No	Large/Medium/Dense	Hardwood, Conifer, Mixed	Moderate
Yes	Large/Medium/Dense	Agriculture/Developed	Low
Yes	Large/Medium/Sparse	Agriculture/Developed	Low
Yes	Small/Dense	Agriculture/Developed	Low
No	Large/Medium/Sparse	Hardwood, Conifer, Mixed	Low
No	Small/Dense	Hardwood, Conifer, Mixed	Low
No	Small/Sparse	Hardwood, Conifer, Mixed	Low
No	Not Identified	Agriculture/Developed	Non-Forested Land Use/Low

Once CSRs were developed, they were compared to the NRP classes given to each RCU to determine an overall NRP hazard call for each RCU. In reaches where field investigations were conducted, LWD pieces per channel width were also used in determining the hazard calls. For reaches that were not investigated, and therefore lack LWD data, priority was given to the higher hazard call due to the overall health of the basin in terms of LWD. Once hazard calls were made, RCUs within each reach were compared to determine a single hazard call for each reach. For reaches containing differing hazard calls, priority was also given to the higher hazard call.

3.3.3 Wildlife Habitat Typing

Wildlife habitat types surrounding the Skookumchuck reservoir were quantified to provide information for assessing the effects of temporary fluctuations in surface elevation on wildlife. The analysis included habitats within one mile of the reservoir edge. Recent aerial photos were examined for different habitat types. The perimeter of these habitat sections was traced onto mylar sheets, resulting in horizontal projections of habitat area. These polygons were then digitized into GIS shape files for analysis. The area of each habitat type was calculated using the GIS software. Perimeter length for each habitat was measured with a digital planimeter and used to determine an edge-to-habitat area ratio, which demonstrates a relative value of habitat fragmentation. Perimeter lengths adjacent to different habitat types were counted and the frequency of edge was calculated.

4 RESULTS AND DISCUSSION

4.1 Instream Habitat Conditions

Within the Study Area, there are several different instream habitat types available to aquatic and terrestrial organisms. Low-gradient glide habitat is the most prevalent habitat type in the area. This habitat is composed of fairly deep, slow-moving water. (Figure 7) The substrate is usually mud, sand, or silt, as these areas are generally depositional in nature. Glide habitat serves as a migration corridor for fish as well as holding habitat in the deeper and slower sections of the glide.

Riffle habitat is also present in the Study Area. Riffle habitat is composed of fast-moving, shallow water with a steeper gradient than that of glides. The substrate is typically gravel or cobble, with boulders present in some areas. This habitat is very important to both anadromous and resident fish species since spawning occurs in riffles. Riffles also provide habitat for a variety of aquatic insects that provide an important food base for fish.

A third habitat type identified in the Study Area is pool habitat. Pools generally occur when flow is obstructed or impounded and water accumulates upstream or downstream of the obstruction. Pools are also formed by the scouring of bank or channel substrate, also usually due to an obstruction. Like riffles, pools are a very important habitat type in the life histories of both anadromous and resident fishes. (Figure 8) They provide holding habitat for migrating fish as well as refuge from predators. They also can provide refuge from warmer water temperatures, which can be a major obstacle in the Centralia reach of the Chehalis River during the summer low-flow months.

Side channels, although rare, are also present in the Study Area. Side channels provide refuge from swift currents as well as from predators. They are an important component of stream habitat diversity, and provide a food base for instream and terrestrial organisms. Side channel habitat provides important rearing habitat for juvenile fish as well as providing habitat for many other aquatic and terrestrial organisms.

The least abundant habitat type identified in the Study Area is cascade habitat. This habitat is only found in Reach 55 of the Skookumchuck River, directly upstream of the Skookumchuck reservoir. Cascade habitat is characterized by steep gradients, large cobble, boulder, or exposed bedrock substrate, and swiftly flowing water. The channel is usually tightly confined, and LWD often becomes trapped within the channel. Many smaller splash pools are usually formed from the falling water scouring out sediment or rock, and provide important holding habitat for migrating fish.

Figure 7. Typical Glide Reach (Photo)

Figure 8. Typical Pool/Riffle (Photo)

Chehalis River. Forty-two stream reaches on the Chehalis River were defined for study. Twenty-four of those reaches, totaling 29.97 miles in length, were selected for detailed field investigation (Map 1).

The mainstem Chehalis River is generally low-gradient and slow moving in the reaches downstream of the confluence with the Newaukum River. This reach is almost entirely glide, with few riffles and no side channel habitat present. Portions of the river are incised (Figure 9). Several reaches in this area were found to have some sort of bank armoring, generally either riprap or discarded cars. The substrate below the Newaukum River confluence is predominantly sand/silt/clay due to sediment fallout from the slow-moving water. The channel in this area is also unconfined, with some areas of active bankcutting contributing to the high load of fine sediments. Upstream from the Newaukum River confluence the gradient becomes steeper, with more riffles and side channels present. Gravel and cobble substrates also become more common as the stream channel gradually becomes more confined. Habitat limiting factors in the Chehalis River (Table G) include water quality and quantity, floodplain conditions, sediment quality and quantity, instream LWD levels, and riparian conditions (WSCC 2001).

Table G. Habitat Limiting Factors within the Study Area.

Factors	Chehalis River	South Fork Chehalis River	Newaukum River	Skookumchuck River
Water quality and quantity	x	x	x	x
Floodplain conditions	x			x
Sediment quality and quantity	x	x	x	x
LWD levels	x	x		x
Riparian conditions		x	x	x
Fish passage		x		x
Road density			x	x

Glides compose approximately 84 percent of the surveyed reaches of the mainstem Chehalis River and range in length up to 15,949 feet. Riffles compose 7 percent of the total sampled length and range in length up to 1,454 feet. Pools are uncommon in the mainstem Chehalis River and make up 1 percent of the total length sampled, with individual pools ranging up to 745 feet in length. Side channel habitat is also uncommon, totaling approximately 8 percent.

Overall, gravel is the most common channel substrate in the mainstem Chehalis, although there are also areas of sand/silt/clay, cobble, boulder and bedrock. Portions of the river from the confluence of the Skookumchuck River to the confluence of the Newaukum River (Reaches 7 through 14) are notably lacking in gravel substrates. This area is dominated by sand/silt/clay substrate (Map 5A).

Although bank erosion does contribute to LWD recruitment, LWD is scarce on the mainstem Chehalis River within the Study Area, as riparian vegetation is sparse. On average, 57 individual pieces of functional LWD are present in each reach, ranging from 0 to 200 pieces per reach. LWD is brought into the river from a variety of sources including upstream sources, windfall, bankcutting, floodplain, jams, and beaver activity.

The banks of the river border a variety of habitats throughout the area. Prairie, pasture, and agricultural lands surround a large portion of the river. Parks, hardwood stands, and thin riparian corridors provide some shade for the river, aiding in the maintenance of cooler water temperatures. However, the Chehalis River also runs through areas that provide little cover, such as treeless floodplains and bedrock hillsides, and along roads. Bank armoring is present in several reaches, particularly between the Newaukum and Skookumchuck confluences (Map 4B-C).

Figure 9. Typical Incised Channel (Photo)

South Fork Chehalis River. Sixteen reaches were defined in the South Fork Chehalis River Basin from the confluence to RM 10.4. Three of the sixteen reaches, totaling 1.79 miles in length (Map 1), were surveyed in the field.

The South Fork Chehalis is a low-gradient, meandering river composed of long, deep glides and pools, with relatively short sections of riffle. The channel is unconfined with areas of bank erosion contributing to fine sediment loads. The dominant substrate in the surveyed reaches is gravel, although there are many areas of fine sediment deposition. Areas of bank armoring in the form of discarded cars occur in Reach 5; however, bank armoring is limited in the reaches surveyed (Map 4D). LWD levels in the South Fork are depressed, most likely due to the absence of riparian vegetation along much of the river. Some of the habitat limiting factors (Table G) influencing the South Fork Chehalis River are water quality and quantity, sediment quality and quantity, LWD levels, riparian conditions, and fish passage (WSCC 2001).

Glides compose approximately 78 percent of the reaches sampled, with individual glides ranging up to 1,493 feet in length. Riffles compose 11 percent of the total sampled river length, and range in length from 19 to 454 feet. Pools, up to 760 feet in length, constitute approximately 8 percent of the total length of the sampled reaches. Additionally, side channels compose 3 percent of the total length sampled, and range in size up to 235 feet in length.

The banks of the sampled reaches are composed primarily of sand/silt/clay. Gravel is the dominant channel substrate, although there are also many areas of sand/silt/clay. These are primarily located in deposition areas where flow is slowed due to glides or pools, and also in areas of extensive bankcutting throughout the subbasin.

LWD is scarce in the South Fork Chehalis, with the primary recruitment processes being bankcutting and upstream sources. The dominant riparian condition in the basin is agriculture and developed land, which limits the recruitment potential of LWD input into the river system. On average, 19.3 pieces (ranging from 15 to 25 pieces) of functional LWD are present in the surveyed reaches.

The banks of the river border several types of habitats throughout the basin. A large portion of the South Fork is surrounded by pasture and reed canarygrass meadows. Stretches of narrow riparian corridors provide some shade which aids in maintaining cool water temperatures, but much of the river runs through areas that do not provide substantial cover (Map 9D).

Skookumchuck River. Fifty-six reaches were defined in the Skookumchuck River basin. Detailed field investigations were performed on 33 reaches totaling approximately 16.28 miles of river within the Study Area (Map 1).

The Skookumchuck River consists mainly of glide habitat with a lesser amount of riffle and pool habitat. In general, the lower portion of the Skookumchuck River is moderately confined. The majority of the confinement is a result of bank armoring, as there were several reaches where bank armoring was observed, generally in the form of riprapped banks and road overpasses (Map 4B). These reaches are generally low-gradient with the substrate primarily composed of cobble and larger gravels. Most of the lower reaches have a gradient between 0 and 1 degree and there are several side channels in this area.

The middle reaches of the Skookumchuck are generally unconfined, with a gradient between 0 and 1 degree. Smaller substrates such as gravels and some fines are present in these reaches. A few instances of bank armoring occur in these reaches, although direct cattle access to the stream channel is also frequently seen. Substrate size increases with proximity to the Skookumchuck dam and there are several areas of exposed bedrock in this area. There are also several side channels present in the middle Skookumchuck. Above the reservoir, the river is moderately to highly confined with a slightly steeper gradient (1 to 4 degrees). There were no observed instances of bank armoring above the reservoir. Habitat limiting factors affecting instream habitat in the Skookumchuck River include (Table G): water quality and quantity, floodplain conditions, sediment quality and quantity, LWD levels, riparian conditions, fish passage, and road density (WSCC 2001).

Glides compose approximately 64 percent of the sampled reaches, with individual glides ranging up to 2,889 feet in length. Riffles, ranging in length up to 756 feet, make up 18 percent of the sampled reaches. Pools compose approximately 6 percent of the total sampled length, with individual pools ranging up to 628 feet in length. Side channels, ranging up to 2,200 feet, compose approximately 10 percent of the surveyed reaches in the Skookumchuck River. Above the reservoir there is also cascade habitat present where the stream flows over areas of exposed bedrock. This habitat encompasses approximately 1 percent of the total surveyed length.

The banks of the sampled reaches are composed primarily of sand/silt/clay substrate. Gravel is the most common in-channel substrate, although cobble and fines are also abundant in some areas. Fines are more prevalent in the middle reaches of the river, whereas larger gravels and cobbles dominate the lower and upper portions. Bedrock is also common in the reaches immediately above and below the Skookumchuck reservoir.

The abundance of LWD in the Skookumchuck River is highly variable, with between 3 and 3,140 pieces present in each reach. Of the reaches surveyed, there are an average of 149 pieces of LWD present per reach. LWD recruitment is primarily from bankcutting, beaver activity, and upstream sources, with windthrow and floodplain contributing to a lesser degree. Although LWD is present throughout most of the lower watershed, recruitment potential is limited in some areas by narrow riparian buffers adjacent to agricultural and pasture land. LWD recruitment in the lower watershed is also limited by land development in and near the riparian buffer.

Below the reservoir, land use in the basin is primarily timber production at the higher elevations, with agriculture, pasture, and residential uses predominating in the lower elevations. The banks of the river border predominantly agricultural lands, with development encroaching into the riparian buffer in the lower watershed. Riparian vegetation is predominantly a mix of young hardwood and conifer species interspersed with patches of agricultural or pasture land (Map 2B). Above the dam, land use is almost entirely timber production.

Mainstem Newaukum River. Seventeen reaches were defined in the mainstem Newaukum River basin. Three of these reaches, comprising approximately 3.48 miles of river length within the Study Area, were sampled. (Map 1). The mainstem Newaukum River consists primarily of glide habitat with some adjoining riffle and pool habitat. The river channel is predominately unconfined with a gradient between 0 and 1 degree. There are several limiting factors affecting habitat in the Newaukum River basin including (Table G): sediment quality and quantity, water quality and quantity, riparian conditions, and road density (WSCC 2001).

In total, glides compose approximately 60 percent of the total sampled river length, and range in length up to 960 feet. Riffles compose 13 percent of the surveyed reaches, with individual riffles ranging up to 366 feet. Pools ranging up to 368 feet in length constitute approximately 7 percent of the total reaches surveyed. Side channel habitat composes 20.1 percent of the total length surveyed; however, this represents one side channel of Reach 2.

Sediments along the banks consist mostly of fines, with gravel and cobble present to a lesser degree in some areas. There was one instance of bank armoring observed in Reach 1 (Map 4C). Cobble and gravel are the substrates most commonly found in the stream channel, with areas of sand/silt/clay substrate also common.

The mainstem Newaukum River channel contains between 22 and 421 pieces of LWD per reach. Of the reaches sampled, there are on average approximately 171 pieces of functional LWD per reach surveyed. Because of agricultural development, LWD recruitment in the lower watershed is primarily limited to upstream sources. Stream canopy cover is also limited in the lower mainstem Newaukum as a result of clearing for pasture and other agricultural land uses (Map 9C).

North Fork Newaukum. Twenty-one reaches were defined in the North Fork Newaukum River basin. Five of these reaches, comprising approximately 2.10 miles of river length within the Study Area, were sampled as part of the investigation (Map 1).

The North Fork Newaukum River consists primarily of glide habitat with some areas of riffle and pool habitat also present. The channel is generally unconfined with a gradient between 0 and 1 degree. Some bank armoring in the form of riprap was observed in Reach 5 (Map 4C).

Glides compose approximately 65 percent of the total sampled river length, and range in length up to 620 feet. Riffles compose 13 percent of the surveyed reaches, with individual riffles ranging up to 1,196 feet. Pools, ranging from 45 to 127 feet in length, constitute approximately 4 percent of the total reaches surveyed. There are no side channels present in the North Fork Newaukum River.

Sediments along the banks consist mostly of fines, with gravel and cobble present to a lesser degree in some areas. Cobble and gravel are the most common substrates in the stream channel, although areas of sand/silt/clay substrate are also common.

The North Fork Newaukum River channel contains between 3 and 107 pieces of LWD per reach. Of the reaches sampled, there are on average approximately 41 pieces of functional LWD per surveyed reach. As a result of agricultural development, LWD recruitment in the lower North Fork watershed is limited, with upstream sources being the primary source. Stream canopy cover is also limited as a result of pasture and other agricultural land uses (Map 9C).

South Fork Newaukum. Sixteen reaches were defined for study in the South Fork Newaukum River basin. Four reaches, comprising approximately 2.08 miles of river length within the Study Area, were surveyed (Map 1).

The South Fork Newaukum River contains primarily glide habitat with riffles and pools present to a lesser degree. The channel is generally unconfined with a gradient between 0 and 1 degree. There is one surveyed reach (Reach 11) where bank armoring (riprap associated with a road) was observed.

Glides compose approximately 57 percent of the total sampled river length, and range in length up to 772 feet. Riffles compose 36 percent of the surveyed reaches, with individual riffles ranging up to 495 feet. Pools, ranging from 30 to 207 feet in length, constitute approximately 3 percent of the total reaches surveyed. Side channel habitat composes 4 percent of the total length surveyed.

Sediments along the banks consist mostly of gravel and cobble, with fines also present in some areas. Cobble and gravel are the most common substrates in the stream channel, with some areas of sand/silt/clay. Bank erosion and upstream sources are the main contributors to the fine sediment deposition.

The South Fork Newaukum River channel contains between 1 and 1,029 pieces of LWD per reach. Of the reaches sampled, there are on average approximately 323 pieces of functional LWD per surveyed reach; however, that figure is heavily weighted by Reach 11, which contains 1,029 pieces of LWD. LWD recruitment in the lower South Fork watershed is limited due to agricultural land use practices and road densities near the channel. Stream channel shading is also affected by these characteristics (Map 9C and 10C).

4.1.1 Spawning Habitat Conditions

4.1.1.1 Anadromous Species

Anadromous fish often build their redds using coarse gravel and cobbles, avoiding areas of the stream that contain high levels of fine sediments. Streams in the Study Area have varying quantities of spawning gravels suitable for anadromous fish.

Chehalis River. The substrate in the lower reaches of the Chehalis River in the Study Area is predominately fines, and spawning gravels are rare. Spawning gravel frequency increases upstream of the Newaukum River confluence, with gravels becoming more common in the reaches near Doty. Of the 24 reaches surveyed in the Chehalis River, 46 percent contain patches of spawning gravels suitable for anadromous species. Of those reaches, 45 percent have spawning gravels extending over 20 percent of their length, indicating reaches with higher concentrations of suitable spawning habitat. These reaches are of greater concern for protection from habitat-degrading processes, as they are considered more functional. Deep glides and the quantity of fine sediment in the middle reaches of the Chehalis River limit the quantity and quality of spawning gravels; several reaches surveyed were dominated by sand/silt/clay substrate (Map 5A). Despite the fact that these areas are classified as poor spawning habitat, there are several stocks of salmon that spawn in the mainstem Chehalis River. WDFW conducts yearly spawner surveys in the mid Chehalis River basin; 1999 salmonid escapement estimates are summarized in Table H. These surveys indicate that spring and fall chinook, coho, and winter steelhead utilize the spawning gravels present in the Chehalis mainstem.

South Fork Chehalis River. The South Fork Chehalis River contains a low quantity of spawning gravels adequate for anadromous fish (Map 5D). Although all three of the reaches surveyed contained some spawning gravels, they only extended over 3 to 8 percent of the total surveyed lengths. Gravel quality and quantity is reduced as a result of increased sinuosity and subsequent bankcutting. These physical processes introduce fines to the stream, making sand/silt/clay the subdominant substrate type, and decreasing the abundance of available spawning habitat. Although the South Fork Chehalis is not considered prime spawning habitat, escapement estimates for coho were higher there than in the other rivers and tributaries sampled by WDFW in 1999 (Table H).

Skookumchuck River. Spawning gravels are abundant in the Skookumchuck River (Map 5B). Of the 33 reaches surveyed, 88 percent contained spawning gravels of adequate size and abundance for anadromous fish. Of those reaches, 66 percent had spawning gravels present along over 20 percent of their length. Cobble and gravel are the dominant substrate types in the upper and lower reaches. Fine sediments are more prevalent in the middle reaches where the channel gradient is lower. Consequently, spawning gravels suitable for anadromous salmonids are more abundant in the upper and lower reaches of the Skookumchuck River. The high escapement estimates for spring and fall chinook, coho and winter steelhead (Table H) indicate that the spawning habitat in the Skookumchuck is functioning and high quality.

Newaukum River. The Newaukum River (including the North and South Forks) also contains a large abundance of spawning gravels. Spawning gravels were present in 92 percent of the nine reaches surveyed. Of those reaches, 55 percent had spawning gravels over 20 percent of their length. Fine sediments are abundant in the North Fork as well as the mainstem, where fines are the subdominant substrate component. Although the sand/silt/clay substrates dominating certain reaches of the Newaukum (Map 5C) negatively affect the quality of spawning gravels in these reaches, escapement estimates in the Newaukum River are high (Table H).

Table H. 1999 WDFW salmonid escapement estimates - mid Chehalis River basin

Species	Misc. Tributaries (RM 55.2 – 100.2)	Skookum-chuck (at RM 67.0)	Newaukum (at RM 75.4)	South Fork Chehalis (at RM 88.3)	Chehalis Mainstem (RM 47.0 – 67.0)	Chehalis Mainstem (RM 75.4 – 100.2)	Total Spawners	% of Basin Escape-ment
Spring Chinook	0	537	343	28	148	147	908	71.7%
Fall Chinook	0	1614	579	110	459	313	2303	27.1%
Coho	2017	2263	2009	2305	0	11	8594	30.8%
Chum	0	0	0	0	0	0	0	0.0%
Winter Steelhead	66	346	1586	544	2	60	2542	23.7%

4.1.1.2 Resident Species

Resident fish species utilize spawning gravels that are medium to coarse in size. Although these smaller-size substrates do not preclude spawning by anadromous salmon, they are of particular importance to smaller trout species.

Chehalis River. There are very few areas of spawning gravels appropriate for resident fish species in the surveyed reaches on the mainstem Chehalis (Map 5A and 5D). The Chehalis River has a relatively small abundance of suitably sized spawning gravels, with 38 percent of the reaches surveyed containing spawning gravels for resident fish. Of these reaches, only 33% had resident species spawning gravels present for more than 20% of their length. The presence of fine sediments in the middle reaches affects the quantity and quality of gravel for resident fish species.

South Fork Chehalis River. The South Fork Chehalis River has inadequate spawning gravels for resident fish. There were no observed areas of suitably sized gravels in the three reaches surveyed, as sand/silt/clay was the dominant substrate (Map 5D). Fine sediments and the limited occurrence of adequate riffles affect the quality and quantity of spawning gravels for resident fish.

Skookumchuck River. The Skookumchuck River also contains limited areas of spawning gravels for resident fish (Map 5B), with 33 percent of the reaches surveyed containing areas of spawning gravels adequate for resident fish. Larger gravels and cobbles are the dominant substrate types throughout the river, limiting the quantity of smaller gravels suitable for the resident fish species. However, 73 percent of those contained suitable spawning gravels over 20 percent of their length, indicating larger areas of useful habitat.

Newaukum River. The North Fork and mainstem Newaukum Rivers both contain a large abundance of spawning gravels for resident fish (Map 5C). Every reach surveyed contained patches of suitable spawning gravels, ranging from 12 to 42 percent of the total reach length. The South Fork Newaukum River is deficient in spawning gravels for

resident fish. Two of the four reaches surveyed contained suitable spawning gravels; however they accounted for only 6 percent and 10 percent of the total reach lengths. Larger mean substrate sizes in the South Fork limit the quantity of the smaller sized spawning gravels that are suitable for resident fish.

4.1.1.3 Spawning Habitat in Tributaries

Small tributaries in the Study Area were investigated to determine presence and extent of spawning gravels for both anadromous and resident fishes. The investigations showed that:

- Lucas Creek is the only small tributary found to have adequate spawning gravels. Pockets of spawning gravels were found, although some fines were present. One coho redd was sighted, but it was not occupied.

- Spawning gravels were not observed in the Middle Fork Newaukum River. The channel is heavily choked with woody debris, making fish passage doubtful. The dominant substrate is cobble/silt, but clay bedrock is also present. Surrounding clearcuts may contribute much of the fine sediment load, as well as the excessive woody debris.

- Bear Creek is choked with organic debris and brush, making fish passage doubtful. The wetted channel was only two to three feet wide, with a wetted depth of approximately three inches. No spawning gravels were identified in Bear Creek.

- A lack of spawning gravels was also found in Salzer Creek at Airport Road; these reaches are dominated by sand/silt/clay substrate. The channel at this location is passable to fish, with a wetted width of approximately six feet and a depth of two feet; however, no fish were observed. An active beaver dam is creating a good holding/rearing pool.

- Nicholson Creek is impassable to fish due to a large beaver dam just upstream from the oxbow into which the creek enters. Below the dam, the creek is choked with organic debris and mud, and no spawning gravels are present.

- A large debris jam at the upstream end of a culvert impedes upstream fish passage on Garrett Creek. The channel below the jam is choked with debris and the substrate is composed of bedrock and silt. No spawning gravels were found.

- No spawning gravels were identified in Dell Creek. The substrate is composed of bedrock and large cobble, and is extremely embedded. A large debris jam is present approximately 250 feet upstream from the mouth, possibly impeding fish passage.

- No suitable spawning gravels were identified in Hope Creek. The substrate consists of bedrock and large cobble, with a small falls (up to two feet vertical) approximately 100 feet upstream of the mouth. Fish passage is most likely impeded due to limited water flow over bedrock.

- Johnson Creek is dominated by cobble and silt substrate, and has no spawning gravels. With a depth of approximately two feet and a wetted width of approximately 10 to 12 feet, there was very little flow at the time of survey.

- Upstream fish passage is possible in Coal Creek West; however, no spawning gravels were identified. Adequate depth and flow exist, and holding pools are present, although the dominant substrate is sand/silt.

- No signs of fish passage were observed in Stearns Creek. Due to the high quantity of fine sediment, it is assumed that no spawning gravels are present.

4.1.2 Rearing Habitat Conditions

Chehalis River. The Chehalis River has limited off-channel rearing and holding habitats (Map 6A and 6D). Twelve percent of the reaches surveyed contained side channels or off-channel habitat adequate for juvenile fish rearing. However, much of this habitat was either perched or dry when the survey was conducted, indicating limited availability to fish. No side channel or off-channel habitats were identified in the upper reaches of the Chehalis within the Study Area. Four of the reaches surveyed contain pools of sufficient depth to offer adequate holding habitat to migrating fish. However, pool frequency in these reaches was low, ranging from 19.1 to 51.4 channel widths per pool. Only one surveyed reach contains pools with sufficient woody cover to offer effective temperature relief. Pieces of LWD functioning as fish habitat are also infrequent in the Chehalis River, averaging 0.5 pieces per reach.

South Fork Chehalis River. Inadequate rearing and holding habitats occur in the South Fork Chehalis River (Map 6D). Side channel or off-channel rearing habitat was identified in one of the three reaches surveyed, accounting for 2.6 percent of the total distance. However, the habitat was dewatered at the time of the survey, indicating that availability is seasonal. Quality holding pools are also uncommon, with only one of three pools surveyed meeting quality criteria. Holding habitat offered by LWD is rare, with only three pieces of functioning LWD identified in the reaches surveyed.

Skookumchuck River. The Skookumchuck River provides a low to moderate amount of rearing habitat for salmonids (Map 5B). Thirty-six percent of the reaches surveyed contain side channels or off-channel habitat. However, nearly half of the side channel or off-channel habitat identified is inaccessible to fish on a consistent basis. One-third of the reaches surveyed contain quality-holding pools. Pool frequency is greatest in the middle and lower reaches downstream of Bucoda, averaging 17.6 channel widths per pool. Most pools identified are of adequate depth to provide holding habitat for

migrating fish. Functioning LWD offering cover for fish is scarce, averaging 1.7 pieces per reach.

Newaukum River. The Newaukum River and both forks are deficient in rearing habitat, yet contain adequate amounts of holding habitat (Map 5C). Of the 12 reaches surveyed, only one reach contains side channel habitat, and it amounts to 1.3 percent of the total reach length. Quality holding pools are abundant in the mainstem and North Fork Newaukum, but are uncommon in the South Fork. LWD functioning as fish habitat was encountered more frequently in the mainstem and North Fork, occurring at a rate of 5.7 and 5.8 pieces per reach, respectively. The South Fork Newaukum has a moderate amount of LWD, averaging two pieces per reach.

4.2 Riparian Function Assessment

4.2.1 Riparian Vegetation Conditions

Land uses in the Study Area include managed forest, agriculture, residential, parkland, urban development and industrial uses. Land use impacts to the riparian areas have reduced forested portions to a width of 50 to 100 feet throughout most of the Study Area. The dominant riparian composition type in the low-lying portions of the Study Area is a sparse hardwood or mixed riparian edge of small or medium trees. Most of these RCUs have a low shrub layer or secondary canopy. The dominant hardwood species are big-leaf maple, black cottonwood, Oregon ash and red alder. The canopy is typically open, with a secondary canopy or shrub understory, although there are several areas where complex canopy habitat is lacking (see Section 4.3.1). Riparian vegetation is described by subbasin as follows:

Chehalis River. In the mainstem Chehalis River, riparian areas are most marginalized around the cities of Centralia and Chehalis (Map 2A and 2D). From the Lincoln Creek confluence to the mouth of the Newaukum River, more than two-thirds of the RCUs indicate either no riparian vegetation or sparse riparian coverage. The riparian canopy found in this area is predominantly mixed, with black cottonwood, big-leaf maple and western red cedar the predominant species. A narrow shrub understory of red-osier dogwood and Pacific willow occurs in patches, usually within the bankfull channel. Otherwise, reed canarygrass and maintained lawn grasses dominate the ground cover. Land uses within this area include residential and commercial development, golf courses, large retail establishments and agriculture (primarily on the west side of the river).

Upstream of the Newaukum confluence to the mouth of the South Fork Chehalis (Reaches 13-25), more than 75 percent of the RCUs indicate either sparse hardwood canopies or no riparian vegetation. The canopy comprises big-leaf maple, black cottonwood and red alder, typically between 12-20 inches in diameter. As in downstream reaches, the understory is composed of willow or red-osier dogwood on the streambanks with reed canarygrass or pasture grasses covering the floodplain portion of the riparian area. Land use in this section of the river is typically rural residential or agricultural.

Above the South Fork Chehalis to Elk Creek (Reaches 26-42), the riparian characteristics are similar to lower reaches, except that Western red cedar dominates those few reaches with dense vegetation, with vine maple as a secondary species. Western red cedar and vine maple are both species associated with moist conditions. This may reflect the increased channel confinement (moderately confined) of the upper Chehalis River valley. The RCUs in the remainder of this portion are dominated by sparse hardwoods.

South Fork Chehalis River. The South Fork Chehalis River primarily flows through managed forest and agricultural lands. The riparian vegetation bordering the river is hardwood-dominated, (Map 2D) and consists mostly of red alder and some big-leaf maple. Understory vegetation in most reaches is dominated by red-osier dogwood, but willow and snowberry dominate in some areas. Reed canarygrass is the most pervasive groundcover; it exists in reaches with trees and in the case of Reach 6, it is the overall dominant plant species.

Skookumchuck River. Agricultural lands and rural residential areas surround most of the Skookumchuck River. Sparse hardwood forests dominate the riparian canopy; however, there are some areas (Reaches 3, 5, 8, 30, 37, 47, and 49) dominated by conifers such as Western red cedar and Douglas fir. Big-leaf maple, Oregon ash, and black cottonwood are present in some reaches, but red alder is the predominant species of hardwood. Snowberry and red-osier dogwood are the most common understory species, although willow, salmonberry, vine maple, Indian plum, ninebark, and red elderberry comprise the understory in some reaches. Although reed canarygrass is the most common herbaceous groundcover, there are six reaches (Reaches 4, 8, 28, 42, 46 and 48) where Himalayan blackberry dominates the groundcover community.

Newaukum River. The Newaukum was divided into three sections for the survey: mainstem Newaukum, North Fork, and South Fork. Riparian vegetation along the Newaukum River is altered by land use practices and continued floodplain modification. Where riparian habitat exists, it is usually sparse. In many places, it is lacking altogether.

The lowest three reaches of the mainstem Newaukum River are characterized by parks, rural residential development, and agriculture, and have dense stands of medium hardwood and mixed overstory vegetation. Oregon ash and black cottonwood are the dominant hardwood species. Groundcover vegetation in this area consists largely of Himalayan blackberry, pasture grasses and forbs, and reed canarygrass. Reaches upstream are markedly different. Reaches 4-9 and 14-17 have sparse riparian vegetation or no riparian vegetation.

The riparian area along most portions of the North Fork of the Newaukum River is sparsely forested, with red alder dominant. Secondary canopies are absent. The understory includes red-osier dogwood, salmonberry, willow, and snowberry; groundcover is limited in most areas to reed canarygrass.

Sparse, mature hardwood woodlands dominate the riparian canopy along the South Fork Newaukum. Of the hardwoods present, red alder and Oregon ash are most common. In reaches with conifers present, the most common is Western red cedar. Willow, snowberry, and red osier dogwood dominate the understory vegetation, and reed canarygrass dominates where groundcover is present.

4.2.2 Near-Term LWD Recruitment

The riparian vegetation conditions discussed in the previous section reflect land use practices, channel modifications, and past woody debris removal practices both outside and within the bankfull channel. In order to evaluate the potential for future LWD recruitment, hazard calls are developed using methods prescribed in the Watershed Analysis Manual (WFPB 1997). The term "hazard call" is used to define whether or not there is low or high hazard of negative habitat impact based on LWD loading to the stream. A channel that is not likely to either retain LWD or to respond to presence of LWD by providing function is said to be in "high hazard" for LWD recruitment and should be considered for restoration or management actions that could improve conditions. A channel that is retaining LWD in a high functional manner is classified as "low hazard."

LWD in a stream channel can provide many functions. It directly provides rearing and holding habitat for juvenile and small fish. Flow deflection, attenuation, or restriction by LWD can result in increased pool formation, side channels and braiding, which in turn provide channel complexity and habitat functions for fish, wildlife, and plant species. LWD often provides sediment trapping, controls bedload movement, and initiates bar formation.

Near-term LWD recruitment refers to the existing conditions at the time of investigations and the likelihood that LWD of optimal dimensions will be introduced into the channel in sufficient quantities and in conjunction with processes that will result in the functions mentioned above.

A review of the LWD Near-term Recruitment Hazard Call Maps (Map 8A-D) indicates that most of the Study Area is at high hazard for LWD recruitment. Many portions of the mainstem Chehalis and Skookumchuck rivers are in non-forested land use areas and therefore already at high hazard. The smaller levels of LWD already found within the channels (Map 7A-D) combined with the sparse existing riparian vegetation contribute to these results.

Chehalis River. There are no reaches at low hazard for near-term LWD recruitment in the mainstem Chehalis River. Although LWD was observed within the Chehalis River in quantity, analyses revealed inadequate levels of in-channel LWD per channel width, an indicator that the river is not retaining the LWD introduced under current conditions (Map 7A).

The data indicate that the entire Chehalis River is lacking in riparian vegetation, recruitment processes, LWD, and associated function. Non-forested land uses are

presently preventing riparian development in the vicinity of the cities of Centralia and Chehalis, and along State Route 6 near Claquato (Map 8D). Modifications to land use planning and practices in these areas would be necessary to alleviate the high hazard conditions in these locations. Other locations of high hazard result from limited or no riparian vegetation and poor LWD retention within the high hazard reaches.

South Fork Chehalis River. The South Fork Chehalis River contains inadequate levels of LWD within its banks (Map 7D). Therefore, this stream is classified as high hazard (Map 8D). In the case of this basin, the high hazard call is due to the inadequate levels of input from the riparian canopy, as well as the channel's limited ability to retain LWD it receives.

Skookumchuck River. Although there are a number of reaches on the Skookumchuck River and its tributaries that have a high number of LWD pieces per channel width (Map 7B), hazard calls are most often high or moderate for this basin (Map 8B). The Skookumchuck flows through many non-forested land use areas, including the community of Bucoda and parts of Centralia. The development associated with these areas does not allow for contribution of LWD into these reaches. Further, the retention of LWD debris within the high hazard reaches that do receive LWD input is not adequate. The only reach that is considered low hazard for having a negative habitat impact is above the Skookumchuck reservoir (Map 8B).

Newaukum River. The number of LWD pieces per channel width varies from low to high in the mainstem Newaukum River (Map 7C). However, even the reaches containing a high density of LWD pieces, such as Reach 1, can be considered high hazard because the LWD is not retained within the channel (Map 8C). In many cases, reaches are considered high hazard due to the non-forested land use areas that surround the banks.

Only one reach of the North Fork Newaukum is considered to be at moderate hazard for negatively affecting the habitat within the reach; the remaining reaches are classified as high hazard (Map 8C). The loading of individual functional pieces of LWD into the stream is fairly low, resulting in moderate or low densities of LWD (Map 8C).

The South Fork Newaukum also comprises reaches considered moderate and high hazard (Map 8C). Despite these hazard calls, there are reaches on the South Fork Newaukum that contain high numbers of LWD per channel width (Map 7C).

Limited LWD input in the Newaukum River most likely results from limited riparian buffer zones and non-forested land use practices. Some reaches have high densities of LWD, yet are considered moderate or high hazard; in these cases, the LWD is not optimally retained within the channel.

4.2.3 Riparian Shade Assessment

Stream canopy coverage within the Study Area is rarely sufficient to provide adequate shading. In western Washington, non-glacial streams below 3,600 feet in elevation are subject to increased temperatures if more than 40 percent of the stream's surface and banks are visible (WFPB 1997). Alteration and removal of riparian growth have increased stream temperatures throughout the Study Area. Several reaches within the Chehalis, Newaukum, Skookumchuck and South Fork Chehalis rivers are identified under State 303(d) water quality listings as below acceptable standards for instream temperatures. Nearly every reach analyzed within the Study Area received a high hazard designation for stream shading. The target shading levels stated in the Watershed Analysis Manual have a 70 percent shade target for all Class A stream sections and a 90 percent target for all Class AA sections. Exceptions to these target levels include Reaches 55 and 56 on the Skookumchuck River. Because of the higher elevation of these Class AA reaches, the target shading level is 80 percent.

Although stream canopy closure occasionally exceeds 40 percent (Map 9A-D), only four reaches within the entire Study Area (Skookumchuck Reaches 12, 19, and 25; and South Fork Newaukum Reach 4) reach target shading levels; therefore all other reaches received a high hazard call for stream shading (Map 10A-D).

Chehalis River. All reaches of the Chehalis River within the Study Area are at high hazard for effects of poor shading (Map 10A and 10D). There are only four reaches shown on the stream canopy closure map (Map 9A and 9D) with greater than 40 percent shading. These reaches (Reach 4, 14, 34, and 42) represent less than 15 percent of the total length of analyzed reaches. Significant sections of the river have no shading at all. With the exception of required buffer strips in areas of forest management, land use in the populated sections of the Study Area generally does not include mandated riparian reserves or revegetation. Therefore, increased shading that could be expected from increasingly maturing riparian forest would only occur along limited portions of the Chehalis River. Reaches 1,6, 8-11, 37 and 38 do not meet State water quality standards for temperature (Table G).

South Fork Chehalis River. The South Fork Chehalis River is also subject to agricultural development in the floodplain, with riparian areas maintained in a disturbed state. As a result of sparse riparian vegetation, average canopy closure in the South Fork is 8.5 percent, far below the target level of 70 percent. Reaches 1-3 of the South Fork Chehalis fail State Water Quality Standards for stream temperature. All of the reaches considered for shade hazard were assigned high hazard calls (Map 10D).

Skookumchuck River. Stream canopy closure for the Skookumchuck River averaged 24 percent over the entire surveyed area. Three reaches, 12, 19 and 25, met target-shading levels and received low hazard calls for stream shading (Map 10B). These reaches represent 6 percent of the total length considered for shade hazard evaluation. Although only Reach 1 of the Skookumchuck is documented as failing to meet State water quality temperature standards, other areas with little or no riparian cover cannot be expected to be protected from water temperature increases.

Newaukum River. There are no reaches on the North Fork or mainstem Newaukum River, and only one reach on the South Fork (Reach 4), that meet or exceed target shade levels. Therefore, a high hazard call was made for this subbasin (Map 10C). Reach 4 of the South Fork Newaukum was the only reach in this assessment to exceed 40 percent canopy closure (Map 9C). Reach 1 does not meet State water quality standards for temperature.

Although portions of the upper basin of the North Fork and South Fork Newaukum were found to meet target-shading levels in a watershed analysis prepared by Weyerhaeuser (1999), agricultural and residential uses in the lower reaches have reduced riparian shading function below levels necessary to meet target criteria.

4.3 Wildlife Habitat Conditions

4.3.1 Wildlife Species of Concern

As described in Section 2.4.2, the WDFW PHS list and the PHS Polygon maps were consulted to determine the potential presence and extent of priority species and habitat within the Study Area. Few of the priority species were observed during field investigation. For most of the species, preferred habitat is not located within or near the Study Area. Other species have marginalized habitat available to them in the Study Area, but cannot be expected to be present in significant numbers. Of the species listed below, the waterfowl and small mammal species were observed most often and likely could benefit from habitat management and restoration efforts. Other species, such as the wolverine, cannot be expected to use the Study Area, simply due to their sparse population and avoidance of human activity.

Bald eagle - Although hardwood open canopy habitat such as that found in the Study Area can be suitable for nesting and roosting, few bald eagles were observed. Human disturbance and snag removal are the most apparent reasons for low bald eagle habitat availability. Bald eagle nesting was observed in the Skookumchuck Reservoir.

Eastern wild turkey – Wild turkeys are usually found near mature oak or other mature hardwood forests, in mountain forests and in wooded swamps. No wild turkey habitat was identified during the field surveys, although one reach of predominant oak overstory was found near the confluence of Salzer Creek and the Chehalis River. Human activity and development preclude the development of viable wild turkey habitat in the area. Sightings of Eastern wild turkey have been documented in the Skookumchuck watershed; however none were observed during the study.

Great blue heron – Herons are known to be present in the Study Area and were frequently observed in and along the Chehalis, Skookumchuck, and Newaukum rivers. Great blue herons are generally tolerant of human activity near their foraging areas, but not near rookeries. No great blue heron nesting was observed within the Study Area.

Harlequin duck – Harlequin duck habitat can be found in tributaries to the Skookumchuck and upper Chehalis rivers. Breeding areas are known to occur in the Skookumchuck River basin, upstream of Bucoda. No harlequin duck breeding habitat was recorded on the mainstem Skookumchuck River, or within the 100-foot buffer. No harlequin ducks were observed during the study.

Hooded merganser – Clear, fast flowing water with sandy, gravelly or cobbled substrate is preferred by hooded mergansers. However, since they are easily disturbed and avoid human activity, mergansers are more likely to be found in the reaches of the Skookumchuck, Chehalis and Newaukum rivers, which are more removed from the cities and developed areas. Hooded merganser habitat occurs within all of these systems and hood merganser breeding and nesting activity has been documented on the Chehalis and Skookumchuck rivers. No individuals were identified during this study.

Mardon skipper – Mardon skippers prefer grasslands at low elevations in the Cascades as well as alpine areas, especially on serpentine soils. Mardon skipper habitat has been reported in the Skookumchuck River basin, primarily north of the Study Area. Mardon skippers were not observed during field surveys.

Mink – Mink habitat includes forested streams and ponds with brushy or rocky cover. Mink habitat is located throughout the Study Area, especially in the lower Newaukum, Middle Fork Newaukum, the Skookumchuck, and higher reaches (Reaches 25-30) of the Chehalis River. Mink were sighted in the Newaukum and Chehalis rivers.

Osprey – Lakes, streams, rivers, and coastal waters with suitable nesting trees near fish populations are the preferred habitat for osprey. WDFW has documented osprey in the Skookumchuck watershed. During this study, osprey were observed in the Chehalis and Newaukum river basins.

Pileated woodpecker – Mature coniferous, deciduous, and mixed forests with large, dead trees are often occupied by pileated woodpeckers. Based on the results of field studies, pileated woodpecker habitat is infrequent within the Study Area, primarily due to limited riparian habitat and the removal of snags. However, pileated woodpeckers were observed on the Chehalis and Newaukum rivers.

Western gray squirrel – Western gray squirrels seldom use the isolated, scattered trees found in the hardwood open canopy portions of the Study Area. While populations have been documented in the northern Skookumchuck River basin, the limited habitat available in the Study Area likely precludes gray squirrels from establishing viable populations. No individuals were observed during the course of field surveys.

Whulge (Edith's) checkerspot – The whulge checkerspot has been documented in prairie areas north of the Study Area. Most of the habitat within the Study Area is not suitable for the checkerspot. Whulge (Edith's) checkerspots were not observed within the Study Area.

Wolverine – Wolverines are very secretive animals that inhabit boreal forests, mountains, or open plains and brushlands. They are not tolerant of human presence or activity. Although an historic sighting was recorded in the Skookumchuck watershed, no wolverines were observed within the Study Area.

Wood duck – Wood ducks inhabit woodlands near shallow, quiet inland lakes, swamps, river bottoms, ponds, marshes, and streams where nest sites are available. Important forest types for the wood duck are central and southern floodplain forests, red maple swamps, temporarily flooded oak forests, and northern bottomland hardwoods. They also prefer areas with many perching sites. Wood duck breeding and nesting areas have historically been located throughout the Chehalis and Skookumchuck basins. One pair was sighted in the Newaukum basin.

4.3.2 Channel and Riparian Wildlife Habitat Conditions

Wildlife habitat within the Study Area was documented through in-channel surveys, riparian habitat surveys, wetlands inventory, and upland wildlife surveys.

Wildlife habitat in the riparian area was characterized based on vegetative species information collected in riparian transects throughout the Study Area. Although riparian vegetation did not necessarily extend 100 feet beyond the streambank in all areas surveyed, wildlife habitat was characterized to that extent in order to determine the width of the available habitat. The habitat types identified reflect the dominant species in the riparian canopy, the presence or absence of multiple canopies or shrubs layers, and the types of herbaceous ground cover present.

Wildlife habitat functions are derived from both the structural shape and complexity of the habitat and the suitability of the vegetation community for food, nesting, and cover. Open hardwood canopies may provide roosting, perching, and nesting potential for large avian species and snag recruitment for cavity nesters and insectivores, but lack thermal cover and predator refuge for smaller bird species and mammals. Conifers may provide thermal protection and forage opportunities for seed eaters, but the dense structure can preclude growth of forbs for herbivorous mammals or sunlight penetration for reptiles and insects.

Multiple canopy structures are often considered preferred for wildlife habitat not only for the diversity of species and niches they provide, but because multiple canopies can be an indicator of undisturbed forest succession. Many shrub species found in secondary canopies are prolific fruit and seed bearers and increase the likelihood of reproductive success in shaded understories. Moisture contained within multiple canopies encourages growth of fungi on coarse woody debris and stumps that are an important component of small mammal diet. Habitat areas without multiple canopy structure still provide wildlife function, particularly loafing and warming for larger mammals, invertebrates, and reptiles.

Land use and agricultural practices often maintain habitat in a disturbed state, either by interrupting succession or seeding (e.g., by mowing, pruning, grazing) or by removing biomass and vegetation altogether (e.g., by harvesting, wood cutting, development). Snags and coarse woody debris are often removed, especially if their presence interferes with equipment or tillage. Typically, agricultural, residential and urban activities reduce habitat function.

Invasive species tend to occur in habitat areas where conditions are marginalized for native or less aggressive vegetation. Invasive species that are common in the Study Area include Himalayan blackberry and reed canarygrass. Although Himalayan blackberry can provide forage opportunities, the monoculture resulting from dense stands of blackberry reduces diversity, limits overall food availability, and offers limited cover for wildlife species. Reed canarygrass can out compete other species, particularly on wetland fringes. Like Himalayan blackberry, reed canarygrass can provide limited forage opportunity, but dense stands of reed canarygrass limit both habitat structure and species diversity.

Habitat throughout the Study Area is consistent, with few species dominating each basin. A complete list of plants identified during the surveys can be found in Attachment A. The habitat types are described as follows:

Agriculture/No Structure. This habitat type is predominantly row crop or pasture. Structure is lacking, and the habitat can be expected to remain in a disturbed state as either harvest or livestock foraging continually prevents vegetative succession.

Coniferous-Open Canopy. Dominated by Western red cedar, coniferous open canopy is limited to very sparse trees with less than 10 percent canopy cover, less than 20 inches diameter, and no secondary canopy or shrub layer.

Coniferous Riparian Woodland. The dominant species in coniferous riparian woodland are Western red cedar and Douglas fir. The canopy coverage is usually greater than 10 percent and includes trees larger than 12 inches in diameter. Understory within the coniferous riparian woodland falls into four broad categories:

No Cover. Due to stand density or poor soil conditions, vegetation is lacking beneath the overstory. This infrequently encountered habitat type is typically a hedgerow (Chehalis Reach 10) or dense managed forest.

Herbaceous Ground Cover. Native plant species, usually horsetail, sword fern, lady fern, or grasses. No woody plant cover.

Multiple Canopy. These areas have secondary canopies, with vine maple, Pacific ninebark, and red-osier dogwood as the dominant shrub species.

Reed Canarygrass. Understory or ground cover is dominated by reed canarygrass, typically as a monoculture.

Hardwood Open Canopy. Dominated by Oregon ash, black cottonwood, bigleaf maple and red alder. The density is sparse, less than 10 percent canopy coverage with trees of varying ages. Many of the trees in this habitat type are a single row along the river, usually lacking a secondary layer or shrub layer due to firewood cutting, grazing, or agriculture. Some blackberry may be present, but not in dense stands.

Hardwood Riparian Woodland. Oregon ash, bigleaf maple and red alder are the dominant species in this canopy. Black cottonwood is occasionally present. The understory within the hardwood riparian woodland is categorized into five types:

No Cover. Habitat types within this category are usually parks and roadside pullouts where vehicular and foot traffic precludes vegetation.

Native Cover. Native plant species, usually ferns, forbs, grasses.

Multiple Canopy. These areas have secondary canopies of either the dominant canopy species or a secondary species. These are predominantly willows, red-osier dogwood, and vine maple.

Reed Canarygrass. Understory or ground cover is dominated by reed canarygrass, typically as a monoculture.

Himalayan Blackberry. The understory or ground cover is dominated by Himalayan blackberry.

Mixed Open Canopy. The mixed open canopy consists of mixed stands with less than 10 percent canopy coverage. Tree size is usually less than 12 inches diameter and secondary canopy is usually lacking.

Mixed Riparian Woodland. Mixed canopy stands with more than 10 percent canopy coverage. Understory is either lacking or unclassified.

Oak Woodland. The area around Salzer Creek Reach 2 is similar to Hardwood Open Canopy, yet the dominant species is Oregon white oak.

Reed Canarygrass. The only vegetation is a monoculture of reed canarygrass, and canopy is lacking.

Mixed canopy habitat is limited throughout the entire Study Area. Sixty-six percent of riparian condition units evaluated for habitat lack multiple canopies, which includes a shrub understory. Grazing, firewood cutting, landscaping practices, agriculture,

development, and the presence of invasive species all contribute to a single canopy structure.

The predominant habitat type is hardwood open canopy, followed by hardwood riparian woodland. Reed canarygrass stands are found in portions of Salzer and Hanaford creeks. It should be noted that sections of both creeks labeled agriculture/no structure are also dominated by reed canarygrass; however, grazing occurs in these areas and they are therefore considered agricultural.

Chehalis River. Wildlife habitat associated with the Chehalis River riparian and riverine areas is determined by the width of the existing riparian vegetation and associated wetlands. As expected, habitat quantity and value vary with the adjacent land use and position within the subbasin. Twenty-two percent of the riparian portion of the Study Area is wetland. Emergent wetlands are the dominant type, followed by forested wetland types. For the purposes of this discussion, reaches are examined upstream from Reach 1. Beginning near the confluence of the Chehalis River and Lincoln Creek up to the mouth of the Skookumchuck River, the habitat is dominated by hardwood riparian woodland with a secondary or shrub layer beneath (Map 11A). Riparian and palustrine forested wetland along the right bank provide cover, with vegetated banks dominated by willows. The dominant canopy species are black cottonwood and bigleaf maple, with a vine maple and willow understory. Some areas along the left bank have reed canarygrass beneath a narrow margin of cottonwoods. The width of riparian vegetation averages 51 feet throughout this segment, largely due to the wetlands on the right bank. Cottonwood snags were identified in every reach throughout this section.

From the mouth of the Skookumchuck upstream to the mouth of the Newaukum, the habitat changes considerably. Thirty percent of the riparian habitat in this section has no cover. The remainder is multiple canopy hardwood riparian woodland. Bigleaf maple is the dominant canopy species. Where a shrub layer exists, red-osier dogwood is the dominant shrub layer. Where ground cover is found, reed canarygrass is dominant. The riparian vegetation throughout this section averages only 35 feet wide. Wetlands associated with this section are mostly emergent, with forested sections in Reaches 10 and 12, both adjacent to narrow oxbows where agriculture is impracticable. These wetlands have Western red cedar with an understory of bigleaf maple, red-osier dogwood, and Pacific willow, with reed canarygrass beneath. Coarse woody debris and snags are scarce; only one snag was recorded throughout this entire section (in Reach 10). Beaver, raccoon and deer were observed throughout this section. Other wildlife observed in this section includes waterfowl utilizing oxbow ponds near Reach 10.

In the section from the mouth of the Newaukum to approximately five miles upstream of the South Fork confluence, there is increased available wildlife habitat. The habitat is largely determined by the presence of adjacent wetlands and land use practices. Although the dominant wildlife habitat type is hardwood riparian forest with multiple canopy, large areas along this section (Reaches 15, 16, 18, and 28) have dense stands of Himalayan blackberry and reed canarygrass dominating the understory. Red alder and bigleaf maple are co-dominant in the overstory, and black cottonwood is sporadically

present. The riparian vegetation averages 41 feet wide in this segment. Map 11D indicates that forested riparian wetlands occur along Reaches 15, 21, 22, and 23. However, the field surveys along Reaches 21 and 23 revealed emergent wetlands and agricultural use immediately adjacent to the river with forested wetland portions set back from the river along Reach 23. All of these wetland areas provide cover and nesting opportunities for a variety of wildlife species. Waterfowl were observed using these wetlands, along with otter, deer, songbirds, beaver and bald eagles. Black cottonwood snags were found in Reaches 15, 16, 21, and 22 of this section, but snags and coarse woody debris were absent from the rest of this section, either due to low candidate populations or clearing.

The remainder of the Chehalis River within the Study Area (to the mouth of Elk Creek) has fewer riparian wetlands, yet the average width of the riparian buffer is 46 feet. Both hardwood and coniferous riparian woodland with multiple canopies are found in this segment. The hardwood overstory is red alder or bigleaf maple with a red-osier dogwood or vine maple understory. Coniferous portions are composed of Western red cedar with vine maple beneath. The valley bottom in this section is narrower, with channel erosion evident along both banks and overhanging vegetation. Beaver and kingfisher burrows were observed in this segment, and snags were identified with evidence of nesting and feeding. Songbirds, deer, beaver, otter, coyote, and small mammals were evident within this section.

South Fork Chehalis River. Agriculture and clearing along the South Fork Chehalis River have reduced wildlife habitat on the South Fork to a narrow band of multiple canopy hardwood riparian woodland mixed with reed canarygrass and agricultural areas, mostly used for grazing. A red alder canopy over red-osier dogwood is the dominant species composition for this habitat type in the south fork. Upstream of Reach 5, reed canarygrass dominates the left bank of the river. Below that, agriculture limits habitat function on the left bank (Map 11D). Wetlands comprise 38 percent of the 100-foot wildlife survey buffer within the South Fork Chehalis. Most of that is palustrine emergent wetland and riparian forested wetland (Map 3D). Snags are sparse; none were observed during field surveys, likely due to poor recruitment and clearing. Wildlife observed within the subbasin included deer, beaver, small mammals, coyote and songbirds.

Skookumchuck River. The Skookumchuck River is dominated by hardwood riparian woodland with multiple canopies (Map 11B). Like the Chehalis River, the habitat conditions along the Skookumchuck vary with adjacent land use. Although the mouth of the Skookumchuck is in an urban setting, the first three reaches have forested riparian areas over 100 feet wide. These reaches are bounded by parks, highway right-of way, and side channels. Stream canopy closure exceeds 30 percent (Map 9B). A hardwood canopy of black cottonwood, bigleaf maple and Oregon ash with an understory of Pacific willow, red-osier dogwood, salmonberry and snowberry extends outward from both banks through all three reaches. Snags and coarse woody debris were found on the right bank of Reach 3.

Reach 4 was more typical of an urban reach with a narrow band of bigleaf maple over Himalayan blackberry and salmonberry. Portions of Reach 4 are straightened and the banks are armored, either with riprap or bridge abutments (Map 4B). A park adjacent to the right bank of Reach 5 provides a forested fringe that runs upstream through Reach 9, downstream of the Hanaford Creek confluence. Hardwood and coniferous riparian woodland with multiple canopies characterize this section. Along Reach 7, Douglas fir with Pacific willow and reed canarygrass form the coniferous woodland, whereas bigleaf maple, red alder and Oregon ash are the dominant hardwood canopies. Salmonberry, red-osier dogwood and Pacific willow for the secondary canopy. Palustrine forested wetlands are present along a narrow fringe on both banks (Map 3B). Bigleaf maple snags were observed in reach five. Waterfowl, deer, beaver, small mammals, and songbirds were observed in this section.

Reaches 10-26 have a narrow riparian fringe averaging 35 feet wide. Wildlife habitat types are mixed with hardwood and coniferous riparian woodlands with open canopies, multiple canopies and varying types of ground cover. Red alder and Oregon ash are the dominant hardwood species, whereas Western red cedar dominates the coniferous canopies. Dominant shrub species in this section are include red-osier dogwood, Pacific ninebark, Pacific willow, Indian plum, vine maple, and salmonberry. This segment is characterized by the narrow riparian forested and emergent wetlands found predominantly on the left bank (Map 3B) associated with side channel and off-channel habitat. Snags are uncommon along this segment, due to the limited snag recruitment candidates and adjacent agricultural land use. Signs of otter and beaver activity were commonly observed in this section.

The section of the Skookumchuck adjacent to the town of Bucoda has reed canarygrass and Himalayan blackberry as dominant ground cover. A wide riparian forest wetland in Reach 27 is dominated by red alder, and increases the average riparian width for this section (up to Reach 32) to 60 feet. Bald eagles were observed in the alders on Reach 27.

Reaches 32-39 are similar in composition. The narrow riparian canopy (averaging 35 feet wide) and associated wetlands are a mixed forest community. Reach 39 is characterized by dense reed canarygrass along both sides of the river. Waterfowl as well as deer, beaver, songbirds and raccoon were observed using this segment of the river. No snags were observed along this portion of the Skookumchuck.

The remainder of the Skookumchuck River to the dam has wider riparian and wildlife habitat characterized by hardwood riparian woodland with multiple canopies. Red alder is the dominant canopy species in all but one hardwood reach (Reach 45). Western red cedar dominates the coniferous reaches. Snowberry, salmonberry and Indian plum are the dominant understory species. Riparian habitat averages 75 feet wide for this section of habitat, mostly limited by agriculture and roadway. Snags were observed in Reach 42 and Reaches 48-53.

The Skookumchuck reservoir and upstream reaches are discussed in Section 4.3.3.

Newaukum River. The Newaukum mainstem, North Fork, and South Fork are predominantly hardwood overstory (Map 11C). Reaches 1-5 are characterized by wide riparian areas with palustine forested and emergent wetlands. Wetlands comprise 43 percent of the 100-foot riparian buffer on the mainstem Newaukum. Although the riparian vegetation averages 51 feet wide, portions of parks and side channel areas often afford over 1,000 feet of forested habitat adjacent to the river (Reach 2). Oregon ash and black cottonwood are the dominant hardwood canopy species, with snowberry, red-osier dogwood, salmonberry, Pacific willow, and vine maple present as secondary canopy and shrub layers. However, the hardwood species do not provide sufficient canopy coverage for the broad stream channel (mean bankfull width is 65 feet). Snags (both ash and cottonwood), nests, and burrows were identified throughout these reaches. Songbirds, beaver, deer, otter, small mammals, raccoon and waterfowl were observed using the river in this section.

Reaches 6-16 up to the fork are hardwood open canopy with areas of agriculture. These reaches are dominated by bigleaf maple in a narrow band over forested and emergent palustrine wetlands. Riparian vegetation is often absent and averages less than 20 feet wide. The emergent wetlands are mostly reed canarygrass. In many areas, canopy coverage averages zero; this entire segment averages less than 10 percent canopy coverage. No snags were identified in this area. Wildlife use is limited to deer, beaver, and songbirds.

The riparian wildlife habitat of the North Fork Newaukum River has been largely eliminated by agricultural activities. Although the average riparian width is 41feet, that number is misleading. Nearly fifty percent of the reaches surveyed had no riparian canopy discernable from aerial photographs (Map 9C). Canopy closure averages 10 percent. These reaches only rated hardwood open canopy after field surveys found scattered red alder or bigleaf maple. Only portions of Reaches 5 and 15 had a canopy beyond the 100-foot zone; both had reed canarygrass subdominant in the ground cover. No snags were observed. Although the NWI coverage does not extend up the North Fork, emergent wetlands of reed canarygrass were observed. No side channel habitat was observed in the North Fork Newaukum. Beaver and deer activity were commonly identified in this area. Shrub species include willows, red-osier dogwood, salmonberry, snowberry, and Himalayan blackberry.

Wildlife habitat along the South Fork Newaukum is mostly hardwood riparian woodland with multiple canopy or hardwood open canopy (Map 11C). Narrow emergent wetlands of reed canarygrass and some forested riparian areas are bordered by agriculture, rural residences, and State Route 508. Although the average width of riparian vegetation is 53 feet, many areas have little more than a thin row of red alder or Oregon ash, the dominant hardwood species. Canopy closure in the South Fork Newaukum averages only 9 percent. Although snags were observed in several reaches (bald eagles were observed using snags in Reach 11) most reaches had few snags or woody debris. Deer, beaver, otter, raccoon and songbirds were observed during field studies.

Bypass Excavation Areas. Upland areas were studied to assess existing habitat conditions where channel bypass excavation may be proposed as a project alternative. There are three locations where bypass alternatives are considered: the Coffee Creek bypass, the hospital bypass, and the SR 6 bypass.

The Coffee Creek bypass area consists primarily of disturbed agriculture/no structure habitat. At the southern end of the potential bypass, there is a combination of reed canarygrass and agriculture/no structure habitat, with a component of Himalayan blackberry habitat. A log yard is present in the southern portion of the bypass footprint, as well as Blakely Junction, which is the I-5 overpass at Reynolds Road. The area directly northeast of Blakely Junction is mixed open canopy habitat, extending north to the first of two small quarry lakes in the area. The area between the two lakes is mostly disturbed open field, with a small stand of dense hardwood riparian woodland with native cover. Northeast of the second lake, the habitat is mainly hardwood and mixed riparian woodlands with native and multiple secondary canopies interspersed with areas of disturbed agriculture/no structure.

The hospital bypass area is predominantly disturbed agriculture/no structure habitat. There is a small band of hardwood riparian woodland habitat south of the Centralia Wastewater Treatment Facility. The footprint of the potential bypass extends over the treatment facility itself, then to the west side of the Chehalis River. There is a 50-foot riparian buffer along the river on the west bank, after which the habitat is dominated by disturbed agriculture/no structure with several areas of sparse and dense hardwood riparian woodland with multiple canopy and reed canarygrass understories.

The SR 6 bypass area is dominated by disturbed agriculture/pasture. The southern portion of the potential bypass includes some herbaceous shrubs and young hardwoods near the Chehalis River, with Himalayan blackberry and reed canarygrass also present. The remainder is disturbed open field. The northern portion of the bypass footprint contains a row of medium hardwoods along the bank of an oxbow, with the remainder of the habitat open field. There is one small area of sparse hardwood woodland habitat in the northernmost area of the bypass footprint.

Flow Restrictor Sites. Riparian and wildlife habitat was assessed in the areas identified for flow restrictors as possible project alternatives. These locations include Chehalis River at RM 103.89, Chehalis River at RM 87.56, South Fork Chehalis River at RM 0.3, Salzer Creek between I-5 and Airport Road, and Dillenbaugh Creek at I-5.

The habitat near the Chehalis River at RM 103.89 is dominated by dense mixed riparian woodland within 300 feet of the bank, becoming mostly coniferous beyond. The understory is composed mainly of willows and red-osier dogwood, with ferns and other herbaceous plant cover also present. Wildlife observed at this location included songbirds, raccoon, and deer.

The Chehalis River at RM 87.56 contains dense hardwood riparian habitat with an understory of vine maple, snowberry, and reed canarygrass. This area is characterized by

steeply sloping hillsides surrounding the river channel, with dense canopy cover. Wildlife observed in this area included songbirds, with sign of deer also present.

The habitat at RM 0.3 of the South Fork Chehalis River is characterized on the left bank by disturbed open field containing Himalayan blackberry and reed canarygrass. There are small areas of hardwood open canopy also present on this bank. The right bank contains a greater amount of hardwood open canopy habitat, with one structure located approximately 60 feet from the stream bank. Above this structure, the habitat is disturbed regenerating clearcut. Songbirds were the only wildlife observed at this location.

Salzer Creek between I-5 and Airport Road contains disturbed agriculture habitat. There are a few young hardwoods along each bank, and reed canarygrass dominates the understory throughout the area. Wildlife observed in this area included songbirds and American crows, with muskrat and beaver sign also present.

The habitat at Dillenbaugh Creek near I-5 is entirely reed canarygrass, with no canopy present. There is a lone cottonwood located approximately 80 feet east of the channel. Wildlife observed at this location included songbirds, great blue heron, and muskrat sign.

4.3.3 Skookumchuck Reservoir Habitat Conditions

The area around the Skookumchuck reservoir is predominantly managed forestland with some areas of coniferous forest, meadows, talus slope, and basalt cliffs (Figures 10 and 11). Most of the forestland has been harvested. Some portions have been replanted with a monoculture of Douglas fir, but most of the habitat is regenerating forestland with a thin buffer of second growth remaining above the existing high water mark (Figure 12). This sparse buffer ranges in width from approximately 10 to 100 feet, and in most cases both survey plots (existing high water plot and 15 feet above high water plot) fall within buffered areas.

Regenerating forestland habitat at the reservoir is composed of two to three feet of slash and typically a heterogeneous mixture of young trees, shrubs and forbs. This shrub and forb layer is remnant understory and is dominated by salal, vine maple, sword fern, and Oregon grape with forbs including bedstraw and Himalayan blackberry that likely came in after harvest (over the slash layer). Snags are uncommon, and reserve trees are typically less than 12 inches dbh. The dominant vegetation at each survey plot is provided in Table K.

Figure 10. Talus slope at Skookumchuck Reservoir

Figure 11. Skookumchuck Reservoir Basalt Cliffs

Figure 12. Typical aquatic edge on the North side of the Skookumchuck reservoir

Eleven habitat types were documented around the Skookumchuck reservoir: aquatic, regenerating forest land, developed (agriculture and maintained), coniferous forest, hardwood forest, mixed forest, cliffs, meadows, mud and quarry /talus. The habitat total acreages and total perimeter lengths are listed in (Table I).

Table I. Habitat types in the Skookumchuck reservoir.

Habitat Type	Total Acreage	Actual Perimeter Lengths (m)
Aquatic (Open water)	548[1]	13411.0
Regenerating Forestland	4905	73919.0
Developed – agriculture	27	1438.0
Developed – maintained	51	5910.6
Hardwood Forest	37	4696.0
Coniferous Forest	1624	37606.0
Mixed Forest	1370	37789.0
Cliffs	21[2]	3689.0
Outwash/mud	6	688.0
Quarry/talus	34	1851.0
Meadow	7	734.0

[1] Total acreage for reservoir and river.

Aquatic Habitat. Aquatic habitat includes all open water habitat of the reservoir, from the top of the Skookumchuck dam to the cascades at the base of Reach 55.

Regenerating Forestland. Regenerating forestland includes harvested areas that have not been replanted. These areas are dominated by shrubs remaining from pre-harvest conditions and some herbaceous plants that have colonized the openings after harvest. Typically there is a thick layer of slash on the ground, which can provide some habitat for small mammals, amphibians, and songbirds. New growth showed evidence of elk and deer browsing.

Developed - Agriculture. Some areas within the one-mile perimeter of the reservoir are agricultural. These areas are below the dam, however, and were not subject to field survey.

Developed – maintained. The dam, buildings, parking areas, lawns, and access roads are included in this category, as well as roads around the reservoir that lead to the active quarry.

Hardwood Forest. Narrow areas of bigleaf maple and black cottonwood adjacent to the Skookumchuck River and road fall within the perimeter. The canopy type is hardwood riparian woodland with multiple canopy.

Coniferous Forest. Areas that were replanted with Douglas fir or second growth areas are usually Douglas fir-dominated forest. The understory is similar to the shrub community found within the regenerating forestlands. The coniferous forest has multiple canopies, with a shrub layer dominated by vine maple and salal.

Mixed Forest. These areas are dominated by Douglas fir and bigleaf maple. The shrub understory is predominantly vine maple, salal, salmonberry, and oceanspray. Ground cover includes sword fern, and trailing blackberry.

Quarry/talus. An active quarry within the perimeter and shotrock disposal area have generated a talus slope adjacent to the reservoir (Figure 10). Talus is considered valuable habitat for amphibians, although usually in a forested setting. Some areas of this talus have become vegetated and could be used by amphibians. Small mammals also use talus slopes, but the presence of human activity within the area may discourage colonization.

Cliffs. Basalt cliffs define most of the eastern perimeter of the reservoir (Figure 11). These are a priority habitat, valuable for cliff nesting birds, raptors, small mammals, and bats.

Outwash/mud. This area, which is associated with the mouth of Fall Creek, was exposed at the time of the field survey and is often exposed during summer and fall. Wildlife use within this area includes amphibian use of partially submerged stumps and slash. This area is likely used by juvenile salmonids and non-game fish during periods of higher water.

Meadow. The area surrounding an undeveloped boat ramp have been cleared and apparently sporadically maintained. This area was not included in the developed - maintained category, as infrequent maintenance allows for grass and wildflower community development. Orchard grass, oxeye daisy, and yellow parentucellia are common within this area.

The habitat edge frequencies and perimeter lengths associated with the eleven different habitat types and the adjacent habitat type are listed below (Table J). The differences in total perimeter lengths for each habitat type in Table I and Table J are due to habitat types that border the outer perimeter of the Study Area. Due to the predominance of managed forestlands within the basin, wildlife habitat has been marginalized. Structure and diversity associated with forest succession have been eliminated.

Table J. Frequency of habitat edge types

Habitat Type	Frequency					
	Aquatic - Reservoir	Regenerating forest land	Developed - agriculture	Developed - maintained	Coniferous forest	Hardwood forest
Aquatic - Reservoir		14.0		12.2	3.5	
Regenerating forest land	61.5		74.4	18.6	80.2	18.2
Developed - agriculture		0.9				59.3
Developed - maintained	4.6	1.6			2.3	22.5
Coniferous forest	8.3	43.2		14.7		
Hardwood forest		1.4		21.0		
Coniferous/ deciduous forest	7.2	34.9	25.6	33.4	6.0	
Cliffs	9.0	1.6				
Meadow	1.9	0.5			0.6	
Quarry/talus	6.2	1.7				
Mud	1.3	0.1			1.5	
River		0.2			5.9	
Total Perimeter	13411.0	59160.0	698.0	5042.0	31849.0	4696.0

Table J (cont). Frequency of habitat edge types

Habitat Type	Frequency					
	Coniferous/ deciduous forest	Cliffs	Quarry/talus	Meadow	Mud	River
Aquatic - Reservoir	3.2	32.7	44.6	35.1	25.0	
Regenerating forest land	69.9	26.4	55.4	38.3	5.7	1.4
Developed - agriculture	0.6					
Developed - maintained	5.7					
Coniferous forest	6.5			26.6	69.3	27.4
Hardwood forest						
Coniferous/ deciduous forest		11.2				55.1
Cliffs	1.4					16.1
Meadow						
Quarry/talus						
Mud						
River	12.7	29.7				
Total Perimeter	29561.0	3689.0	1851.0	734.0	688.0	6814.4

The area around the Skookumchuck reservoir is predominantly managed forestlands. Therefore, the high abundance of new clearcut (less than five years old) is to be expected. New clearcut also has the lowest acreage-to-edge ratio (0.38), which indicates the habitat has a high degree of patchiness. While a high degree of interspersion is often considered beneficial to wildlife species, the poor quality of regenerating forestlands and ongoing human activity within the Skookumchuck reservoir area compromises diversity.

Descriptions of habitat found at the existing high water mark and new potential shoreline can be found in Table K. Plot locations are illustrated in Figure 6.

Table K. Habitat descriptions along the Skookumchuck Reservoir

Plot	Existing High Water Mark	15 Feet Above High Water Mark
1	Basalt rock cliff with small ledges. Sparse (10%) overhanging vegetation of willow and Himalayan blackberry.	Basalt rock cliff with small ledges. Overhanging vegetation of willow, with red alder and Douglas fir.
2	Basalt rock cliff with small ledges. No overhanging vegetation.	Fractured basalt rock cliff. Overhanging vegetation of oceanspray and Douglas fir, grasses and mosses also present.
3	Gravelly/clay beach with poa grass (*Poa* spp.).	Open field with sparse Douglas fir and red alder. Orchard grass and yellow parentucellia dominant ground cover.
4	Fractured cobble shore with willow and oceanspray. Small band of large black cottonwood and Douglas fir between water and regenerating clearcut.	Regenerating forestland, with thick layer of slash. Plot located within the small buffer of Douglas fir, beaked hazelnut and big leaf maple. Understory dominated by wild rose, and salal.
5	Plot located at mouth of Turkey Creek. Gravel/sand shore with eroding basalt banks. Dominant species are orchard grass and oceanspray.	Plot located upstream along the bank of Turkey Creek. Thick, mature buffer of red alder and Western red cedar along creek. Thick understory of mixed shrubs with no dominant species.
6	Compressed clay shore with sand and gravel. Unvegetated shoreline with willow and reed canarygrass. Canopy composed of big leaf maple and black cottonwood.	Small buffer of Douglas fir and beaked hazelnut. Steep sloped with understory dominated by vine maple, hedgehog dogtail and oxeye daisy.
7	Gravelly/sand shoreline with some bedrock. Small patches of reed canarygrass present.	Plot located in regenerating forestland with no canopy. Dominant ground vegetation is wood groundsel and Canada thistle among slash.
8	Gravelly/sand shoreline with small buffer of Douglas fir and Western red cedar. Understory composed of Scouler's willow and red currant.	Plot located on edge of sparse buffer of Douglas fir and regenerating forestland. Dominant vegetation of tansy ragwort and trailing blackberry.
9	Cobble beach with fractured rock with small buffer of red alder. Dominant understory is blackberry and willow.	Small buffer of Douglas fir and Western red cedar. Dominant understory is vine maple and oceanspray.
10	Large cobble shoreline with thick buffer of black cottonwood and madrone. Dominant understory is willow, bedstraw and water parsley.	Plot located within buffer of madrone and Douglas fir. Understory dominated by vine maple and salal.
11	Basalt rock cliff.	Plot located on top of the basalt rock cliff face. Vegetative coverage of approximately 30%, dominated by English plantain and oceanspray.
12	Large boulders along shoreline with no canopy. Small cottonwoods present, but dominant vegetation is Scouler's willow, oxeye daisy and reed canarygrass.	Plot located within regenerating forestland. Dominant vegetation is Oregon grape and oxeye daisy within layer of slash.
13	Basalt rock knoll, Thick (90%) overhanging vegetation dominated by big leaf maple and black cottonwood. Oceanspray and birdsfoot trefoil present within rock.	Steep sloped with rock with small buffer of big leaf maple and beaked hazelnut. Oxeye daisy and birdsfoot trefoil are the dominant ground cover.
14	Gradually sloped clay shoreline with narrow buffer of shrub size Oregon ash and pacific willow. 100% coverage by reed canarygrass.	Plot located within regenerating forestland. Small big leaf maple and beaked hazelnut present. Ground cover dominated by a thick layer of slash with intertwined bedstraw.
15	Gradually sloped clay shoreline with narrow buffer of Oregon ash. Reed canarygrass covered 90% of plot.	Plot located within regenerating forestland. Rockier substrate with no canopy, small red alders were present. 100% ground cover, composed mostly of slash and mixed shrubs.
16	Steep sloped boulder shoreline with no vegetation.	Boulders with Saskatoon, stonecrop and bedstraw.
17	Plot located between rock face and beginning of bouldered slope below the rock quarry. No vegetation present.	Plot located between rock face and beginning of bouldered slope below the rock quarry. No vegetation present.
18	Steep boulder slope below the rock quarry. No vegetation present.	Steep boulder slope below the rock quarry. No vegetation present.

Table K (cont.). Habitat descriptions along the Skookumchuck Reservoir

19	Flat silty shore below step boulder slope. Dominant vegetation is velvet grass and horsetail present.	Steep boulder slope below the rock quarry. Mosses covering 75% of boulders.
20	Columnar basalt cliff. No vegetation.	Columnar basalt cliff. No vegetation.
21	Gradually sloped mud bank, with small willow and sedges (*Carex* sp.)	Young red alder stand with thick understory dominated by sword fern and salmonberry.
22	Large boulder shore at base of basalt cliff. Dominant canopy is Douglas's maple and Western red cedar, with understory of dogwood and willow all growing between boulders. Boulders covered with mosses.	Steep boulders covered with moss at the base of a basalt rock cliff. Dominant canopy is red alder and Western red cedar. Moss and sword fern are the dominant ground cover.
23	Steep boulder/cobble shore covered by dense salal. Canopy dominated by overhanging red alder.	Dense salal approximately 3ft thick over talus/boulders.
24	Cobble shore covered with bentgrass. Canopy dominated by Douglas fir, with thick understory of manroot, thimbleberry and sword fern.	Young red alder stand with thick understory dominated by vine maple, sword fern and bentgrass.
25	Cobble shore with few trees. Dominant trees are red alder and Oregon ash. Dominant vegetation is bentgrass and slash.	Regenerating forestland with sparse trees, mostly Oregon ash. Dominant vegetation is salmonberry, sword fern and blackberry.
26	Sand/gravel bank with bedrock, approximately 40% coverage of bentgrass.	Second growth of big leaf maple and Douglas fir. Understory dominated by nettles and sword fern, with plenty of fallen wood.
27	Sandy shore with large root wad. 100% coverage by bentgrass.	Thin buffer along stream with several snags. Understory dominated by sword fern, nettles, vine maple and red elderberry.
28	Steep cobble shore with a thin buffer of red alder along shore. Dominant understory is bentgrass and oceanspray.	Regenerating forestland with 1-2' slash. Sword fern, trailing blackberry and thistle are the dominant understory, with sparse red alders.
29	Steep sandy/cobble shore with small buffer of red alder. Shoreline dominated by logs, bentgrass and red elderberry.	Regenerating forestland with 1-2' slash. Salmonberry, trailing blackberry, sword fern and nettles are the dominant understory, sparse red alders.
30	Eroded clay bank with overhanging roots (Douglas fir). Overhanging vegetation dominated by red alder and big leaf maple. Sparse understory of bentgrass.	Very dense buffer of red alder and Douglas fir. Understory dominated by sword fern and mosses.
31	Short bluff of fractured basalt with thin buffer of big leaf maple. Exposed rock partially covered by oceanspray, sword fern and mosses.	Buffer of big leaf maple, with a dense slash layer. Dominant vegetation is blackberry, red elderberry, vine maple and sword fern.
32	Clay beach on delta of Fall Creek with heavy ATV use. Thin buffer of willow and alder with bentgrass understory.	Regenerating forestland with sparse Douglas fir and red alder. Understory dominated by slash, salmonberry, bentgrass and sword fern.
33	Clay beach with bentgrass and Pacific willow along shore.	Regenerating forestland along stream buffer. Buffer composed of red alder and Western red cedar. Understory of dense slash, vine maple and sword fern.
34	Thin buffer of red alder and willow along shore, with bentgrass understory.	Regenerating forestland with several snags and sparse cascara and vine maple. Dense slash with sword fern, trailing blackberry and bedstraw.
35	Undercut bank with overhanging willow, alder and cascara. Bentgrass understory.	Regenerating forestland with few snags and sparse red alder and vine maple. Dense slash with sword fern, trailing blackberry and thimbleberry.
36	Rocky outcrop of fractured basalt with overhanging willow and red alder, with bentgrass understory.	Regenerating forestland with no canopy. Understory composed of slash, sword fern, trailing blackberry and huckleberry.
37	Gravelly beach with decayed Douglas fir stumps. Willows along shore with bentgrass understory.	Regenerating forestland with replanted Douglas fir (~20ft tall). Understory composed of slash, sword fern and oceanspray.
38	Gravelly beach with thin buffer of red alder and bentgrass understory.	Plot located with small buffer of red alder. Dense slash with sword fern, bedstraw, vine maple and huckleberry.

5 REFERENCES

City of Centralia. 1999. Wastewater treatment plant draft environmental impact statement. Utilities Department, Centralia, Washington.

Dvornich, K. M., K. R. McAllister, and K. B. Aubry. 1997. Amphibians and Reptiles of Washington State: Location data and predicted distributions, Volume 2 *in* Washington State Gap Analysis - Final Report, (K. M. Cassidy, C. E. Grue, M. R. Smith and K. M. Dvornich, eds.), Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 146 pp.

ENSR Consulting and Engineering (ENSR). 1994. Comprehensive Flood Hazard Management Plan for Lewis County, Volume I. Prepared for Lewis County Department of Public Services, Chehalis, Washington. ENSR Consulting and Engineering in association with KCM, Inc., Applied Environmental Services, Inc., and Shapiro and Associates, Inc. Doc. No. 4107-004.

Envirovision Corp. 2000. Chehalis basin level 1 assessment. Envirovision Corp. in association with WPN and SAIC, Olympia, Washington.

Hiss, J.S. and E.E. Knudsen 1993. Chehalis River basin fishery resources: status, trends, and restoration goals. U.S. Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, Washington.

National Marine Fisheries Service (NMFS). 1995. Proposed rule: Endangered and threatened species; proposed threatened status for three contiguous Evolutionarily Significant Units of coho salmon ranging from Oregon through central California. Fed. Reg. Vol 60, No. 142, July 25, 1995, p. 38011.

National Marine Fisheries Service (NMFS). 1999. Proposed rule: Endangered and threatened species; threatened status for Southwestern Washington/Columbia River coastal cutthroat trout in Washington and Oregon, and delisting of Umpqua River cutthroat trout in Oregon. Fed. Reg. Vol. 64, No. 64, April 5, 1999, p. 16397.

Soil Conservation Service (SCS). 1987. Soil survey of Lewis County area, Washington. U.S.D.A. Soil Conservation Service in cooperation with Washington State Department of Natural Resources and Washington State University Agricultural Research Center.

U.S. Army Corps of Engineers. 2001. Grays Harbor native char – a literature review. Prepared by the U.S. Army Corps of Engineers for the Grays Harbor Navigation Project. Seattle District, Seattle, Washington.

U. S. Fish and Wildlife Service (USFWS). 1982. Status of Chehalis River salmon and steelhead fisheries and problems affecting the Chehalis Tribe. Fisheries Assistance Office, Olympia, Washington.

U. S. Fish and Wildlife Service (USFWS). 1999. Endangered and threatened wildlife and plants: determination of threatened status for bull trout in the conterminous United States: final rule. 50 CFR Part 17.

U.S. Forest Service (USFS). 1999. Steam inventory handbook, level I & II. Pacific Northwest Region, Region 6. Version 9.9.

Washington Department of Fisheries (WDF) 1975. A catalog of Washington streams and salmon utilization, Volume 2, Coastal Region. Washington Department of Fisheries, Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW) 1996 Final environmental impact statement for the Washington State management plan for elk Wildlife Management Program. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW).1996a. 1996 Game Status and Trend Report. Wildlife Management Program, Washington Department of Fish and Wildlife. Olympia, Washington. 328pp.

Washington Department of Fish and Wildlife (WDFW).1996b. Environmental Support Statement for Elk Management. Wildlife Management Program, Washington Department of Fish and Wildlife, Olympia Washington. 217pp.

Washington Department of Fish and Wildlife (WDFW). 1998. Washington state salmonid stock inventory: bull trout/Dolly Varden. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1999. Washington state status report, October 1999. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 2000. Washington state salmonid stock inventory: coastal cutthroat trout. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 2001. Priority habitats and species: May 7, 2001. Olympia, Washington.

Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes (WDFW and WWTIT). 1994. 1992 Washington state salmon and steelhead stock inventory. Olympia, Washington.

Washington Forest Practices Board (WFPB). 1997. Board manual: standard methodology for conducting watershed analysis. Version 4.0. Olympia, Washington.

Washington State Conservation Commission (WSCC). 2001. Salmon and steelhead habitat limiting factors. Water Resource Inventory Areas 22 & 23 Chehalis Watershed. Final Report, June 2001. Olympia, Washington.

Weyerhaeuser Co. 1999. In draft. Upper North Fork and Upper South Fork Newaukum watershed analysis: synthesis and overview sections. Tacoma, Washington.

ATTACHMENT A:

Plant Species Observed in the Study Area

Plant species observed in the Study Area

Scientific Name	Common Name
Acer circinatum	Vine maple
Acer glabrum	Douglas maple
Acer macrophyllum	Big leaf maple
Adenocaulon bicolor	Pathfinder
Adiantum pedatum	Maidenhair fern
Agrostis exarata	Spike bentgrass
Alnus rubra	Red alder
Amelanchier alnifolia	Western serviceberry
Arbutus menziesii	Pacific madrona
Arctostaphylos uva-ursi	Kinnickinnick
Asarum caudatum	Wild ginger
Athyrium filix-femina	Lady-fern
Berberis nervosa	Cascade oregongrape
Betula occidentalis	Water birch
Carex spp.	Sedge
Cirsium arvense	Canada thistle
Claytonia sibirica	Siberian miner's lettuce
Cornus spp.	Dogwood
Cornus stolonifera	Red-osier dogwood
Corylus cornuta var. cornuta	Beaked hazelnut
Cynosurus echinatus	Hedgehog dogtail
Dactylis glomerata	Orchard-grass
Delphinium spp.	Larkspur
Digitalis purpurea	Common foxglove
Epilobium angustifolium	Fireweed
Equisetum arvense	Common horsetail
Fraxinus latifolia	Oregon ash
Galium triflorum	Sweetscented bedstraw
Gaultheria shallon	Salal
Holcus lanatus	Velvet-grass
Holodiscus discolor	Oceanspray
Juncus spp.	Rushes
Leersia oryzoides	Cutgrass
Leucanthemum vulgare	Oxeye-daisy
Lotus micranthus	Small-flowered lotus
Malus fusca	Pacific crabapple
Marah oreganus	Manroot
Moss	Moss
Oemleria cerasiformis	Indian plum
Oenanthe sarmentosa	Water-parsley
Oplopanax horridus	Devils club
Oxalis oregana	Redwood sorrel
Parentucellia viscosa	Yellow parentucellia
Phalaris arundinacea	Reed canarygrass
Physocarpus capitatus	Ninebark
Plantago lanceolata	English plantain
Plantago spp.	Plantain
Poa sandbergii	Sandberg's bluegrass
Poa spp.	Bluegrass
Polystichum munitum	Sword-fern
Populus balsamifera var. trichocarpa	Black cottonwood
Prunella vulgaris	Self-heal
Prunus emarginata	Bittercherry
Pseudotsuga menziesii	Douglas fir
Pteridium aquilinum	Bracken fern
Quercus garryana	Oregon white oak

(Continued on next page)

(Continued from previous page)

Rhamnus purshiana	Cascara
Ribes sanguineum	Red currant
Rosa nutkana	Nootka rose
Rubus discolor	Himalayan blackberry
Rubus laciniatus	Evergreen blackberry
Rubus parviflorus	Thimbleberry
Rubus spectabilis	Salmonberry
Rubus ursinus	Trailing blackberry
Rumex acetosella	Sheep sorrel
Rumex crispus	Curled dock
Salix lasiandra	Pacific willow
Salix scouleriana	Scouler willow
Salix sitchensis	Sitka willow
Salix spp.	Willow
Sambucus racemosa var. arborescens	Red elderberry
Saxifraga mertensiana	Wood saxifrage
Scirpus microcarpus	Bulrush
Sedum oreganum	Oregon stonecrop
Senecio jacobaea	Tansy ragwort
Senecio sylvaticus	Wood groundsel
Solanum americanum	Black nightshade
Spirea douglasii	Douglas spirea
Symphoricarpos albus	Snowberry
Synthyris reniformis	Snow-queen
Thuja plicata	Western red cedar
Trifolium dubium	Least hop clover
Trifolium spp.	Clover
Tsuga heterophylla	Western hemlock
Urtica dioica	Stinging nettle
Vaccinium parvifolium	Red huckleberry
Vicia cracca	Tufted vetch
Vicia hirsuta	Hairy vetch

ATTACHMENT B:

Fish and Wildlife Species Which May Occur in the Study Area

Fish and Wildlife Species Which May Occur in Project Area

Species		Status		Observed in Study Area	Observed in Skookumchuck Reservoir
Scientific Name	Common Name	Federal	State		
Fish					
Acipenser medirostris	Green sturgeon				
Acipenser transmontanus	White sturgeon				
Catostomus platyrhynchos	Mountain sucker		**C**		
Couesius plumbeus	Lake chub		**C**		
Ictalurus punctatus	Channel catfish				
Lampetra ayresi	River lamprey	**SC**	**C**		
Micropterus dolomieui	Smallmouth bass				
Micropterus salmoides	Largemouth bass				
Novumbra hubbsi	Olympic mudminnow		**S**		
Oncorhynchus clarki clarki	Coastal resident/Searun cutthroat				
Oncorhynchus clarki lewisi	Westslope cutthroat	**SC**			
Oncorhynchus gorbuscha	Pink salmon				
Oncorhynchus keta	Chum salmon				
Oncorhynchus kisutch	Coho salmon			X	
Oncorhynchus mykiss	Rainbow trout/Steelhead			X	
Oncorhynchus nerka	Sockeye/Kokanee salmon				
Oncorhynchus tschawytscha	Chinook salmon			X	
Prosopium coulteri	Pygmy whitefish		**S**		
Rhinichthys falcatus	Leopard dace		**C**		
Salvelinus confluentis/S. malma	Bull trout/Dolly Varden	**T**	**C**		
Stizostedion vitreum	Walleye				
Amphibians/Reptiles					
Ambystoma gracile	Northwestern salamander				X
Bufo boreas (spp. A)	Western toad	**SC**	**C**		
Clemmys marmorata	Western pond turtle	**SC**	**E**		
Contia tenuis	Sharptail snake		**C**		
Hyla regilla	Pacific Treefrog			X	
Lampropeltis zonata	California mountain kingsnake		**C**		
Plethodon dunni	Dunn's salamander		**C**		
Plethodon larselli	Larch Mountain salamander	**SC**	**S**		
Plethodon vandykei	Van Dyke's salamander	**SC**	**C**		
Rana aurora aurora	Northern red-legged frog		**SC**	X	
Rana pipiens	Northern leopard frog		**E**		
Rana pretiosa (spp. A)	Oregon spotted frog	**C**	**E**		
Rhyacotriton cascadae	Cascades torrent salamander		**C**		
Rhyacotriton kezeri	Columbia torrent salamander	**SC**	**C**		
Taricha granulosa	Rough-skinned newt		**C**		X
Thamnophis sp.	Garter snake			X	X
Birds					
Accipiter gentiles	Northern goshawk	**SC**	**C**		
Agelaius phoeniceus	Red-winged blackbird			X	
Aix sponsa	Wood duck			X	

Anas platyrhynchos	Mallard duck			X	
Aquila chrysaetos	Golden eagle		**C**		
Ardea herodias	Great blue heron			X	X
Aythya affinis	Scaup			X	
Brachyramphus marmoratus	Marbled murrelet	**T**	**T**		
Branta canadensis	Canada goose			X	X
Branta canadensis leucopareia	Aleutian Canada goose	**T**	**T**		
Bucephala albeola	Bufflehead				
Bucephala clangula	Common goldeneye				
Bucephala islandica	Barrow's goldeneye				
Buteo jamaicensis	Red-tailed hawk			X	
Carduelis tristis	American goldfinch				X
Carpodacus spp.	Finch			X	
Catharus ustulatus	Swainson's thrush				X
Cathartes aura	Turkey vulture			X	X
Ceryle alcyon	Belted kingfisher			X	X
Chaetura vauxi	Vaux's swift		**C**		
Charadrius vocuferus	Killdeer			X	
Cinclus mexicanus	American dipper			X	
Colaptes auratus	Northern flicker				X
Columba fasciata	Band-tailed pigeon				X
Corvus brachyrhynchos	American crow			X	X
Cyanocitta stelleri	Steller's jay			X	X
Cygnus buccinator	Trumpeter swan				
Cygnus columbianus	Tundra swan				
Dendragapus obscurus	Blue grouse				
Dryocopus pileatus	Pileated woodpecker		**C**	X	X
Empidonax difficilis	Pacific-slope flycatcher				X
Eremophila alpestris strigata	Streaked, horned lark	**C**	**C**		
Falco columbarius	Merlin		**C**		
Falco peregrinus	Peregrine falcon	**SC**	**E**		
Gavia immer	Common loon				X
Grus canadensis	Sandhill crane		**E**		
Haliaeetus leucocephalus	Bald eagle	**T**	**T**	X	X
Histrionicus histrionicus	Harlequin duck	**SC**			
Hirunidae	Swallow				X
Junco hyemalis	Dark-eyed junco			X	X
Lophodytes cucullatus	Hooded merganser				
Meleagris gallopavo	Wild turkey				X
Melospiza melodia	Song sparrow				X
Mergus merganser	Common merganser			X	
Mergus serrator	Red-breasted merganser			X	
Nycticorax nycticorax	Black-crowned night heron				
Oreortyx pictus	Mountain quail				
Pandion haliaetus	Osprey			X	
Parus atricapillus	Black-capped chickadee			X	
Pooecetes gramineus affinis	Oregon vesper sparrow	**SC**	**C**		
Progne subis	Purple martin		**C**		
Sitta carolinensis aculeata	Slender-billed, white-breasted nuthatch	**SC**	**C**		
Spizella spp.	Sparrow			X	X

Spizella passerina	Chipping sparrow				X
Sphyrapicus sp.	Sapsucker				X
Strix occidentalis	Spotted owl	**T**	**E**		
Tachycineta bicolor	Tree swallow				X
Tachycineta thalassina	Violet-green sparrow			X	
Trochilidae	Hummingbird				X
Troyomanes bewickii	Bewick's wren				X
Turdus migratorius	American robin			X	X
Tringa malanoleuca	Greater yellowlegs			X	
Zonotrichia leucophrys	White-crowned sparrow				X
Mammals					
Antrozous pallidus	Pallid bat				
Canis latrans	Coyote			X	X
Castor canadensis	Beaver			X	X
Cervus elaphus nelsoni	Rocky Mountain elk			X	X
Cervus elaphus roosevelti	Roosevelt elk				
Corynorhinus townsendii	Townsend's big-eared bat	**SC**	**C**		
Eptesicus fuscus	Big brown bat				
Gulo gulo	Wolverine	**SC**	**C**		
Lontra canadensis	River otter			X	X
Martes Americana	Marten				
Martes pennanti	Fisher	**SC**	**E**		
Mustela vison	Mink			X	
Myotis sp.	Myotis bats		**C**		
Odocoileus hemionus columbianus	Columbian black-tailed deer				
Odocoileus hemionus	Black-tailed deer			X	X
Ondatra zibethicus	Muskrat			X	
Porcyon lotor	Raccoon			X	
Sciurus griseus	Western gray squirrel	**SC**	**T**		
Tamius spp.	Chipmunk			X	
Thomomys mazama	Western pocket gopher	**C**	**C**		
Ursus amricanus	Black bear				X
Vulpus vulpus	Fox				X
Zapus spp.	Jumping mouse				X
Invertebrates					
Euphydryas editha taylori	Whulge checkerspot	**C**	**C**		
Habrodais grunus herri	Golden Hairstreak				
Mitoura grynea barryi	Juniper hairstreak		**C**		
Mitoura johnsoni	Johnson's hairstreak		**C**		
Papillio spp.	Swallow-tailed butterfly				X
Polites mardon	Mardon skipper	**C**	**E**		
Speyeria zerene bremnerii	Valley silverspot	**SC**	**C**		
Speyeria zerene hippolyta	Oregon silverspot	**T**	**E**		

C – candidate; E – endangered; T – threatened; SC – species of concern; S - Sensitive

ATTACHMENT C:

Chehalis Basin Escapement Estimates

Chehalis Basin Escapement Estimates, 1986-1996

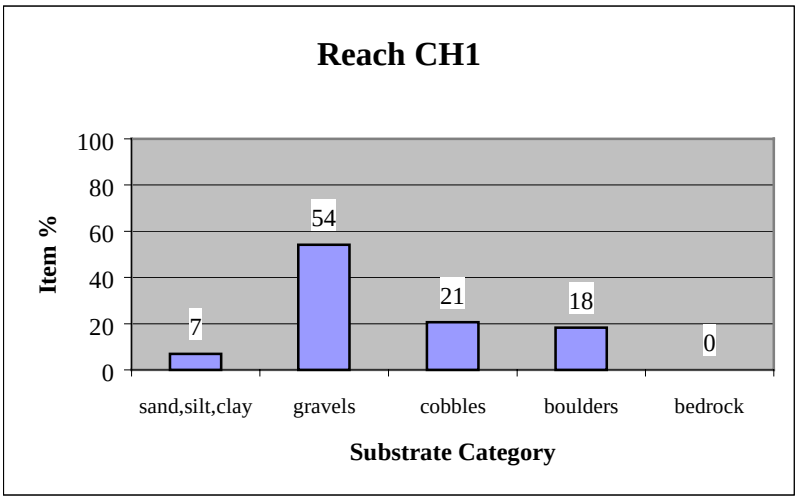
		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Misc. Tributaries	Fall Chinook											
	Spr. Chinook[a]	38	5	46	3	21	19	26	11	8	32	14
	Coho[d]	945	816	2967	3575	1365	3987	1485	2600	605	2143	2775
Mainstem Chehalis	Fall Chinook (RM 53-106)	568	1782	2420	1607	541	801	797	1206	312	556	2493
	Spr. Chinook (RM 94.3-100.4)	77	68	149	174	168	45	50	119	78	74	110
	Coho (RM 97.1-113.5)	41	116	272	0	134	105	262	360	18	274	197
South Fork Chehalis	Fall Chinook[b]	289	0	534	454	67	354	146	48	278	538	394
	Spr. Chinook[b]	11	5	6	0	0	0	0	0	3	237	485
	Coho[b]	429	400	1792	1178	311	1256	672	865	171	1129	1948
Skookumchuck	Fall Chinook	723	1347	2213	1160	457	912	913	983	548	840	510
	Spr. Chinook	569	490	1059	692	551	644	940	397	794	809	951
	Coho[c]	990	260	1434	3284	2124		1124	1814	192	1795	5016
Newaukum	Fall Chinook[e]	169	480	1689	989	227	456	471	87	478	728	817
	Spr. Chinook[f]	842	214	1187	818	508	522	599	592	385	722	1845
	Coho[c]	740	460	2209	2079	1905		1985	1399	683	2167	5550
Total Basin Escapement	Fall Chinook[g]	1749	3609	6856	4210	1292	2867	2327	2324	1616	2662	4214
	Spr. Chinook	1537	782	2447	1687	1248	1230	1615	1119	1268	1874	3405
	Coho[h]	3145	2052	8674	10116	5839	5348	5528	7038	1669	7508	15486

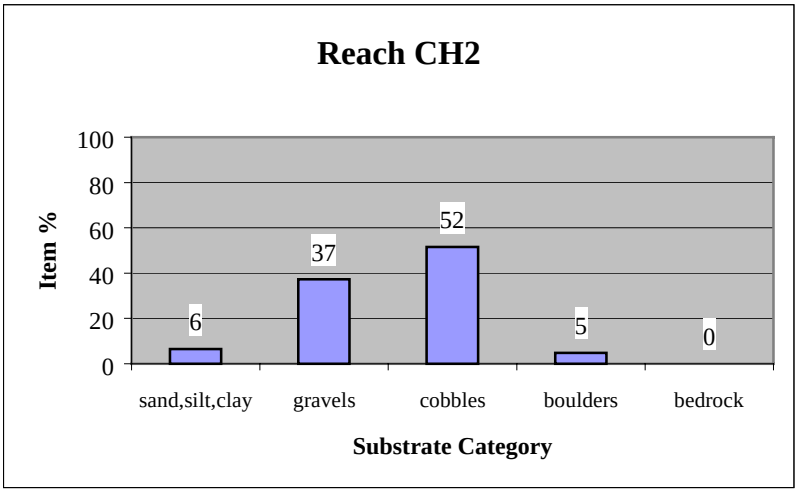
a. Elk Creek only
b. Includes Stillman Creek and mainstem South Fork only
c. Includes main tributaries
d. Includes most small tributaries from Capps Creek downstream to Scatter Creek
e. Includes Mainstem, North, Middle, and South forks, and Lucas Creek
f. Includes Mainstem and North Fork only
g. No estimates for Misc. Tributaries
h. No estimates for Skookumchuck and Newaukum in 1991

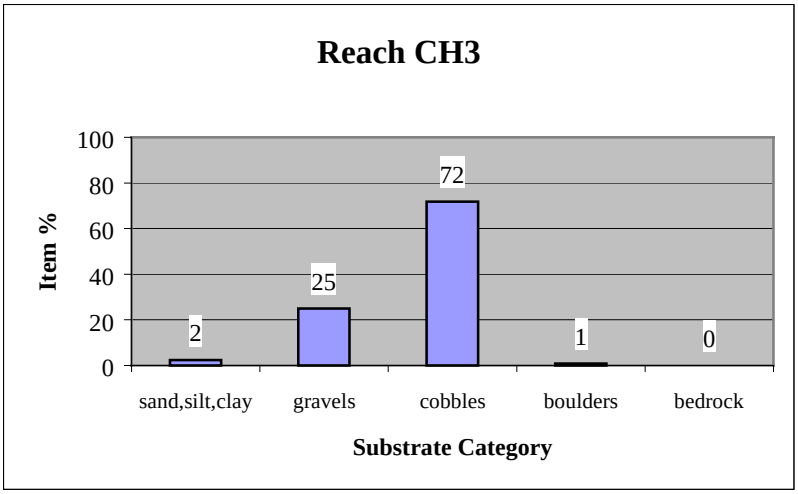
ATTACHMENT D:

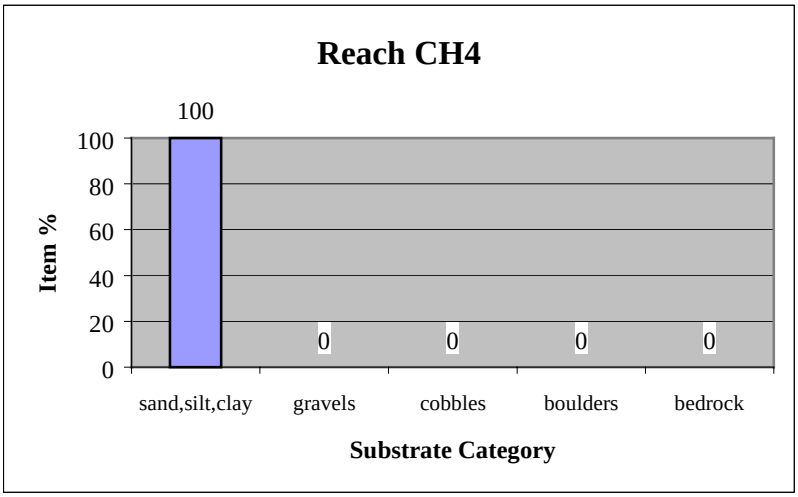
Substrate Characterization Charts

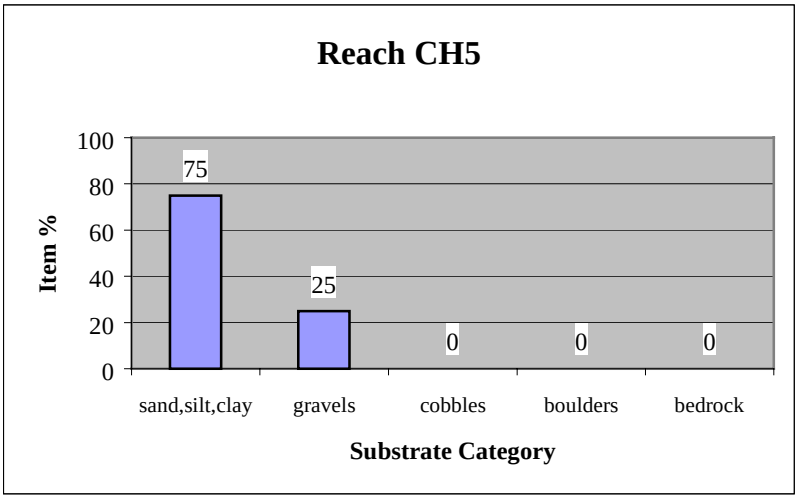
Chehalis

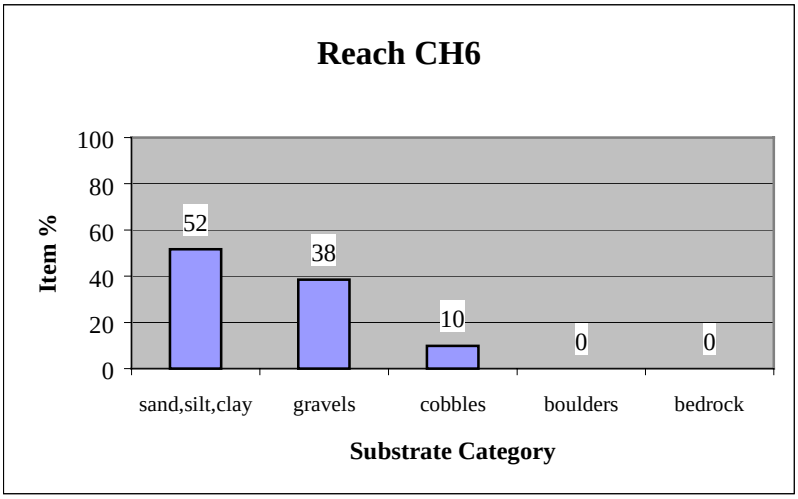

Reach CH1
Item %
100
80
60
40
20
0
7
54
21
18
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

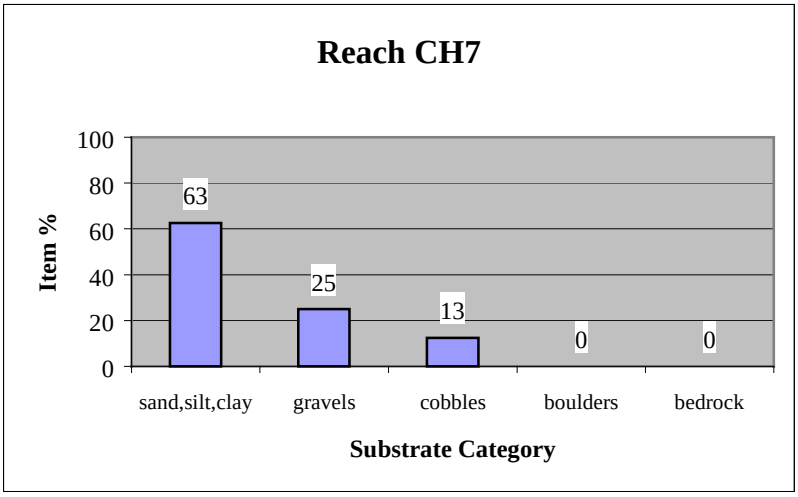

Reach CH2
Item %
100
80
60
40
20
0
6
37
52
5
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

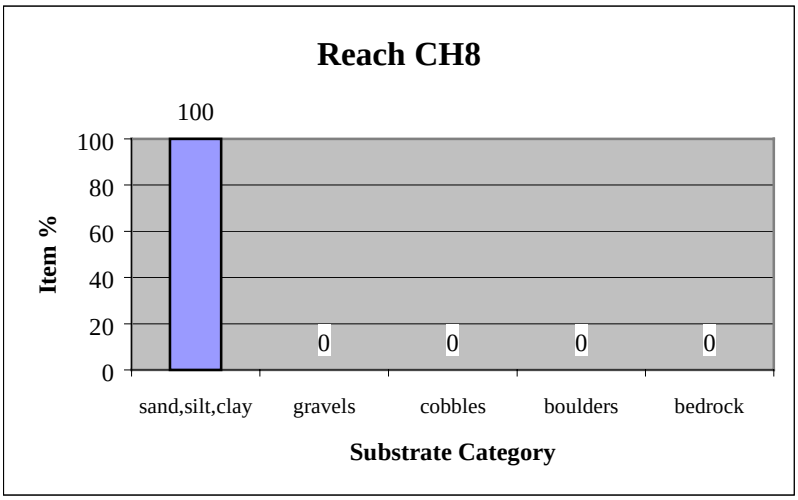

Reach CH3
Item %
100
80
60
40
20
0
2
25
72
1
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

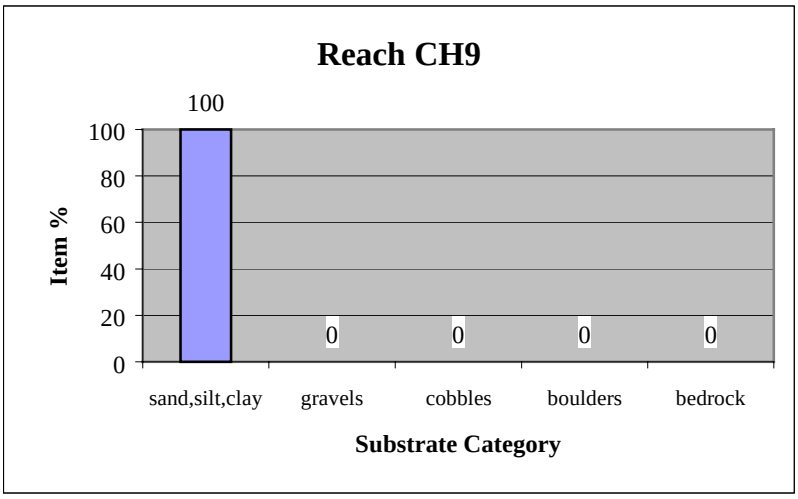

Reach CH4
100
0
0
0
0
100
80
60
40
20
0
Item %
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

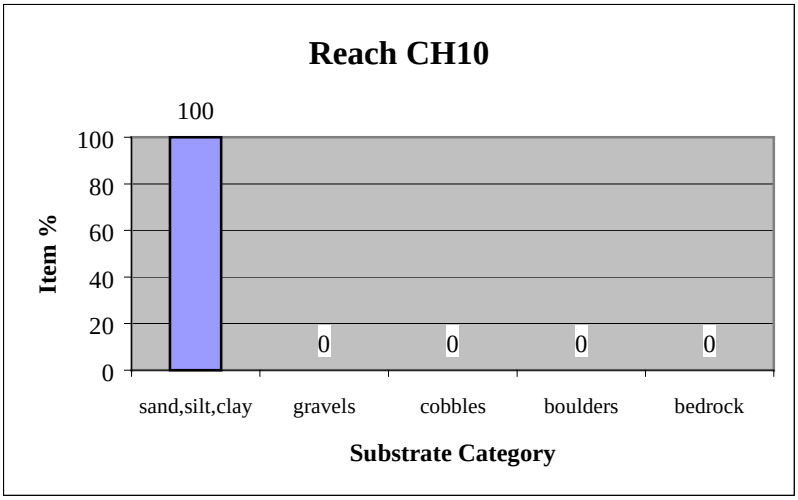

Reach CH5
75
25
0
0
0
100
80
60
40
20
0
Item %
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

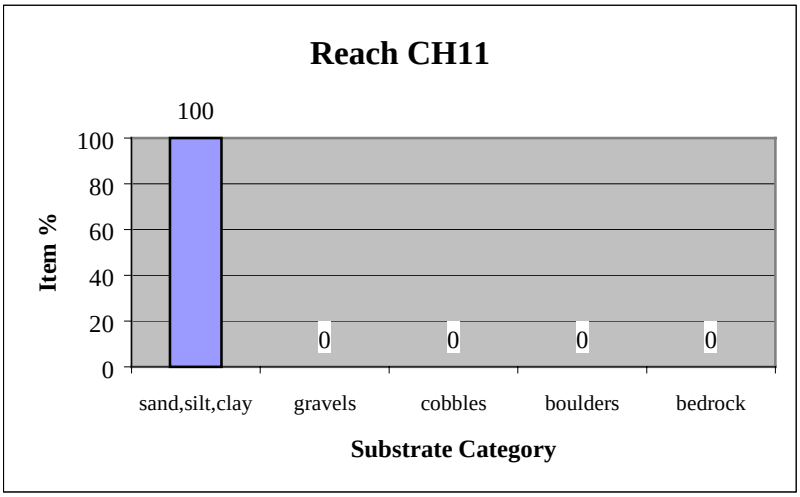

Reach CH6
52
38
10
0
0
100
80
60
40
20
0
Item %
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

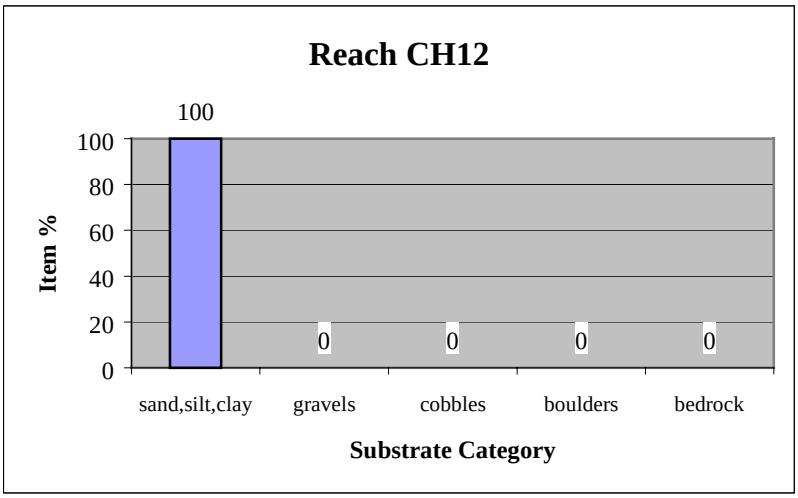

Reach CH7
Item %
100
80
60
40
20
0
63
25
13
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

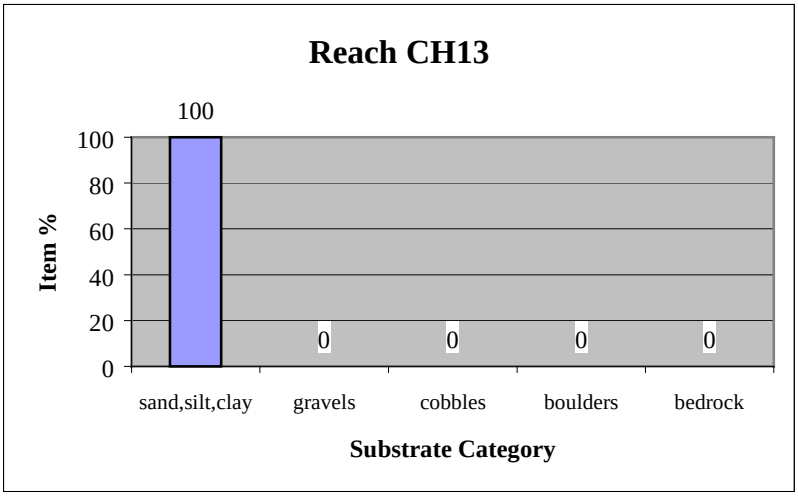

Reach CH8
Item %
100
80
60
40
20
0
100
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

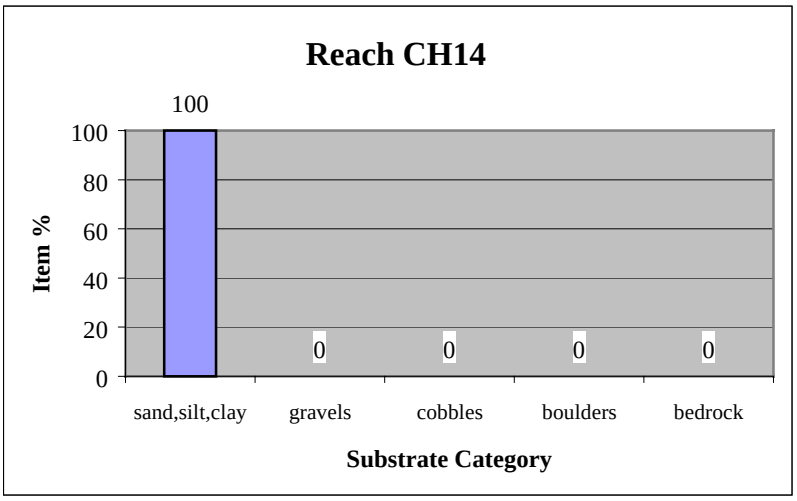

Reach CH9
Item %
100
80
60
40
20
0
100
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

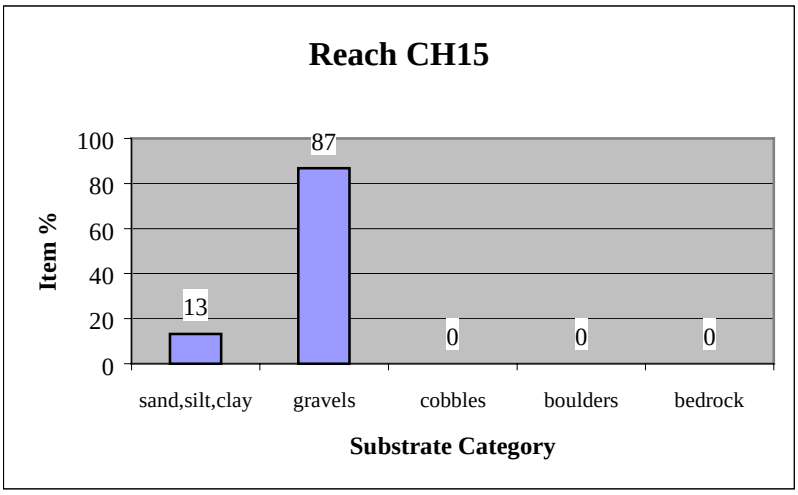

Reach CH10
100
100
80
60
40
20
0
Item %
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

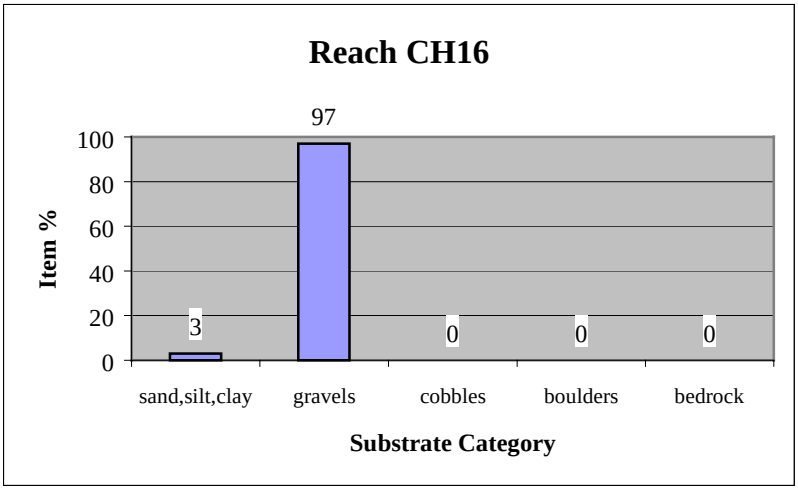

Reach CH11
100
100
80
60
40
20
0
Item %
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

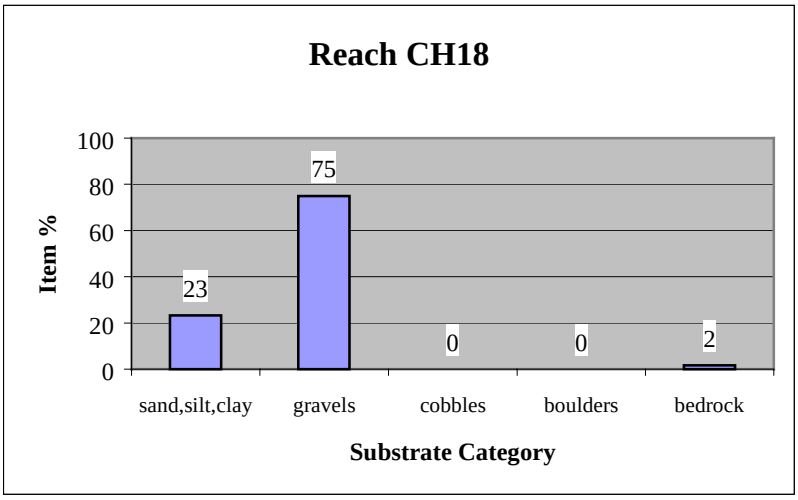

Reach CH12
100
100
80
60
40
20
0
Item %
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

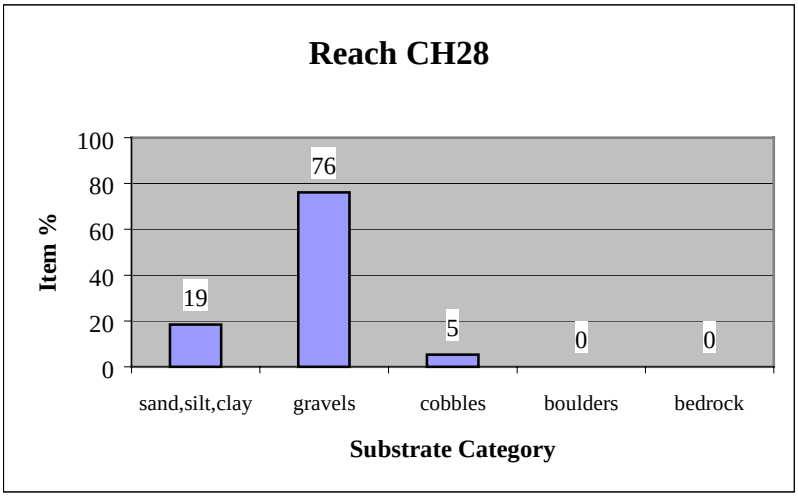

Reach CH13
100
100
80
60
40
20
0
Item %
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

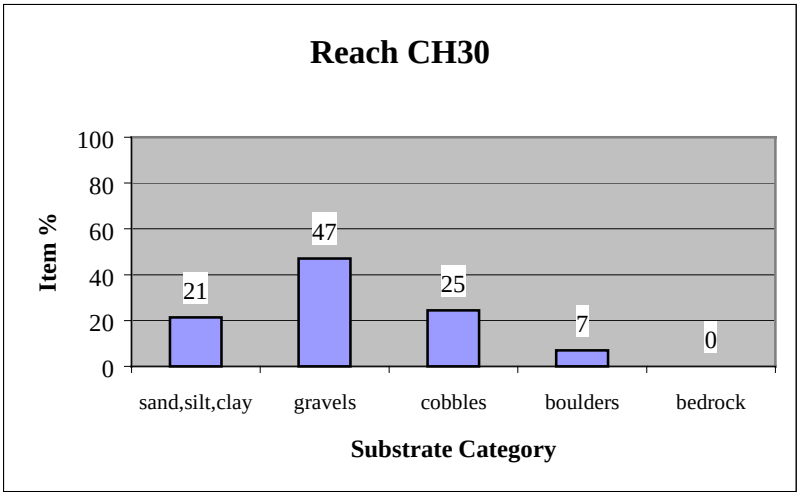

Reach CH14
100
100
80
60
40
20
0
Item %
0
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

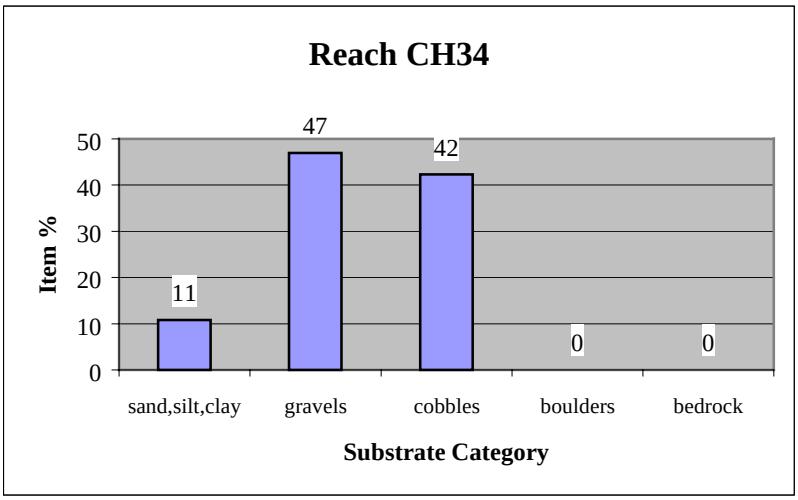

Reach CH15
100
87
80
60
40
20
0
Item %
13
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

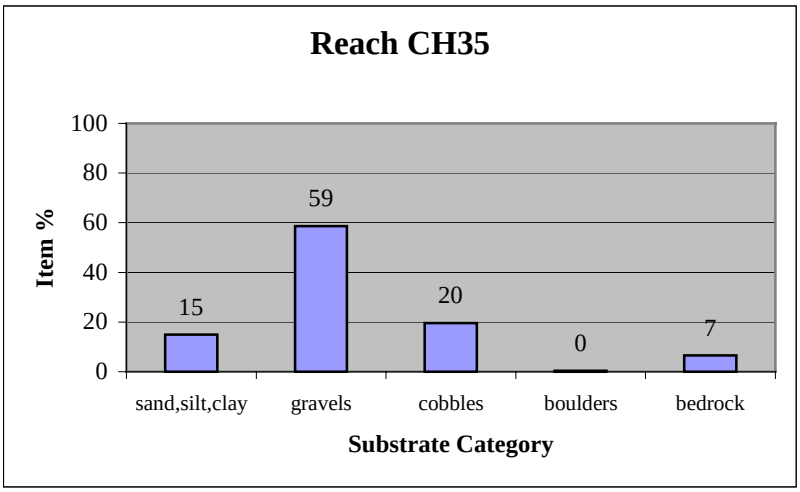

Reach CH16
Item %
100
80
60
40
20
0
97
3
0
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

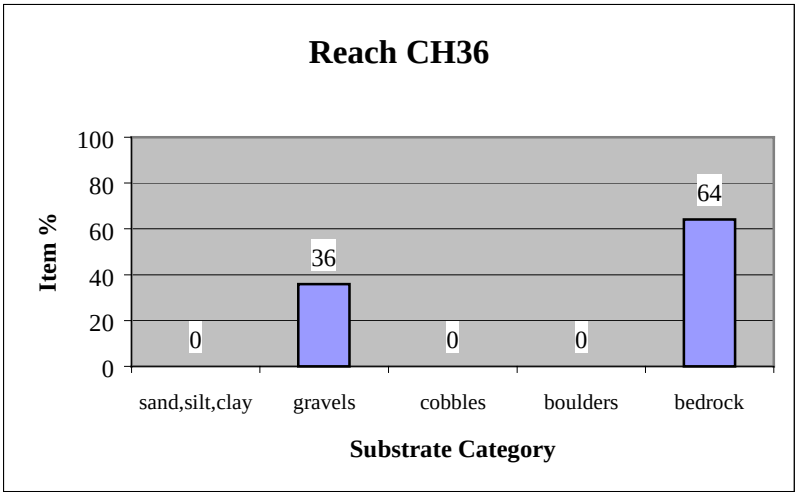

Reach CH18
Item %
100
80
60
40
20
0
75
23
0
0
2
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

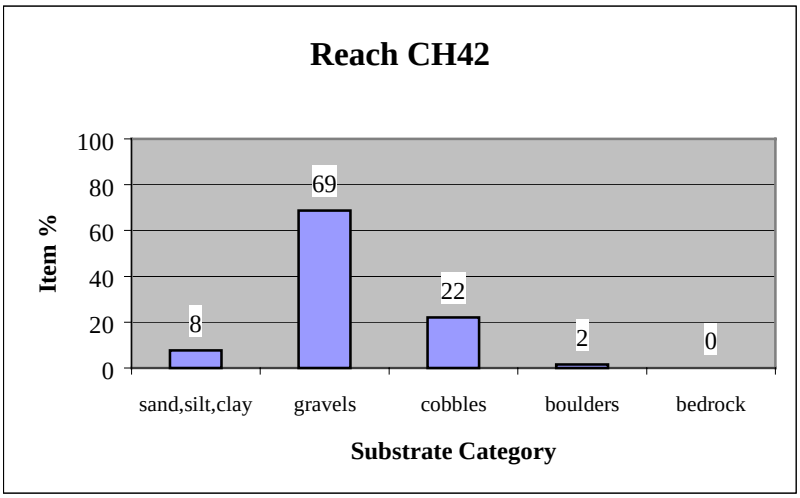

Reach CH28
Item %
100
80
60
40
20
0
76
19
5
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category


Reach CH30
Item %
100
80
60
40
20
0
21
47
25
7
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

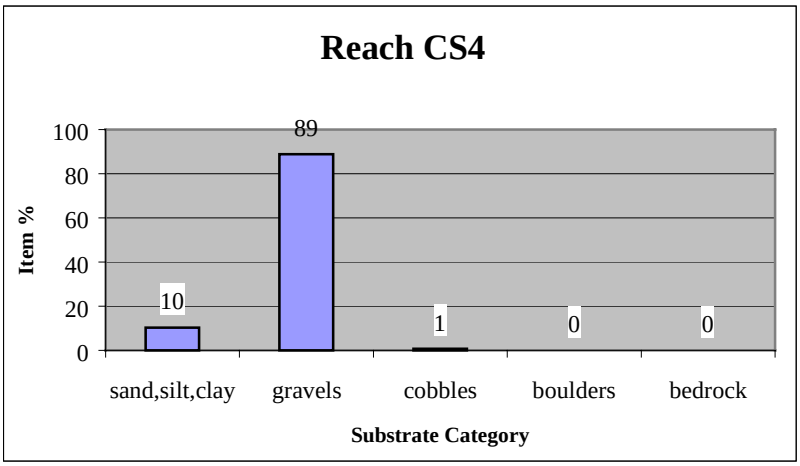

Reach CH34
Item %
50
40
30
20
10
0
11
47
42
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

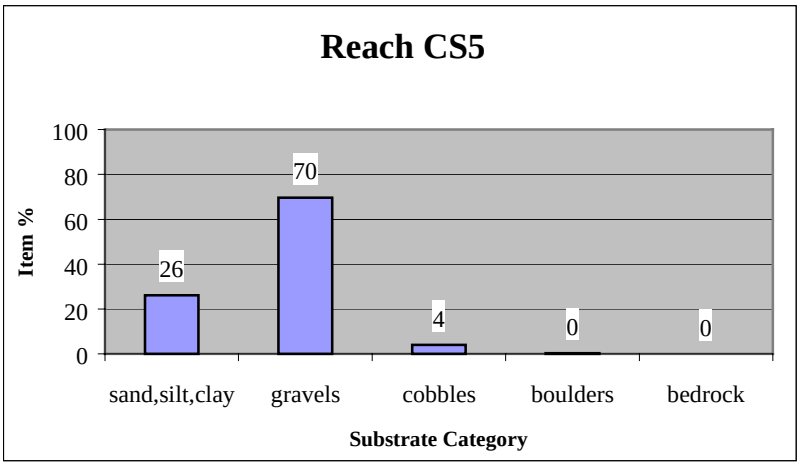

Reach CH35
Item %
100
80
60
40
20
0
15
59
20
0
7
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

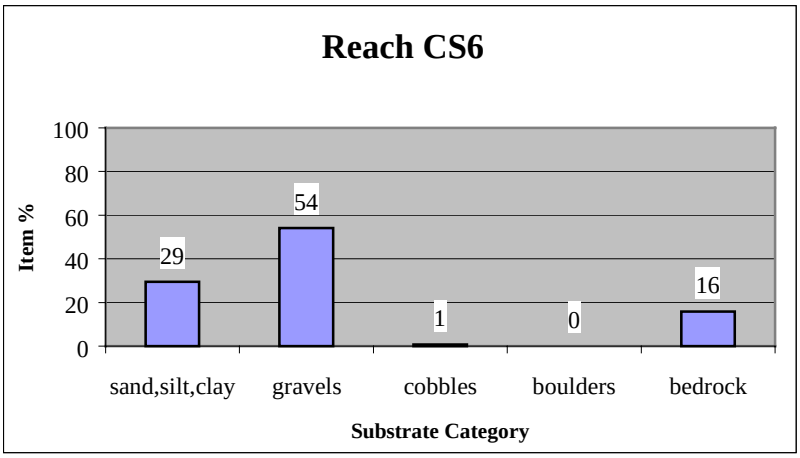

Reach CH36
Item %
100
80
60
40
20
0
0
36
0
0
64
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category


Reach CH42
Item %
100
80
60
40
20
0
8
69
22
2
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

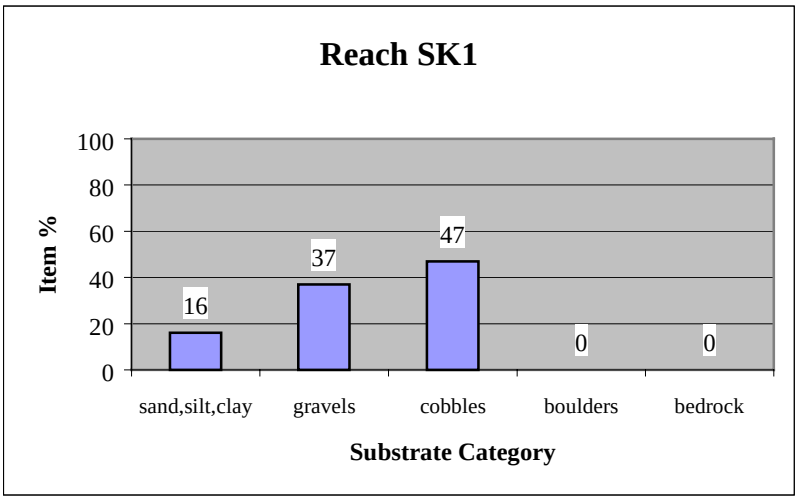
South Reach Chehalis

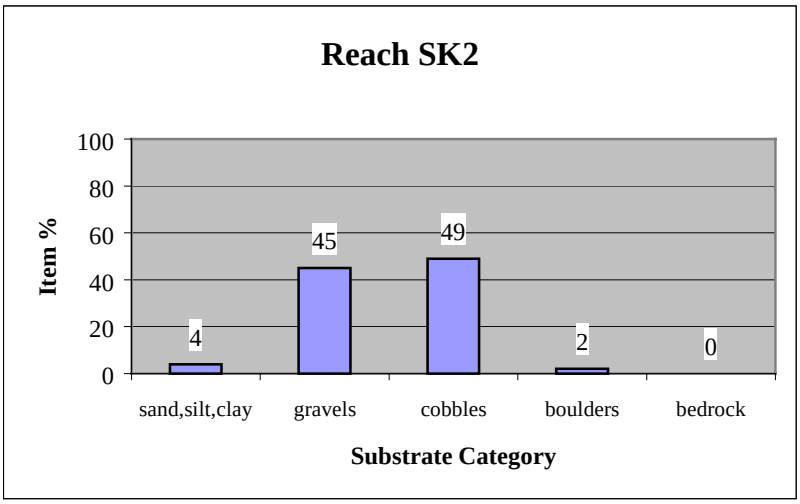


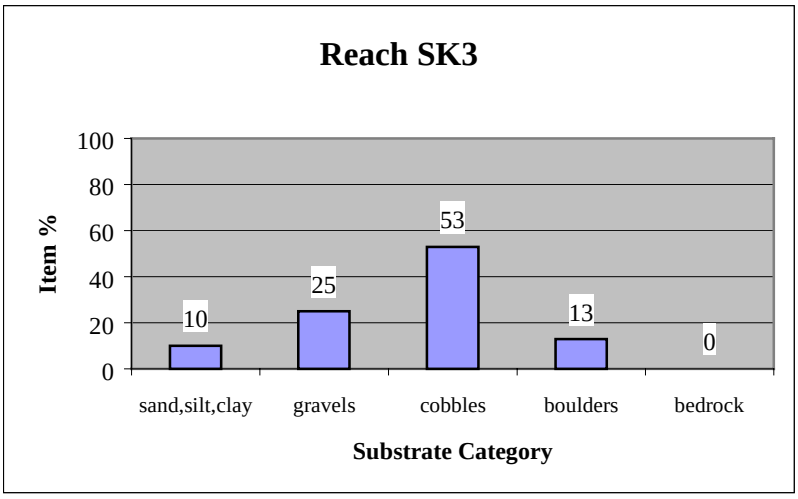


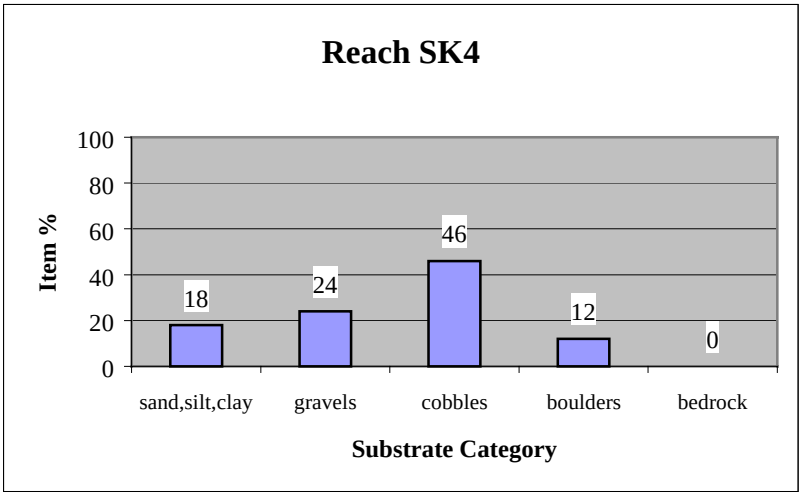


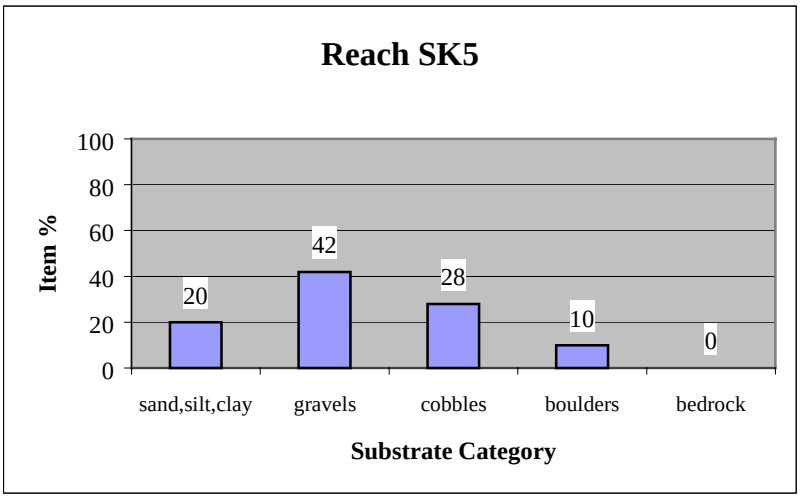
Skookumchuck

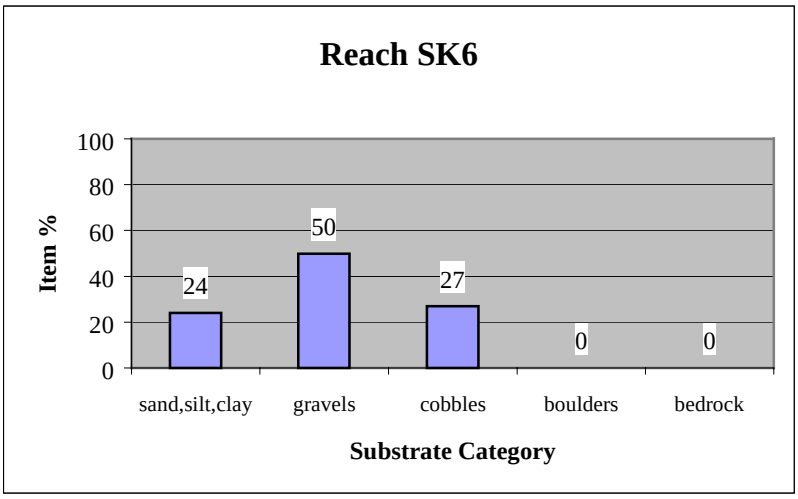


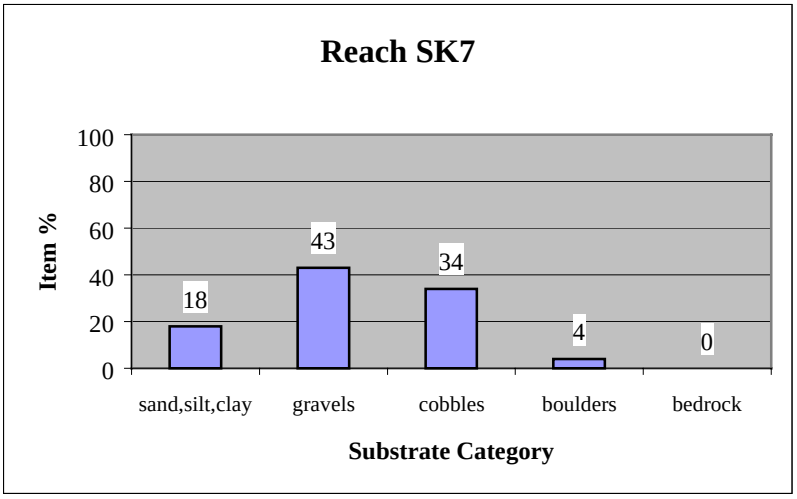


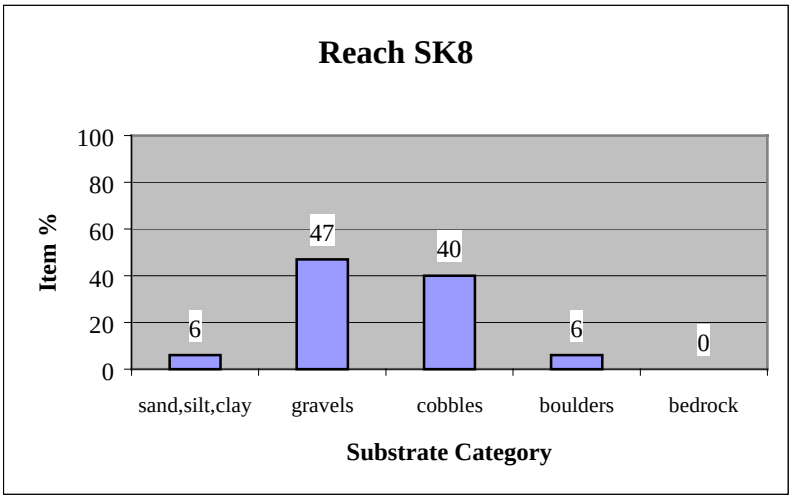


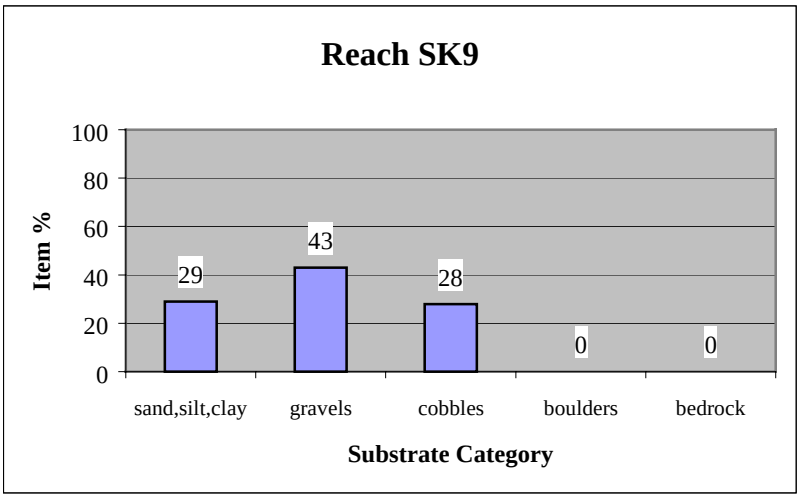

Reach SK4
Item %
100
80
60
40
20
0
18
24
46
12
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

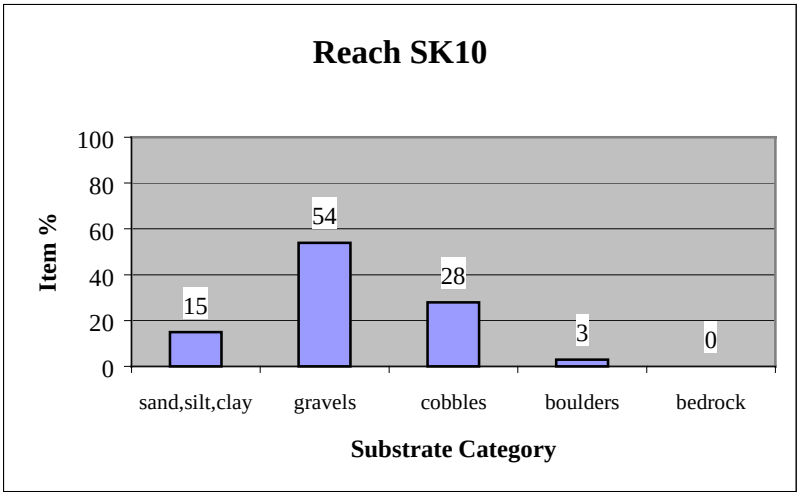

Reach SK5
Item %
100
80
60
40
20
0
20
42
28
10
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

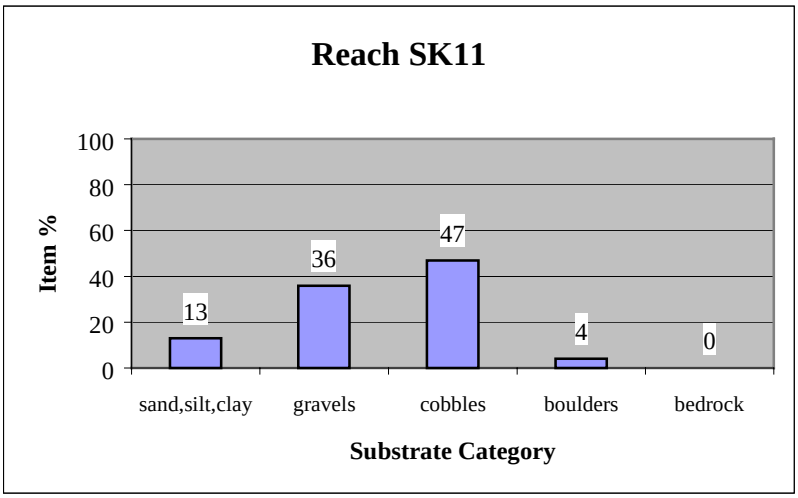

Reach SK6
Item %
100
80
60
40
20
0
24
50
27
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

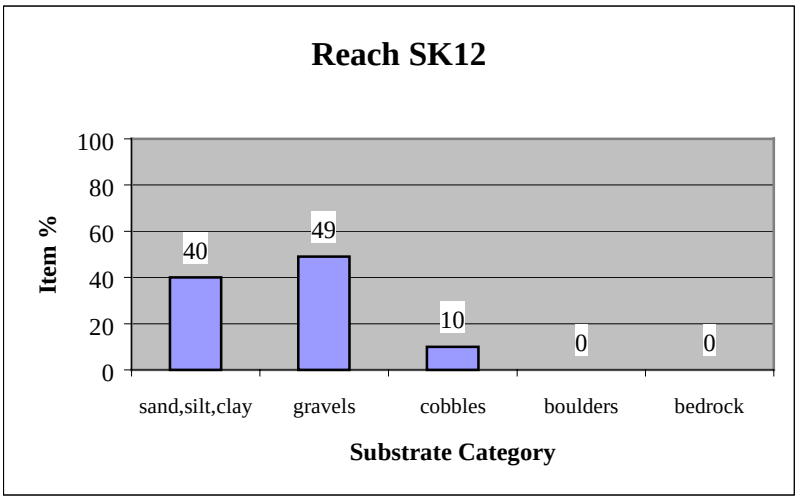

Reach SK7
Item %
100
80
60
40
20
0
18
43
34
4
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

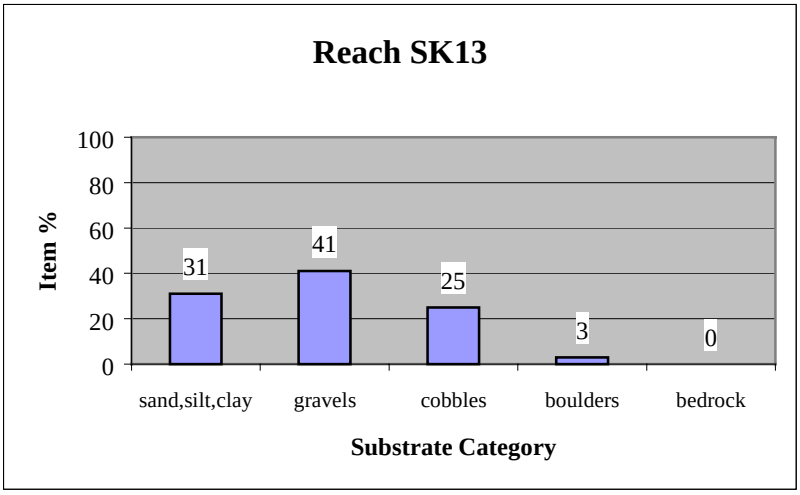

Reach SK8
Item %
100
80
60
40
20
0
6
47
40
6
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

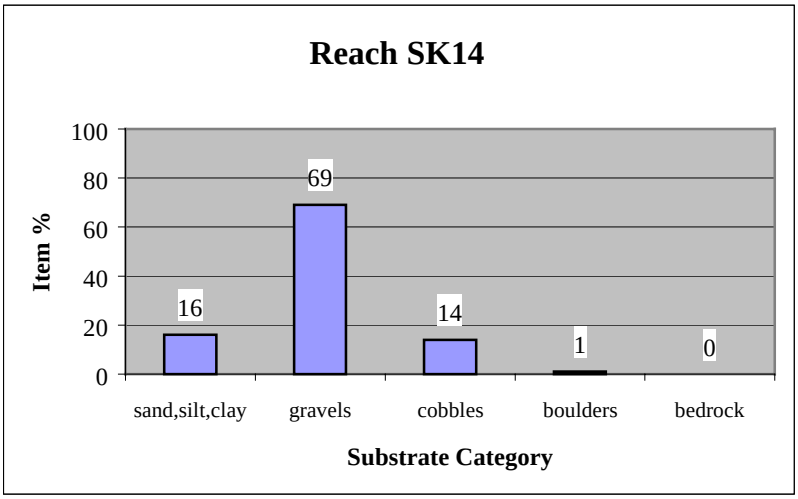

Reach SK9
Item %
100
80
60
40
20
0
29
43
28
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

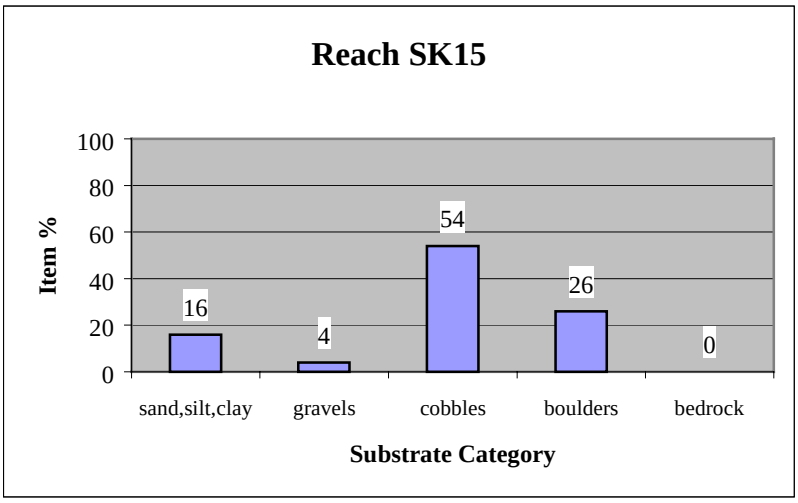

Reach SK10
Item %
100
80
60
40
20
0
15
54
28
3
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

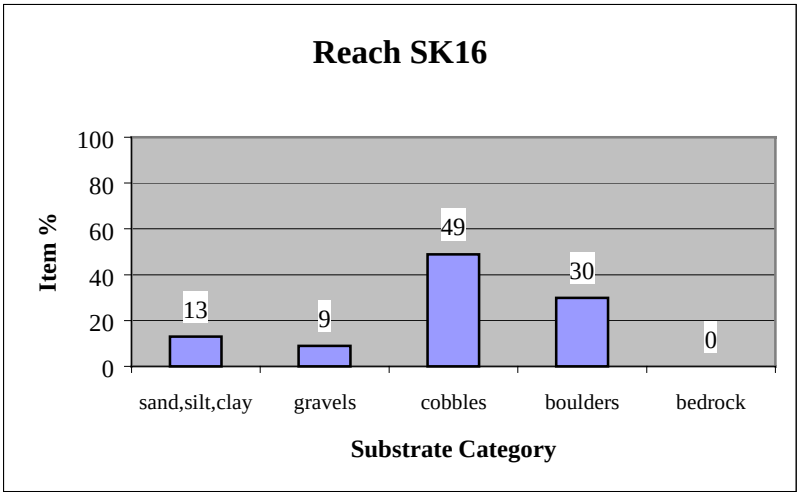

Reach SK11
Item %
100
80
60
40
20
0
13
36
47
4
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

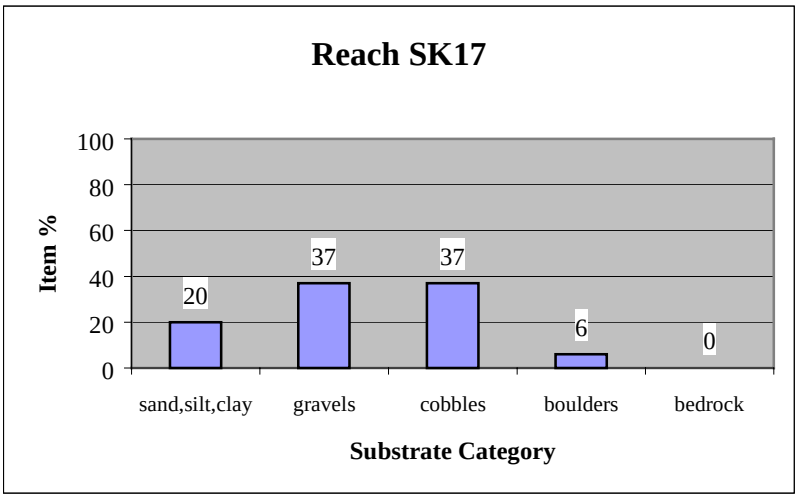

Reach SK12
Item %
100
80
60
40
20
0
40
49
10
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

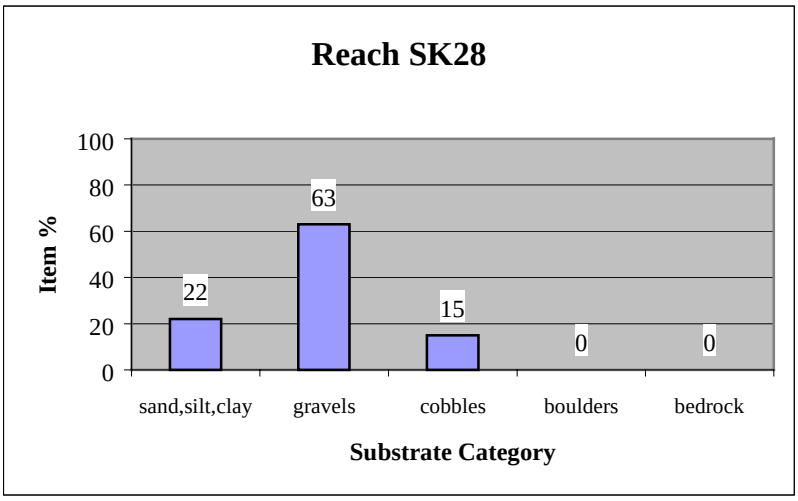

Reach SK13
Item %
100
80
60
40
20
0
31
41
25
3
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

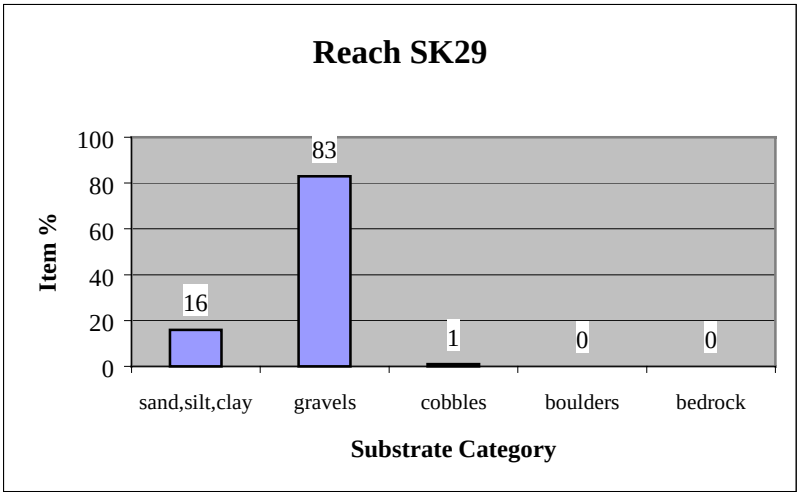

Reach SK14
Item %
100
80
60
40
20
0
16
69
14
1
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

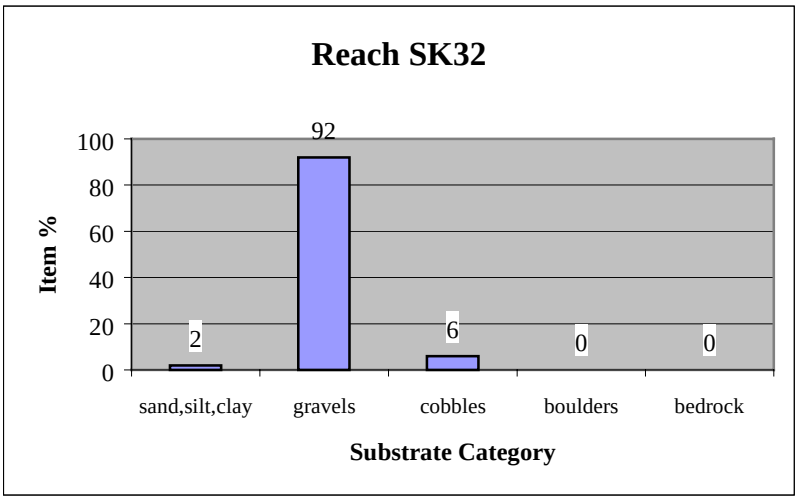

Reach SK15
Item %
100
80
60
40
20
0
16
4
54
26
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

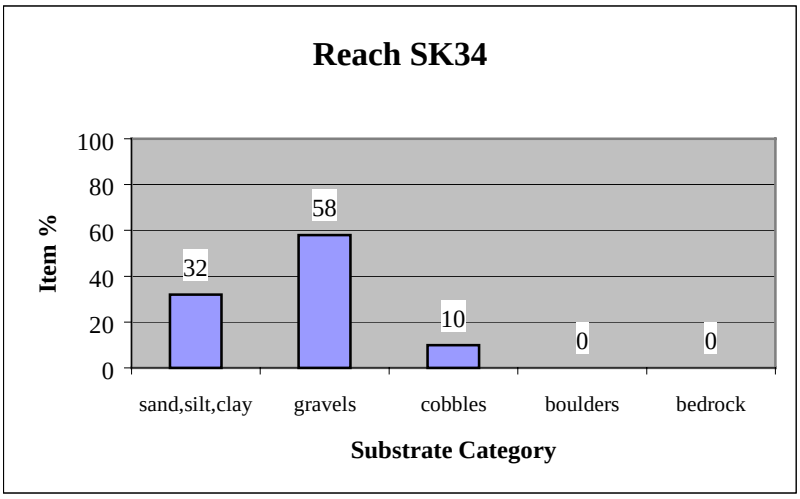

Reach SK16
Item %
100
80
60
40
20
0
13
9
49
30
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

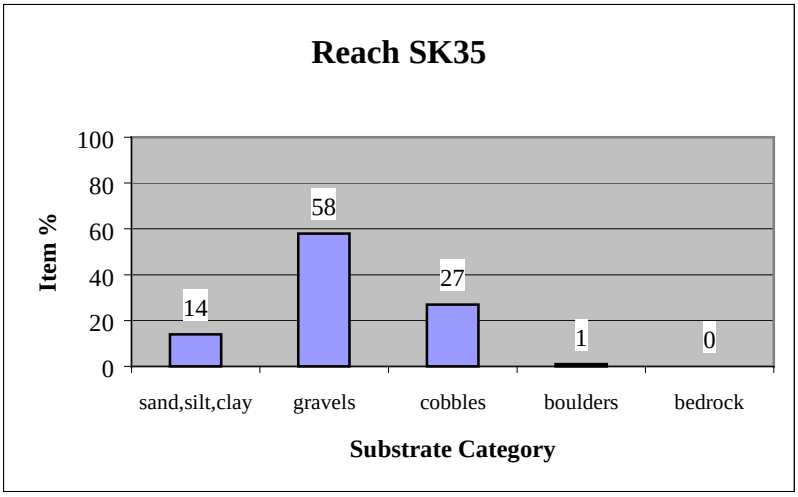

Reach SK17
Item %
100
80
60
40
20
0
20
37
37
6
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

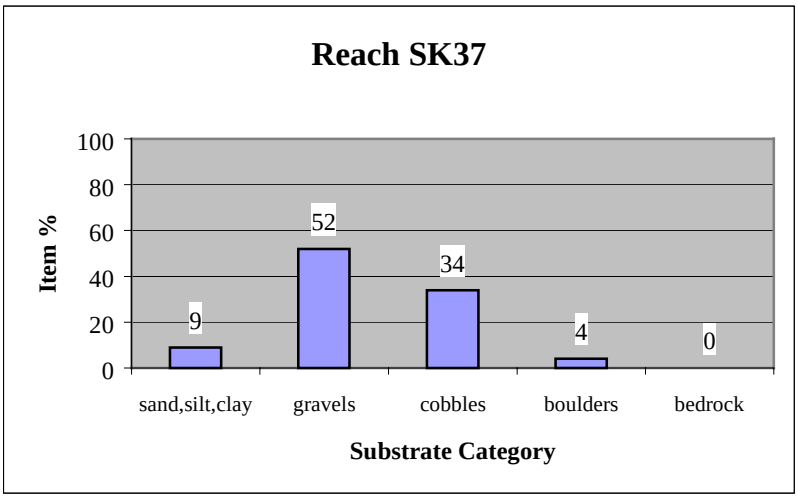

Reach SK28
Item %
100
80
60
40
20
0
22
63
15
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

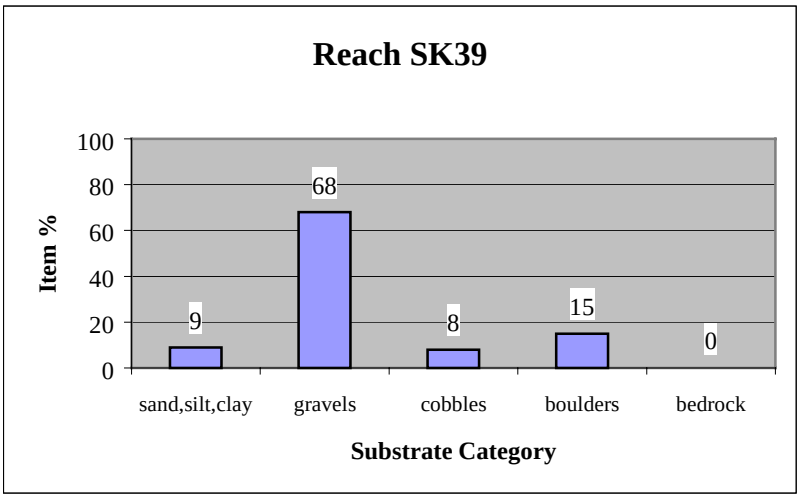

Reach SK29
Item %
100
80
60
40
20
0
16
83
1
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

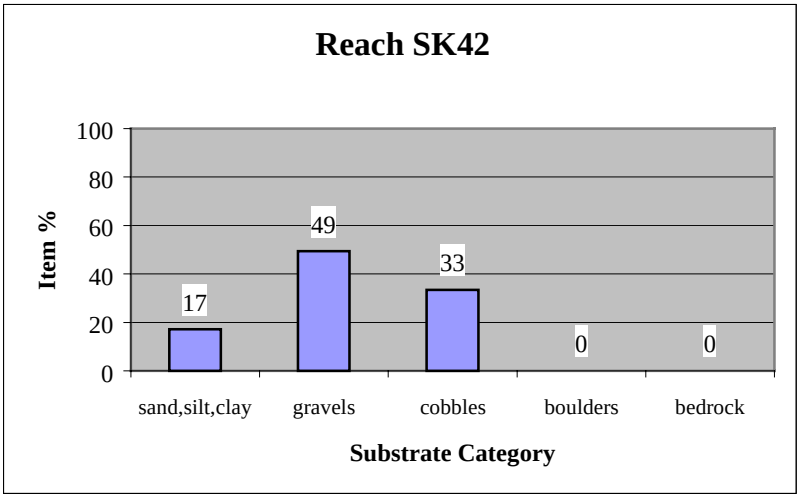

Reach SK32
Item %
100
80
60
40
20
0
2
92
6
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

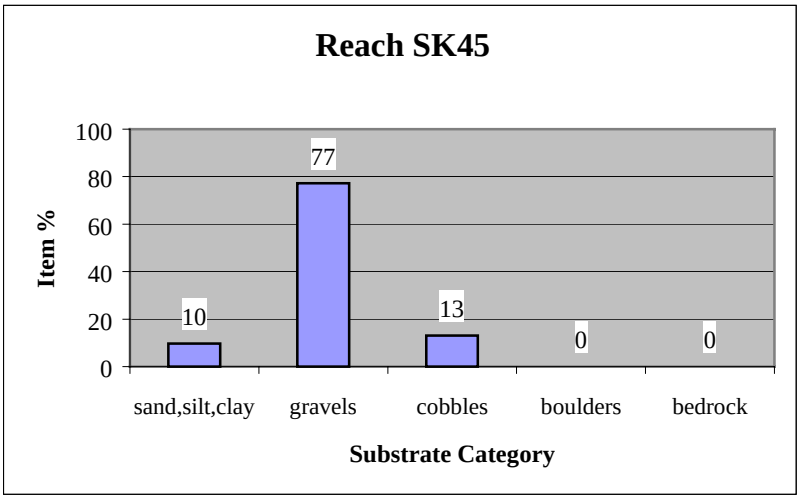

Reach SK34
Item %
100
80
60
40
20
0
32
58
10
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

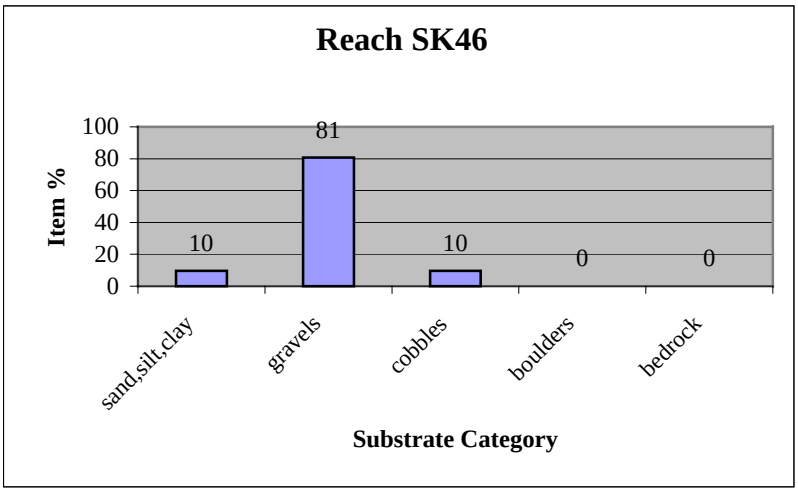

Reach SK35
Item %
100
80
60
40
20
0
14
58
27
1
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

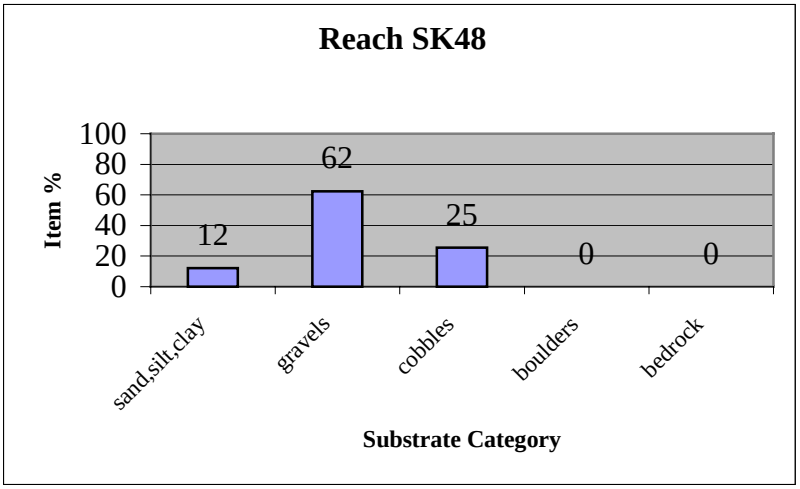

Reach SK37
Item %
100
80
60
40
20
0
9
52
34
4
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

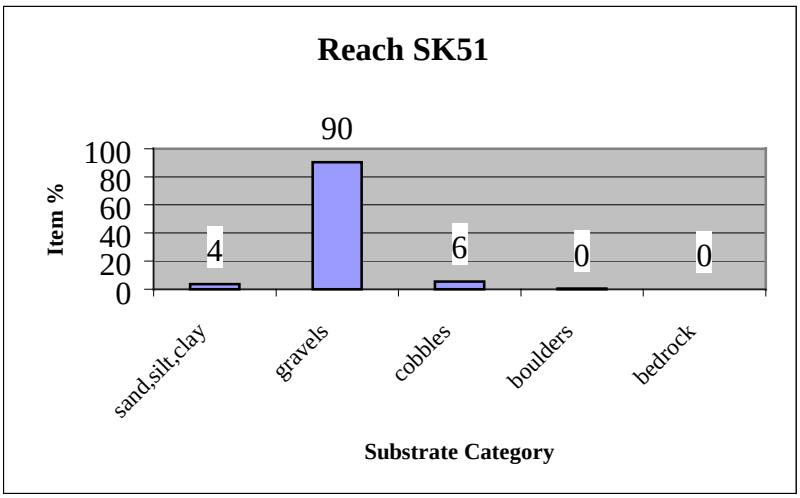

Reach SK39
Item %
100
80
60
40
20
0
9
68
8
15
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

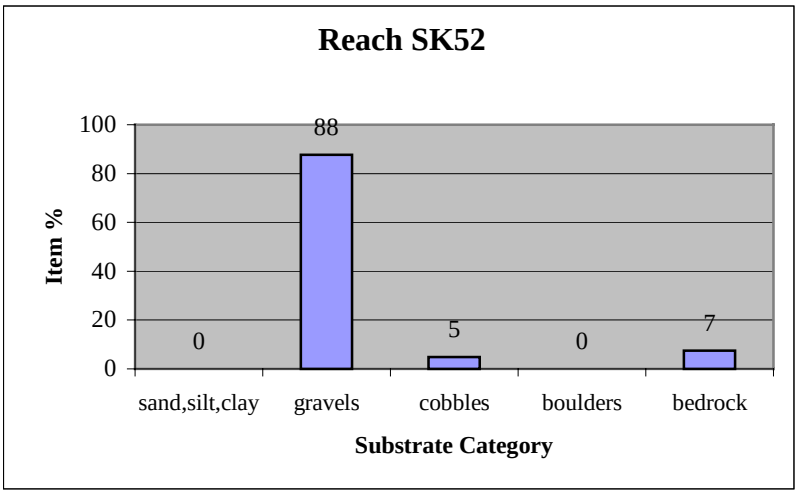

Reach SK42
Item %
100
80
60
40
20
0
17
49
33
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

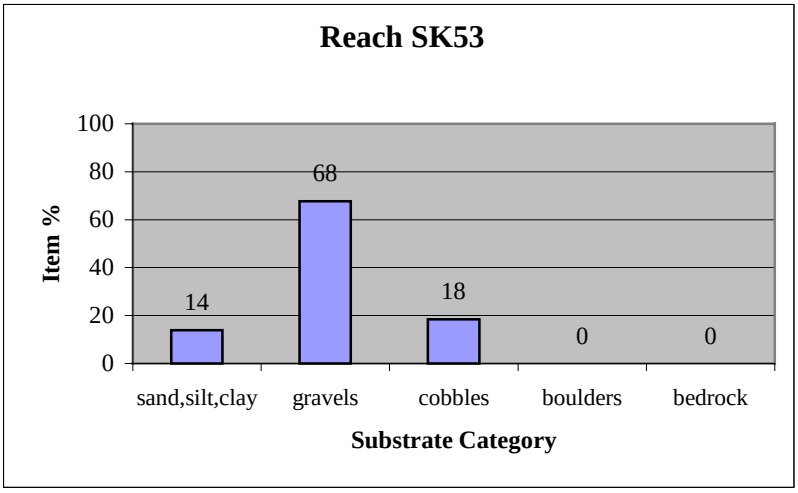

Reach SK45
Item %
100
80
60
40
20
0
10
77
13
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

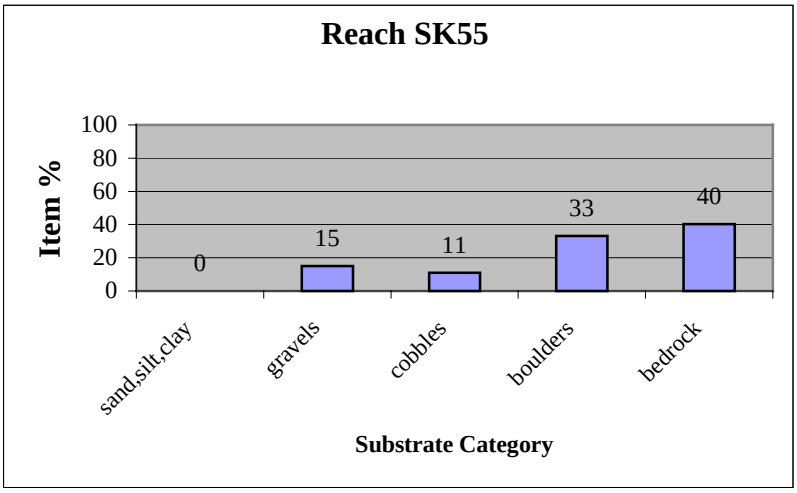

Reach SK46
Item %
100
80
60
40
20
0
10
81
10
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

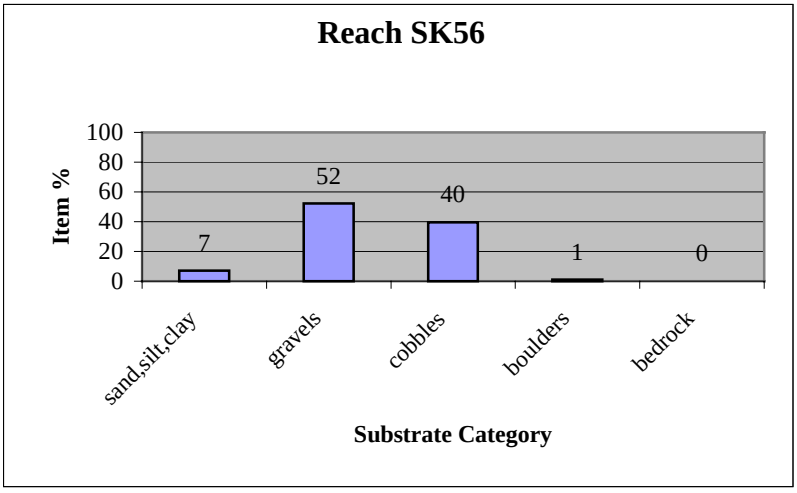

Reach SK48
Item %
100
80
60
40
20
0
12
62
25
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category


Reach SK51
Item %
100
80
60
40
20
0
4
90
6
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

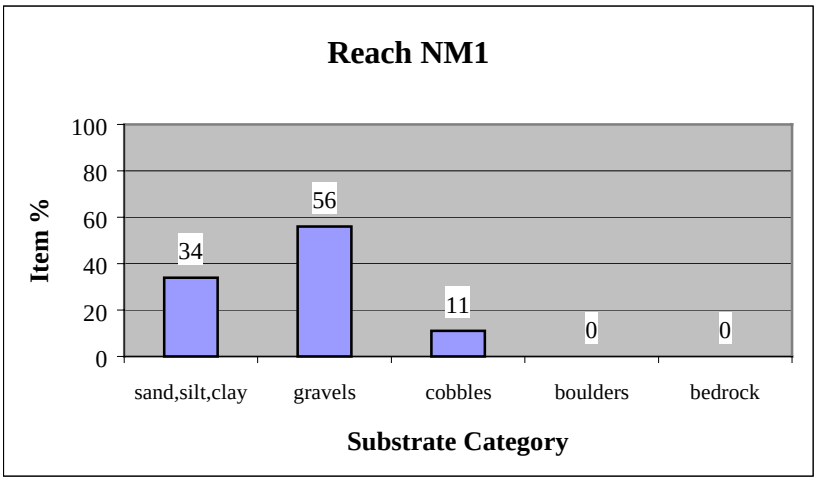

Reach SK52
Item %
100
80
60
40
20
0
0
88
5
0
7
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

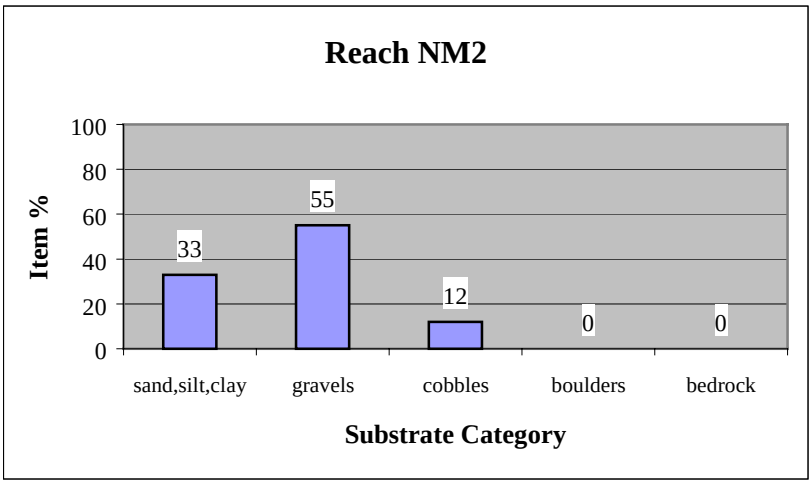

Reach SK53
Item %
100
80
60
40
20
0
14
68
18
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

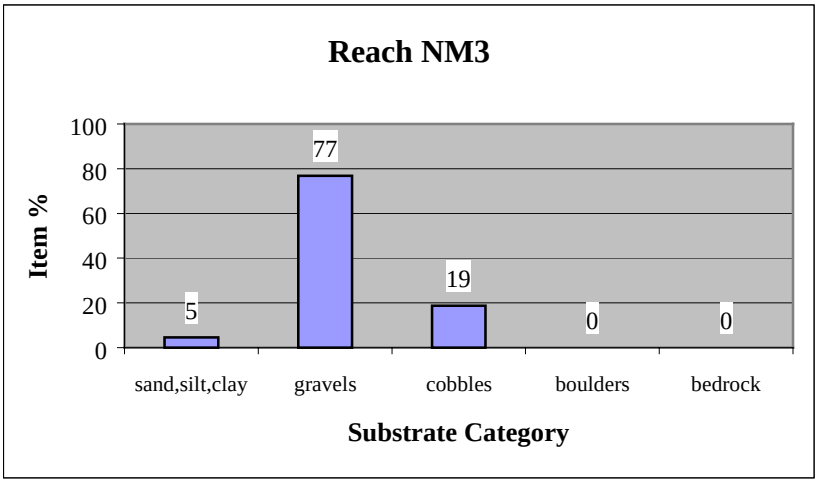

Reach SK55
Item %
100
80
60
40
20
0
0
15
11
33
40
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category


Reach SK56
Item %
100
80
60
40
20
0
7
52
40
1
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

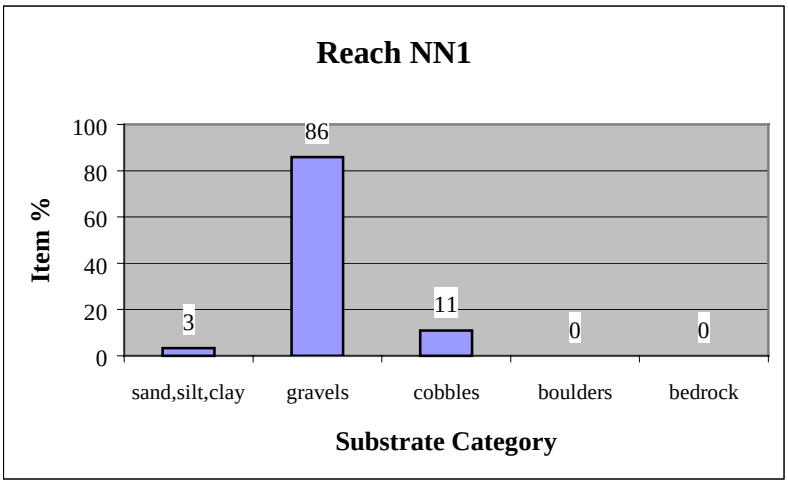
Mainstem Newaukum

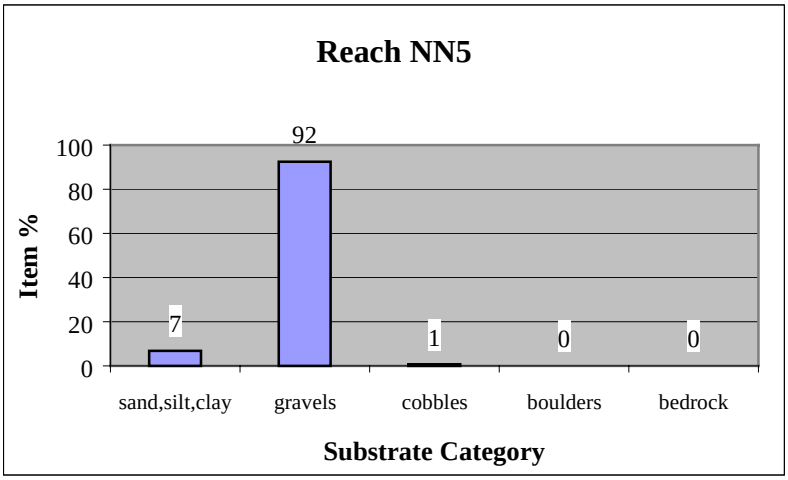


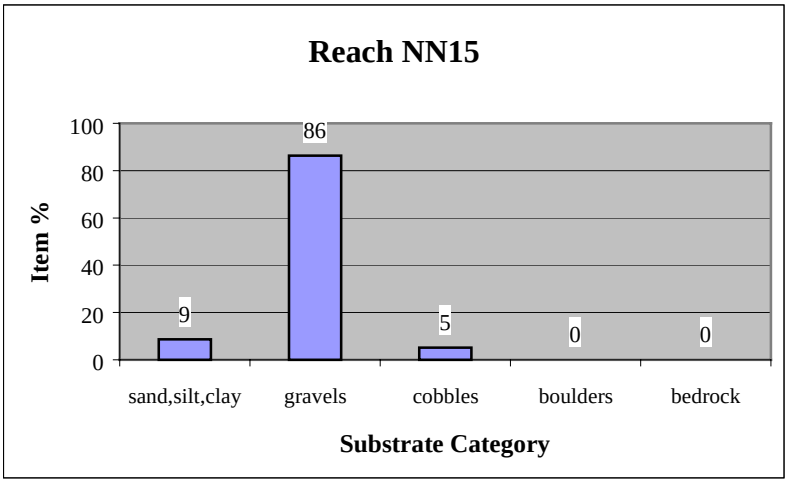


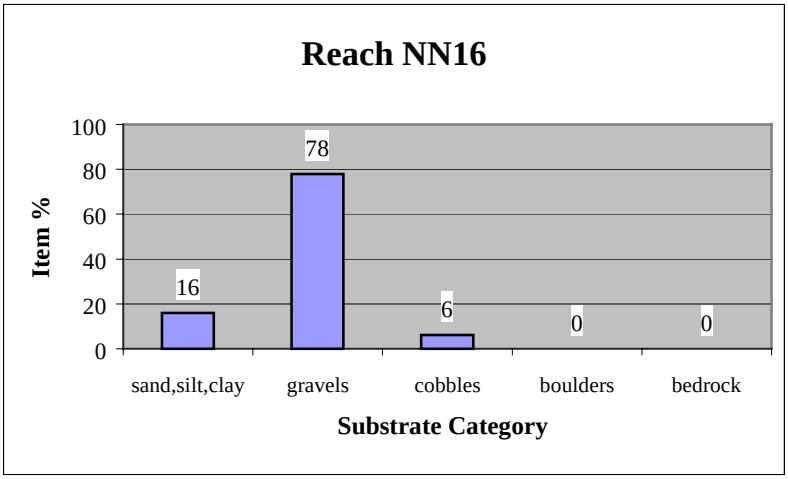


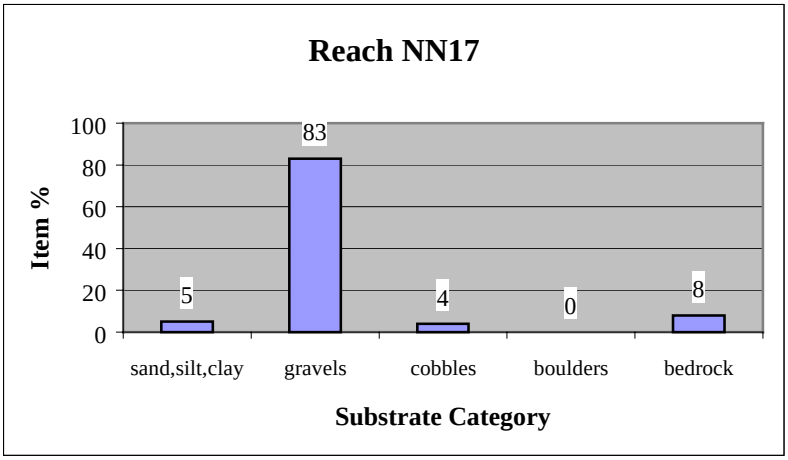
North Fork Newaukum



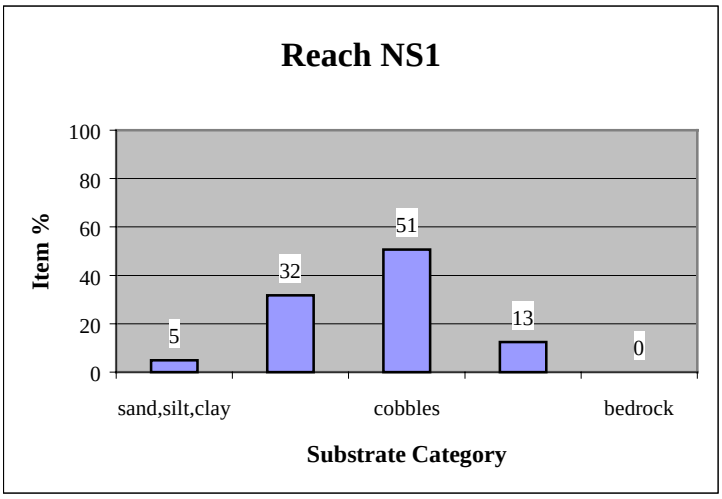


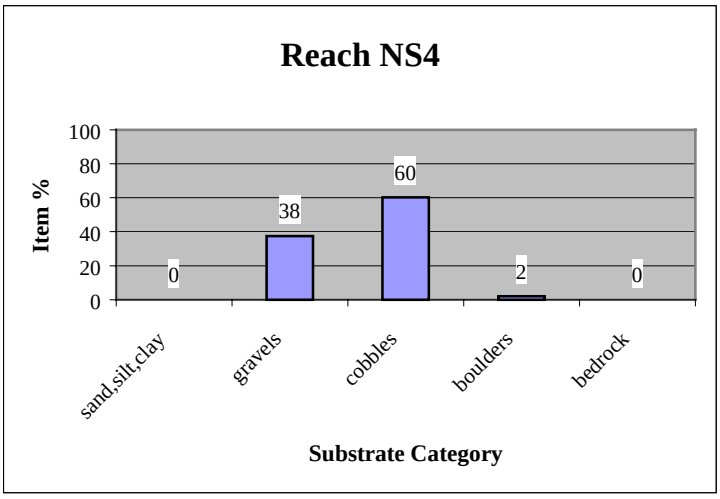


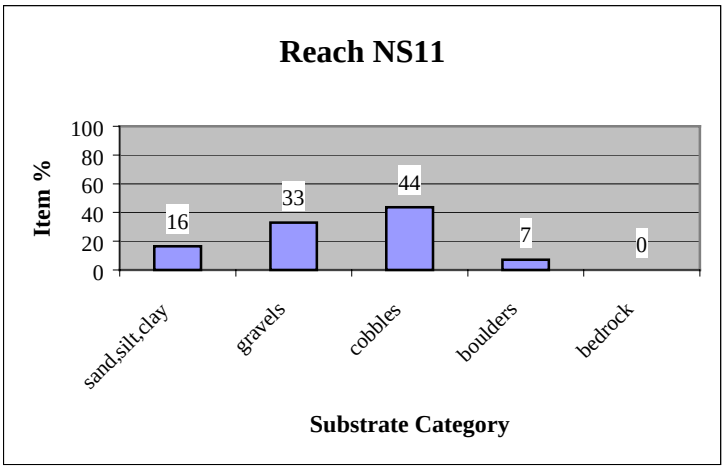

Reach NN16
Item %
100
80
60
40
20
0
16
78
6
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

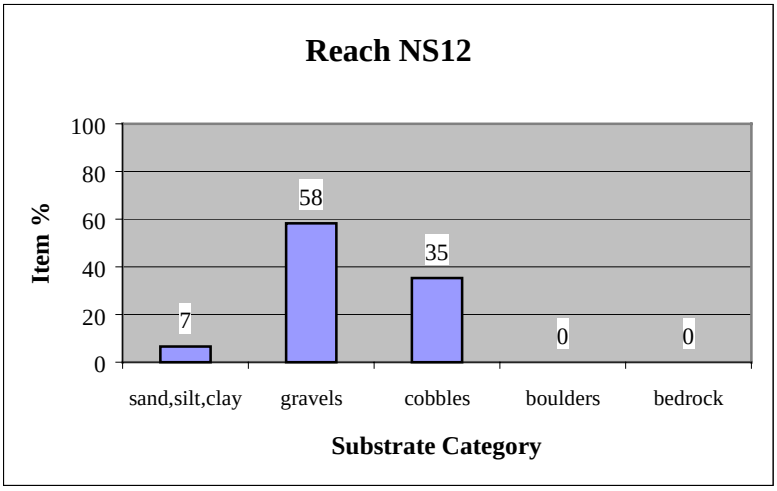

Reach NN17
Item %
100
80
60
40
20
0
5
83
4
0
8
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category

South Fork Newaukum








Reach NS12
Item %
100
80
60
40
20
0
7
58
35
0
0
sand,silt,clay
gravels
cobbles
boulders
bedrock
Substrate Category