Little Quilcene-Leland Watershed
Rapid Habitat Assessment and Prioritized Restoration Framework

Technical Report

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Executive Summary

This report summarizes the findings of an aquatic habitat condition assessment of the Little Quilcene River and its tributaries on the Olympic Peninsula of Washington State. Field surveys and reporting were completed by Wild Fish Conservancy Northwest for Pacific Ecological Institute, with overall project goals intended to rapidly assess the current habitat conditions within the Little Quilcene watershed, and to generate an inaugural framework for future restoration and recovery of the entire watershed and its component systems and processes. Project elements were multi-faceted and interrelated; intended to provide the ecological background and basis for future on-the-ground restoration work. To this end, Wild Fish Conservancy staff and field personnel reviewed and synthesized background literature and past research relevant to aquatic habitat conditions in the Little Quilcene River, Ripley Creek, Howe Creek, and Leland Creek sub-basins, and collected and analyzed data documenting the current condition of in-stream and riparian habitats, and spawning by anadromous and resident salmonids. An examination of the loss of habitat connectivity throughout the watershed included a review of known water diversions and anthropogenic barriers to fish migration, and field assessments and cataloguing of previously unidentified fish passage barriers caused by infrastructure and urban and rural development. Wild Fish Conservancy also conducted an extensive water type survey of headwater tributary streams with the goal of identifying previously unclassified fish-bearing habitat, and correcting errors in the mapping of streams and fish habitat by state regulatory agencies. The distribution and composition of juvenile and resident freshwater fish species (with an emphasis on salmonids) was ascertained in headwater basins during these water typing efforts, contributing to a better understanding of fish use throughout the watershed.

Habitat conditions were found to be poor-to-fair throughout the surveyed reaches of the mainstem Little Quilcene and major tributaries, with lower and mid-valley reaches of the Little Quilcene River and Leland Creek particularly degraded in their ability to sustain and support aquatic ecosystem functionality. However, findings of this study also revealed great potential to reverse the trend of the past century of aquatic and riparian habitat degradation, and to provide for better habitat conditions for anadromous and resident fish, and other aquatic organisms inhabiting the stream channel and riparian corridor network in the Little Quilcene sub-basin.

Several related activities will contribute to future recovery of the watershed. Riparian corridor preservation and re-forestation provides for stream shading and mitigation of summer temperature maxima, streamside cover for fish and other aquatic and riparian-dependent wildlife, infiltration, storage, and slow-release of precipitation that sustains the historic hydrological regime, reduction of fine sediment delivery into the stream system from damaged headwater tributary channels, deforested valley slopes, and unstable roads, and the future recruitment of persistent large woody debris into stream channels. Removal of bank armament structures that currently confine waterways will restore the natural erosion processes that create a meandering stream within the channel

migration zones, and play a vital role in the maintenance of in-stream and riparian habitat diversity. Supplementation of in-stream large woody debris structures imparts another factor in the creation and maintenance of channel habitat diversity via pool and side channel formation, substrate scour and re-distribution, and long-term stream bank and gravel bar stability. Large woody debris is also a vital component of stream nutrient input, locking of fine sediments, and the retention of spawning gravels for fish.

Restoration of watershed connectivity by replacement or repair of anthropogenic structures that currently hinder the natural migration of fish throughout the stream network will result in increased production potential for anadromous and resident species, including stocks that are currently listed as threatened under the Endangered Species Act (hood canal summer chum salmon, Puget Sound chinook salmon, Puget Sound steelhead trout, and native bull trout). Connectivity also encompasses that part of the watershed that we cannot observed directly, but is imperative for proper functioning of the local hydrology. Groundwater moves throughout the hyporheic network, feeding surface springs that provide perennial flow to stream-adjacent and headwater wetlands. Protection of these wetland reaches from damaging timber harvest and residential development practices (wetland draining and clearing, groundwater pumping for wells, and surface water diversion for agriculture) is critical to maintaining the surface and sub-surface flow regime throughout the downstream watershed, particularly in the late-summer to early-fall drought period, when sustaining surface flows for resident fish populations are naturally limited in the Little Quilcene sub-basin.

A number of specific habitat restoration options are discussed in Part II of the report, but it is also hoped that this document will be used as a template to explore further opportunities for restoration throughout the greater Little Quilcene – Leland Creek community watershed, using the detailed recommendations as examples. Some landowners contacted during the course of this study were either unaware or indifferent to the presence of salmonids and other native fish and aquatic organisms in tributary streams transiting their properties. In a very few cases, outright hostility was encountered due to a general lack of understanding about the role of regulatory agencies in stream and riparian corridor protection (i.e. the fear of “the hammer”). Project partners (WFC, PEI) wish to highlight throughout this process that, although change is oftentimes slow to materialize, an emphasis on workable solutions and consensus-building is generally more productive in creating and upholding an environment where stakeholders are all working toward a similar goal – a healthy, life-sustaining watershed for people, wildlife, and fish.

Photo 1 – Little Quilcene River flowing through a rural landscape in east Jefferson County.

Introduction

Through the initial phase of their "Citizen Watershed Assessment Program", Pacific Ecological Institute (PEI) seeks to organize local stakeholders to provide input and generate workable solutions for watershed management issues in the Little Quilcene River basin. To understand the watershed-specific problems and potential solutions, and to implement aquatic habitat restoration at a watershed scale, PEI also solicits the expertise of local and regional aquatic resource and fish habitat restoration consultants. Throughout 2006 and 2007, PEI consulted planning experts, members of the Quilcene-area community, and the available scientific literature and public policy papers to develop a targeted scope of work for habitat and water quality assessment within the Little Quilcene River – Leland Creek sub-basin. The scope of work focused on reach break assessment, stream channel mapping, water typing, fish composition and distribution assessment, and fish habitat assessment, to accomplish the following goals:

- Develop site-specific protection and restoration priorities within a watershed context;
- Develop a hierarchical strategy for protection and restoration of landscape processes that form and sustain diverse conditions and habitats within the watershed, focusing on protecting high quality, intact fish habitat, reconnecting isolated high quality fish habitat, and restoring landscape processes;
- Create a framework to support and expedite priority restoration actions within the watershed; and

- Proactively identify and recommend means to defuse existing watershed or land-use “time bombs” that could potentially alter or disrupt aquatic habitat functions in the future.

In early 2007, PEI partnered with Wild Fish Conservancy Northwest (WFC) to provide scientific consultation for a Rapid Habitat Assessment designed to quickly and accurately evaluate the current habitat conditions within the Little Quilcene River sub-basin, to help identify potential threats and opportunities in the watershed, and to generate a priority framework for future on-the-ground restoration. Through science, education, and advocacy, Wild Fish Conservancy promotes technically and socially responsible habitat, fisheries, and hatchery management to better sustain the region’s wild-fish heritage. Beginning in Spring 2007, PEI solicited comment from WFC staff to fine-tune the scope of work agreement, which serves as the basis for the ongoing PEI-WFC partnership.

Background

Watershed setting – The Little Quilcene River discharges to Quilcene Bay on Hood Canal just east of the town of Quilcene, in east Jefferson County, Washington. The approximately 30-square mile watershed is bounded by the Salmon-Snow Creek watershed to the north, several small, independent watersheds to the east (Donovan, Thorndyke, and Tarboo Creeks), and the Big Quilcene and Dosewallips watersheds to the south and west, respectively. There are 12.2 miles of mainstem channel, and a combined total tributary length of 81.2 miles. The only significant lakes within the boundaries of the Little Quilcene sub-basin are Lake Leland (108 acre surface area) in the Leland Creek tributary valley, and Lords Lake, a municipal water storage reservoir on a dammed headwater tributary of Howe Creek. Additionally, several large forested wetlands / beaver pond complexes contribute surface water storage and year-round flow to the upper Little Quilcene and its tributaries. A formerly extensive cedar forest wetland in the Leland Creek valley (to the north of Lake Leland) was historically logged, ditched, and drained during the conversion of the valley bottomland to agriculture, and was further truncated and channelized by the construction of the adjacent US Highway 101.

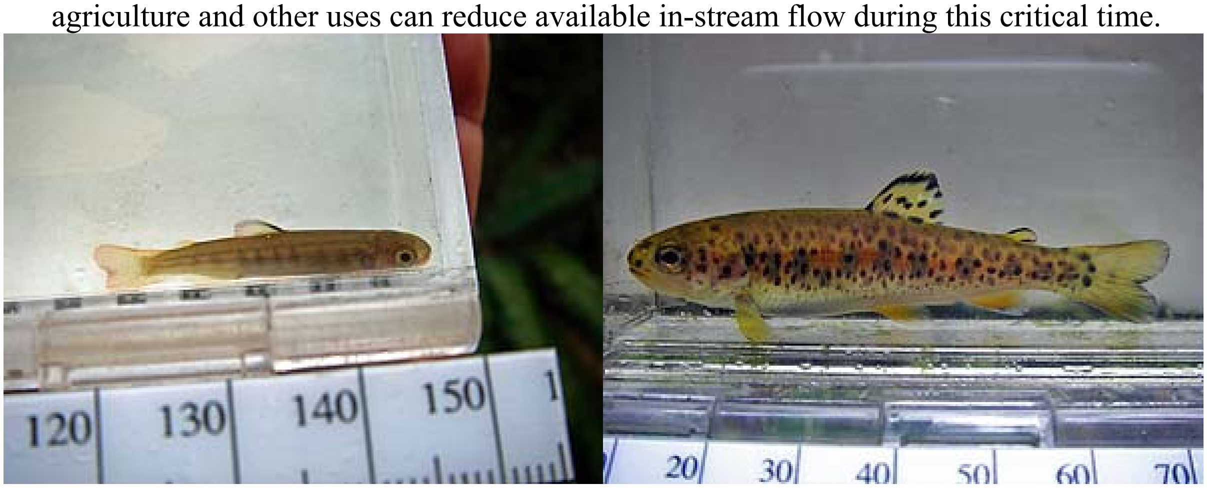
Geologically, the upstream one-third of the watershed lies within the basalt-rich, erosion-resistant Crescent formation, which tends to contribute to the formation of steeply dissected stream valleys, often confined within narrow bedrock canyons. Anadromous fish habitat within this upper watershed reach is limited by natural barrier falls/cascades on both the mainstem and major tributaries. This headwater district includes lands with extensive past and ongoing timber harvest activities managed by the US Forest Service as well as private forest resource managers (primarily Pope Resources / Olympic Resources Management – mapped ORM properties can be viewed at http://www.orminc.com).

Photo 2 – Re-forestation of a clearcut headwater slope in the Little Quilcene River sub-basin. Forest lands in the upper watershed are managed for high timber yield.

From approximately river mile 6.6 downstream to the mouth (including such larger tributaries as Leland, Ripley, and Howe Creeks), the geologic character of the sub-basin becomes dominated by unconsolidated glacial sediments inter-bedded with siltstone and sandstone, and river-deposited gravel alluvium (Grimstad and Carson 1981). The overall gradient moderates, though stream channels are still somewhat confined by foothills and steep valley walls. This middle portion of the watershed contains extensive low-gradient anadromous fish habitat, with dominant land uses in state and private forestland, small-scale agriculture, and rural residential housing. The lower 1.8 river miles traverse a broad floodplain delta, and the Little Quilcene River enters an extensive tidal estuary at the head of Quilcene Bay (the western arm of Dabob Bay on Hood Canal), approximately one mile north from the Big Quilcene River mouth. Extensive dikes and bank armoring that were historically constructed to protect private residences and roadway infrastructure truncate the lower river channel and floodplain in and around the town of Quilcene.

Photo 3 – Wild Fish Conservancy field crews reconnoiter a sub-reach (1A) along the lower Little Quilcene River that has been subject to over-development – note bank armoring and landscaped lawn (w/ non-native vegetation) extending to river's edge.

Lying within the rainshadow of the Olympic Mountains, stream flows and groundwater recharge rates are naturally limited in the Little Quilcene and surrounding tributary basins. Average annual precipitation in the upper watershed is less than 50 inches, with approximately 70% falling during the wet winter months (November-April). Thus, water levels are at their lowest during the much drier late summer and early fall seasons; also the time when migrating adult salmon return to the mainstem Little Quilcene River and its tributaries to spawn. Because they tend to rear in off-channel habitats and headwater habitats respectively, juvenile coho salmon and resident trout are particularly sensitive to water quality and availability late in the season, and surface water appropriations for agriculture and other uses can reduce available in-stream flow during this critical time.



Photos 4 &5 – Juvenile coho salmon (*Oncorhynchus kisutch* – left) and coastal cutthroat trout (*Oncorhynchus clarki clarki* right) observed in headwater tributary streams of the Little Quilcene watershed in April of 2008.

Mean annual flow in the Little Quilcene River is approximately 54 cubic feet per second, though this can vary from less than 10 cfs during the summer low-flow period to well over 400 cfs during mid-winter flood events. The City of Port Townsend diverts up to 9.56 cubic feet per second from the mainstem, while maintaining a 6 cfs mimimum in-stream flow at their RM 7.1 diversion, which is used to fill the Lords Lake Reservoir (with a storage capacity of about 500 million gallons), before being diverted out of the watershed to supply urban and industrial needs (USFS and WDNR 1994). Although in place since 1957, this municipal water right is junior to a total of 5 cfs of historic water rights held by private landowners in and around the town of Quilcene (originally organized under the Quilcene Irrigation District – Ed Young WDOE, pers. comm.). Washington Department of Ecology currently maintains an administrative closure to further surface water appropriations from the Little Quilcene sub-basin (WDOE 1998).

Study background – Unlike the other principal Hood Canal rivers with headwater reaches located within the protective jurisdictions of congressionally-designated wilderness areas and the Olympic National Park, water quality and availability in the Little Quilcene sub-basin are especially vulnerable to headwater land-use practices and modifications including (but not limited to): clearcut logging of headwater-adjacent slopes; fish passage barriers and potential sedimentation associated with road construction and maintenance; and municipal and residential water appropriations. Lower mainstem and tributary valleys are prone to oversimplification of in-stream habitat that are the result of past levee-building and bank armament, removal of large woody debris from stream channels (cedar salvage from western Washington streams was a common practice historically), extensive ditching and loss of riparian vegetation and hydrologic continuity throughout the tributary channel network (Leland Creek in particular), diversion of mainstem and tributary surface flows for agricultural use, compromised water quality from stream-adjacent livestock pasturage and agriculture practices, riparian overstory removal for past and continuing rural residential development, and fish passage barriers associated with highways and local surface streets as well as water impoundment structures.

Despite this litany of potential factors contributing to the decline of aquatic and riparian habitats in the Little Quilcene, the watershed has not been a priority for focused past or ongoing restoration activities relative to adjacent watersheds though all are confronted with similar and equally critical water resource issues. With the exception of the Little Quilcene, the major west-side Hood Canal rivers (Big Quilcene, Dosewallips, Hamma Hamma, and Skokomish) have all had comprehensive watershed analyses compiled by state and federal salmon-recovery coordinating entities as provided under the umbrella of the 1998 Washington State Watershed Planning Act (Chapter 90.82 RCW). Limited monitoring and assessment of available water resources and aquatic habitat conditions and biological processes in the Little Quilcene watershed have been conducted by various representative agencies and entities of Water Resources Inventory Area 17 (WRIA 17) – a regional watershed planning unit, composed of federal, state, county, and municipal governments, vested Native American Tribes, watershed enhancement organizations, and private citizen groups. The 2003 WRIA 17 (Quilcene/Snow Creek) Watershed Management Plan recognized a need to protect and restore in-stream and stream-adjacent (i.e. riparian) habitats for the benefit of native fish and other aquatic organisms, as well as riparian-dependent wildlife species. Of the ten sub-basins situated within WRIA 17, the Little Quilcene River was specifically identified as an "Area of Concern" due to historic aquatic and riparian habitat degradation, and ongoing issues related to water quality, availability, and hydraulic continuity. The Little Quilcene sub-basin is currently listed as a Tier 2 priority watershed for habitat protection and restoration in the Hood Canal Coordinating Council's Salmon Recovery Strategy (citation).

The WRIA 17 "Habitat Factors Limiting Analysis" (Correa 2002) considered a variety of interrelated habitat condition and stream process elements potentially limiting salmonid production in the Little Quilcene sub-basin, including fish access (e.g. artificial passage barriers), floodplain modifications, current and historic channel and riparian conditions, sediment loading, water quality (limited in scope to temperature, dissolved oxygen, and suspended solids), watershed basin hydrology (annual flow regimes, location and extent of impervious surfaces, and hydrologic maturity of basin-wide vegetative cover), and biological processes (with a particular emphasis on nutrient input – or lack thereof - from anadromous fish carcasses). At the time of its publication, there was a conspicuous lack of existing data for most of these factors relative to adjacent watersheds, and the report relies heavily on expert opinion provided by members of the Technical Advisory Group (TAG) who had local, working knowledge of the Little Quilcene sub-basin. These data gaps have been addressed in-part by more recent work conducted by the Hood Canal Salmon Enhancement Group (HCSEG), Point No Point Treaty Council Tribes (PNPTC), Pacific Ecological Institute (focusing on water quality concerns in Lake Leland) and the Washington Department of Fish and Wildlife. Details of their data collection protocols are briefly summarized in the Methods section of this report, along with a discussion of relevant conclusions that can be drawn from the available data as it couples with findings of the 2007 Wild Fish Conservancy habitat reconnaissance.

Methods

This section provides an overview of methods for the various facets of the Little Quilcene Rapid Habitat Assessment including: reach delineation; in-stream and riparian habitat reconnaissance surveys; anadromous salmon and steelhead spawning surveys; fish passage barrier assessment; water quality data collection and synthesis; and water typing and juvenile resident fish distribution surveys. Also discussed are the existing data from previous studies that were reviewed and incorporated into this watershed assessment.

Reach Delineation – Stream reaches are a useful construct to partition a watershed in order to further characterize habitat conditions, and to document and analyze habitat utilization by anadromous and resident fish species. Natural channel habitat morphology is governed by three intrinsic factors: stream size, gradient, and valley confinement (Beechie and Sibley, 1990). A direct relationship exists between stream size and basin area, regardless of the hydrologic regime (total available precipitation and groundwater movement) of a given watershed. Basin area expands downstream in a given watershed, as the stream integrates (or captures) an increasing number of adjacent tributary basins. Thus, stream reaches are delineated by significant changes in basin area, with reach demarcations often located at the confluence of major tributaries contributing >20% of the receiving stream flow (Pleuss et. al. 1999).

Gradient is also an intuitive indicator of changes in the types and proportions of available habitats. Low-gradient sections of a stream differ markedly in fish species and/or life-history composition and habitat utilization relative to higher-gradient channel segments. Stream courses within a region of high topographic diversity support a wider range of available habitat types, from very high-gradient headwater reaches that may not support fish in abundance (or at all), to low-gradient, lower-velocity, meandering valley bottom reaches that are suitable for spawning and channel rearing by anadromous salmonid species as well as resident trout and a variety of other aquatic organisms.

Channel confinement is controlled by the local geology and geomorphologic history of a stream valley, as well as hydrologic flow regimes. All of these factors contribute to the ability of a stream to erode and incise into the surrounding landscape. Confinement tends to be high in upstream segments of a river basin, particularly in mountainous landscapes, and especially on the east side of the Olympic Peninsula where headwater streams often encounter the Crescent Basalt formation, resulting in steep-sided, erosion-resistant bedrock canyons in upstream segments. Lower elevation valleys are generally broader, with reduced opportunity for channel incision. As a result, valley bottoms are relatively unconfined, and streams tend to spread out and deposit their ample sediment load across the valley floodplain. These reach-governing factors (stream size, gradient, and confinement) are interrelated, and changes in any or all of these variables are generally easy to identify using a combination of topographic/aerial mapping and on-the-ground observation.

To that end, WFC staff obtained a digital GIS file containing the Salmon and Steelhead Habitat Inventory and Assessment Project (SSHIAP) segments from SSHIAP staff (Steve Todd, PNPTC) and used this model to identify preliminary reach breaks for the entire Little Quilcene watershed. Developed from remote interpretation of aerial photography, the SSHIAP segments represent a good first approximation of watershed reach breaks. The SSHIAP segment breaks were then modified based on the results of the WFC field reconnaissance to better match geo-morphological boundaries of the Little Quilcene mainstem and major tributaries, and to facilitate future location of the pertinent habitat features, conditions, and restoration opportunities as outlined in Parts II and III.

In-stream / Riparian Habitat Evaluation – Over the course of nine-days in October 2007, WFC field crews conducted a rapid habitat reconnaissance of the Little Quilcene River, Leland Creek, Ripley Creek, and Howe Creek. Surveys were designed to refine the initial SSHIAP reach breaks, collect qualitative habitat observations (visual estimates), identify potential restoration opportunities, and note locations requiring later visits for barrier and water type assessment. Over broad stream reaches representing all or portions of the SSHIAP stream segments, the following data were reported:

1. Approximate reach-average bankfull width, gradient, and wetted width at the time of the survey. Though not measured directly (due to time constraints), WFC field personnel have extensive experience estimating these variables.

2. Dominant/sub-dominant habitat type by category (riffle, riffle/pool, pool/riffle, deep glide, pond/wetland, or dry/subsurface channel).

3. Primary and secondary pool-forming factors including: single-piece large woody debris, LWD jam, rootwad, roots of standing live trees/stumps, scour-resistant bank, boulder, channel bedform, artificial bank, or beaver dam.

4. Residual pool depths for a sub-sample of pools (measured).

5. Estimated percent pool surface cover (provided by jams, overhanging vegetation, undercut stream banks etc.).

6. Relative substrate composition by size class: silt/mud (< 2 mm), sand (2-6 mm), small-to-large gravels (6-64 mm), cobble (64-256 mm), boulder (256-4096 mm), and bedrock (>4096 mm or solid piece).

7. Categorical abundance and size of single-piece large woody debris (sparse, moderate, or abundant) in the small (4-8 in.), medium (8-20 in.) and large (>20 inch diameter) size classes.

8. Count and size of LWD jams (small jam: 3-9 pieces, medium: 10-29 pieces, large 30-69 pieces, or extra-large 70+ pieces).

9. Location and approximate length of side/split channels, tributaries, beaver ponds, natural fish-migration barriers, and sites of significant bank erosion and/or channel sedimentation.

10. Artificial/anthropogenic bank and in-stream channel modifications, stream crossings, fish passage barriers (i.e. culverts), and local water diversions.

11. Dominant riparian forest type (hardwood, mixed, or conifer), reach-average canopy cover (estimated), and representative overstory and understory species.

12. Approximate riparian stand age: young (<40 yrs), immature (40-80 yrs), mature (80-150 yrs), and old (150+).

13. Riparian forest disturbance and/or significant stream-adjacent incursions of non-native/invasive plant species.

14. Areas of anadromous and resident salmonid spawning potential (either direct survey observation of salmon spawning, or spawning gravel aggregates).

15. Observations of other aquatic and terrestrial fauna.

No single survey methodology can completely characterize habitat conditions and stream use by all aquatic species. However, most literature on the subject details a strong affinity for specific habitat attributes depending on species and life-history stage, and these habitats are generally grouped within geographic segments (i.e. reaches) of a watershed. Patterns of this type in the Little Quilcene sub-basin are too numerous to catalog, but would include (for example), the use of lower-gradient mainstem habitat for spawning and juvenile rearing by chum salmon versus the greater frequency of utilization of slower side-channels and off-channel beaver-pond habitat for rearing by juvenile coho, and adult coho spawning in somewhat higher-gradient tributaries and upstream reaches. The highest stream reaches (usually located above natural cascades or waterfalls that create barriers to anadromy) are often occupied by resident trout, and this general pattern is commonly noted where these species are found co-habiting a river basin in the region.

Existing stream channel and riparian habitat data for the Little Quilcene River and tributaries was obtained, summarized, and compared with the results of the WFC field reconnaissance to broadly depict current aquatic and riparian habitat conditions in relation to use by resident and anadromous fish species throughout the sub-basin. Available habitat data for the Little Quilcene watershed are provided by a Point No Point Treaty Council (PNPTC) Timber-Fish-&-Wildlife (TFW) ambient monitoring survey (Bernthol and Rot 2001, with Little Quilcene data originally collected in 1993/1994). Additionally, in 2004, the Hood Canal Salmon Enhancement Group (HCSEG) implemented a planned region-wide monitoring program. As a first step in this process, HCSEG field personnel inventoried baseline in-stream habitat conditions in the mainstem Little Quilcene River and tributaries following a modification of the standard TFW habitat unit survey protocol.

The Point No Point Treaty Council (PNPTC) ambient monitoring and Hood Canal Salmon Enhancement Group (Werner et. al. 2003) habitat assessments utilized somewhat similar survey methods. In the PNPTC ambient monitoring surveys (Bernthol and Rot, 2001), large woody debris (LWD) and in-stream habitat units (pools and riffles) were identified and measured along continuous stream sections, with bankfull channel widths measured at 100 meter intervals following the Timber, Fish, and Wildlife (TFW) "method for the habitat unit survey" (Pleuss et al. 1999). This protocol was developed by WDFW to standardize statewide in-stream and riparian habitat assessment and monitoring, but it is very labor-and-resource intensive. HCSEG conducted an extensive, continuous survey for LWD jams, as well as intensive surveys for LWD, pool, and channel characteristics at 500-meter channel intervals. During the extensive survey, "stream teams" walked mainstem and tributary channels establishing survey benchmarks, and identifying and enumerating log jams (many of the HCSEG 100-meter plastic benchmark tags are still visible in the Little Quilcene and tributaries). For each 500 meter segment of this extensive survey, one randomly-selected 100-meter sub-reach was intensively surveyed for LWD (both jams and single pieces), pools, and channel riparian characteristics. Both the PNPTC and HCSEG surveys used comparable pool criteria, and collected similar types of information about the number and characteristics of log jams and large woody debris. Direct quantitative comparisons of the two habitat surveys are exceedingly problematic, however, because of divergence in the location of reach breaks, and differences in the continuity of the collected data (note, for example, that PNPTC did not include Leland Creek in the survey effort).The results from both surveys are summarized to provide a qualitative comparisons with Wild Fish Conservancy findings during the habitat reconnaissance survey (see Results and Discussion pp. 24-40, and the *Habitat Reconnaissance Survey Notes* detailed in Part III of this report).

Spawning Surveys – Long-term patterns of salmon spawner abundance are used by WDFW and Tribal co-managers to gauge stock health and to forecast (sometimes quite inaccurately) future run returns. Washington Department of Fish and Wildlife classifies stock health status in their Salmonid Stock Inventory (http://wdfw.wa.gov/fish/sasi/) on the basis of past returns (also known as escapement, usually generated from spawning ground survey data) and other factors such as genetic analyses (native vs. mixed, with mixed indicating that hatchery brood stock originating from outside the resident population has interbred with the native stock), and the degree of hatchery influence on production (a completely wild run vs. a "composite" run that is supplemented with hatchery-raised fish). For example, summer chum in the greater Big Quilcene / Little Quilcene basin (Dabob Bay tributaries) have since 1992 been supplemented by WDFW hatchery propagation and release under the Summer Chum Salmon Conservation Initiative (Ames et. al. 2000); the production is considered "composite" in that it is made up of both wild stock and hatchery fish. Genetic analysis has concluded that summer chum in the tributaries to Dabob Bay are not differentiated, so the origin is considered "native". The WDFW hatchery complex on the Big Quilcene River also contributes both coho and late fall chum to Quilcene Bay.

Photo 6 – Late fall chum salmon (*Oncorhynchus keta*) spawning en-masse in the gravel tail-out of a pool in the Little Quilcene River in December of 2007.

Run timing for late fall coho salmon in the Little Quilcene River is bi-modal – that is, coho appear both in early fall (October) and late fall (the "Christmas fish" that peak in mid-to-late December), with a distinct lag between runs. Coho runs in the other major

Hood Canal tributary streams historically peaked during the late fall (Amato, 1996). Manipulation of run timing at the US Fish and Wildlife Service National Fish Hatchery on the Big Quilcene River is well documented (USFWS staff – pers. comm.), resulting in the return of coho salmon to the hatchery as early as the first week of October. WFC staff speculate that the early-run coho in the Little Quilcene River originally strayed from the Big Quilcene hatchery returns, and have since established a self-sustaining run, with the late run representing the original (pre-hatchery) wild stock.

Photo 7 – Coho salmon (*Oncorhynchus kisutch*) spawning in a narrow side channel of the Little Quilcene River in December of 2007.

Table 1 summarizes the current status of salmon, steelhead, and coastal cutthroat trout stocks that spawn within the Little Quilcene sub-basin.

Table 1: Status of WDFW Salmonid Stock Inventory (SaSI)-listed Little Quilcene stocks

SaSI Stock	Origin	Production	Status
Quilcene summer chum	Native	Composite	Depressed
Quilcene late fall chum	Mixed	Composite	Healthy
Quilcene/Dabob coho	Mixed	Composite	Depressed
Quilcene/Dabob winter steelhead	Unresolved	Unresolved	Unknown
West Hood Canal coastal cutthroat trout	Native	Wild	Unknown

A "stock" is defined by WDFW as "a group of fish that return to spawn in a given area at the same time". Note that, although the Little Quilcene river and tributaries do not currently have any stock listed as critical ("declined to the point where the stocks are in danger of significant loss of genetic diversity"), both summer chum and fall coho salmon are currently considered to be depressed (defined as a stock "whose production is below expected levels based on available habitat and natural variation in survival, but above where permanent damage [to the stock] is likely"). The SaSI report stresses that a "healthy" listing does not necessarily indicate that there should be no concern regarding

production levels. A healthy stock may in fact be quite robust, but could also be limited in production to the point where there is no harvestable surplus. It is also important to keep in mind that the most recent status determinations were generated in 2002, and production levels of some stocks may have changed considerably since that time.
To evaluate the relative abundance of adult salmon among separate reaches in the Little Quilcene watershed, WFC obtained and summarized recent salmon spawning survey records, and also conducted seasonal spawning surveys in major tributaries to complement ongoing WDFW mainstem index surveys. The WDFW spawning survey database was also queried for all available information pertaining to the Little Quilcene River and its tributaries. Peak species/stock live and dead counts were summarized by reach length for the available period of record, 1944-2007. Based on this data summary, consultation with WDFW staff, and detailed knowledge of the potential for anadromous fish-use in the watershed, several tributary reaches were selected for spawning surveys.

From 1 November 2007 to 14 January 2008 WFC field crews conducted 44 reach-length spawning surveys for coho and late fall chum salmon, specifically targeting Leland Creek (WRIA 17.0017), a Leland tributary (17.0080), "Wildwood Creek" (WRIA 17.0082), and Ripley Creek (17.0089), as well as a mid-valley segment of the Little Quilcene River (WRIA 17.0076) that is not currently included in surveys by WDFW. On three separate dates in spring 2008 (late April and early May), spawning surveys were also conducted for steelhead and coastal cutthroat trout on the tributary reaches. WFC and WDFW survey results for the 2007-2008 spawning season are summarized in relation to the historical records to provide context on key salmon spawning strongholds within the Little Quilcene watershed.

A final note about stream nomenclature: all streams lacking a common name are referenced throughout this report by an alphanumeric code generated from the nearest identifiable trunk stream, and the order in which they are encountered upstream from the mouth of the primary channel (regardless of left-bank or right-bank). If the stream has a unique numerical identifier as provided in the Catalog of Washington Streams and Salmon Utilization (Williams et. al.1975) this is also given for clarification. Thus (for example), the Little Quilcene River (for example) the Little Quilcene River is #17.0076, indicating WRIA 17 stream # 0076. The first upstream tributary of the Little Quilcene is referred to as 17.0076A, the next, 17.0076B etc. This naming convention was developed from past Wild Fish Conservancy water typing efforts (see pp. 24-27, below), and has been consistently implemented for new water type project locations around the state. Also note for future reference throughout this report that stream banks are characterized as left or right from the point of view of an observer facing downstream.

Fish Passage Barrier Assessment – Transportation infrastructure represents a considerable threat to the connectivity of the fish-bearing stream network in a given watershed. Intended to carry the stream channel beneath roadways and railways, the construction of culverts, in particular, all too often results in the loss of upstream habitat by preventing or hindering fish migration along the stream channel. Culverts physically block channels if they are perched above the level of the streambed, are broken or damaged, or undermined by scour post-construction scour. Culverts that are too small, or pitched too steeply, create velocity barriers by constricting the channel and/or increasing the gradient so that fish cannot physically move upstream against the force exerted by the flow of water through the culvert. Under-sized culverts (and poorly engineered bridge abutments) are also susceptible to debris jams, causing the upstream channel to backwater and severely erode adjacent stream banks. Further barriers are created when a culvert either lacks internal streambed material, or the retained material is so deep and unconsolidated that it causes otherwise perennial flow to disappear subsurface through the culvert during late-summer low water periods.

Photo 8 – Barrier culvert outlet at a private road crossing of a fish-bearing stream.

To identify the artificial barriers to fish migration in the Little Quilcene River sub-basin, Wild Fish Conservancy GIS personnel acquired a current list of known fish passage impediments from the Washington Department of Fish and Wildlife's Salmonscape website (http://wdfw.wa.gov/mapping/salmonscape). This data set and map portal includes a comprehensive inventory of public (state and county) road crossings of known and potentially fish-bearing streams generated from previous culvert inventory and assessment work by WDFW, WSDOT, and Jefferson County Public Works Department. Agency transportation and stream map layers were then queried and cross-referenced, resulting in a complete list of public and private road crossings. Where landowner permission was obtained, WFC field surveys of the previously un-inventoried private road culverts were conducted from February - March 2008 using the WDFW fish passage barrier assessment method (WDFW 2000). The method employs a cursory "level A" and (where necessary) a more detailed "B-level" examination to gauge the ability of various salmonid life-stages to migrate upstream through the culvert. This assessment is based on direct and indirect (such as local channel scour) measurements of flow velocity, culvert diameter relative to stream bankfull width, culvert and stream grade, culvert materials and construction, and the presence and type of natural streambed substrate retained throughout the culvert. All newly-identified fish passage barriers will be submitted to WDFW Salmonid Screening, Habitat Assessment, and Restoration division staff (SSHEAR) for inclusion on their WRIA 17 watershed prioritization list. Prioritization for repair is based on a number of inter-related factors stemming from the culvert assessment, but specifically takes into account the potential "gain" in fish habitat upstream from the offending barrier structure – i.e. the greater the length of recoverable upstream habitat, the higher the ranking for a particular barrier on the priority list. Repair and replacement of artificial fish passage barriers are ongoing by state and county agencies and local watershed restoration groups, as funding becomes available.

Water Type Assessment and Fish Distribution – In 1975, the state of Washington developed a process to identify and classify streams, lakes, and wetlands into several categories or "types" depending on their physical, biological, and human-use characteristics. This process, called water typing, was originally intended to regulate forest practices that potentially impact Washington's surface waters, but the water type inventory has now become the fundamental tool for protecting and conserving aquatic habitats, not only on industrial forest lands, but also in the rural and urbanizing areas. Cities and counties in Washington are required to adopt critical areas regulations by the Growth Management Act (RCW 36.70A.060). The GMA was amended in 1995 to require all municipalities to include "best available science" when enacting policies that regulate land-use activity and development, in order to protect the functions and values of critical areas (including stream corridors and wetlands, RCW 36.70A.172). The law also requires jurisdictions to periodically review, evaluate, and, if necessary, revise their critical areas ordinances to ensure that they meet GMA requirements (for more detailed information specific to Jefferson County, the complete text for Title 18.22 JCC is available at http://www.co.jefferson.wa.us/commdevelopment/CriticalAreas.htm).

The amount of protection that streams and wetlands receive is entirely governed by the WDNR water type classification system (as set forth in WAC 222-16-031). Briefly, bodies of water that are classified as Type 1 are considered "state significant shorelines" (as defined in RCW 90.58), and include major rivers, lakes, and seashores. Type 1, 2 and 3 streams are considered fish-bearing, and receive greater protection (in the form of stream corridor riparian buffers) than Type 4 and 5 (non fish-bearing) streams.

Table 2: WDNR Water Type Conversion chart

permanent (new) Water Typing designation	**Interim (old) Water Typing designation**
Type "S" - shoreline	Type 1 Water
Type "F" – fish-bearing	Type 2 and 3 Water
Type "Np" – non fish-bearing, perennial	Type 4 Water
Type "Ns" – non fish-bearing, seasonal	Type 5 Water

Source: Washington Department of Natural Resources Forest Practices : Water Typing. Olympia, WA. http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticesApplications/Pages/fp_watertyping.aspx

This system was recently revised by WDNR (2006 - Table 2), but Wild Fish Conservancy still advocates the use of the interim classification system (Types 1-5) for the specificity that is implied by conferring a Type 2 classification. Type 2 waters are defined as having (among several other characteristics) "highly significant fish populations", and provide greater protection for periodically inundated wetlands that are so critical for hydrologic stability in a watershed, as well as habitat for numerous aquatic and riparian-dependent wildlife species. Combining Type 2 and 3 streams into a single "F" (for fish-bearing) category actually results in a loss of critical information regarding the degree of biological use of the stream or other water body.

Today, state and local regulatory agencies rely on water typing to protect the state's surface waters from adverse impacts associated with the broad range of human land-use activities. Unfortunately, most of those agencies are falling short of the mark for a surprisingly simple reason: they are relying on inaccurate, out-dated maps, and hundreds of miles of productive aquatic habitats are being damaged by inappropriate land-use practices because they have been misidentified. Map errors and inaccuracies in the fish-bearing stream network traversing forested, agricultural, and developed lands in Washington State have been well-documented by Wild Fish Conservancy and others, typically resulting in the under-protection of approximately 50% of the length of fish-bearing streams, with some streams entirely absent from water type maps.

Photo 9 – Headwater tributary stream typical of those targeted by WFC for water type investigations in the Little Quilcene watershed. A noticeable gradient change is the demarcation between fish-bearing (Type 3) and non fish-bearing, perennial (Np / Type 4) habitat – clearly visible where the stadia rod crosses the stream channel.

To provide a solid foundation for in-stream and riparian habitat protection in the Little Quilcene watershed, Wild Fish Conservancy conducted a water typing assessment of priority stream reaches during March-April 2008. Based on a review of WDNR water type maps and our field knowledge of the watershed from the habitat reconnaissance, spawning surveys, and fish passage inventory, WFC staff identified a subset of priority headwater tributary streams with potentially incorrect water type classifications. Field surveys to document stream channel geometry and fish presence/absence were used to correct type classifications and map errors. Juvenile and resident fish-use data is a natural ancillary product of water typing, providing additional information on species composition and distribution in typed reaches. Wild Fish Conservancy will submit all water-type changes and map corrections to Washington Department of Natural Resources Forest Practices Application and Review System (FPARS), with recommendations for updating their database to reflect findings in the Little Quilcene River sub-basin.

Field methodology for the standard water type survey is briefly described as follows: where landowner permission was obtained, two-person teams walked priority headwater streams measuring gradient, stream widths, taking habitat photographs, and documenting fish presence/absence by eye, hand-netting or with electro-fishing gear. Surveys started at the downstream confluence with previously documented fish-bearing ("F" or Type 3) waters, and proceeded upstream to the end of the newly-identified fish-bearing habitat. The upstream extent of fish-bearing water was established in the field by a multi-factor assessment of physical habitat features (stream gradient, presence of natural fish passage barriers, bankfull width, and wetted perennial flow) and/or the absence of fish. Non fish-bearing (Type 4 and 5) streams that did not appear on current WDNR water type maps were also noted when located during the course of water type surveys for fish-bearing (Type 3) habitat. In those few cases where field crews were unable to obtain landowner permission, water type surveys relied on points of public access such as county road crossings, and the unsurveyed channel segments were mapped to the best extent possible using topographic maps and remote imagery such as LiDAR and aerial photographs.

Results and Discussion

Reach Delineation – Findings of the habitat reconnaissance survey resulted in the development of six contiguous reach segments for the Little Quilcene River, extending from the upper limit of tidal influence near the river mouth estuary on Quilcene Bay upstream to the confluence of the Howe Creek tributary (17.0090) at river mile (RM) 5.2. Little Quilcene reaches 1 and 3 were further partitioned into two separate sub-reaches denoted 1A, 1B, 3A, and 3B. Leland Creek (17.0017) was divided into five reaches from the confluence with the Little Quilcene River upstream to the vicinity of a perennial left-bank tributary (17.0079) at approximate RM 2.1. Although unsurveyed during this habitat reconnaissance, Leland Creek Reach 6 would extend upstream from the terminus of Reach 5 to the outlet of Lake Leland (Map 5, Appendix 1). A total of three reach breaks were identified for the surveyed portion of lower Ripley Creek (from the mouth upstream to approximately RM 1.5) based primarily on valley confinement, with Reach 1 further divided into two sub-reaches (1A, 1B) to differentiate extensive beaver-dam influenced habitat from the higher-gradient, much more confined downstream channel. The Howe Creek habitat reconnaissance resulted in four distinct reach breaks along the ~1.1 miles of surveyed channel upstream from the Little Quilcene River confluence. Reach breaks are described in full in the *Habitat Reconnaissance Survey Notes* (Part III), and appear on Maps 2-6, Appendix 1, and these mainstem and tributary reach breaks roughly correspond to the segment breaks of the PNPTC-TFW ambient habitat monitoring project (Table 3; with the exception of Leland Creek – not monitored).

Table 3 – Summary data for Little Quilcene – Leland sub-basin reach breaks from the Little Quilcene – Leland Watershed *Habitat Reconnaissance Survey* (Part III).

Little Quilcene River

WFC habitat survey reach	location by river mile	Reach length (ft) [1]	Reach average gradient	Avg. bankfull width (ft)	valley confinement/ natural barrier	river mile location of artificial structures	corresponding TFW habitat survey segment
Reach 1, sub-reach 1A	0.25 - 0.8	3820	1%	30	unconfined-to-moderate[2] / no barrier	dikes/levees & bank armoring	TFW segment 2 (note: TWF segment 1 is located entirely downstream within the tidal estuary at the river mouth)
Reach 1, sub-reach 1B	0.8 - 1.2	2340	1-2%	25	unconfined / no barrier	dikes/levees & bank armoring Center Rd. bridge at RM 0.8 abandoned bridge at RM 0.83 culvert return of the "Wildwood Diversion Canal" at RM 1.2	TFW segment 2
Reach 2	1.2 - 1.7	2360	1-3%	25	moderate / no barrier	bank armoring	TFW segment 2
Reach 3, sub-reach 3A	1.7 - 2.75	5520	2-3%	25	unconfined / no barrier	bank armoring US Hwy 101 bridge at RM 1.8 inlet of "Wildwood Diversion Canal" at RM ~2.6	TFW segment 3
Reach 3, sub-reach 3B	2.75 - 3.2	2450	3%	24	unconfined / no barrier	cobble "push-up" dam at RM ~3.0 railroad flatbed driveway bridge at RM ~3.1	TFW segment 4
Reach 4	3.2 - 3.5	1470	4-5%	N/A	confined / no barrier	engineered log jam at RM ~3.2	TFW segment 4
Reach 5	3.5 - 4.35	4480	3-4%	24	moderate / no barrier	none noted	TFW segment 4
Reach 6	4.35 - 5.2	4620	2-4%	24	moderate / no barrier	railroad flatbed bridge at RM 4.5 cobble "push-up" dam at RM ~4.6	TFW segment 5

Leland Creek

WFC habitat	location by river mile	Reach length	Reach average	Avg. bankfull	valley confinement/	river mile location of	corresponding TFW habitat

survey reach		(ft)	gradient	width (ft)	natural barrier	artificial structures	survey segment
Reach 1	0.0 - 0.37	1950	3-4%	22	moderate / no barrier	wooden footbridge at RM 0.37 bank armoring	N/A
Reach 2	0.37 - 0.84	2490	2-3%	25	moderate / no barrier	log stringer bridge at RM 0.43, Rice Lake Road bridge at RM 0.7	N/A
Reach 3	0.84 - 1.33	2560	2-3%	20-20	moderate / no barrier	Hwy 101 culvert at RM 1.05	N/A
Reach 4	1.33 - 1.67	1810	1%	12-15	moderate / no barrier	wooden footbridge at RM 1.35 w/ associated bank armoring	N/A
Reach 5	1.67 - 2.3	3430	1-3%	12-15	confined / no barrier	wooden footbridge and log stringer driveway bridge at RM 1.6 wooden footbridge at RM 1.7 log stringer bridge at RM 1.78	N/A

Ripley Creek

WFC habitat survey reach	location by river mile	Reach length (ft)	Reach average gradient	Avg. bankfull width (ft)	valley confinement/ natural barrier	river mile location of artificial structures	corresponding TFW habitat survey segment
Reach 1 sub-reach 1A	0.0 – 0.73	3830	5% (max of 12% in the cascade section)	20 (down to a min of 14 in the confined canyon)	confined-to-moderate partial barrier cascade for initial ~300 ft.	culvert beneath Lords Lake Loop Road at RM 0.12 railroad flatbed bridge at RM .28 wooden footbridge at RM 0.67	TFW segment 1
Reach 1 sub-reach 1B	0.73 – 0.91	970	1-2%	N/A (see *habitat recon notes* in Part III)	unconfined / no barrier	none	TFW segment 1
Reach 2	0.91 – 1.05	750	3-4%	8	moderate / no barrier	none	TFW segment 2
Reach 3	1.05 – 1.5 continuing	2320+	3-4%	8	confined-to-moderate partial barrier cascade series	none	TFW segment 2

Howe Creek

WFC	location by	Reach	Reach	Avg.	valley	river mile	corresponding

habitat survey reach	river mile	length (ft)	average gradient	bankfull width (ft)	confinement/ natural barrier	location of artificial structures	TFW habitat survey segment
Reach 1	0.0 – 0.27	1440	8% , 4%	25	moderate / no barrier	none	TFW segment 1
Reach 2	0.27 – 0.31	200	4%	24	confined / ~75 ft. falls at RM 0.31	none	TFW segment 1
Reach 3	0.27 – 0.47	860	2-3%	16	moderate / no barrier	culvert beneath Lords Lake Loop Road at RM 0.45	TFW segment 2
Reach 4	0.27 - 1.07	3130+	1-2%	14	unconfined	culvert beneath Lords Lake Loop Road at RM 1.9	TFW segment 3

[1] Reach length only refers to linear stream channel surveyed, though survey may have terminated prior to attaining the upstream end of the reach - this occurred during habitat surveys on both Ripley Creek and Howe Creek – see Part III (reaches R3 and H4) for details

[2]the Little Quilcene River through Reach 1 has very little natural confinement, but is artificially constricted by levees and road berms.

In-stream / Riparian Habitat Evaluation - A detailed, reach-level discussion of aquatic and riparian habitat conditions for the Little Quilcene River and its major tributaries is provided in the *Habitat Reconnaissance Survey Notes* (Part III).

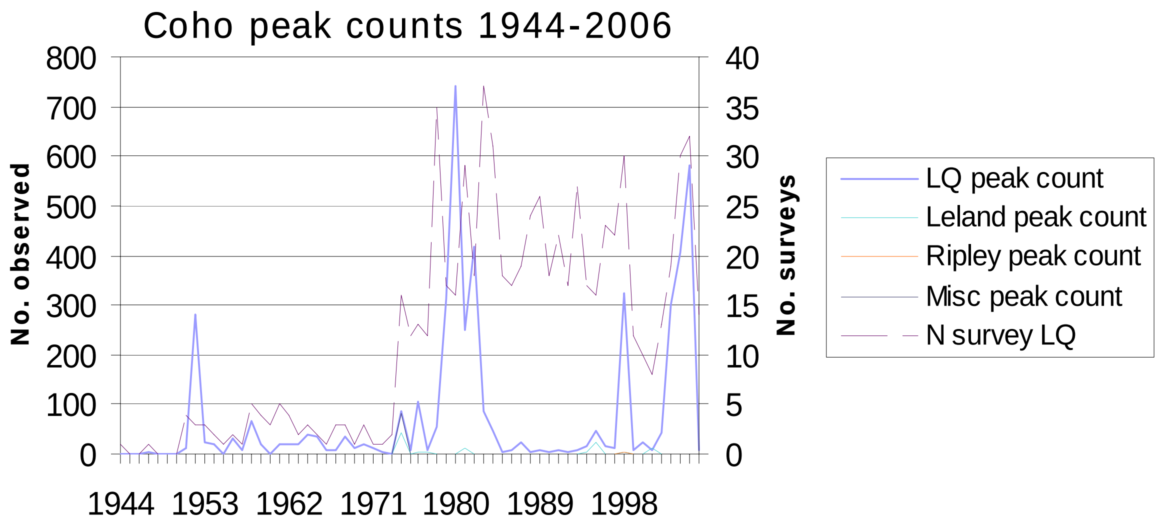
Like many of the tributaries to Puget Sound, a century and a half of logging, agricultural, practices, and settlement have taken their toll on the Little Quilcene watershed. Prior to the removal of the majority of instream and stream-adjacent large wood, photos from the turn-of-the century Olympic Peninsula streams document channels completely choked by log jams that extended for hundreds of meters. These were the conditions under which native salmonids and other riparian dependent species evolved, and are dramatically different from current conditions.

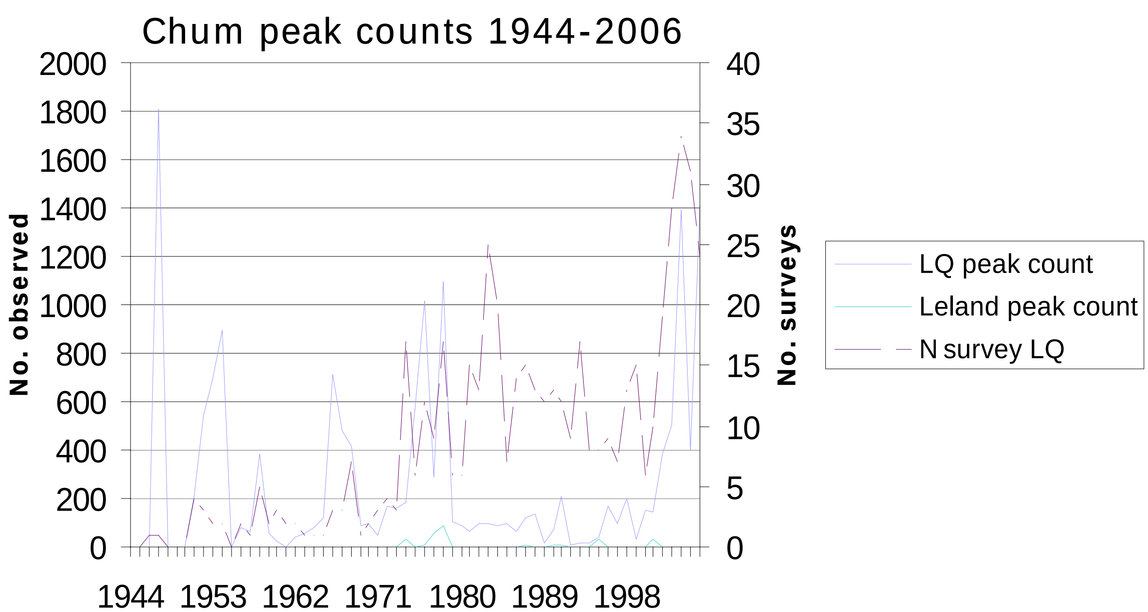
Documented Large Woody Debris (LWD) loads for the Little Quilcene and its tributaries are well below the threshold values for in-stream LWD and as set in the Hood Canal Summer Chum Conservation Initiative (Ames et. al. 2000). A lack of LWD has resulted in the formation of long reaches of plane-bed channel morphology, typical of a simplified and impacted stream system. Restoring in-stream LWD to impacted reaches will greatly benefit the habitat functions in those reaches. The reestablishment of native riparian vegetation throughout the basin will restore the habitat forming process of in-stream LWD recruitment.

Photo 10 – Riparian corridors on upstream reaches of the Little Quilcene River are generally intact (note large cedar tree on the verge of falling into stream, contributing LWD), but these reaches are outside the primary productive salmon spawning grounds (photo shows that substrates are mostly bedrock and angular cobble).

Spawning Surveys – Over the period 1944-2006, WDFW and cooperating agencies and entities conducted 1604 separate spawning ground surveys in the Little Quilcene watershed, targeting predominantly coho and fall chum salmon in the river mainstem, with fewer and more infrequent surveys for other salmon species. The frequency of spawning surveys (*N survey* Fig. 1) averaged only 2 per year prior to1974 (presumably conducted at or near the peak of the run), increasing to 21.6 and 15.1 surveys per year from 1974 to present for coho and chum salmon, respectively. Figure 1 summarizes available peak count data for coho and chum in the Little Quilcene – Leland sub-basin.

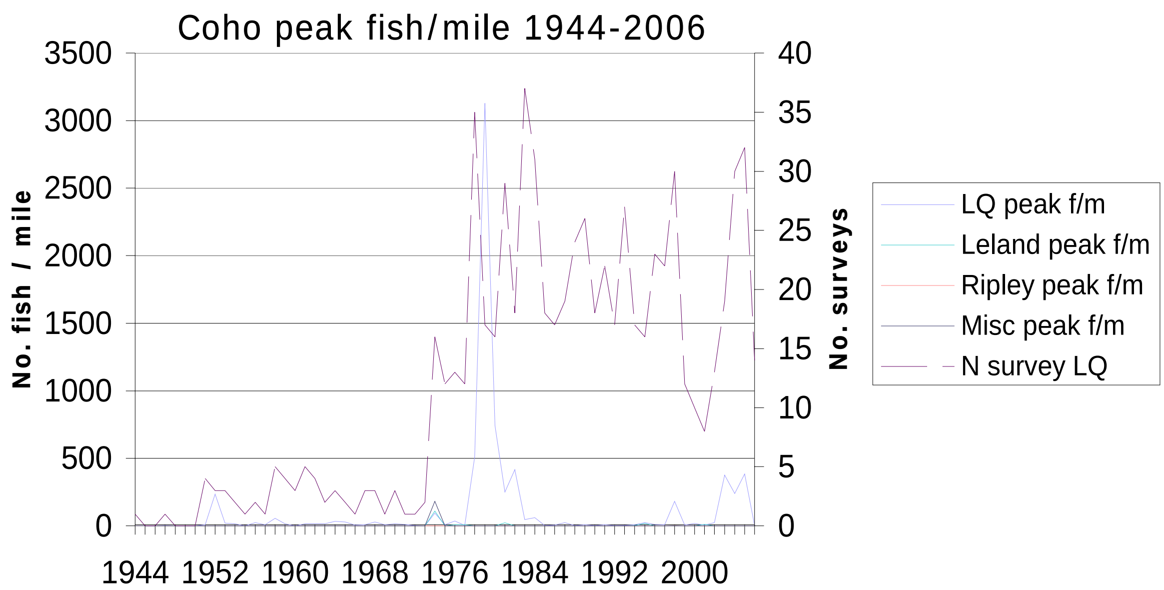
Figure 1 – Peak counts of coho and chum salmon in the Little Quilcene River, Leland and Ripley Creeks (Washington Dept. of Fish and Wildlife data, 1944-2006).

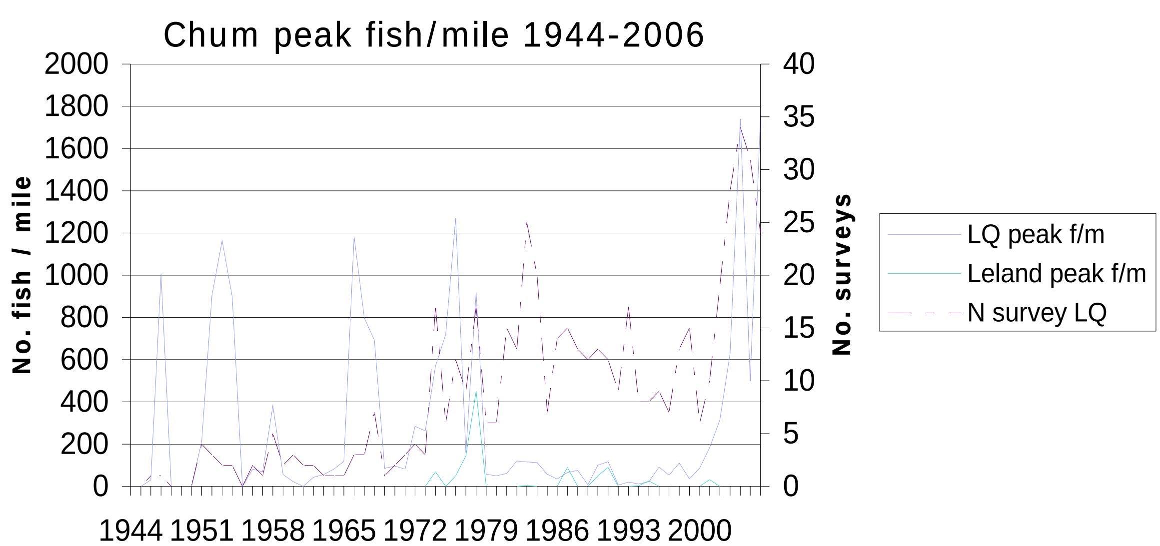




The under-representation of tributary reaches in the overall survey effort immediately becomes apparent (Fig. 1). Of the completed WDFW coho spawning surveys, only 43 of 774 (5.6%) were conducted in tributaries, with only eight years during the span of available data with ≥2 spawning surveys in tributary streams. Observed peak counts are often directly attributable to survey effort (i.e. the greater the number of surveys in a given spawning season, the more likely that a particular survey date will correspond to the peak of the run, and hence the higher the recorded fish observation). As depicted in Figure 2, standardizing spawn survey data by the number of fish per length of surveyed reach provides a means of comparing fish densities between mainstem and tributary reaches for a given survey year (esp. those few years when spawner surveys occurred in tributaries as well as the mainstem). These extrapolated fish densities represent the best estimation of run size given the highly variable nature of the available data. The relative trend in estimated population size over time is apparent for the surveyed streams (Fig. 2).

Figure 2 – Density (fish/mile) of coho and chum salmon in the Little Quilcene River, Leland and Ripley Creeks (Washington Dept. of Fish and Wildlife data, 1944-2006).





In spite of gloomy forecasts, the 2007-2008 spawning season proved quite productive for coho and fall chum salmon in the Little Quilcene watershed. Peak live + dead coho densities of 243.3 fish per mile were observed in the WDFW lower mainstem index reach (from the river mouth upstream to the Leland Creek confluence), whereas much lower densities (live+dead) of 0.0 - 47.7 fish/mile were observed in middle mainstem and tributary reaches surveyed by Wild Fish Conservancy (Table 4). Chum counts documented by WDFW in lower reaches of the Little Quilcene were 59.4 (live + dead) fish observed per mile, while WFC observations in the reach upstream from the Highway 101 bridge crossing were a comparable 53.8. Note that chum salmon were not observed in Ripley Creek, Wildwood tributary (17.0082), or Leland tributary (17.0080).

Table 4: Peak count calendar dates and fish densities (live + dead observed per mile) for coho and chum in the Little Quilcene River and tributary spawning survey index reaches.

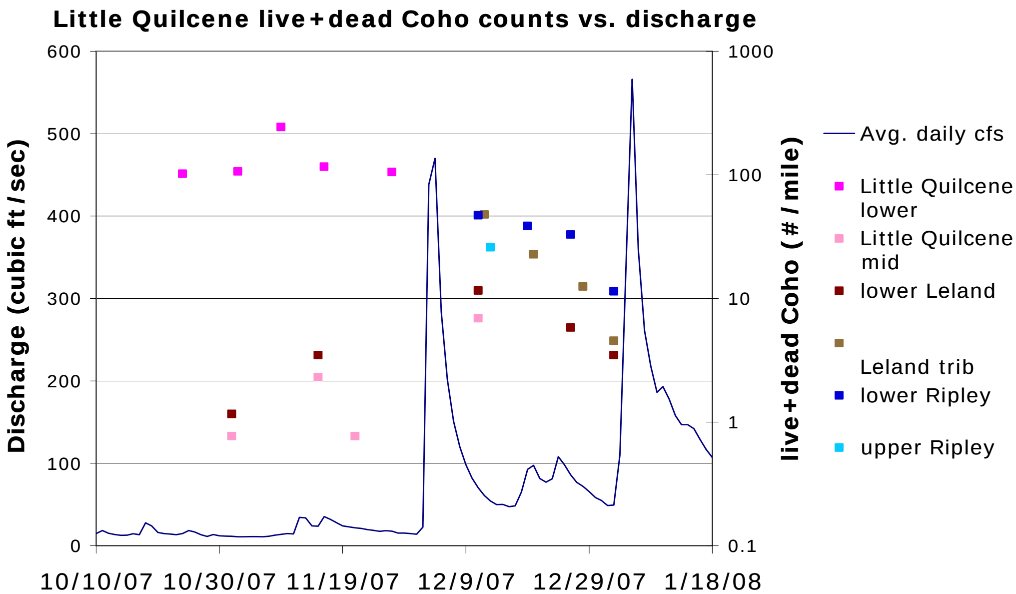
			Coho					Chum			
Stream (survey reach)	Entity	survey length (mi.)	# L+D /mile	# D /mile	# (N) surveys	Peak live[1] count date	Peak dead count date	# L+D /mile	# (N) surveys	Peak live[1] count date	Peak dead count date
lower river (reaches 1-2)	WDFW	1.8	243.3	7.2	6	9-Nov-07	24-Oct-07	59.4	5	12-Dec-07	16-Nov-07
middle river (reach 3)	WFC	1.3	6.9	0.8[2]	6	11-Dec-07	11-Dec-07	53.8	6	11-Dec-07	11-Dec-07
Leland Creek (RM 0 – 0.86)	WFC	0.86	11.6	2.3	9	11-Dec-07	26-Dec-07	18.6	9	26-Dec-07	n/a
17.0080 trib (RM 0 – 0.88)	WFC	0.88	47.7	6.8	5	12-Dec-07	12-Dec-07	0.0	5	n/a	n/a
lower Ripley (reach 1A)	WFC	0.7	47.1	20.0	6	11-Dec-07	26-Dec-07	0.0	6	n/a	n/a
upper Ripley (reaches 2-3)	WFC	0.27	25.9	11.1	5	13-Dec-07	13-Dec-07	0.0	5	n/a	n/a
Wildwood Cr. 17.0082 trib (RM 0 – 0.08)	WFC	0.08	0.0	0.0	5	n/a	n/a	0.0	5	n/a	n/a

[1]Though the listed dates may represents the peak run, WFC spawning surveys in the Little Quilcene mainstem surveys were discontinued after Dec. 11, 2007 at the request of project sponsors (PEI).

[2] Peak dead counts in the mainstem Little Quilcene were reduced by washing of carcasses out of the index reach during flood events.

Along with knowledge of spawning salmon abundance and general population trend for individual stocks (Table 1), the freshwater distribution of spawners can also inform the process of prioritizing reaches for targeted habitat restoration, particularly for widely distributed species such as coho salmon, steelhead and cutthroat trout. Though limited tributary spawning surveys have been conducted in the Little Quilcene watershed, when available, the ratio of tributary-to-mainstem spawner abundances reveals the significance of different areas for salmonid migration, spawning, and rearing. For example, the peak coho abundance (live+dead coho/mile of survey) in Little Quilcene tributaries was highly variable, ranging from 0.0-309.3% (median 20.7%) for the eight years with ≥2 surveys in one or more tributaries over the period 1974-2001. This variability supports the theory that tributary coho abundance corresponds to water availability, with individual fish adapting their spawning strategies depending on the volume and frequency of seasonal freshets. In wet years, adult coho salmon appear to distribute widely throughout the watershed, spawning preferentially in smaller tributary channels with greater favorable cover, whereas in dry years, coho are more confined to the mainstem, and can less-readily access tributaries. In contrast to the mainstem WDFW index reach, relatively high coho carcass counts were observed in tributary reaches including Leland Creek, Ripley Creek, and a previously unsurveyed left-bank tributary to Leland (17.0080), indicating that abundant fall rains and high stream flows during the 2007-2008 spawning season allowed many coho to transit the Little Quilcene mainstem reaches, and to penetrate further upstream into tributary spawning grounds. Note in Figure 3 that coho abundance in tributary reaches corresponds to dramatic surges in stream flow associated with the significant rain events of early December, 2007, and early January 2008.

Figure 3: Density of live + dead coho salmon (# per mile) relative to mainstem stream gauge flow data in the Little Quilcene River and tributary index reaches for 2007-2008.



Located approximately one-half mile downstream from the outlet of Lake Leland, the 17.0080 Leland Creek tributary (Map 5, Appendix 1) likely represents the upstream extent of the majority of anadromous spawning activity in the Leland watershed. Impromptu spot-checks of several lakeshore tributaries (including the upper mainstem of Leland Creek) during the peak of the coho run did not reveal the presence of adult coho upstream from this tributary, and landowners interviewed reported that they were unaware of salmon spawning in lake tributaries during recent memory. Fall chum salmon concentrated their spawning in the lower and middle Little Quilcene River and lower reaches of Leland Creek. Chum salmon, as a rule, are much less mobile than other salmonid species, unable to negotiate steeper and confined reaches of upstream tributaries that coho and steelhead traverse with relative ease. A partial natural barrier cascade at the mouth of Ripley Creek restricts chum from entering the tributary, and the tendency toward collective spawning as a chum life history trait generally requires larger areas of spawnable gravels that are usually located in lower-gradient stream reaches. Historically, late fall chum probably occupied spawning grounds in middle-to-upper reaches of Leland Creek when chum abundance was much higher, forcing vanguard spawners further upstream, but currently diminished populations don't require as much spawning habitat, and don't appear to migrate upstream as they once did. Degraded habitat in the middle watershed likely reduced spawning opportunities for chum in the vicinity of Lake Leland and downstream reaches. ESA-listed summer chum do not spawn in upstream tributaries as these are inaccessible during the low-flow late-summer /early fall spawning period. Summer chum were not targeted for spawning surveys by WFC.

Despite an apparent abundance of gravel spawning habitat, repeated surveys during the peak of fall chum and coho spawning failed to reveal any evidence of anadromy in the "Wildwood" right-bank tributary to the Little Quilcene (WRIA 17.0082 located several hundred feet upstream from the Highway 101 bridge crossing – Map 2, Appendix 1). The cause for this lack of habitat utilization is speculative – perhaps the runs were extirpated and salmon have not yet re-colonized the tributary. The existence of barrier culverts located along private road crossings upstream have significantly reduced the length of available habitat (see Part II, LQ-7), but the lower ~400 ft. channel reach seems eminently suitable for spawning by anadromous salmonids and resident trout, and state records indicate that it supported salmon spawning in the past.

As with many other Puget Sound and Hood Canal streams reporting, spawning steelhead abundance in the Little Quilcene River and tributaries was very low during the 2008 winter-spring season. As part of the expanded Hood Canal Steelhead Supplementation Project, Washington Department of Fish and Wildlife and cooperating entities conduct regular spawning ground surveys for steelhead in the Little Quilcene River from the tidewater mouth upstream to the Howe Creek confluence (RM 5.2). A total of only 13 steehead redds were identified from January through April, with no direct observations of live fish (Joy Lee, Long-Live-The-Kings, pers. comm.). Wild Fish Conservancy had limited opportunity to conduct steelhead spawner surveys in Little Quilcene tributary streams, stymied by high flows and lack of visibility to a single survey of Leland Creek (5/12/08), and three surveys of Ripley Creek and the 17.0080 Leland Creek tributary on April 18, 30, and May 12. Steelhead spawning activity (live fish or recently-constructed redds) was not in evidence during these surveys, although these data are too circumspect to conclude that steelhead were not spawning in tributary streams during the 2008 season. Further investigation of steelhead use of upstream tributaries in the Little Quilcene is warranted, but given the extremely low returns reported for the mainstem, it is unlikely that the few steelhead that may have spawned in tributary reaches would have been detected with this limited survey effort.

Fish Passage Barrier Assessment – GIS output from a cross-query of available WDFW, Jefferson County, and WSDOT culvert inventory databases resulted in the identification of more than one-hundred previously-surveyed culvert crossings of state and county roads in the Little Quilcene and Leland Creek sub-basins. Field teams briefly visited each of these culverts to verify the accuracy of the initial survey, and to determine a sub-set of culverts requiring an updated barrier assessment. Of the initial list of (110) culvert-crossings on public roads gleaned from the available databases, we verified the correct classification of 99 separate culverts, and re-surveyed the remaining 11 that, for a variety of reasons, appeared to be incorrect upon examination (the associated stream was misclassified as non fish-bearing habitat, a new culvert had been installed subsequent to the initial survey, or the original barrier status assessment was simply incorrect).

Limited private property access hindered the ability of field crews to assess barrier status on stream crossings of private roads and driveways throughout the watershed. However, where permission to access private property was obtained (primarily land owned and managed by Pope Resources, Bonneville Power Administration, Washington Department of Natural Resources, and a short list of private individual landowners) surveyors made initial assessments of and additional 74 previously unsurveyed culvert crossings. The majority of these were located on non fish-bearing (Np and Ns) streams or (in a few cases) along decommissioned roads where the culvert had been removed, and did not require additional scrutiny.

Barrier assessment was conducted on 9 private-road culvert crossings of fish-bearing streams, as well as a large tributary to Howe Creek (Cedar Creek, WRIA 17.0093) that was overlooked during the state assessment of culverts along the upper Lords Lake Loop Road. This last was assessed by WFC personnel, and found not to present a fish-passage barrier, thus, it does not appear with the list of barrier culverts detailed in Appendix 2 and appearing on Maps 2-7. This culvert data will be submitted to the WDFW Salmonid Screening, Habitat Enhancement, and Restoration (SSHEAR) section for fish passage priority index scoring. Although federally-listed and other at-risk salmon stocks tend to focus prioritizing for the repair of artificial fish passage barriers with the assumption that salmon-healthy stream habitats benefit all other aquatic and riparian-dependent organisms in the watershed, it should be remembered that other resident fish species and juvenile life stages differ substantially in their ability to negotiate partial barriers that may not present a hazard to migrating salmonids. It has been demonstrated that the upstream limit native sculpin distribution in some western Washington streams, for example, corresponds to in-stream barriers that in many cases were deemed passable to trout and salmon (LeMoine 2007). And if the potential habitat gain from a barrier culvert fix along a headwater tributary is small relative to downstream anadromous reaches, it is an unlikely priority candidate for repair, though these short, upper basin reaches habitat may be critical habitat for widely distributed, small resident trout populations.

Water Type Assessment – Locations for water type upgrades, stream corrections, and newly-mapped headwater wetlands are depicted on Maps 2-6, Appendix 1. Wild Fish Conservancy water-typing efforts in the Little Quilcene watershed during March-April 2008 resulted in the re-discovery of approximately 25,000 linear feet (or ~4.7 miles) of fish-bearing ("F" or Type 3) habitat on streams that were erroneously classified as non fish-bearing waters. This distance does not include thousands of feet of newly documented fish-bearing habitat in man-made waterways (Cemetery Drain and the Wildwood Diversion Canal). Although these canals fall outside the criteria for classification as "F" (or Type 3) habitat (WDNR specifies that water typing only apply to "natural waterways" as described in WAC 222-16-031), they clearly represent significant spawning and rearing habitat for adult and juvenile salmonids in the Dabob Bay watershed, and in most respects, are functionally similar to natural Type 3 water courses.

Numerous Type 4 and Type 5 streams (perennial and seasonal non fish-bearing, respectively) were also located and mapped by WFC survey teams, as well as several sizeable but previously unidentified headwater wetlands, including the beaver pond source for the mainstem of Howe Creek. WFC verified that, with a few minor exceptions (i.e. short stream lengths, usually less than 400 ft.) Washington Department of Natural Resources water type maps were reasonably accurate on many of the headwater tributaries of the Little Quilcene River, Cedar Creek, Howe Creek, and Leland Creek.

Early knowledge that many of these smaller headwater tributaries appeared to be typed accurately enabled personnel to adaptively manage their field time, and to concentrate effort on those areas that would most likely result in significant fish habitat upgrades.

Specific stream reaches re-discovered and newly-typed as fish-bearing (Type 3) habitat include ~7500 linear ft. of previously un-mapped and unclassified habitat on a headwater reach of Ripley Creek (upstream from Reach 3), ~1950 ft. of Type 3 upgrade on several small tributaries to Ripley Creek that were previously classified as non fish-bearing, ~2790 ft. of additional channel (incorrectly mapped) along headwater tributaries to the Upper Leland Valley wetland complex (tributary 17.0017*Q-e/f*) that have been ditched and diverted through agricultural fields, ~1850 ft. of tributary channel below and above a barrier culvert on the north fork of the 17.0080 Leland Creek tributary (a massive debris flow from past logging activity has buried the area around the tributary *H-d* confluence, causing flow to become sub-surface and severely limiting fish access to potential upstream habitat – Map 5), ~3300 ft. of tributary channels to the wetland below Lake Leland that did not previously appear on WDNR water type maps, ~1280 ft. of channel crossing the Snow Creek Road to an extensive beaver pond wetland at the headwaters of the lengthy fish-bearing stream that is the largest western tributary to the Lake Leland shoreline (tributary 17.0017*N*, entering the lake near the end of Munn Road), and ~4100 ft. of "F" (Type 3) habitat on a right-bank tributary to the mainstem Little Quilcene River (17.0088 or tributary *K)* that is located in the vicinity of ongoing residential development.

Although previously identified as a Type 3 stream, a gradient barrier was discovered on a small Leland Creek tributary (Leland tributary *E*) resulting in the downgrading of the stream to non fish-bearing (Type 4) habitat above the barrier. In the course of investigating this channel, it was noted that slash and erosion debris deposited in the channel subsequent to past logging activity has caused the stream to go subsurface for several hundred feet along the fish-bearing portion above the Highway 101 culvert. Riparian leave trees have experienced heavy windthrow, choking the channel along the steep canyon upstream, contributing to the degraded conditions. Anadromous barriers were also mapped on the 17.0078 and 17.0079 Leland Creek tributaries (*C* and *D*).

In Western Washington, Forest Practices Regulations require that a 50 ft. no-harvest riparian buffer be retained along any perennial (Np or Type 4) non fish-bearing streams within the boundaries of a timber harvest unit, for a variable upstream distance depending on how far the Type 4 stream extends above a confluence with Type 3 classified waters. Regulations for intermittent (Ns or Type 5) streams dictate mitigation to prevent sediment delivery to stream channels if timber harvest activities expose more than 10% of the soil surface. Many of these headwater tributaries are located on ONF or private forest land (ORM), and surrounding slopes are subject to intensive past and current timber harvest activities, yet they are important contributors to water-quality in downstream fish-bearing streams. A survey of the headwater channel of Howe Creek resulted in several hundred linear feet of stream upgrade to Type 3 habitat, as well as identifying a large beaver pond at the headwaters. This area and the headwaters of Ripley Creek, the Little Quilcene, and Leland Creek have all seen extensive very recent clearcut logging that in some cases (particularly with Type 4 and Type 5 headwater tributaries) failed to leave mandatory riparian buffers, or to mitigate for potential soil erosion. In those cases where adequate riparian buffers were left along streams, significant instances of tree blow-down have occurred due to high wind storms of the past few seasons, often burying headwater tributaries in extensive swaths of downed trees. Lack of an adequate riparian buffer was noted along the last several hundred feet of Type 3 habitat on the logged areas of the Leland Creek headwaters (above Lake Leland), as well as logging debris deposited in the channel on the (larger) east fork tributary of upper Leland Creek (tributary *U*). Some surrounding wetlands also did not appear to have been protected with an adequate buffer. Spring-fed wetlands provide storage and slow-release of precipitation falling on headwater tributaries, ensuring clean water and adequate flows to lower stream reaches.

Fish distribution – Surveyors brought-to-hand via netting or electro-fishing several resident cutthroat trout from headwater tributary streams including upper Ripley Creek at the Snow Creek Road culvert crossing (CC #98, Map 7, Appendix 1), and Cedar Creek (17.0093, a sizeable Howe Creek tributary) at a previously unsurveyed (non-barrier) culvert crossing of Lords Lake Loop Road. Tissue samples obtained from these trout are kept in cold storage for possible future genetic analysis. Howe Creek and Ripley Creek share a contiguous, low-gradient headwater wetland located on the drainage divide adjacent to the Lords Lake Loop Road. WFC biologists speculate that resident cutthroat in both sub-basins are not genetically isolated, and that gene flow occurs with migration and inter-breeding across the watershed divide via connected wetlands during periods of high water. Restoring habitat connectivity throughout these watersheds is vital to the maintenance of genetic diversity among conspecific populations that would otherwise become isolated from eachother due to anthropogenic impacts. Examples include the loss of migration corridors due to barrier road culverts, levees, and railroad and highway berms etc., or the draining of and disconnecting of wetland habitats for agriculture land "reclamation", removal of beaver and the consequent degradation of once-extensive former wetland areas, and timber harvest practices in headwater basins that result in the loss of perennial springs that feed the downstream tributary network.

Photo 11 – The few remaining trees in the upper left of the photo supposedly "buffer" a spring-fed seasonal tributary to the headwaters of Ripley Creek.

Juvenile coho salmon were discovered in the plunge pool below the outlet of the barrier culvert crossing of Leland Valley Road West on the 17.0078 tributary to Leland Creek (tributary *C,* Map 6, Appendix 1). Resident cutthroat trout were netted both below and above this perched culvert (CC #86 – Appendix 2, and Part II: section L-1). Cutthroat trout were observed well into the upper reaches of the northern of two primary headwater forks of the WRIA 17.0080 Leland Creek tributary (PC #61, Map 5). Juvenile coho were also observed in this latter stream, indicating that adult coho accessed headwater habitat well above the upstream extent of the spawning survey index reach during the fall spawn. Finally, three-spine stickleback *(Gasterosteus aculeatus)* were discovered downstream from the outlet of two barrier culverts (PC #47 and #48, Map 4 and Appendix 2) on a headwater tributary of the Upper Leland Valley wetland complex (tributary 17.0017 *Q-f*) that has been ditched through livestock pasture, and mostly cleared of native riparian vegetation. Stickleback are well known to withstand conditions (i.e. high temperatures and degraded water quality), often surviving in conditions where salmonids cannot. However, the landowners (Appendix 3, #10) have indicated interest in assisting with salmon recovery efforts in the past (Andrews Creek, a tributary of the Salmon / Snow watershed to the north, also transits the property), and they may be convinced to participate in a restoration of this significant stretch of headwater habitat (see Part II, section L-5) that ultimately discharges to Lake Leland.

Surface water rights are exercised by landowners in and around the town of Quilcene via a diversion canal that exits the mainstem Little Quilcene River in sub-reach 3A (Map 2). The "Wildwood Diversion Canal" (so-named in this document because a segment of the canal continues for several thousand feet in a ditch adjacent to Wildwood Road on the outskirts of Quilcene) is potentially a significant source of increased mortality for coho salmon entering from the river at the diversion canal entrance. Adult coho spawned at the diversion entrance during the 2007-2008 spawning season (with at least 1 redd located a short distance downstream within the canal proper), and several hundred juvenile coho were observed in the initial downstream reach below the diversion dam.

For all intents and purposes, the Wildwood Canal is currently providing the low-gradient, off-channel rearing habitat that is essential for juvenile coho, but generally limited in the Little Quilcene mainstem. Juvenile salmon enter the canal to escape high seasonal flow velocities in the adjacent river. The fish are likely subject to elevated water temperatures, and higher rates of predation due to a complete lack of holding cover, but it is unlikely that juvenile smolts will navigate upstream in the canal to return to the mainstem when they begin their out-migration toward the river mouth. The only available option is a slow downstream transit along the open canal that is receiving sediment input from ongoing residential construction along Big Leaf Lane. Fish in the canal are forced into a lengthy section of aluminum pipe suspended over a ravine, and through several perched culverts in a ditch along Wildwood Road, then several thousand feet of livestock pasture and road-side ditches, finally discharging to a livestock watering pond adjacent the canal culvert crossing of Highway 101. Depending on water management actions at a river-return / control structure (comprised of sandbags and concrete riprap) just below the diversion canal entrance, the water level in the ditch downstream to the culvert is often not sufficient to cause overflow from the pond down to the culvert inlet that is located just south of the Cemetery Road / Highway 101 intersection (the mouth of the canal marks the upper end of sub-reach 1B). Under these conditions, any fish transiting the length of the canal to the culvert at the Little Quilcene River are trapped in the livestock pond with no exit but to return "upstream" toward better holding water, and wait for higher flows to again escape back to the river. Further details regarding opportunities to mitigate the potential impacts of the "Wildwood Diversion Canal" on native fish populations are provided in Part II, LQ-3 and LQ-4.

WFC water type surveys also documented juvenile coho rearing in an agricultural ditch referred to locally as "Cemetery Drain" (see Part II, pg. 26 and Map 2, Appendix 1). This previously un-mapped ditch flows along a narrow riparian corridor of medium-sized alder trees upstream from a separate tidewater confluence at the head of Quilcene Bay (between the mouths of the Little Quilcene and Big Quilcene Rivers). Cemetery Drain crosses Center Road and Highway 101 via large-diameter culverts, and continues through downtown Quilcene as an open ditch while crossing local roads through several smaller culverts. Invasive Himalayan blackberries obscure the channel below the highway crossing, and the channel flows for long distances in an open ditch through agriculture fields and pastureland surrounding a (now greatly-reduced) former valley-bottom wetland complex. The channel originates at several small but perennial spring-fed seeps to the west and northwest of Cemetery Road. Compromised water quality due to elevated temperatures, agricultural run-off, and greater risk of predation from lack of cover indicate that Cemetery Drain is also a likely sink for Quilcene Bay coho populations.

Photo 12 – Salmon habitat in downtown Quilcene; upstream view of Cemetery Drain.

Part II:
Recommended Actions for Watershed Restoration and Recovery

How do we get from here…

Photo 13 – Highly degraded habitat: a former Type 3 fish-bearing tributary stream that was converted to an agricultural drainage ditch flowing through pastureland (Cemetery Drain).

…back to there!

Photo 14 – A relatively intact segment of the Little Quilcene River: note the diverse pool / riffle habitat with in-stream large woody debris and native riparian vegetation.

Watershed-wide recommendations for habitat protection and restoration in the Little Quilcene River and Leland Creek sub-basins:

- Update Jefferson County Fish and Wildlife Habitat Conservation Areas maps (FWHCA, i.e. "critical areas"), and encourage landowner compliance with and agency enforcement of minimum state riparian buffer standards for all stream reaches, ponds, and wetlands in the Little Quilcene watershed. Although standard wetland delineation was outside the scope of this project, all wetlands that were "re-discovered" during WFC water typing efforts in headwater reaches of the Little Quilcene, Ripley Creek, Howe Creek and Leland Creek sub-basins are depicted on Maps 2-6 (Appendix 1). The wetlands should be officially surveyed and delineated to provide protection in full under current WDNR forest practice regulations. Jefferson County Critical Areas maps should reflect these previously un-documented wetlands so that they are adequately protected from damaging forestry and agricultural practices and continuing development.

- In cooperation with Jefferson Land Trust, acquire lands or promote conservation easements as parcels become available within the functional forested reaches and in critical wetland areas to protect current habitat status from further degradation. In particular, several parcels along the mainstem Little Quilcene and major tributaries with high fish production value still have residual stands of mature conifer forest in the riparian corridor. These would be suitable candidates for tax-incentive conservation agreements with landowners, or possible land-trade through the WDNR Trust Land Transfer program. Note: streamside acreage has recently become available by a seller along Leland Creek near the end of Reach 5.

- Work with agricultural and residential landowners and local non-profits and volunteers to remove non-native vegetation within the riparian corridors (refer to Part III: *Habitat Reconnaissance Survey Notes* for detailed locations of streamside incursions of invasive species incursions in the Little Quilcene watershed), and supplant with native species for bank-stabilization and future wood recruitment. Introduce landowners to the various Jefferson County Conservation District (JCCD) riparian improvement and cost-share incentive programs such as CREP and WHIP (Conservation Reserve Enhancement and Wildlife Habitat Incentives).

- Explore options to install engineered log-jams and introduce large wood pieces and rootwads in place of the current levees and bank armoring (supplemented LWD should appear natural - not cabled to stream banks). Suggested removal or replacement of artificial bank armoring should consider the effects on adjacent and downstream landowners, as well as the channel habitat form and function, and future riparian conditions (refer to Table 3, Part I for reach locations of bank armoring on the Little Quilcene and scattered locations on lower Leland Creek).

- Initiate and enforce *best management practices* in the agricultural areas, focusing on protecting stream banks and water quality from livestock impacts, improving riparian and pasture conditions by fencing off riparian areas, planting vegetation barriers, and initiating pasture-rest and seasonal-preference grazing strategies. Landowners with existing fences abutting the stream channel should be encouraged to establish new fence lines with a wider setback, and to install nose-pumps, solar pumps, or other non-stream-access livestock watering alternatives.

- Investigate recent timber cutting within the river riparian corridor (Little Quilcene sub-reach 3B and Reach 6 in Part III), and enforce existing regulations protecting state-mandated stream buffers. Headwater stream surveys along Howe Creek and Leland Creek beyond the head of Lake Leland also identified areas of significant blowdown of riparian buffers in recent timber harvest units. Deposition of unnaturally large amounts of coarse woody debris in headwater channels can result in later channel degradation, and isolating migration barriers for resident fish populations. Monitoring and enforcement of current harvest activities should be initiated to ensure compliance with riparian buffer standards for Type 4 (Np) perennial tributaries and forested wetlands on timberlands owned and managed by local private timber resource companies and the Forest Service. Headwater tributaries and wetlands of Ripley Creek, Leland Creek, and the 17.0080 Leland tributary have been particularly hard-hit by recent clearcut logging, with skid roads damaging some spring sources, and very little mitigation / re-forestation evident for logging near Type 5 channels as required by state law (WAC 222-30).

- Given predicted changes in climate and competing residential and municipal water uses, the protection of groundwater and in-stream flows is essential to sustaining watershed processes in the Little Quilcene – Leland Creek sub-basin. Washington State Department of Ecology has yet to adopt minimum stream flow recommendations consistent with the Dungeness-Quilcene Water Resources Management Plan (JST, 1994) and the WRIA 17 Watershed Management Plan (Cascadia, 2005). Well-drilling for expanding rural residential development continues to be exempt from state regulation throughout the watershed, and wells often tap near-surface groundwater that is vital to the maintenance of late summer and early fall in-stream flows via subsurface water movement, particularly in the rainshadow watersheds of the eastern Olympic Peninsula. WFC recommend the initiation of an advocacy program targeting state water resources regulatory agencies (WDOE) to adopt and enforce minimum in-stream flow requirements. The City of Port Townsend and the Port Townsend Paper Corporation (owners of the Port Townsend paper mill) could be approached with a request to modify their current water diversion practices to increase or restore available surface flow during the summer/fall seasonal drought. This recommendation should also include a continuing program of community-education about water conservation practices, relating residential/commercial water usage not only to future water availability for people, but also the effects on salmon and native aquatic species.

- Initiate research to ascertain the current distribution and population status/trends of native freshwater mussels throughout the Little Quilcene sub-basin. Though potentially missed during the rapid habitat reconnaissance survey, WFC field crews did not locate freshwater mussels in any of the surveyed stream reaches, and this may be an indication of their scarcity and/or possible decline. Leland Creek is known to have harbored past populations of mussels, and mussels are a key indicator organism for water quality and watershed health. The current listing of several resident mussel species on the Washington State Department of Fish and Wildlife Priority Habitats and Species list certainly lends “teeth” to habitat protection for mussel beds mapped in watershed tributaries and trunk stream.

- The 2007 NOAA Fisheries listing of Puget Sound Steelhead as “threatened” under the federal Endangered Species Act (ESA) should result in funding and resources quickly becoming available for research and habitat restoration. Although stocks of steelhead in Hood Canal tributary streams are considered severely depressed, so little information exists on population trend for winter steelhead in the Little Quilcene sub-basin that the stock status is currently listed by SaSI as “unknown” (WDFW 2002).

  As part of their expanded Hood Canal Steelhead Project, Long Live the Kings (LLTK) have initiated a hatchery supplementation and spawner monitoring program throughout the Hood Canal basin, including spawning surveys in the mainstem Little Quilcene River. However, tributaries of the Little Quilcene and Leland Creek that may support winter steelhead production are not currently monitored, presenting a significant data gap, and an opportunity to partner with LLTK to expand spawning surveys for winter steelhead throughout the sub-basin.

- A community-wide education program targeting rural residential land-owners, farmers, school children, and local civic leaders about the importance of maintaining intact riparian corridors, water-quality protection, the benefits of beavers in headwater habitat, and the “bragging rights” of having wild salmon spawning and rearing within city limits and surrounding rural streams would likely ease the transition to a more stream-friendly community in Quilcene. Included in this recommendation could be the creation of a local committee with representatives from state regulatory agencies, and technical experts from the Jefferson County Conservation District (JCCD) and local watershed enhancement groups to address agricultural and development practices and complaints, and offer solutions as an alternative to heavy-handed regulation enforcement.

Targeted, reach-specific restoration opportunities:

Little Quilcene River – see LQ-1 through LQ-7 on Maps 2 and 3 (Appendix 1).

1. Hood Canal Salmon Enhancement Group (HCSEG) have acquired properties along the lower river (sub-reach 1a) adjacent to mouth, and are implementing restoration efforts including the removal/breaching of dikes that truncate the floodplain habitat of the lower main channel and limit salmon spawning opportunities upstream from the tidewater estuary. This would be an excellent opportunity for Pacific Ecological Institute to partner with a lead local watershed restoration organization to assist with the re-establishment of a meandering river

channel entering Quilcene Bay, and to enhance habitat for ESA-listed Hood Canal summer chum that preferentially spawn in the estuary and lower river reach.

Photo 15 – Ongoing (August 2008) restoration of lower Little Quilcene River by HCSEG includes levee removal, construction of a meandering channel, supplementation with large woody debris, and eventual planting with native riparian vegetation.

2. A formerly lengthy stretch of boulder riprap was removed from the left bank of the river channel ~800 feet upstream from the Highway 101 bridge crossing (Reach 3, sub-reach 3A).

Photo 16 – Erosion of Little Quilcene River left channel bank (Reach 3, sub-reach 3a) at the site of a former bank stabilization project (note boulder riprap in background).

2. (cont'd) Investigate the impacts of ongoing erosion at this site, consider installation of an engineered log jam(s) and/or planting bank-stabilizing conifers.

3. The landowner / ditch manager (Appendix 3, #1) on the right-bank of the river at the Wildwood Diversion Canal entrance (in sub-reach 3A) expressed interest in the proposed idea of installing a fish-screen barrier to prevent the passage of juvenile salmonids downstream from the river into the diversion canal. Although this is not a natural waterway (it was constructed for irrigation purposes near the turn of the 20^{th} century), the physical characteristics now qualify the canal as a Type 3 (fish-bearing) channel, and numerous juvenile coho were observed in the upstream reaches by WFC field crews.

Photo 17 – Early autumn low-flow upstream view at the "Wildwood Diversion Canal" entrance showing de-watering that occurs in the mainstem Little Quilcene River (right).

This project would offer the potential to partner with landowners/farmers to mitigate for the surface water diversion from the river, and would represent a relatively small investment for a potentially large return in juvenile coho survival in the Little Quilcene River. In addition, a feasibility study could be initiated to explore the potential positive and negative impacts of naturalizing the entire length (or portions) of the existing diversion canal and/or reconnecting it to the mainstem as a side channel during times of the year when it would be most beneficial to spawning salmon (the side channel already exists as a water-return route just downstream from the entrance – water level in the canal is currently managed by a sandbag control and concrete riprap control structure).

4. Seasonal high flows routinely flatten the cobble push-up dam at the entrance to the Wildwood Diversion Canal (see #3, above). Repeated channel manipulations during re-construction, and subsequent re-distribution of the excavated substrates

by winter floods, have severely homogenized the channel habitat at this location, resulting in an extended plane-bed channel form.

Photo 18 – View of the cobble diversion dam (remains are visible on left-bank) after seasonal high flows have flattened the dam and re-distributed channel substrates. Several logs are visible at the right-bank entrance to the "Wildwood Diversion Canal" downstream.

Investigate water rights claims by local landowners/canal water users and compare with state (WDOE) and Jefferson County records to verify current water rights status of canal water users. Although water rights-users are entitled to maintain their diversion, an opportunity exists to collaborate with permitting agencies (WDFW, WDOE) and interested parties responsible for ditch maintenance (Appendix 3, #2) to moderate their approach to this annual stream manipulation, particularly if heavy equipment is used within the ordinary high water mark of the channel. Re-construction should be timed to ensure that salmon and steelhead eggs and alevin have hatched and emerged from interstitial gravels in spawning sites throughout the channel near the canal entrance, and installation of pool-forming engineered log jams may be appropriate for the entire sub-reach upstream from the Wildwood Diversion Canal inlet to diversify spawning and rearing habitats within the plane-bed riffle.

5. A man-made cobble push-up dam near the lower extent of sub-reach 3B diverts flow away from a homesite atop an eroding bank (Jefferson County parcel #702111036 physical address: #285 Lords Lake Loop Rd.). The dam results in the complete de-watering of spawning gravels in two of three downstream channel braids during low flow periods, and increases flow rates and the potential for erosion along the right bank. Split and side channel reaches are few-and-far between in the Little Quilcene River, but these often provide the most productive spawning and rearing habitats. Explore alternatives to restore in-stream flow connectivity, and to assist the landowner with erosion concerns. Options include

an investigation of the feasibility of engineering log jams, and planting bank-stabilizing conifer trees for long-term protection of the eroding left bank.

Photos 19-20 – Downstream view of another cobble diversion dam (left) near the upper extent of sub-reach 3b. “Push-up” dam diverts flow from an eroding left-bank bluff (right), but de-waters the downstream split channel.

6. Another man-made cobble push-up dam located in Reach 6 did not appear to be a water diversion; its function was unclear at the time of the habitat reconnaissance. Such channel manipulations, though common along many state waterways, can be very detrimental to fish migration and habitat structure, and are direct violations of WDFW hydraulics ordinances (unless the appropriate permits are obtained by landowners). A program of informational signage placed at key public access points throughout the watershed, and a letter-writing campaign targeting streamside landowners may help to reduce the incidence of substrate manipulation by otherwise uninformed recreational users and residents.

Photo 21 – Upstream view of a third cobble “push-up” dam; Little Quilcene, Reach 6.

7. WFC personnel determined that fall chum and coho salmon did not utilize the 17.0082 tributary to the mainstem Little Quilcene River during the 2007-2008 spawning season (tributary *D*, with a right-bank confluence located in Reach 3, sub-reach 3a). This stream (sometimes referred to as "Wildwood Creek") extends for ~400 ft. above the river to a culvert crossing of Big Leaf Lane that is a complete barrier to upstream fish passage, and contributes to downstream erosion.

Photos 22-23 – A view of "Wildwood Creek" ~350 ft. upstream from the Little Quilcene River confluence (left), and ~50 ft. below a barrier culvert crossing of Big Leaf Lane (right). The "Wildwood Diversion Canal" crosses the Wildwood Creek ravine via a suspended aluminum pipe, and the culvert barrier disconnects several-thousand feet of potential mainstem and tributary anadromous habitat upstream from Big Leaf Lane.

WFC water type survey crews did not have access to private property to determine the full extent of habitat potential above this barrier culvert (PC #74, Appendix 2), but a review of the WDNR water type maps indicates a *minimum* habitat gain of ~1950 ft. upstream to a major channel fork at the 17.0083 tributary confluence, with the likelihood of an additional ~4400 ft. of potential anadromous habitat on the Wildwood Creek mainstem (17.0082), and the 17.0083 (*D-a*) and 17.0084 (*D-b*) tributaries combined above two additional barrier culvert crossings of local roads (PC #'s 71, 72, 73 Appendix 2). All of these culverts are located along a private road system that extends into an area of ongoing residential development (to the north and west of Wildwood Road), so they were not identified for the Jefferson County Culvert Inventory and Prioritization (Till et. al. 2000), and WFC personnel were unable to obtain permission to conduct barrier assessments. However, cursory examinations concluded that all three culverts are fish-passage barriers, and replacement with at-grade culverts of appropriate size to handle winter seasonal high flows would re-connect anadromous and headwater resident fish habitat throughout the 17.0082 tributary network, representing the largest potential gain in fish-bearing habitat from a culvert replacement project identified by WFC during the course of the Little Quilcene Rapid Habitat Assessment.

<u>Leland Creek and Lake Leland</u> – see L-1 through L-7 on Maps 4, 5, & 6 (Appendix 1)

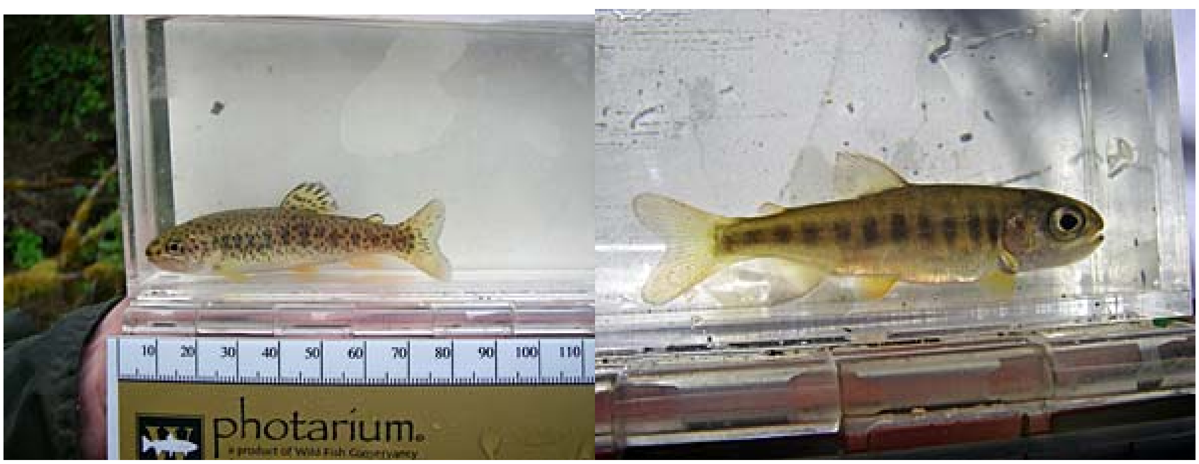
General -Water quality issues in Leland Creek become particularly problematic for native fish and other aquatic organisms during the late summer and early fall dry season (or in years of lower-than-average precipitation) when numerous seasonal tributaries have ceased to flow. Clean, clear, cool water from the few perennial Leland Creek tributaries provides thermal refugia for trout and salmon fry escaping elevated temperatures in Leland Creek proper, and serves to mitigate mainstem temperatures downstream. Much research in recent years has focused on water quality and temperature issues in Lake Leland, but protection and restoration of these year-round Leland Creek tributaries should also become a priority in any future management plan for aquatic and riparian habitats, and as such, they are the focus of the majority of WFC's recommendations for the greater Leland watershed.

1. Replacement of a perched culvert located at mile-post 3.12 of the West Leland Valley Road would offer an exceptional opportunity to partner with Jefferson County on a capital improvement project. The stream (17.0078 – tributary *C*, Map 6) is used by both anadromous coho and resident cutthroat trout, with coho salmon currently spawning in the short reach downstream from the culvert outlet, and cutthroat observed both below and well above the culvert. Nearly 950 ft. of potential salmon spawning and rearing habitat continues above the culvert to a natural gradient barrier, with an additional 2450 ft. of Type 3 habitat upstream from this anadromous barrier, for a total gain of approximately 3400 linear feet of fish-bearing habitat. The headwaters are fed by a series of perennially spring-fed, low-gradient streams and associated wetlands that are located within a remarkably intact setting of mature timber and natural riparian vegetation on state land.

   A road bridge or at-grade culvert crossing, coupled with the permanent protection of the forested headwater reach (via conservation easements on adjoining private land and acquisition of the state property through the WDNR Trust Land Transfer program *before it comes due for harvest*), would secure and restore this potentially very productive tributary, and protect water quality near the source for downstream rearing juvenile coho and resident trout in both the tributary and Leland Creek. The culvert (CC #86, Appendix 2) is currently ranked 22nd on the barrier prioritization list for Jefferson County (Till et al. 2000).

   Landowners at the mouth of this stream (Appendix 3, #3) have indicated a keen interest in riparian restoration and conservation of stream reaches through their property, both along their Leland Creek frontage (though not a part of the mainstem spawning survey index reach, adult coho were observed spawning in numbers here during WFC spot-surveys) and along the tributary from the Leland confluence upstream beyond the culvert crossing of Leland Valley Road West.

Photo 24 – Barrier culvert crossing of Leland Valley Road West on the 17.0078 tributary.



Photos 25-26 - Cutthroat trout (left) and juvenile coho salmon (right) were netted in the culvert plunge pool.

2. During the course of intensive WFC investigations of tributary reaches, the 17.0080 Leland Creek tributary was discovered to be very productive spawning and rearing habitat for coho salmon. Although the spawning-survey reach of this *H* tributary (Map 5) flows in large part through a naturally forested valley with a riparian corridor of mature conifers and deciduous trees (WDNR ownership), water quality could become compromised by land-use practices along headwater reaches. Uplands surrounding these headwater tributaries are managed primarily for timber harvest, with recent, extensive clearcut logging and blowdown of riparian buffers during high wind events. The construction of channel-crossing skid-roads has damaged several spring-fed feeders to these tributaries, causing a Type 4 (Np) stream to flow subsurface in at least one instance noted during water typing efforts. The channels are further degraded by off-highway vehicle (OHV)

use along the Bonneville Power Administration's powerline swath. OHV tracks were noted in many sensitive wetland areas. Both the north and south headwater forks - WRIA 17.0080 continues as the north fork, and the *H-a* tributary enters from the south - merge in the center of an extensive wetland / former pastureland located along the cleared BPA powerline right-of-way. This wetland is heavily overgrown with reed canary grass, and the southern tributary has been extensively ditched through this former pasture. Both tributary forks are lacking in riparian overstory and undstory cover to mitigate downstream summer temperatures.

a. Streamside planting of high-growing conifer species is not an option along a short segment of this reach, as BPA will continue to maintain an essentially de-foliated swath directly beneath the powerlines.

Photo 27 – Downstream view along the degraded south fork headwater tributary of WRIA 17.0080 (tributary *H-a*). Note extensive incursion of non native grass beginning to green-up. WRIA 17.0080 continues downstream in a forested valley that begins at the distant tree-line.

This segment would benefit from the removal of invasive vegetation, and the planting of low-growing native riparian shrubs to provide much-needed shade and pool cover. Conifers and deciduous trees should be planted along both channel forks above and below the relatively narrow powerline corridor to create future riparian forest habitat.

b. Hydraulics ordinances banning motorized vehicles from stream channels should be enforced, and educational signage installed reminding local OHV enthusiasts of the pertinent regulations. Adjacent land management agencies (WDNR, BPA, ORM) should be encouraged to maintain and replace current ditches and culverts to minimize downstream sedimentation from small, seasonal tributaries that are outsized for current infrastructure during high flow periods, and are actively eroding un-maintained road surfaces, contributing sediment to the main 17.0080 channel during heavy rainfall or rain-on-snow events. Turbid water from suspended sediments was observed several times during spawning surveys in the downstream index reach.

Photos 28-29 – Ns (Type 5) seasonal tributary channel eroding an old road-bed in a headwater area that receives heavy use by OHVs (left), and in-stream sedimentation visible at a (non-barrier) culvert outlet just below the confluence of the 17.0080 Leland tributary and its south fork (17.0080 *H-a*).

c. Replacement of a barrier culvert (PC #62, Appendix 2) and re-construction of the channel through a debris flow that currently blocks up-channel fish migration at the tributary mouth, would result in a gain of ~1850 ft. of fish-bearing habitat along the *H-d* tributary to the north fork 17.0080mainstem (Map 5). Cutthroat trout were observed at the tributary confluence, and juvenile coho were netted in the mainstem just downstream.

d. The final ~670 ft. of the 17.0080 Leland tributary below the double-culvert crossing of Highway 101 (CC #'s 100/101, Appendix 2) flows through a ditched channel in a residential yard before dispersing into former wetland just above the Leland Creek confluence. Adult coho salmon were in large part able to traverse this short, undefined channel segment to access spawning grounds in the index reach above the highway, but the potential exists for stranding in adjacent livestock pasture during high water periods. Stranding can be directly fatal, and also increases predation risk. Run-off from the livestock pasture likely compromises water quality in Leland Creek downstream. Fencing set-backs for livestock, and riparian restoration and re-construction of a meandering channel through the pasture segment along this stream would benefit out-migrating juvenile coho as well as returning adults. The landowner (Appendix 3, #5) appeared somewhat receptive, and may become more enthusiastic if/when informed that the tributary through their property is a source of significant coho production in the Leland watershed.

Photos 30-31 – Inadequate livestock fencing setbacks (left) on the 17.0080 tributary near the confluence with Leland Creek; a common occurrence on streams flowing through pastureland throughout Leland Valley. An adult male coho stranded in a flooded field (right), and then killed by otters before it had an opportunity to contribute to the genetic pool of the next generation of wild salmon.

3. Long stretches of Leland Creek below the outlet of Lake Leland, and ditched fish-bearing (Type 3) channels along the Upper Leland Valley wetland complex (Maps 4 and 5) lack adequate riparian tree cover and are heavily influenced by invasive reed canary grass (see reach descriptions in the *Habitat Reconnaissance Survey Notes: Part III*). As a result, summer temperatures in Leland Creek regularly exceed state water quality standards, and likely limit mainstem fish use.

Photo 32 – Fence-line separates reed canary grass-dominated wetland just below the outlet of Lake Leland from fish-bearing (Type 3) tributary 17.0017*I* that vanishes in pastureland before reaching a confluence with Leland Creek (in the background against the forested ridge).

3. (cont'd) A project partnering with JCCD and multiple local landowners and community volunteers to remove invasive reed canary grass and conduct tree plantings would improve long-term habitat conditions in upper Leland Creek, and benefit water quality in downstream reaches. Riparian restoration accomplishes the twin goals of improving shade conditions for stream temperature mitigation, and future channel recruitment of large woody debris.

   Approach landowners with property along Leland Valley Road West about the feasibility of re-establishing the hydraulic connections with adjacent wetlands along the historic/abandoned railroad grade in Leland Valley, by reconstructing former channels (where necessary – see photo, above) and re-opening the many wetland-to-wetland and wetland-creek connectors. The railroad berm currently functions as a levee, truncating the channel migration zone and fracturing wetland and side-channel connectivity. These off-channel habitats have repeatedly been demonstrated to be of particular importance to the over-winter survival of juvenile coho and steelhead prior to smolting and river out-migration. Spring-fed Type 4 and 5 (Np and Ns) tributaries draining upslope land to the west of the roadway contribute cool, clean water to wetlands on the valley floor, and should be protected with native riparian vegetation buffers where they transit rural residential property and pasture. Removal of sections of the railroad grade could facilitate the movement of juvenile and resident fish into this off-channel habitat during periods of compromised water quality in the mainstem.

4. Nearly 1400 feet of fish-bearing habitat along the eastern headwater tributary to the Upper Leland Valley wetland complex (17.0017*Q-d*) is almost completely disconnected by ditching of the downstream channel within the floodplain. The channel was altered from its former course southwesterly toward the wetland confluence, and now flows in a very shallow ditch through livestock pasture to the northwest, before turning to the south at a confluence with the 17.0017*Q-e/f* tributaries at a submerged culvert crossing of Highway 101.

Photo 33 – Channel diversion that disconnects fish-bearing (Type 3) habitat from tributary 17.0017*Q-d* emerging from a side canyon upstream from the Upper Leland Valley wetland.

4. (cont'd) The ditched channel below Leland Valley Road East is almost completely overgrown with non-native grasses, with very little native riparian cover, and continues upstream to a recently-installed barrier culvert crossing of Leland Valley Road East (CC #44.5, Appendix 2). Should salmon and steelhead eventually be encouraged to return to Upper Leland Valley wetland tributaries, this stream could provide excellent spawning habitat in the short canyon reach located just above the roadway (on property parcel #802134004). Re-connecting the lower segment of this tributary, fencing livestock away from the stream, and restoring the riparian buffer would help to improve water quality in Lake Leland.

5. The Boulton Farm spans the upper reaches of both Andrews Creek (WRIA 17.0221) and the headwater tributaries to the Upper Leland Valley wetland complex (17.0017*Q-e/*f, Map 4). Native fish access to the fish-bearing (Type 3) tributaries traversing the property would benefit from the replacement of two barrier culverts located along a ditched portion of the western headwater tributary (PC #47, 48, Appendix 2). The landowner (Appendix 3, #10) may also be amenable to a complete restoration of the two channels that could eventually be utilized for spawning if native salmon and steelhead are encouraged to return to Lake Leland and upstream tributaries. Three-spine stickleback were discovered just below the outlet of the lower culvert. Stickleback are a native fish capable of withstanding degraded water quality and high stream temperatures, often surviving in stream conditions where trout and salmon would be jeopardized. Amphibians use the channels and adjacent wetlands for reproduction. Both streams are spring-fed Type 4 tributaries exiting areas of extensive upslope logging (observed riparian buffers adhered to state forest practice minimums), but are now confined within ditches through livestock pasture on the valley floor.


Photos 34-35 – Three-spine stickleback (*Gasterosteus aculeatus* - left) and frog egg masses (right) located at the ditched outlet of barrier culverts along the 17.0017*Q-f* tributary to the Upper Leland Valley wetland complex.

5. (cont'd) Livestock are currently fenced from direct access to these channels, but pasture run-off was evident at the time of the stream survey. Very little riparian cover remains (a scattering of willow trees), and the streamside vegetation is predominantly composed of invasive Himalayan blackberry, reed canary grass, and non-native pasture grasses. A complete habitat restoration would include riparian plantings, and the re-construction and naturalization of meandering channels along portions that are currently ditched. At minimum, replacement of invasive vegetation with native trees and shrubs and encouraging wider fencing setbacks would reduce summer maximum water temperatures and pasture run-off toward the ditched wetlands that discharge directly into Lake Leland downstream.

Photo 36 – Wetland habitat in Upper Leland Valley now relegated to a ditch along Highway 101. Fish-bearing (Type 3) habitat continues for several thousand feet further upstream along eastern (17.0017*Q-d*) and western (17.0017*Q-e/f*) headwater tributaries. All run-off into this ditch eventually enters Lake Leland approx. 2 miles downstream.

6. *Lake Leland and its tributaries –*

   a. The Leland Creek culvert crossing of the Leland Valley Road West just below the outlet to Lake Leland is not a fish passage barrier, but is backwatered during high water periods, overflowing the roadway and creating hazardous driving conditions for local residents. Replacement of this culvert (CC #76, Appendix 2) with a bridge or new culvert of sufficient size to handle the highest seasonal flows would ensure adequate fish passage downstream into Leland Creek during all water levels, and reduce the potential for stranding of adult salmon should they return to the Leland Lake tributaries to spawn.

   b. Although no longer functional, removal of the fish weir at the Lake Leland outlet could be the first step to initiating a complete resurrection of the ditched Leland Creek channel downstream through wetlands (see Leland #3, above).

Photo 37 – Defunct fish weir and reed canary grass invading the channel at the Leland Creek outlet from Lake Leland.

c. Washington Department of Fish and Wildlife routinely supplants native trout populations in Lake Leland with hatchery rainbow trout to provide sport-fishing opportunities for local anglers. Should salmon and steelhead be encouraged to return to Lake Leland and upstream tributaries, they would be subject to possible high rates of predation by planted rainbows, and hatchery fish could potentially dilute wild steelhead genetic stock through inter-breeding. This issue would need to be addressed in any plan to promote steelhead and salmon to return to the upper Leland Creek watershed.

d. Short reaches of spawning habitat exists in several Lake Leland tributaries. Segments of the 17.0017*O* and 17.0017*P* tributaries (Map 5) below gradient barriers at Snow Creek Road have adequate spawning gravel for resident trout (and potentially anadromous salmon), and may serve as thermal refugia when summer temperatures and water quality in the lake become untenable. These tributaries currently lack vegetative cover where they transit lakeshore residential properties. Educate landowners about the value of shade trees and native shrubs not only to resident fish, but also to lake water quality.

e. Tributary 17.0017*N* enters Lake Leland near the end of Munn Road (Map 5). This tributary has several thousand feet of newly-mapped fish-bearing habitat above the lake confluence. Although the Munn Road culvert is not a fish passage barrier, the stream both above and below the culvert is heavily overgrown with invasive vegetation (esp. Himilayan blackberry and English ivy), and the channel is armored and rip-rapped through several residential properties downstream toward the lake (incl. parcel #802261012). Native riparian cover has largely been removed along this reach, replaced by residential landscaping and non-native commercial plants along the banks. A wooden dock is located directly adjacent to the stream mouth where reed canary grass partially obscures the lake confluence. The landowners at the confluence (Appendix 3, #8) may be open to native riparian restoration, and should be included in community meetings discussing water quality concerns and the potential return of salmon to Lake Leland and watershed tributaries.

Photo 38 –confluence of the 17.0017*N* tributary on private property on the southwest shore of Lake Leland. Fish-bearing habitat extends upstream beyond Snow Creek Road.

f. A small man-made dam and impoundment along a headwater reach of the 17.0017*N* tributary (see Leland #6e above and Map 5) is a complete fish-passage barrier, causing the Type 3 stream to flow subsurface for a distance. This structure is located on private property (ORM) several hundred feet below the Snow Creek Road culvert crossing. A restoration project to re-connect newly-classified fish-bearing habitat with a headwater beaver pond to the north of Snow Creek Road could include removal of the small dam, and the replacement of two barrier culverts (PC #2 and CC #95, Appendix 2).

Photo 39 – Barrier culvert crossing of a decommissioned logging road along newly-mapped Type 3 habitat on a headwater reach of the 17.0017*N* tributary to Lake Leland.

Photo 40 – Extensive beaver pond wetland located just upstream from a culvert crossing of Snow Creek Road (CC 95) at the headwaters of the 17.0017*N* Lake Leland tributary.

7. The Highway 101 culvert crossing of Leland Creek (SC #99, Appendix 2) is considered a "B-level" barrier – i.e. a barrier under low flow conditions only. This culvert does not currently appear among the 84 listed barriers scheduled for eventual repair in the Jefferson County Culvert Inventory and Prioritization (Till et. al. 2000). Although negotiating this culvert is likely problematic for resident

trout and juvenile salmon migrating through the watershed during low flow periods, the culvert is not a significant barrier for spawning adult salmon because early-season flows are too low for summer chum to enter Leland Creek downstream. Stream flows high enough to permit entry at the mouth also elevate the water level in the culvert enough to facilitate the passage of adult salmon.

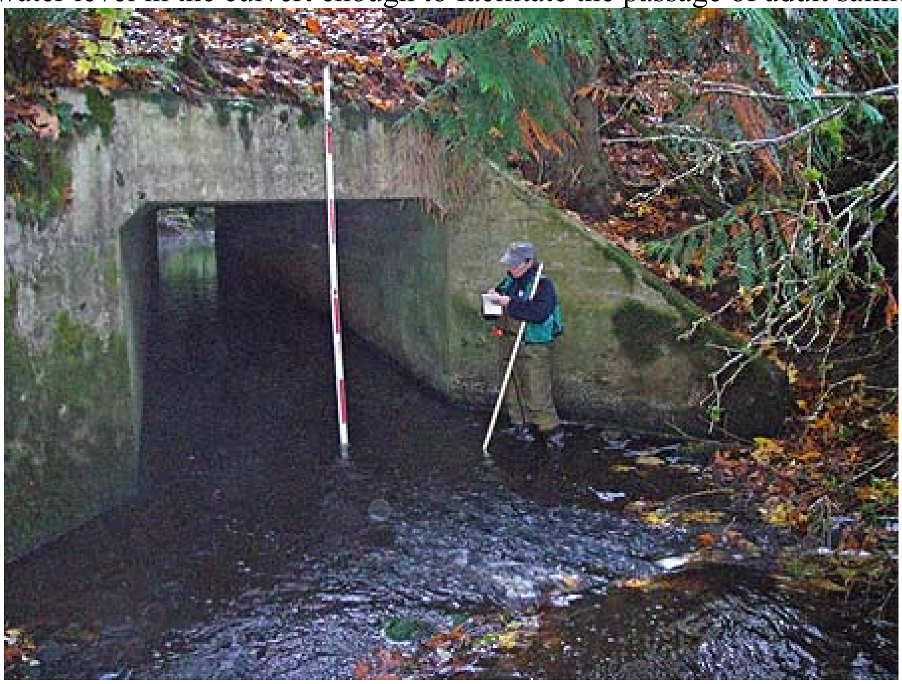


Photo 41 – Upstream view through the outlet of the Highway 101 culvert on Leland Creek (Reach 3). The culvert (SC 99) creates a partial fish-passage barrier during low-flow periods.

<u>Ripley Creek</u>– see R-1 through R-5 on Map 7 (Appendix 1)

1. A 16-inch diameter log spanning the channel at the Ripley Creek confluence with the Little Quilcene River is currently embedded in the substrate, creating an impediment to fish migration into the mouth of the stream. This would be a quick fix to improve fish passage into and out of the tributary during low water periods.

Photo 42 – High water view of channel-spanning log at the mouth of Ripley Creek; the log is a partial barrier to fish migration during late summer / early fall low flows.

2. The owner of a railroad flatbed bridge connecting adjacent pasture along the channel in sub-reach 1a (Appendix 3, #6) has expressed interest in supplementing native vegetation along the riparian corridor through his property for the benefit of spawning salmon. This sub-reach was a stronghold for coho salmon during the 2007-2008 spawning season. However, much of the reach lacks large woody debris to create pools and habitat complexity for rearing juvenile fish. The riparian buffer is largely composed of mature alder trees and dense vine maple, with little regeneration of conifer trees in the understory. The surface channel for a distance of several hundred meters from the above the bridge downstream to the river confluence becomes completely dry during late summer and early fall. A restoration project that included the introduction of pool-forming woody debris into the channel, along with planting of streamside conifer trees for future shade and wood recruitment would improve both spawning and rearing habitat for coho salmon and resident cutthroat trout. Residual pools formed by the placement of rootwads and small engineered log jams may hold water over the dry season to increase juvenile rearing habitat.

3. The riparian corridor along the "beaver pond reach" of lower Ripley Creek is completely dominated by invasive plant species, with the stream reduced to multiple narrow channels threading through dense swaths of reed canary grass.

Restoration of this reach (sub-reach 1B, Part III) by removing the non-native vegetation and planting of both conifer and deciduous trees and shrubs would contribute to the long-term enhancement of aquatic and riparian habitats, and improve short-term passage of coho salmon into upstream spawning grounds.

Photo 43 – Downstream view of reed canary grass-dominated wetland habitat created by beaver activity near a local powerline crossing in sub-reach 1B of lower Ripley Creek.

4. Beaver pond wetlands are very productive habitats for coho salmon and other wetland dependent species. The importance of beavers for in-stream and riparian health and function should be stressed to local landowners, so that beaver are retained in the Ripley sub-basin, and encouraged to propagate throughout the Little Quilcene watershed.

5. A potential partial-barrier culvert crossing of Snow Creek Road may impede the seasonal migration of cutthroat trout in the Ripley Creek watershed. Though not a complete fish-passage barrier, channel scour in the vicinity of the culvert outlet (CC #98, Appendix 2) indicates that a "B-level" analysis is necessary to determine whether the culvert creates a velocity barrier during high flow periods. Cutthroat trout were located in Ripley Creek just upstream from this culvert crossing, along the headwater segment of an ~7500 ft. reach of Ripley Creek that was newly-identified and mapped as fish-bearing (Type 3) habitat during WFC water typing efforts. Field personnel also identified another potential barrier culvert on private land (PC #1, Appendix 2) along the Ripley Creek headwater reach, though the potential habitat gain above this culvert is minimal.

Howe Creek see H-1 and H-2 on Map 7 (Appendix 1)

General - Riparian and in-stream conditions in the Howe Creek tributary basin are somewhat more intact than other Little Quilcene tributaries surveyed for this report (Ripley Creek, Leland Creek), likely due to its isolation in the upper part of the watershed, steep gradient lower reaches, and a general lack of residential development. Timber harvest is ongoing on private forest land throughout the headwater basin. This may be contributing to increased flash flows and possible sedimentation of the mainstem Little Quilcene River downstream. Salmon and steelhead are prevented from accessing the Howe Creek tributary network above Reach 2 by a high waterfall barrier, but resident trout were observed throughout the upper watershed.

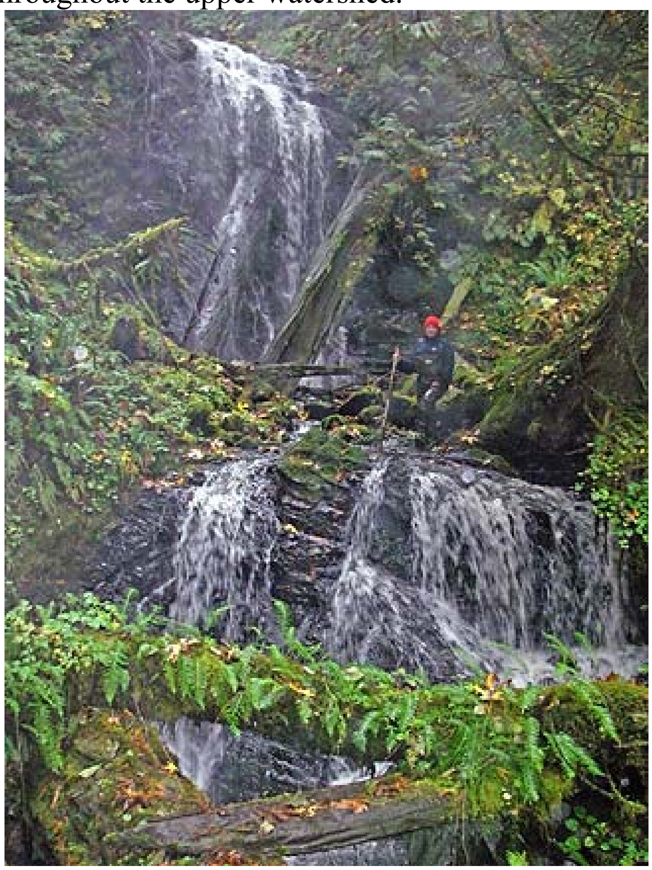


Photo 44 – Anadromous barrier falls located at the upper extent of Howe Creek, Reach 2 during the habitat survey.

1. Reach 4 of Howe Creek consists of an extensive series of beaver pond wetlands that are completely dominated by reed canary grass (even more so than Ripley Creek, sub-reach 1B – see photo 40, pg. 23). Resident trout in upper Howe Creek and its upstream tributaries may be hindered from migrating throughout the available habitat above the anadromous barrier of Reach 2 by the channel conditions of Reach 4. Restoration of this reach by removing the non-native vegetation and planting of both conifer and deciduous trees and shrubs would

contribute to the long-term enhancement of aquatic habitat in Howe Creek and throughout the Little Quilcene watershed downstream. Such a restoration would improve habitat conditions and facilitate migration for resident trout.

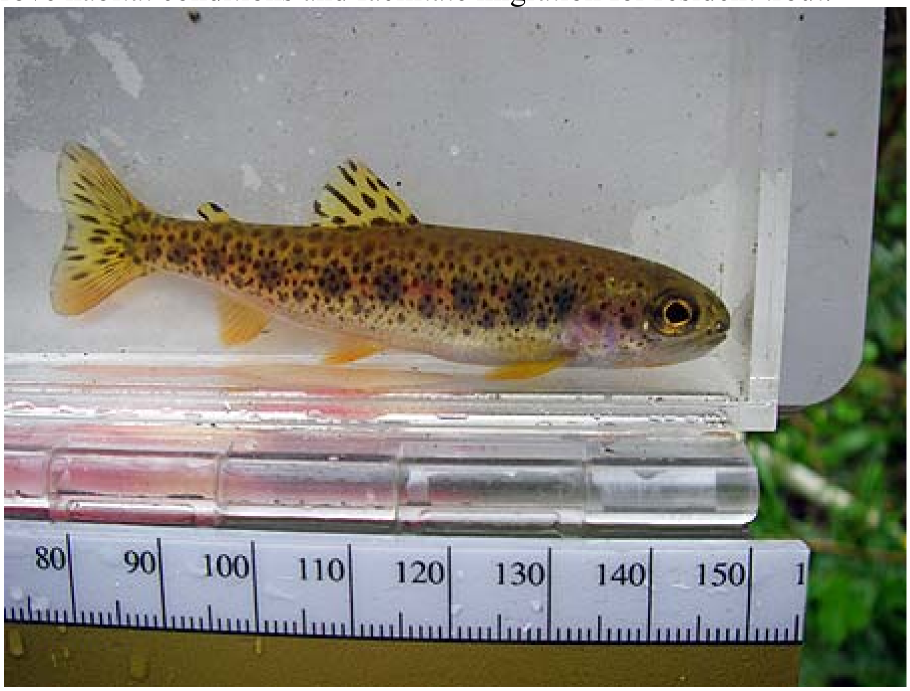


Photo 45 – Seventy millimeter cutthroat trout brought-to-hand via electro-fishing in the Cedar Creek (WRIA 17.0093) headwater tributary to Howe Creek (WRIA 17.0090).

2. The importance of beavers for stream and riparian health and function should be stressed to local landowners so that beaver are retained in the Howe sub-basin, and encouraged to propagate throughout the greater Little Quilcene watershed.

Photo 46 – Blowdown of conifer trees in the riparian buffer surrounding a beaver pond wetland (visible in background) in the recently clearcut headwater basin of Howe Creek.

Cemetery Drain

General **–** Opportunities exist to enhance salmon spawning and rearing habitat within the city limits of the town of Quilcene. "Cemetery Drain" is an agricultural ditch emanating from several spring-fed sources to the west of Cemetery Road (Map 3, Appendix 2) and continuing downstream to a separate tidewater confluence in Quilcene Bay, directly east of Quilcene. WFC surveyors documented juvenile coho salmon just upstream from the culvert crossing of Center Road, and JCCD staff (Al Latham pers. comm.) indicate that juvenile coho have been observed as far upstream as the several culvert crossings of Columbia Avenue. Although there are no concrete data regarding survival of coho in this waterway (Type 3 habitat based on physical and biological characteristics), it is likely that compromised water quality, elevated stream temperatures, and increased risk of predation all contribute to low probability of survival-to-outmigration for juvenile coho.

Landowners contacted along this drainage ditch were completely unaware that it was used by spawning salmon. A significant restoration project could entail complete naturalization of the ditch upstream to the outlet of valley-bottom wetlands in the vicinity of Cemetery Road. Fencing of livestock away from the upstream channel, removal of non-native vegetation and replacement of bank armoring with natural materials both upstream and downstream from the Highway 101 and Center Road culvert crossings, replacement of several partial-barrier culvert crossings of local roads, and re-creation of a riparian corridor throughout the channel length would enhance spawning success, and contribute to improved water quality discharging into nearshore habitats in Quilcene Bay.

Photos 47-48 – Salmon habitat?! Cemetery Drain traversing the outskirts of Quilcene (left), and a single individual from a large school of juvenile coho discovered in Cemetery Drain in downtown Quilcene (right).

Part III: Little Quilcene - Leland Watershed
Habitat Reconnaissance Survey Notes

Note: Lengths and distances reported in this summary are not intended to be precise. Project dictates precluded the time and effort necessary to take linear measurements in the field with a hip chain, and points of interest were approximated on maps of fairly large scale. Distance measurements were later developed in the lab from these maps. When noted, river miles (RM) are accepted values given in the "Catalog of Washington Streams and Salmon Utilization" (Williams et. al. 1975), and do not necessarily correspond to actual channel distance measurements reported by this and other sources, which take into account current stream course and channel meander.

- **Little Quilcene River**

Habitat reconnaissance surveys were conducted along the Little Quilcene River (stream catalog ID 17.0076) on October 8-10, 2007. Surveys extended from just above the mouth at Quilcene Bay upstream to the Howe Creek confluence (RM 5.2). Though habitat conditions are significantly degraded along several of the surveyed reaches, the physical characteristics of the stream channel, and substantial migratory and resident fish use both qualify the Little Quilcene River as a Type 2 (fish-bearing) water of the state from the tidewater mouth upstream to a natural cascade marking the upper extent of anadromous fish habitat (just below the city of Port Townsend's diversion dam at RM 7.1). Fish-bearing (Type 3) habitat continues on the mainstem and headwater tributaries upstream into the Olympic National Forest. See reaches LQ1 – LQ6 on Maps 2 and 3, Appendix 1.

Little Quilcene River:
Reach 1, sub-reach 1A

Overview – Sub-reach 1A extends from a Jefferson County easement / property access road just above the river mouth tidal estuary at RM 0.25 (see Part II, LQ-1) upstream to the Center Road bridge crossing in the town of Quilcene (RM 0.8). Apart from a short stretch of open, unconfined delta at the tidewater mouth, this sub-reach passes through primarily agricultural and rural residential lands, and is confined by man-made levees along nearly its entire ~3820 ft. length. Although there are short sections of unaltered stream channel along the right bank in this sub-reach, most of the channel is constricted by low dikes, with banks heavily armored by rock and boulder riprap, and landscaped residential yards extending to the river's edge.

Channel Conditions – In-stream habitat in sub-reach 1A is dominated by riffles (~75% of available habitat) alternating with mostly shallow pools having long tail-outs (~25%). There are abundant, clean gravel deposits with evidence of heavy spawning activity by anadromous chum salmon at the time of the habitat reconnaissance survey. Bankfull widths averaged ~30 ft., and channel gradient was ~1% throughout the reach length. Overall substrate is composed of 40% large gravels, 30% small gravel, and 30% sand. Artificially-armored stream banks are the primary pool-forming factor, with the roots of standing live trees as a secondary factor. Pools in this sub-reach range from 1-to-3.6 ft. maximum depth, but generally lack cover (averages less than 15% of pool surface area). In several places, large wood pieces have been integrated with bank armoring, but large woody debris (LWD) is otherwise sparse throughout, contributing to a paucity of holding cover for fish, relatively small, shallow pools, and a general lack of habitat diversity. Existing woody debris is mostly composed of small and medium-sized single pieces (in the 4-8 in. and 8-20 in. diameter size classes, respectively), many of which are integral with bank armoring structures. Large woody debris greater than 20 inches in diameter is rare, represented by only five pieces that are currently cabled to the bank for armoring. No log jams were observed, and there is very little natural meander or split / side channel habitat in this sub-reach, with the majority of the channel laterally confined by low dikes.

No natural barriers to fish migration were observed within this sub-reach, nor were there any mainstem culverts or other artificial barriers (with the exception of confining levees). No tributaries enter the Little Quilcene River within sub-reach 1A. A short left-bank side channel is located ~660 ft. above the BPA powerline crossing (located at RM 0.4).

Riparian Conditions – Riparian habitat is composed primarily of mixed deciduous forest, dominated by sapling and young red alder *(Alnus rubra)* in the 6-15 in. diameter class, with lesser amounts of willow *(Salix sp.)*, big-leaf maple *(Acer macrophyllum)*, and planted non-native tree species associated with residential landscaping. The riparian corridor has been altered along many stream segments by encroaching residential development, and overall canopy cover is estimated at less than 50% along the reach. Right-bank riparian conditions are generally more disturbed, with non-native species such as Himalayan blackberry *(Rubus armeniacus)*, tansy ragwort *(Senecia jacobaea)*, climbing nightshade *(Solanum dulcamara)*, reed canary grass *(Phalaris arundinacea)*, and English ivy *(Hedera helix)* invading the understory throughout.

Aquatic Biota – Adult coho and fall chum salmon were spawning at the time of the habitat reconnaissance. An active beaver lodge was noted on the right bank at the BPA powerline crossing (RM 0.4). No freshwater mussels were observed during the survey.

Little Quilcene River:
Reach 1, sub-reach 1B

Overview – Sub-reach 1B extends from the Center Road bridge in the town of Quilcene (RM 0.8) upstream to the "Wildwood Diversion Canal" confluence (RM 1.2), where the river becomes confined for a short distance against the highway embankment just downstream and opposite the intersection of Highway 101 with Cemetery Road. Over the ~2,340 ft. length of this sub-reach, the river meanders through a broad alluvial valley, but becomes increasingly confined by adjacent valley slopes continuing upstream. Channel gradient and dominant fish habitat types essentially match those of sub-reach 1A, but the main channel is less restricted by dikes and bank armoring in sub-reach 1B, with more braiding around islands, larger diameter substrates, and generally deeper pools.

Channel Conditions – Sub-reach 1B is dominated by riffles (~75%) and pools with long tail-outs (~25%). Channel gradient is 1-2%, and there is abundant salmon spawning habitat with variable substrates composed of large and small gravels, sand, and cobble. Average pool depths are greater than sub-reach 1A, with many pools exceeding 3.0 ft. in maximum depth. The deepest pool had a residual depth of 4.7 ft., formed around a rootwad that was cabled to the bank. Dominant and subdominant pool-forming factors are live tree roots and small log jams respectively, however pool cover is again limited. Bankfull width measures ~25 ft., with an average wetted width of 15-20 ft. at the time of the habitat reconnaissance survey.

Large woody debris (LWD) is sparse throughout this sub-reach, limiting fish cover, pool formation, and overall habitat diversity. Most LWD is comprised of small (4-8 inch) or medium (8-20 in. diameter) logs. Only six pieces >20 inches were found in sub-reaches 1A and 1B combined, with three of these logs forming part of a bank armoring project. Two small log jams (3-9 total pieces) were observed, both contributing to pool-formation.

Two side channels and one split channel are located in this sub-reach. The 390-foot long split channel begins ~400 ft. upstream from an abandoned bridge (located ~150 ft. above the Center Road bridge crossing) in Quilcene. A side channel located ~1140 ft. above the abandoned bridge parallels an adjacent right-bank river terrace for 650 ft. downstream. This side channel is fed by groundwater seepage, and was connected to the main channel by surface flow at the downstream confluence only. A second side channel measuring ~330 ft. in length enters the river from the left bank at a distance of ~1390 ft. upstream from the abandoned bridge.

Left-bank tributary *A*, located ~250 ft. above the abandoned bridge, was dry at the time of the habitat survey. This tributary was correctly classified as non fish-bearing habitat on the WDNR stream type map. The upstream extent of sub-reach 1B is marked by a culvert at the mouth of the "Wildwood Diversion Canal" (note: this name is not official, but is provided here-in to facilitate ease of the discussion). The culvert is located on the right bank of the river ~200 ft. above the point where the channel first encounters the highway prism. The 1.5 ft. diameter pre-cast concrete culvert appears to be a partial fish-passage barrier; it has a gradient of greater than 1%, with boulder rip-rap armoring the channel at the outlet. The diversion canal enters the culvert inlet from the perched outlet of a plastic pipe that drains a livestock watering pond just beyond the ditch-line along the west edge of Highway 101.

Riparian Conditions – The riparian vegetation in sub-reach 1B is composed of a mixed deciduous and conifer forest dominated by young red alder trees, big-leaf maple, willow, vine maple *(Acer circinatum)*, western hemlock *(Tsuga heterophylla)*, and a lesser component of western red cedar *(Thuja plicata)*. Overall canopy cover averages ~50%, with short segments of less than 30% where residential development and public roads and private driveways encroach upon the riparian corridor. Although the riparian buffer is occasionally up to 100 ft. wide along this sub-reach, streamside forests are dominated by young and/or sparsely distributed trees, with extensive incursions of non-native/invasive Himalayan blackberry, English ivy, *clematis*, and morning glory *(Convolvulus sp.)*

throughout the understory, particularly in previously disturbed areas. Livestock have direct access to the river channel at two locations along this sub-reach located ~400 ft. downstream from the mouth of the Wildwood Diversion Canal culvert, and at a private driveway bridge ~200 ft. upstream from the canal culvert confluence.

Aquatic Biota – Adult coho and fall chum salmon were spawning in sub-reach 1B at the time of the habitat survey. No beaver activity or freshwater mussels were observed.

Little Quilcene River:
Reach 2

Overview – Reach 2 extends for ~2360 ft. upstream from the Wildwood Diversion Canal confluence (RM 1.2) to the mouth of Leland Creek (17.0077, RM 1.7, river tributary *C*). This is a transitional reach of intermediate valley confinement, with the channel often meandering against and actively eroding steep bluffs of unconsolidated glacial sediments that provide spawning gravel material for anadromous and resident fish.

Channel Conditions – Similar to Reach 1 downstream, channel habitat in Reach 2 is dominated by riffles (75%-80%) and pools (20%-25%). Stream gradient averages 1-2%, within a 25-foot bankfull width. Substrates are primarily large gravel and cobble, with a noticeable increase in available spawning gravels mid-reach, near the mapped confluence of left-bank tributary *B*. Residual pool depth measurements averaged 3-4 ft., with very low surface cover (~10%). Small jams and single logs are the dominant pool forming factors, with a few pools forming as a result of scour around bedrock outcrops. Gradient increases to ~3% through an ~150-foot long section of bedrock-confined channel, lacking in pools and spawning gravels, that is located ~250 ft. below the mouth of Leland Creek.

Large woody debris is sparse throughout this reach, with most single pieces in the small (4-8 in. diameter) and medium (8-20 in.) size classes. Three small jams were observed in this reach: at ~200 ft. and ~600 ft. above the diversion canal confluence (RM 1.2); and the third located at ~450 ft. downstream from Leland Creek. Wooden bank armament was constructed on the left bank at the large jam located ~600 ft. above the canal culvert.

No natural barriers were observed in this reach. No side channels and only one split channel were noted, the 100-foot long split channel occurring ~90 ft. above a prominent left-bank bluff composed of glacial till that is located several hundred feet below the mapped confluence of non fish-bearing left-bank tributary *B* (RM 1.5 - approximately midway between the Wildwood Diversion Canal culvert and the mouth of Leland Creek). This tributary was not located during the habitat reconnaissance survey.

Riparian Conditions – Riparian vegetation in this reach is dominated by young alder and big-leaf maple, together with small conifer stands composed of western red cedar, Douglas-fir *(Pseudotsuga menziesii)*, and grand fir *(Abies grandis)* along the left bank. Understory shrubs are primarily thickets of Pacific ninebark *(Physocarpus capitatus)* and vine maple. A 650-foot stream segment located ~100 ft. downstream from reach end at Leland Creek is bordered by a healthy, relatively broad riparian forest with a larger proportion of mature conifer trees. Canopy cover is ~30% at the downstream end of Reach 2 (in the vicinity of the diversion canal culvert) gradually increasing to as much as 70% upstream. Non-native/invasive English ivy, Himalayan blackberry, and clematis are present in riparian areas throughout this reach, but at fewer locations and lower densities relative to Reach 1 downstream, reflecting the less-disturbed riparian corridor of Reach 2.

Aquatic Biota – Adult coho salmon were spawning in Reach 2 at the time of the habitat reconnaissance survey. No beaver activity or freshwater mussels were observed.

Little Quilcene River:
<u>Reach 3, sub-reach 3A</u>

Overview – With a total length of ~7970 ft., Reach 3 extends from the Leland Creek confluence (RM 1.7, ~250 ft. below the Highway 101 bridge crossing) upstream to the mouth of a bedrock canyon located ~460 ft. above a private driveway crossing via an old railroad flatbed bridge - bridge is located in sub-reach 3B at RM ~3.1, near a point where the Little Quilcene River makes its closest approach to the Lords Lake Loop Road and just downstream from right-bank tributary *G*.

Sub-reach 3A is ~5520 ft. in length from the mouth of Leland Creek upstream to the confluence of right-bank tributary *F* (17.0085, RM 2.75). Land-use along sub-reach 3A is primarily rural residential, with adjacent landscaped yards extending to river's edge.

Channel Conditions – Channel habitat in sub-reach 3A is characterized as alternating riffles (60-70%) and pools (30-40%), with most pools ranging from 1.5-4.0 ft. in depth. Pools are usually formed by log jams or single pieces of large woody debris, and average pool cover is ~30%, with >50% of available cover provided by jams, and less than 10% of cover from single LWD pieces, undercut banks and channel scour. The remaining 30%-40% of pool cover is provided by over-hanging streamside vegetation. Bankfull widths range from ~25 ft. in downstream areas of this sub-reach, to a 36-foot maximum width in the channel segment directly adjacent to the Wildwood Diversion Canal inlet (RM ~2.6). Wetted widths averaged ~21 ft. during the field reconnaissance, and the gradient is 2-3%. There are a greater variety of substrate sizes relative to downstream reaches 1 and 2, with substrates dominated by small (~25%) and large gravels (~25%), complemented by lesser amounts of boulder (15%), cobble (15%), and sand (20%).

Large woody debris abundance is higher in this reach compared to downstream reaches. Thirteen log jams were observed: nine small, three medium, and one large jam with the latter composed mostly of 15-20 in. diameter conifer logs that are inducing left-bank erosion near the confluence of right-bank tributary *D* (17.0082, RM 1.95). In-stream woody debris in this reach is dominated by pieces in the 8-20 inch size class (medium), with only eight pieces greater than 20 inches. Most of these larger pieces are currently cabled to stream bank armoring, thus limiting their role in creating and maintaining habitat diversity via dynamic movement and log jam formation within the stream system.

There are no natural barriers in sub-reach 3A. Bridge abutments and riprap at the Highway 101 crossing (RM 1.8) constrict the stream channel and increase flow velocity. A man-made cobble push-up dam diverts ~10% of surface flow from the main channel into a right-bank irrigation ditch *(heretofore referred to as the Wildwood Diversion Canal* – see Part II, LQ-3 and 4). The inlet to this canal is located ~1000 ft. downstream from the tributary *F* confluence (17.0085, RM 2.75). Due in part to past and on-going channel manipulation to maintain the diversion dam, the riverbed at this location is composed entirely of plane-bed riffle; much wider and shallower relative to upstream and downstream segments. Stream banks are armored at two locations within the sub-reach: boulder riprap incorporating 3 logs armors the right bank ~650 ft. above the Highway 101 bridge; and two large boulders ~150 ft. further upstream are all that remain of a bank armoring project that previously extended for 75 ft. (Part II, LQ-2). The left bank is actively eroding at this location, resulting in the recruitment of new gravel sediment.

Two split channels are located along this sub-reach, at ~570 ft. and ~2400 ft. upstream from the Highway 101 bridge respectively. Tributary *D* (17.0082, "Wildwood Creek" at RM 195) with a mapped right-bank confluence ~770 ft. above Highway 101 was not located during the habitat reconnaissance survey (Part II: LQ-7). Right-bank tributary *E* was ~3 ft. wide with a 2% gradient at a confluence ~1940 ft. above Hwy 101. Tributary *F* (17.0085, RM 2.75) was previously classified as fish-bearing habitat for the initial ~300 ft. upstream from the mouth, and appeared from river-level to increase gradient at the upper extent of fish-bearing habitat as indicated on the WDNR stream type field map.

Riparian Conditions – The lower one-third of sub-reach 3A is dominated by a mixed riparian forest of big-leaf maple, black cottonwood *(Populus trichocarpa)*, and red alder, with sapling and young cedar and grand fir regenerating beneath the deciduous canopy. Riparian composition in the middle third of the sub-reach shifts to young-to-mature Douglas-fir and western red cedar intermixed with smaller stands of big-leaf maple and red alder, and a dense understory of vine maple and salmonberry *(Rubus spectabilis)*. Abandoned pastureland was noted on the right bank ~250 ft. above the mapped confluence of tributary *D*. Deciduous species reassert their canopy dominance over the upper third of this sub-reach, with short sections of the left bank cleared and landscaped for rural residences. Overall canopy cover averages approximately 60-70% throughout. Non-native/invasive European holly *(Ilex aquifolium)* and clematis were observed on the left bank at the downstream end of the sub-reach, and there are several dense patches of English ivy on the forest floor of streamside alder stands, particularly noted in the ~150-foot channel segment continuing above the Highway 101 bridge.

Aquatic Biota – Adult coho salmon were spawning in sub-reach 3A at the time of the habitat reconnaissance, though at lower densities than in Reaches 1 and 2 downstream. No beaver activity or freshwater mussels were observed.

Little Quilcene River:
<u>Reach 3, sub-reach 3B</u>

Overview – Sub-reach 3B measures ~2450 ft. in length, extending from the confluence of right-bank tributary *F* (17.0085, RM 2.75) upstream to the mouth of a bedrock canyon located ~460 ft. above a private driveway crossing via an old railroad bridge (at RM 3.1, just downstream from the mapped confluence of tributary *H).* A significantly higher preponderance of side channels and two extended split channels, declining pool habitat, and an increase in substrate size distinguish sub-reach 3B from adjacent sub-reach 3A. Land use is mostly low density rural residential with landscaped yards that are generally screened from the river by a narrow riparian buffer. Livestock fencing was noted on the left bank at the start of this sub-reach, though the pastures were empty during the survey. An American (pine) marten was observed crossing a log near the tributary *F* confluence (see Zielinski 2001 for a discussion of habitat requirements for the persistence of marten).

Channel Conditions – The stream channel is dominated by long riffles (~90%), alternating with small pools (~10%), with most of the few available pools formed by in-stream large woody debris. Significantly fewer LWD pieces were observed in this reach relative to downstream reaches, with small LWD jams occupying or contributing to the formation of overflow side channels, and very few forming main channel pools. LWD in this reach is dominated by small (4-8 in. diameter) and medium (8-20 in.) pieces, with only two logs greater than 20 inches. Substrates are primarily cobble and sand in downstream portions of the reach, replaced by large gravels upstream. Stream gradient is ~3% throughout, with a bankfull width of ~24 ft., and wetted widths averaging ~18 ft. at the time of the habitat reconnaissance survey.

No natural barriers were observed in sub-reach 3B. A man-made cobble push-up dam located ~200 ft. below the private driveway railroad bridge (RM 3.1) diverts stream flow toward the right-bank, and away from a private residence atop an eroding left-bank bluff (see Part II, LQ-5).

Two split channels were observed in this sub-reach: an ~400-foot long split that begins ~150 ft. downstream from the mapped location of tributary *G* that is partly de-watered by the cobble diversion mentioned above, and an ~320-foot long channel split located near the upper end of the reach, ~430 ft. upstream from the mapped location of tributary *H*. Right-bank tributaries *G* and *H*, with mapped confluences at ~1470 ft. and ~2190 ft. upstream from tributary *F* (RM 2.75) respectively, were not located during the survey.

Riparian Conditions – The left-bank riparian corridor along sub-reach 3B is dominated by young western red cedar, with a lesser component of Douglas-fir and big-leaf maple. Cascara *(Rhamnus purshiana)*, salmonberry, and sapling alders comprise the occasionally dense understory. Right-bank riparian buffers are primarily small-diameter alder, flanked by stands of young cedar at distances greater than 50 ft. from the stream bank. The left-bank riparian corridor has been cleared in several locations for residential properties. Canopy cover averages ~50% throughout, and the riparian corridor is ~30-50 feet wide along both banks. Logging of Douglas-fir was observed ~330 ft. upstream from the confluence of tributary *F*. No significant occurrence of invasive plant species was noted.

Aquatic Biota – Adult coho salmon were spawning in sub-reach 3B at the time of the stream reconnaissance. No beaver activity or freshwater mussels were observed.

Little Quilcene River:
<u>Reach 4</u>

Overview – Reach 4 begins at the mouth of a bedrock canyon located ~460 ft. upstream from a private driveway crossing via an old railroad bridge (bridge is located at RM ~3.1 in sub-reach 3B), and continues to the head of the canyon ~330 ft. above the confluence of tributary *I*, for a total reach length of ~1470 ft. This reach is characterized throughout by steep-sided canyon walls and the stream bed formed primarily of bedrock.

Channel Conditions – Channel habitat in Reach 4 is dominated by riffles (80-90%), with 80% bedrock and 20% boulder substrates. Spawning gravel is very limited. Bankfull width was not systematically measured, but is generally narrower than adjacent reaches due to confining canyon walls. Channel gradient is 4-5% throughout, and large woody debris is sparse, providing little in-stream structure. Most LWD falls in the medium size class (9 pieces, 8-20 in. diameter), with fewer small (5 pieces, 4-8 inches) and large logs (only 2 logs greater than 20 inches). One medium and three small jams were documented within the reach at the time of the habitat survey, including a small engineered log jam that is cabled into place ~65 ft. upstream from start of the reach.

No natural barriers and no side channels were observed within this confined, higher-gradient reach. Right-bank fish-bearing tributary *I*, identified on WDNR stream maps at approximate RM 3.4, was not located during the habitat reconnaissance survey.

Riparian Conditions – Young-to-mature cedar and Douglas-fir forest dominates the riparian corridor along this reach, complemented to a lesser degree by big-leaf maple. Canopy cover averages ~85% within the canyon segment, but is reduced to less than 60% nearing the upstream end of the reach. No non-native/invasive plants were observed.

Aquatic Biota – No fish or freshwater mussels were observed in Reach 4 during the habitat reconnaissance survey. A large, recently-active beaver dam was noted along the right bank adjacent to the mapped confluence of tributary *I* (RM ~3.4).

Little Quilcene River:
<u>Reach 5</u>

Overview – Reach 5 extends for ~4480 ft. upstream from the bedrock canyon of Reach 4 to the confluence of Ripley Creek (17.0089, RM 4.35, river tributary *L*). The river valley fluctuates between moderately-confined and confined throughout the length of this reach.

Channel Conditions – In-stream habitat is dominated by riffles (75%) and pools with long tail-outs (25%), with pools increasing to ~40% of available channel habitat in the vicinity of Ripley Creek. Pools range from 1.2-to-3.8 ft. deep, and are generally formed around single pieces of LWD or small jams. As with other downstream reaches, pool cover remains quite low (~10%). Substrate composition is highly variable along this reach, shifting from a coarse mix of gravel/cobble/boulder in the lower reach, to finer gravels and sands mid-reach. Bedrock predominates through a small canyon segment just below the Ripley Creek confluence, and substrates are bedrock/gravel/boulder/cobble in nearly-equal proportions upstream from this short, bedrock-controlled canyon. Large woody debris abundance is low, with most pieces (51%) consisting of small logs (4-8 inches), and fewer medium (36%, 8-20 in. diameter) and large logs present (only 12% of LWD pieces were >20 in.). Fourteen small, two medium, and two large log jams were noted. Gradient in this reach is ~3-4% within an ~24 ft. bankfull width, and an average wetted width of ~20 ft. at the time of the habitat reconnaissance survey.

No natural barriers were observed in Reach 5. With the exception of an old logging road that approaches the left bank ~580 ft. above the mouth of tributary *K* (road does not intrude on the channel) there are no apparent bank or in-stream channel modifications within the reach. A 2.5-inch diameter pipe with attached hose enters the river ~170 ft. upstream from the logging road, but due to lack of private property access, surveyors were unable to determine the purpose of this pipe (possible small water diversion, or surface run-off and drainage).

An ~330-foot long side channel is located ~560 ft. below the mouth of Ripley Creek. Two tributaries are depicted entering from the right bank in the Reach 5. Surveyors were unable to locate the mapped confluence of tributary *J* (17.0087) at RM 3.85. Tributary *K* (17.0088, RM 3.9) was 2.5 ft. wide with very little surface flow at the time of the habitat reconnaissance survey, entering the Little Quilcene River ~990 ft. above reach start.

Riparian Conditions – The riparian corridor in downstream segments of Reach 5 is dominated by young deciduous trees (small diameter big-leaf maple and red alder), shifting to mature conifer forest upstream (cedar, Douglas-fir, and western hemlock), with a lesser component of cottonwood and alder along the short bedrock canyon segment below the mouth of Ripley Creek. Canopy cover ranges from ~60% for the downstream deciduous riparian stands, to over 80% within the small canyon. Invasive burdock and tansy ragwort were observed on the left bank ~660 ft. above reach start.

Aquatic Biota – A few adult coho salmon were spawning in this reach at the time of the habitat reconnaissance survey. No beaver activity or freshwater mussels were observed.

Little Quilcene River:
<u>Reach 6</u>

Overview – Reach 6 encompasses the ~4620 ft. of river channel from the Ripley Creek confluence (17.0089, RM 4.35, tributary *L*) upstream to the mouth of Howe Creek (17.0090, RM 5.2, tributary *O*). The Little Quilcene River at the start of this reach flows east-southeast through a relatively open valley, becoming moderately-confined along upstream segments in the vicinity of the Howe Creek confluence.

Channel Conditions – Riffles predominate (~80%), and pools comprise the remaining ~20% of available habitat in Reach 6. The riffle proportion increases to greater than 95% in the upper ~1400 feet of the reach. Log jams are the dominant pool-forming factor, with pools averaging ~2.0 ft. in residual depth. Though LWD abundance is sparse, there is a greater proportion of large (>20 in. diameter) logs in this reach relative to most downstream reaches. One large, two medium, and six small log jams were observed in Reach 6, and a notable large jam (~650 above Ripley Creek) creates a series of scour pools and gravel deposits that receive extensive use by spawning anadromous salmon relative to the remainder of the reach. Three adult coho and three recently-constructed redds were observed in the immediate vicinity during the habitat reconnaissance survey.

Steep, eroding banks located in the vicinity of tributary *N* and Howe Creek contribute fine sediments to the channel, and are potential sources for spawning gravel recruitment. The predominantly alluvial channel segments along Reach 6 are interrupted by higher gradient bedrock/boulder cascades comprising less than 5% of in-stream habitat located at distances of ~670 ft., 1260 ft., and 3,010 ft. upstream from the mouth of Ripley Creek. Average bankfull width is ~24 ft. throughout, and gradient ranges from 2-4%.

A 2-ft high channel-spanning step that is formed over the largest debris jam may impede fish movement at low flows, but there are no other natural barriers to fish migration in this reach. A man-made push-up cobble diversion dam has been constructed ~260 ft. above tributary *M*, creating an artificial 16-foot long pool upstream (see Part II, LQ-6). At the time of the survey, a natural jam composed of river-deposited debris was present just above the man-made dam pool, creating an additional pool similar in size and depth. A steel bridge that crosses the channel ~1350 ft. upstream from Ripley Creek accesses a recent/ongoing right-bank residential development.

Two tributaries and a single short split channel segment were documented in Reach 6. With a bankfull width of 4 ft. and a gradient of 1-2%, tributary *M* does not appear on WDNR stream type maps. The tributary is a short, spring-fed stream entering from the right bank ~1800 ft. above Ripley Creek, and trout were observed at the mouth of this previously unclassified channel at the time of the habitat survey. Unmapped tributary *N* enters the river by falling over a steep, right bank bluff ~1300 ft. downstream from the confluence of Howe Creek at reach end (17.0090, RM 5.2, river tributary *O*), and an ~120-foot long split channel is located near tributary *N,* ~1600 ft. below Howe Creek.

Riparian Conditions – The left-bank riparian corridor is dominated by young-to-mature conifer trees (western red cedar, Douglas-fir, and western hemlock), intermingled with small deciduous stands of mature black cottonwood and young red alder for the initial ~750 ft. above Ripley Creek in Reach 6. The right bank riparian corridor above Ripley Creek was recently logged, and now dominated by young deciduous trees and evergreen shrubs with a significantly reduced canopy cover. Riparian vegetation is composed of 50-60% young, small-diameter deciduous trees and 40-50% young conifers in the segment extending from ~750 ft. to ~1750 ft. above the mouth of Ripley Creek. Conifer stands comprise the right-bank riparian buffer, and deciduous forest dominates the left bank from the short canyon segment upstream from tributary *M* to reach end at the mouth of Howe Creek. Riparian forest was recently cleared for rural residential development ~1590 ft. downstream from Howe Creek (near tributary *N*), though the riparian corridor in the vicinity of the Howe Creek confluence still harbors large diameter "old growth" hemlock and cedar trees along both stream banks. Canopy cover averages ~40% from the mouth of Ripley Creek upstream beyond the steel bridge, increasing to 60-65% in the vicinity of Howe Creek. No non-native/invasive species were observed along this reach.

Aquatic Biota – Though not abundant, a few adult coho salmon were spawning in this reach at the time of the habitat reconnaissance survey, and several small, unidentified trout were observed in the initial ~50 ft. of tributary *M*. Beaver activity was observed ~360 ft. below the large steel bridge. No freshwater mussels were observed in Reach 6.

- **<u>Leland Creek</u>**

Habitat reconnaissance surveys were conducted along Leland Creek (stream catalog ID 17.0077) on October 22 & 25, 2007. Surveyed reaches extend from the Little Quilcene River (at RM 1.7) upstream beyond the confluence of tributary *D* (17.0079, RM 2.1) located adjacent to Highway 101 in Leland Valley. Though habitat conditions are severely degraded along several of the reaches, the physical characteristics of the stream channel, and substantial anadromous and resident and fish use both qualify Leland Creek as a Type 2 water of the state from the mouth to the outlet of Lake Leland at RM 4.1, and Type 3 habitat continuing upstream through Lake Leland well into the headwater reach. See Reaches L1 – L5 on Maps 4, 5, and 6 in Appendix 1.

Leland Creek:
<u>Reach 1</u>

Overview – Reach 1 extends for ~1,950 ft. from the Little Quilcene River confluence (~250 ft. downstream from the Highway 101 river bridge) upstream to an adjacent right-bank field located ~300 ft. below a seldom-used log stringer driveway bridge (~ RM 0.4). The Reach 1 / Reach 2 break is marked by a refurbished wooden footbridge on residential property near the regularly-mown field. The channel is moderately confined throughout.

Channel Conditions – The majority of in-stream habitat in Reach 1 consists of riffles (60%-80%), with the remainder in pools (20%-40%). Pool habitat becomes dominant over a short (~400 ft.) segment near the mid-point of the survey reach, and pools range from 25-40 ft. in length and 8-15 ft. wide. Maximum residual pool depth was 4.2 ft., with the majority of pools averaging ~2.0-3.0 ft. deep. Pool cover steadily increased from 10-15% of pool surface area in the lower half of the reach, up to 30-40% cover further upstream. Live tree roots and erosion-resistant banks are the dominant and subdominant pool forming factors, respectively. Gradient is 3-4%, and bankfull widths were 18-to-25 ft., with an average wetted width of ~12 ft. at the time of the survey.

Channel substrates are dominated by large gravels (~60%) with a lesser component of larger cobble (~40%). Bedrock formations outcrop at only one location in this reach, ~650 ft. upstream from the mouth. Due to a higher proportion of cobble substrate, spawning gravels are concentrated in somewhat isolated patches in Reach 1 relative to upstream reaches in Leland Creek, and where present, spawning gravels appeared to be embedded within dense deposits of fines and sands at the time of the habitat survey. Consequently, suitable spawning sites appear to be less regular and of lower quality, though chum and coho salmon were observed spawning in most areas of available gravel.

Large woody debris (LWD) was sparse throughout Reach 1, with only ~4 pieces per 330 linear ft. of channel. In-stream LWD generally consisted of small diameter logs, with ~50% of pieces in the 4-8 in. size class, and ~50% of medium size (8-20 in. diameter). Only two pieces exceeded 20 inches, and most LWD occurred as single logs with only two small (3-9 pcs) and three medium jams (10-29 pcs) documented along the reach.

No side channels, tributaries, or natural barriers were observed in this reach. The right bank has been armored for ~40 ft. along the edge of a residential property ~1000 ft. above the mouth. Several discarded tires, sections of metal fence, and miscellaneous trash were also found in the channel, with the greatest debris concentrations in the upper half of the reach. A 2-inch diameter PVC pipe from an unknown source enters the stream at a distance of ~1470 ft. above the Leland Creek confluence with the Little Quilcene.

Riparian Conditions – Riparian forest species composition, age, and size classes are highly variable along this lower stream reach, which has been repeatedly disturbed by past logging and development. Left-bank riparian cover is dominated by regenerating second-growth forest, while the right-bank consists of 1-to-5-acre rural residential property parcels in various stages of development. Canopy removal and conversion to non-native vegetation along the right bank is associated with these properties. Although much past logging has taken place along both banks in this reach, there is notably less riparian disturbance from residential development on the left bank due to steeper slopes.

In general, the riparian corridor has a mixed conifer and deciduous composition, with sparse-to-moderate tree densities. Overstory species include big-leaf maple, red alder, Douglas-fir, western red cedar and western hemlock, with conifer stands patchily distributed throughout on the right bank. The left-bank riparian corridor is characterized by young-to-mature Douglas-firs with sapling cedar, hemlock, and big-leaf maple in the dense understory. The generally narrow (<100-foot wide) riparian buffers are dominated by deciduous tree species, with an understory shrub layer of salmonberry, vine maple, and sword fern that contribute to a generally higher pool cover along this reach. Canopy cover averages 60-80% throughout, with the exception of a mid-reach segment of ~400 ft. where cover is reduced to ~30% due to recent riparian logging that has impacted both stream banks, resulting in a preponderance of immature vegetation types. Non-native / invasive reed canary grass, Himalayan blackberry, and English ivy have aggressively colonized disturbed areas of the riparian corridor, competing with regenerating native trees and shrubs for limited space on valley walls. Young big-leaf maple and red alder trees predominate upstream of this logged section, with the notable exception of a small stand of mature (12-20 in. diameter) cedars. A regularly-mown field encroaches on the riparian zone at the site of a recently-refurbished footbridge marking the end of Reach 1.

The distribution of invasive species in riparian zones of lower Leland Creek is patchy, with the heaviest concentrations in areas of past disturbance. English ivy and Himalayan blackberry dominate the understory along both banks for the initial ~330 ft. of channel. Dense blackberry, ivy, and reed canary grass are also associated with riparian logging near the middle of the reach. Beyond this point, the riparian corridor has experienced past logging but is generally less disturbed, with sparser incursions of blackberry and reed canary grass. The shade-tolerant Herb Robert *(Geranium robertianum)* was noted intermittently along this reach, with the most extensive patch located ~330 ft. below the footbridge that marks the end of Reach 1/start of Reach 2. Japanese knotweed *(Fallopia japonica, syn. Polygonum cuspidatum)* was documented on the right bank ~70 ft. below this footbridge, representing the only observation of knotweed directly adjacent to stream channels in the Little Quilcene watershed during the rapid habitat reconnaissance.

Aquatic Biota – Adult coho salmon were observed spawning at an average rate of ~1-2 fish per 330 linear feet of stream channel at the time of the habitat reconnaissance survey. No beaver activity or freshwater mussels were observed in Reach 1.

Leland Creek:
<u>Reach 2</u>

Overview – Reach 2 is ~2490 ft. in length, becoming progressively more confined by adjacent valley slopes as it continues upstream from the small wooden footbridge located at a mown field at the start of the reach (the footbridge is ~300 ft. below a permanent, though apparently seldom-used log stringer bridge at RM 0.43). The upper end of Reach 2 is located at a concrete bridge crossing of the Rice Lake Road at RM 0.7 (or 0.84 true).

Channel Conditions – Pools ranging from 25-50 ft. in length and 8-10 ft. wide comprise 50-70% of the habitat in this reach, with riffles representing the remaining 30-50%. Residual pool depths range from 1.8-3.2 ft., with the majority averaging 2.5-3.0 ft. deep. Long, shallow gravel tail-outs are common throughout, providing greater potential for spawning relative to Reach 1. Channel substrates consist of 30-50% large gravel and 30-40% cobble, with lesser proportions of small gravel, sand, and bedrock. Estimated pool cover was ~40% in lower portions of the reach, decreasing to ~15% further upstream. Small debris jams and single wood pieces are the primary pool-forming factors, with erosion-resistant banks and roots from standing live trees as secondary factors in the formation of pools and short split-channel segments. Gradient was ~2-3% throughout, with an average bankfull width of ~25 ft., and wetted widths ranging from 14-22 ft. at the time of the habitat reconnaissance survey.

No tributaries and only one side channel were observed in this reach. In-stream large woody debris accumulations form an ~150-foot long split channel located ~900 ft. above the start of the reach, but LWD is otherwise sparse, dominated by medium (8-20 in.) logs with relatively fewer 4-8 in. pieces, and only five logs greater than 20 inches in diameter. Only one medium and four small jams were observed along the entire length of Reach 2. No natural barriers were observed in this reach. A seldom-used log stringer bridge is located ~300 ft. above the wooden footbridge that marks the Reach 1 / Reach 2 break, and Rice Lake Road crosses the channel via a concrete bridge with associated upstream and downstream bank armoring (boulder riprap). Neither bridge impedes fish passage, but both constrict the channel and potentially restrict the downstream movement of logs. Two 6-inch diameter corrugated plastic pipes collect roadway run-off from ditches and deliver it to the downstream channel on either side of the Rice Lake Road bridge.

Riparian Conditions – Riparian species composition is ~60% conifer (cedar, Douglas-fir, and hemlock) and ~40% deciduous (big-leaf maple and alder) in the lower portion of this reach (below the split channel segment at ~900 ft. upstream from reach start). Estimated canopy cover averages 70% in the lower third of the reach, decreasing to less than 50% cover upstream. Relative to adjacent reaches, the Reach 2 riparian corridor has a higher density of larger diameter trees and a lower prevalence of invasive species in the forest understory. A notably healthy residual stand of 25-to-30 inch cedar dominates the right-bank riparian buffer at a distance of ~440 ft. upstream from the log stringer bridge. The riparian corridor from the split channel segment upstream to the Rice Lake Road bridge has experienced past logging, and the resulting canopy composition is ~80% young deciduous (big-leaf maple and red alder) and 20% conifer (a scattering of Douglas-firs greater than 20 inches in diameter, and smaller cedar and hemlock). Understory vegetation is primarily vine maple, salmonberry, salal *(Gaultheria shallon)*, and sword fern *(Polystichum munitum)*, with extensive incursions of reed canary grass, Himalayan blackberry, and English ivy occurring locally along both banks, particularly ~700 ft. upstream from the start of the reach at the log stringer bridge.

Aquatic Biota – Adult coho salmon were spawning at a lower density than Reach 1 at the time of the habitat reconnaissance survey. No beaver activity or freshwater mussels were observed in Reach 2 during the survey, though there have been previous documented reports of freshwater mussels along this reach (Ted Labbe, WDFW staff - pers. comm.).

Leland Creek:
<u>Reach 3</u>

Overview – Reach 3 is approximately 2560 ft. in length from the Rice Lake Road bridge crossing (RM 0.7 or 0.84 true) upstream to a significant broadening of the stream valley at a point ~180 ft. above the Hwy 101 culvert crossing (located at RM 1.05 or 1.3 true). Reach 3 is moderately confined throughout, with ample gravel spawning habitat.

Channel Conditions – In-stream habitat is composed of ~70% riffles and ~30% pools with long, shallow tail-outs for the initial two-thirds of the reach above the Rice Lake Road bridge crossing. The floodplain widens briefly ~1000 ft. upstream from the bridge, and pool depth and length increase as a result, with pools comprising ~70% of available habitat along this short, broader reach segment, separated by short (~10-foot) riffles. Pools typically measure 50 ft. in length and 15 ft. wide, with residual depths of 1.5-3.0 ft, and are primarily formed by log jams and live tree roots in the lower third of the reach, with log jams and large boulders as the dominant pool-forming factors further upstream. Pool cover is relatively low, ranging from ~15-20%. Bankfull widths were 20-25 ft., with wetted widths of 15-18 ft. at the time of the habitat reconnaissance survey. Stream gradient averages ~2-3% along the reach below the Highway 101 culvert crossing, decreasing to ~1-2% toward the upstream end of the reach, just above the highway.

Large woody debris is sparse throughout, dominated by small (4-8 in. diameter) pieces, with fewer 8-20 inch logs. Six small and four medium-sized jams were observed. Substrates are composed of small gravel (70%), fines (20%), and larger gravels (10%) for the initial ~1300 ft. upstream from the Rice Lake Road crossing, and bedrock and cobble dominate from the middle of the reach upstream beyond the Highway 101 culvert.

No natural barriers to fish passage were observed in this reach. The Highway 101 culvert (SC #99, Appendix 2) is a partial fish-passage barrier during seasonal periods of low flow (estimated at only 33% passable – see Part II, L-7). This 6.0 ft. by 8.5 ft. cast-in-place concrete box culvert is completely lacking retained stream sediments, and water depth inside the culvert was only 0.55 ft. at the time of the habitat survey, and estimated at only ~0.2-0.3 ft. during an earlier reconnaissance in September. A partly-buried 4-inch plastic pipe enters the pool below the culvert. WFC field crews were unable to access private property to ascertain the origin or function of this pipe (possible small water diversion).

Surveyors noted a single ~130 ft. long split channel formed by a log jam and located ~910 ft. above the Rice Lake Road crossing. Left-bank tributary *A* was completely dry at the time of the habitat survey, with an average gradient of ~40-45% for the initial ~80 ft. above the Leland confluence, moderating to ~20% upslope. This tributary was correctly classified as non fish-bearing (Ns or Type 5) habitat on the WDNR stream type maps, entering Leland Creek ~740 ft. above the Rice Lake Road bridge.

Riparian Condition – Riparian forest composition along this reach is ~60% deciduous species (red alder and big-leaf maple) and ~40% conifer (Douglas-fir and cedar). Scattered throughout the predominantly young, small diameter riparian forests are individual trees and very limited stands of mature alder, cedar, and Douglas-fir. Salmonberry, vine maple, and sword fern comprise the understory, and the riparian forest provides an overall canopy cover of ~70%. Non-native / invasive Himalayan blackberry was present at the downstream end of Reach 3, associated with stream bank armoring and riprap at the Rice Lake Road bridge crossing.

Aquatic Biota – Five adult coho salmon and one carcass were noted in this reach during the habitat reconnaissance survey, with four of the coho actively spawning on newly-constructed redds. No beaver activity or freshwater mussels were observed in Reach 3.

Leland Creek:
<u>Reach 4</u>

Overview – Reach 4 is approximately 1810 ft. in length from a point where the valley becomes noticeably less constricted (~180 ft. above the Highway 101 culvert, located at RM 1.05 or 1.3 true) to a confluence with left-bank tributary *B* ~1990 ft. upstream. Riparian enhancement has been initiated along the ~1100 ft. segment above a private wooden footbridge that is located ~150 feet above the start of the reach.

Channel Conditions – The stream channel appears to have been historically ditched along several segments in the lower half of Reach 4, while the upper portions of the reach meander in long glides through former small pastures now reverting to wetland habitat. Dense incursions of reed canary grass occur along the channel margins throughout, and past channel ditching and invasive grasses appear to have influenced channel geometry, creating and maintaining deep, slow-moving glides that differ significantly in appearance and function from the predominantly riffle / pool sequence of downstream Reaches 1-3.

Approximately 80-90% of the channel length in Reach 4 is composed of deep, slow-moving glides (1.5 – 2.0 ft. deep at the time of the habitat survey) separated by short (~10-15 ft. long) riffles. Substrate is composed of ~70% small gravel and ~30% silt in the 150-foot segment downstream from a wooden footbridge that is located ~330 ft. above the Highway 101 culvert. Substrate composition shifts to ~65% silt and ~35% small gravel for another 330 ft. beyond the footbridge to the beginning of a small wetland (former pasture) that borders the channel. Substrate through the wetland channel is ~50% silt and ~50% small gravels, continuing upstream to a log jam at the end of the reach. Bankfull and wetted widths averaged 12-15 ft., with a gradient of ~1%, and spawning gravel is very sparse due to the prevalence of extensive fine sediments throughout.

Large woody debris is also sparse in this reach, composed of small (4-8 in. diameter) and medium (8-20 inch) logs. Only three small and one medium-sized jam were documented. Dense stands of Pacific ninebark along the channel hindered a complete inventory of logs and coarse woody debris through the initial half of this reach.

No natural barriers to fish migration were observed in this reach. A wooden footbridge crosses the channel ~330 ft. above Highway 101, and a 7-foot long section of riprap lines both banks beneath the bridge. The bridge support stringers had recently been replaced, with cut rounds from the original supports deposited in the channel below the bridge.

There were no side channels documented in Reach 4. Tributary *B* enters from the left bank ~1990 ft. above the Highway 101 culvert, marking the upstream end of the reach. This previously unclassified tributary was dry at the time of the habitat survey, with a bankfull width of 2.5 ft., and a gradient of 15-20% above the Leland Creek confluence.

Riparian Conditions – The dominant riparian vegetation along the length of Reach 4 is invasive reed canary grass, with dense stands of Pacific ninebark providing 70%-90% canopy cover through the initial ~1000 ft. of channel upstream from the survey start. Left-bank forest stands upslope from the streamside ninebark are ~70% young conifer (western red cedar and Douglas-fir) and 30% deciduous (red alder and big-leaf maple). Invasive reed canary grass dominates the low, wet ground through the upper half of the reach, with young big-leaf maple, alder, cedar, and Douglas-fir on the wetland margins. Canopy cover is limited (15%-40%) in this segment, and remnant Himalayan blackberry, thistle, climbing nightshade, and holly trees *(Ilex aquifolium)* compete with native plants.

Stream-adjacent former pasture in this lower reach segment has been recently planted in cedar, Douglas-fir, and pine, with a complement of alder saplings, red-osier dogwood, and other native shrubs. Riparian restoration efforts along the right bank vary from 15 to 40 feet wide from the wooden bridge upstream to the wetland/old pasture, and continue on the left bank for an additional ~700 ft. upstream. Preparation for future restoration was evident along the right bank (mowing and removal of streamside reed canary grass).

Aquatic Biota – Despite a general lack of spawning habitat, one live adult coho and three recently-constructed redds were observed in this reach at the time of the habitat survey. No beaver activity or freshwater mussels were noted in Reach 4, and evidence of muskrat was apparent on the right bank at the upstream end of the riparian restoration segment.

Leland Creek
Reach 5

Overview – Reach 5 extends for ~3430 ft. upstream from the tributary *B* confluence (located at the upper end of a small wetland/former pasture ~1990 ft. above the Hwy 101 culvert crossing) to the downstream end of an extensive beaver pond wetland complex that begins ~1070 ft. above the left-bank confluence of tributary *D* (17.0079, RM 2.1). The channel is naturally confined in this reach, and potentially influenced in the upper third by the Highway 101 road embankment at the top of the valley wall. WFC surveyors terminated the habitat reconnaissance several hundred feet above the mouth of tributary *E* due to the homogeneity of in-stream and riparian habitats upstream through the remainder of the distance to the outlet of Lake Leland. Habitat along Reach 6 (unsruveyed, but largely visible from Highway 101) is characterized by long, low-gradient ditch-like segments almost entirely dominated by invasive reed canary grass (Part II, L-3).

Channel Conditions – Channel habitat in the lower two-thirds of Reach 5 is comprised of pools with long glide-like tailouts (~60-80%), interspersed with short riffles (20-40%). Pools ranged in length from 30-80 ft., and are 8-10 ft. wide, with residual pool depths of 1.8-3.2 ft. Single LWD pieces and bank-supporting perennial vegetation (e.g. limbs and root structures of vine maple) were the primary and secondary pool-forming factors. Leland Creek assumes the form of a low-gradient, meandering channel choked with wetland vegetation for a short distance approximately mid-reach (~850 ft. downstream from the tributary *C* confluence), and this wetland is identified on WDNR FPARS maps.

Beginning ~420 ft. upstream from the mouth of tributary *C* (17.0078, RM 1.85), the upper third of Reach 5 is dominated by a single segment with the form and function of a glide, though it is technically a dam pool formed by natural debris accumulating at a point where the channel abruptly changes direction along the scour-resistant left bank (the Highway 101 road prism). Pool cover is almost non-existent in this segment due to a lack of large woody debris. Bankfull widths range from 12-15 ft, and wetted widths were 8-12 ft. at the time of the habitat survey, with shorter incised channel segments measuring approx. 5 ft. wide with correspondingly greater depths. Channel gradients were 2-3%, decreasing to ~1% in the long, straight, glide-like pool adjacent to the highway berm. Substrates are 70-80% small gravels and 20-30% silt, with the longer glide-like pool substrates composed of 90% muck (decayed organic matter), with 10% scattered cobble.

LWD is sparse throughout the reach: three small and four medium pieces were observed, along with two logs greater than 20 inches in diameter. Five small and two medium jams were located in the lower two-thirds of the reach. Debris damming the upper pool/glide was composed entirely of coarse organic material not meeting the minimum requirements for classification as a log jam.

No natural barriers were observed in Reach 5. Two separate but adjacent private bridges (a log stringer driveway bridge and a deteriorated footbridge) are located ~1260 ft. below tributary *C*. A wooden footbridge (under re-construction at the time of the survey) and another log stringer driveway bridge cross the channel ~830 ft. and ~370 ft. below the confluence of tributary *C*, respectively. With the exception of riprap armoring the right bank for ~50 ft. at the upper driveway crossing, the bridges in this reach do not adversely constrict the channel. Large boulders in the channel ~200 ft. below the upper driveway bridge are likely remnants from earlier attempts to stabilize the stream bank at this site. A 4-inch plastic pipe enters the channel from the left bank ~190 ft. below the footbridge.

No split or side channels were observed in this reach. Tributary *C* (17.0078, RM 1.85) is identified as fish-bearing (Type 3) habitat by WDNR. The 5 ft. wide tributary had a gradient of ~ 4% and an average wetted width of 3.0 ft. at the time of the habitat survey, continuing upstream from the Leland Creek confluence for several hundred feet to a perched, barrier culvert crossing of Leland Valley Road West (CC #86, Appendix 2). Gravel substrates appear eminently suitable for spawning, and the landowner reported coho salmon in tributary *C* during previous seasons. Tributary *D* (17.0079, RM 2.1) enters from the left bank where Leland Creek first meanders adjacent to Highway 101.

Riparian Conditions – The initial ~400 ft. of channel upstream from the tributary *B* confluence are characterized by gentle meanders through dense stands of vine maple, with an overstory of 60% deciduous (young to mature big-leaf maple and sapling alder) and 40% conifer species (young Douglas-fir and cedar). The riparian corridor becomes more open, with swaths of reed canary grass invading former small pastures and rural residential clearings throughout the remainder of the reach upstream to the mouth of tributary *D*. Red alder replaces big-leaf maple as the dominant deciduous species along valley slopes, and canopy cover is 60% along the lower two-thirds of the reach, with streamside incursions of reed canary grass occur at variable densities throughout. Himalayan blackberry was observed along the left bank ~650 ft. above tributary *B*, and climbing nightshade was noted near several of the bridge crossings.

The glide segment comprising the upper third of the reach had a dense deciduous canopy of young alder and big-leaf maple trees (70%) with ~30% young conifer (Douglas-fir, western red cedar and western hemlock). The understory is composed of vine maple, elderberry *(Sambucus racemosa)*, and sword fern, and canopy cover is greater than 80%. The channel exits the forest canopy as it approaches tributary *E*, and reed canary grass once again becomes predominant as beaver dams appear near the start of Reach 6.

Aquatic Biota – Four adult coho were spawning in Reach 5 at the time of the habitat reconnaissance survey, and numerous recently-constructed redds were noted, particularly in the vicinity of tributary *D*. No beaver activity or freshwater mussels were observed.

- **Ripley Creek**

Habitat reconnaissance surveys were conducted on Ripley Creek (stream catalog ID 17.0089) on October 15 & 29, 2007. Surveyed reaches extend from the Little Quilcene River confluence (at RM 4.35) upstream for ~7840 ft. Physical characteristics of the stream channel and substantial anadromous and resident fish use qualify Ripley Creek as a Type 3 water of the state from the mouth upstream through the headwaters reach that is located adjacent to the Lords Lake Loop Road near the intersection with Snow Creek Road. Time constraints and lack of access to private property forced termination of the Ripley Creek habitat reconnaissance in the middle of Reach 3. The remainder of the mapped channel was extrapolated from remote imaging (LiDAR and aerial photographs). See Reaches 1-3 on Map 6, Appendix 1.

Ripley Creek
Reach 1, sub-reach 1A

Overview – Reach 1 encompasses two distinct sub-reaches for a total length of ~4800 ft. upstream from the Little Quilcene River confluence to the upper end of a beaver pond wetland complex (sub-reach 1B) located ~120 ft. beyond a local powerline crossing.

Sub-reach 1A extends for ~3830 ft. from the Little Quilcene River upstream to the confluence of an unnamed, non fish-bearing left-bank tributary draining a large beaver pond that is located to the east, near a private, gated gravel road. The channel is highly confined along most of this sub-reach, passing though a less confined segment where it encounters pasture ~1000 ft. upstream from the Lords Lake Loop Road culvert crossing. The valley also widens briefly approaching the outlet channel of the large beaver pond.

Channel Conditions – Ripley Creek had no surface flow for the initial ~990 ft. of channel upstream from the Little Quilcene River at the time of the habitat reconnaissance survey, and a landowner reported that this is the typical flow regime for summer and early fall. Consequently, aquatic habitat in this lowest sub-reach segment could not be fully characterized. A series of bedrock chutes and step pools extend for ~300 ft. upstream from the mouth, and the remainder of the dry channel appeared to consist predominantly of shallow riffles and infrequent pools (later verified during salmon spawning surveys).

Channel habitat along the wetted portion of the sub-reach (beginning ~330 ft. upstream from the Lords Lake Loop Road culvert crossing) is dominated by riffles (80-90%), with the number and size of pools (10-20%) gradually increasing upstream. Pools range from 10-30 ft. in length and 5-20 ft. wide, with residual depths of 0.8-2.5 ft. Where the few log jams are present, pool cover can be high (~90%), but otherwise remains low at ~10%. Confinement within a small, narrow canyon limits both the extent and depth of gravel spawning habitat in the channel below the culvert crossing, where substrates are dominated by bedrock, boulder, cobble, and large and small gravels (~30% combined).

Large woody debris is sparse and widely scattered, composed of small (4-8 in. diameter) and medium (8-20 inch) logs. Fewer than ten pieces of LWD greater than 20 inches in diameter were documented, and few jams were observed. LWD abundance gradually increased in upstream portions of sub-reach 1A. Gradient ranges from 2-8%, with the steepest segments located just above the mouth, moderating a short distance below the Lords Lake Loop Road. Bankfull widths range from 14 ft. to 24 ft., with the narrowest segment found in the confined channel just upstream from the Little Quilcene confluence.

Two natural impediments to fish migration were observed in lower Ripley Creek below the Lords Lake Loop Road: a recently-fallen channel-spanning log embedded in the substrate just above the mouth (see Part II, R-1); and a series of natural bedrock chutes extending for the initial ~300 ft. segment above the mouth. Both likely impede upstream fish migration during low flow periods. With the exception of the Lords Lake Loop Road culvert and two small bridges, no bank or in-stream channel modifications were observed in sub-reach 1A. The 8 ft. diameter corrugated steel culvert (CC #14, Appendix 2) has stream-bed material throughout, and does not present a barrier to fish passage. A railroad flatbed bridge spans the channel to connect adjoining livestock pastures ~830 ft. above the roadway culvert (Part II, R2), and a private wooden footbridge crosses the channel ~300 ft. below the confluence of the large beaver pond outlet channel (tributary *D*) at the start of sub-reach 3B, though neither bridge results in a significant channel constriction.

No side channels were documented in sub-reach 1A during the survey, and an ~35-foot long split channel was noted ~600 ft. upstream from the Lords Lake Loop Road culvert. Surveyors did not locate two non-fish bearing tributaries *(A* and *C)* and the single fish-bearing tributary *(B)* with mapped confluences entering from the right bank within this sub-reach. The WDNR map indicates that tributaries *A* and *B* have a mutual right-bank confluence. Left-bank tributary *D* (the beaver pond outlet channel) was dry at the time of the habitat reconnaissance survey, though subsurface flow to Ripley Creek is likely.

Riparian Conditions – Riparian forest composition from the railroad bridge crossing downstream to the mouth of Ripley Creek is 50-60% conifer and 40-50% deciduous species, with deciduous prevalence increasing progressively upstream. The understory is dominated by vine maple, salmonberry and sword fern. Young (8-20 in. diameter) and mature (>20 inch dbh) stands of cedar, Douglas-fir, and western hemlock comprise the left-bank riparian corridor, while right-bank stands are generally younger, composed primarily of sapling (4-8 in. dbh) and young conifer trees. Big-leaf maple, red alder, and vine maple of various age classes occupy near-stream riparian buffers throughout. Canopy cover ranges from ~50% up to 85% in sub-reach 1A. No significant occurrence of non-native / invasive species was observed during the habitat reconnaissance survey.

Young alder trees dominate the riparian corridor (50-60%), with a lesser component of young western hemlock and Douglas-fir, and a dense salmonberry understory in the moderately confined segment located ~1000 ft. above the Lords Lake Loop Road. Livestock are fenced from the channel within an ~30-50 ft. wide riparian buffer as it continues upstream adjacent to pastureland above the railroad flatbed bridge crossing. Canopy cover is highly variable throughout this segment, ranging from 30-90%. Non-native climbing nightshade was noted at the railroad flatbed bridge crossing, and reed canary grass encroaches for ~1000 ft. along the channel through adjacent horse pasture.

Aquatic Biota – Juvenile salmonids were visible in a medium-sized pool with good cover (beneath a log jam) ~100 ft. upstream from the railroad flatbed bridge crossing, with juvenile fish (<10 total) also noted in another pool ~420 ft. below the wooden footbridge. No beaver activity or freshwater mussels were observed in this reach.

Ripley Creek:
<u>Reach 1, sub-reach 1B</u>

Overview – Sub-reach 1B extends for ~970 ft. upstream from the left-bank confluence of an unnamed, non fish-bearing tributary that drains a large beaver pond located to the east of the stream valley, near a private gravel road. The channel passes through a confined (~40 ft. wide) valley bottom for the initial ~200 ft. of this sub-reach, then broadens into an unconfined floodplain / beaver pond wetland complex for the remaining distance through to the upper end of Reach 1, ~120 ft. upstream from a local powerline crossing.

Channel Conditions – Beaver dams control the character of the aquatic and riparian habitat in this sub-reach. At least two recently-active beaver dams and associated ponds were noted, the first measuring 3-4 ft. in height and located ~250 ft. upstream from the start of the sub-reach, and the second > 4 ft. tall and located ~100 ft. further upstream. The two associated impoundments measure ~30 ft. wide, and produce brown tannic water at their outlets that tends to stain Ripley Creek downstream. A series of 10-15 additional small beaver dams upstream from the two largest dams form a network of deep channels and wetland ponds occupying a relatively unconfined valley (Part II, R3 and R4).

Substrates throughout this beaver pond sub-reach were mostly silts and fine sediments typical of slower, low-gradient depositional wetland habitats. Observation of large woody debris abundance was limited by water depth and clarity, and extensive swaths of obscuring reed canary grass. However, the majority of single LWD pieces were medium (8-20 in. diameter) logs, and a single small log jam was noted among the beaver dams. Small, low beaver dams of this type are rarely barriers to adult or juvenile fish migration, but may impede fish movement for short durations, particularly during low flow periods. Because the channel consists of multiple threads distributed throughout the floodplain, accurate bankfull width could not be measured during the habitat reconnaissance survey. Wetted widths averaged ~30 ft. throughout this reach, with gradient ranging from 1-2%.

An abandoned powerline access road once crossed the channel ~120 ft. downstream from the end of the reach, but is becoming overgrown where it approaches both stream banks. No significant bank or channel modifications were apparent in this sub-reach.

No split / side channels were noted, and there are no mapped tributaries in sub-reach 1B.

Riparian Conditions – Invasive reed canary grass dominates all riparian vegetation in this sub-reach, encroaching extensively upon the stream channel and ponded wetland areas. Young alder trees occur along the fringes of the riparian corridor, with evidence of recent logging and land clearing upslope. Most visible forest stands are regenerating second or third growth largely composed of deciduous species. Canopy cover is ~70% along more confined portions of the reach, but only ~30% in the beaver pond / wetland segment.

Aquatic Biota – No salmonids were observed in this sub-reach, though visibility was limited by tannic flow. Beaver activity was apparent from numerous freshly-cut limbs and recent evidence of dam repair. No freshwater mussels were observed.

Ripley Creek:
<u>Reach 2</u>

Reach 2 continues for ~750 ft. upstream from the upper extent of the beaver-pond dominated, unconfined valley of sub-reach 1B (~120 ft. above a local powerline crossing) to the beginning of the highly-confined Reach 3. Reach 2 is distinguished from Reach 3 by relatively moderate confinement throughout.

Channel Conditions – This reach is characterized by a classic small stream riffle-and-pool sequence, with riffles comprising ~65-75% of available habitat. Pools typically measured 12-20 ft. in length, and from 5-8 ft. wide, with residual depths of 0.9-1.6 ft. Pool cover is low - from 15-25%, and large woody debris is sparse. Eight small debris jams obstruct the relatively narrow channel at various locations along the reach length. Channel substrates are dominated by small and large gravels (30-40%, each size class), with the remaining cobble component increasing upstream. Spawning gravels are patchy and limited throughout the reach, appearing more suitable for small-bodied resident trout. Gradient is 3-4% within a bankfull width of 8-10 ft. Wetted widths averaged 3-5 ft. at the time of the habitat reconnaissance survey.

No natural barriers to fish migration were observed in Reach 2. No split / side channels were noted, and no bank or channel modifications were apparent. A non fish-bearing tributary *(E)*, with a mapped confluence on the left bank ~310 ft. upstream from the start of the reach (~430 ft. upstream from the powerline crossing), was not located.

Riparian Conditions – The riparian corridor in this reach is composed of ~70-80% deciduous tree species and 20-30% conifer. Mature red alder (>20 inches dbh) dominates the riparian forest in the lower third of the reach, while a mixed stand of big-leaf maple, Douglas-fir, cedar, hemlock, and young alder occur along the upstream riparian corridor. Native salmonberry, vine maple, Devil's club *(Oplopanax horridus)*, sword fern, and youth-on-age *(Tolmiea menziesii)* complement eachother in the often dense understory. Canopy cover remains low at ~15-25%. Reed canary grass is present in abundance adjacent to the beaver pond wetland of sub-reach 1B, but becomes sparser upstream.

Aquatic Biota – Juvenile salmonids (10-15) were visible in several shallow pools along the lower reach segment. No beaver activity or freshwater mussels were observed.

Ripley Creek:
Reach 3

Overview – Reach 3 extends for ~2320+ ft. upstream from the point where the stream channel begins to become confined by adjacent valley walls at the upper end of Reach 2 (located ~870 ft. above the local powerline crossing). This reach is highly confined by intermittently steep valley walls, and is relatively inaccessible. Due to time constraints, surveyors terminated the habitat reconnaissance prior to locating the upper extent of this lengthy reach along a channel that does not appear on current WDNR stream type maps, but is known to continue upstream to the headwaters in the vicinity of the intersection of the Lords Lake Loop Road and the Snow Creek Road.

Channel Conditions – Dominant aquatic habitat in the surveyed portion of Reach 3 is composed of short bedrock chutes and longer riffles, interspersed with shallow pools defined by bedrock erosion. Spawning gravels are very limited in this reach due to extensive bedrock substrates, but limited channel-obstructing large woody debris also contributes to pool formation and isolated gravel pockets within riffles. Pools range from 5-25 ft. long and 5-18 ft. wide, with residual depths of 0.6-2.0 ft. Pool cover varies considerably (5-40%) with the highest cover exhibited by pools associated with small log jams. Gradient is ~3-4%, with bankfull widths ranging from 4-12 ft., and average wetted widths between 5 ft. and 10 ft. at the time of the habitat reconnaissance survey.

Individual large woody debris pieces consisted almost exclusively of small and medium-sized logs, occurring in nearly equal proportions throughout the reach. LWD greater than 20 inches in diameter documented along this reach was often incorporated into log jams (17 small, 4 medium, and one large jam), and most jams appeared stable and persistent.

No stream bank or channel modifications were observed along the length of Reach 3. A channel-spanning bedrock step ~3.3 ft. in height with a 2-foot deep plunge pool occurs ~20 ft. upstream from the tributary *F* confluence. A bedrock chute, located ~1300 ft. upstream from the first step, has an initial elevation drop of 3.2 ft. drop, and an additional 3.0 ft. drop over a distance of 5.0 ft. while passing beneath a large-diameter spanner log. Both of these natural features are potential fish-passage impediments during low flows.

Right-bank tributary *F* was previously misclassified as non fish-bearing (Ns or Type 5) habitat, entering the channel ~910 ft. above the confluence of tributary *E* (or approx. 1340 ft. above the local powerline crossing). The tributary *F* gradient is 5-6% within a bankfull width of 3 ft., and a wetted width averaging 1.5 ft. at the time of the survey.

Riparian Conditions – Riparian vegetation is dominated by second-growth mixed deciduous and conifer forest consisting of alder, big-leaf maple, western red cedar, Douglas-fir, and western hemlock. Scattered among the predominantly sapling-to-young trees are a few mature cedars and Douglas-firs. The understory is composed of dense salmonberry, vine maple, red huckleberry *(Vaccinium parvifolium)*, Devil's club, sword fern, youth-on-age, and maidenhair fern *(Adiantum pedatum)* on steep, stream-adjacent bedrock bluffs. Canopy cover is relatively high, averaging ~60-70%, and though present, invasive reed canary grass is sparse in this reach compared to downstream reaches.

Aquatic Biota – No fish, beaver activity, or freshwater mussels were observed in Reach 3 during the habitat reconnaissance survey.

- **Howe Creek**

Habitat reconnaissance surveys were conducted on Howe Creek (stream catalog ID 17.0090) on October 16, 2007. Surveyed reaches extend from the Little Quilcene River confluence (RM 5.2) upstream beyond the first of two culvert crossing of the Lords Lake Loop Road. Due to the inaccessible nature of the confined lower stream valley, aquatic and riparian habitats are in better condition relative to other Little Quilcene tributaries. However, lower-gradient middle reaches are highly modified, including lengthy segments dominated by non-native vegetation, and headwater reaches have experienced intensive timber harvest activities. Physical characteristics of the stream channel and resident and anadromous fish use qualify Howe Creek as a Type 3 water of the state from the mouth upstream to a beaver pond source that was identified by Wild Fish Conservancy personnel during water typing of headwater mainstem and tributaries (Part II, H-2). See Reaches 1-5 on Map 6, Appendix 1.

Howe Creek:
Reach 1

Overview – Reach 1 extends for ~1,440 ft. from the Howe Creek confluence with the Little Quilcene River upstream to the mouth of a deeply-incised bedrock canyon. The stream channel throughout Reach 1 is moderately confined by steep valley walls.

Channel Conditions – Channel habitat in the lower half of this reach is predominantly logjam- and boulder-formed step pools interspersed with shallow riffles. The upper channel is dominated by riffles separated by short cascades and small scour pools. Residual pool depths average ~1 ft., with the deepest measuring only 1.3 ft. Pool cover is ~90% and is provided by abundant large woody debris. Small and medium-sized LWD jams are the dominant pool-forming factors. Cobble and sand comprise the substrate near the mouth, alternating with small sections of exposed bedrock. Boulder and cobble are prevalent in upstream portions of the reach, with limited deposits of large and small gravel. Bankfull width measured ~25 ft., with a gradient of ~8% in the lower reach, moderating to 4% at a distance of ~720 ft. upstream from the mouth.

Large woody debris is abundant with most pieces in the 8-20 in. diameter range. Numerous conifer logs greater than 20 inches in diameter function as key pieces in log jams along the reach, and a large jam extending for ~90 ft. upstream from the mouth is composed of numerous overlapping small jams that appear as a single, continuous jam. This jam may create a temporary fish passage barrier for adult salmon during some flows.

No bank or channel modifications were observed. There is a small channel braid ~940 ft. upstream from the mouth, and no side channels were noted in this reach. Two fish-bearing right-bank tributaries and one non fish-bearing left-bank tributary that appear on the WDNR water type maps were not located during the habitat reconnaissance survey.

Riparian Conditions – Riparian vegetation is dominated by young-to-mature big-leaf maple and red alders (60%), with a conifer component of young cedar, hemlock, and Douglas-fir (40%). Canopy cover is 60% throughout. No invasive species were noted.

Aquatic Biota – Resident trout were observed in most pools along the length of Reach 1. No beaver activity or freshwater mussels were observed.

Howe Creek:
Reach 2

Overview – Reach 2 begins at the mouth of a bedrock canyon located ~1,440 ft. upstream from the Little Quilcene River confluence, and extends for ~200 ft. upstream through the 20-25 ft. wide canyon to the base of a 75-ft. high waterfall that marks the upper extent of anadromous fish passage in Howe Creek at RM 0.3 (see Part II, H-1).

Channel Conditions – Riffle habitat dominates this canyon reach, interspersed with a few small scour and step pools. The largest pool measured ~12 ft. wide by 15 ft. long, with a residual depth of 1 ft. Bedrock and boulder substrates prevail throughout. The bankfull width averages ~24 ft., and channel gradient is ~4% upstream to the falls at reach end.

Large woody debris is abundant, and most of the wood in this reach appears old and stable, with the majority of pieces measuring 8-20 inches in diameter. A single large channel-spanning jam was observed ~130 ft. above the canyon entrance.

No bank or channel modifications were observed along this reach

No side channels or tributaries enter Howe Creek in Reach 2.

Riparian Conditions – Riparian vegetation is dominated by young-to-mature conifer forest (cedar, hemlock, and Douglas-fir, 60%) with lesser amounts of young-to-mature big-leaf maple and red alder (40%). Canopy cover is 60% with additional shade provided by the steep canyon walls. No non-native/invasive species were observed in this reach.

Aquatic Biota – Resident trout were noted throughout Reach 2, though at lower densities than in Reach 1 downstream. No beaver activity or freshwater mussels were observed.

Howe Creek:
Reach 3

Overview – Reach 3 extends for a distance of ~860 ft. from the barrier falls upstream to a culvert crossing of the Lords Lake Loop Road (RM 0.45). An old parking area with a gated access road is perched on the right bank canyon edge near the falls, and a long-abandoned trail with overgrown wooden steps follows a ridge from the parking area to a viewpoint overlooking the falls. The channel above the falls passes through a moderately confined valley bottom, with steep slopes along the right bank. The road prism for the Lords Lake Loop Road forms the left-bank berm along upstream segments of this reach.

Channel Conditions – Channel habitats are dominated by riffles (~80%) and LWD-formed pools (~20%) averaging 1-1.5 ft. deep. The deepest pool, measuring 2.5 ft., is located at the culvert outlet below the Lords Lake Loop Road crossing, indicating that the culvert is undersized. Substrate composition is ~40% small gravel, 20% large gravel, 20% cobble, 10% bedrock, and 10% sand. Gradient is ~2-3%, with a bankfull width in the 15-17-foot range, and an average wetted width of ~10 ft. at the time of the survey.

Large woody debris is sparse in this reach, with the majority of LWD pieces measuring 8-20 inches in diameter, with a total of six jams – three small and three medium-sized. A few very large diameter LWD key pieces (> 48 in.) span the channel at several locations.

No natural barriers to fish migration were observed. With the exception of the culvert crossing of Lords Lake Loop Road, no artificial bank or channel modifications were noted in Reach 3. The large diameter corrugated steel culvert (CC #20, Appendix 2 and Map 6) has no retained substrate and appears to have a gradient of greater than 1%, creating a partial fish-passage barrier.

No side channels or tributaries were observed in this reach.

Riparian Conditions – A diverse forest of young-to-mature cedar, Douglas-fir, and western hemlock dominate riparian slopes upstream from the barrier waterfall. Intermixed within the conifer stands are remnant old-growth cedar trees (>40 in. dbh), and small stands of young alder and big-leaf maple. Canopy cover is ~80% throughout. No non-native/invasive species were observed.

Aquatic Biota – No beaver activity or freshwater mussels were observed.

Howe Creek:
<u>Reach 4</u>

Overview – Reach 4 extends from the lower Lords Lake Loop Road culvert crossing (at RM 0.45) upstream for ~3,130+ ft. Due to time constraints, surveyors terminated the habitat reconnaissance midway through an extensive series of beaver dam wetlands, and did not observe the upper part of this reach extending upstream to a second culvert crossing of the Lords Lake Loop Road (CC #35, Appendix 2). The Reach 4 channel meanders through an unconfined valley bottom and floodplain with the appearance of a former lake/beaver pond that is now heavily overgrown with invasive reed canary grass.

Channel Conditions – The first of a series of beaver dams is located ~1220 ft. above the lower Lords Lake Loop Road culvert crossing. Channel habitat downstream from the beaver dam segment is composed of riffles (70%) and pools (30%) with depths ranging from 1.3-2.0 ft. Impounded pools connected by numerous multi-thread channels that meander through the extensive reed canary grass-dominated wetland characterize the habitat through the beaver dam section. Channel substrate below the beaver dam reach is 70% small gravels and 30% sand, while substrates within the beaver pond wetland are dominated by silt and intermittent, small gravel deposits. Gradient is 1-2%, with a bankfull width of ~14 ft., and an average wetted width of ~10 ft. at the time of the survey.

Large woody debris is sparse in this reach, with in-stream wood significantly less abundant than in downstream reaches of Howe Creek. A few remnant old growth logs (greater than 48 inches in diameter) lie partly-overgrown amid the extensive swaths of reed canary grass, and these logs often span wetland secondary channels, providing fish cover, and serving as nurse logs for regenerating tree seedlings. However, most LWD observed in this reach falls into the 8-20 inch diameter class. Three small and two medium-sized jams were located in Reach 4.

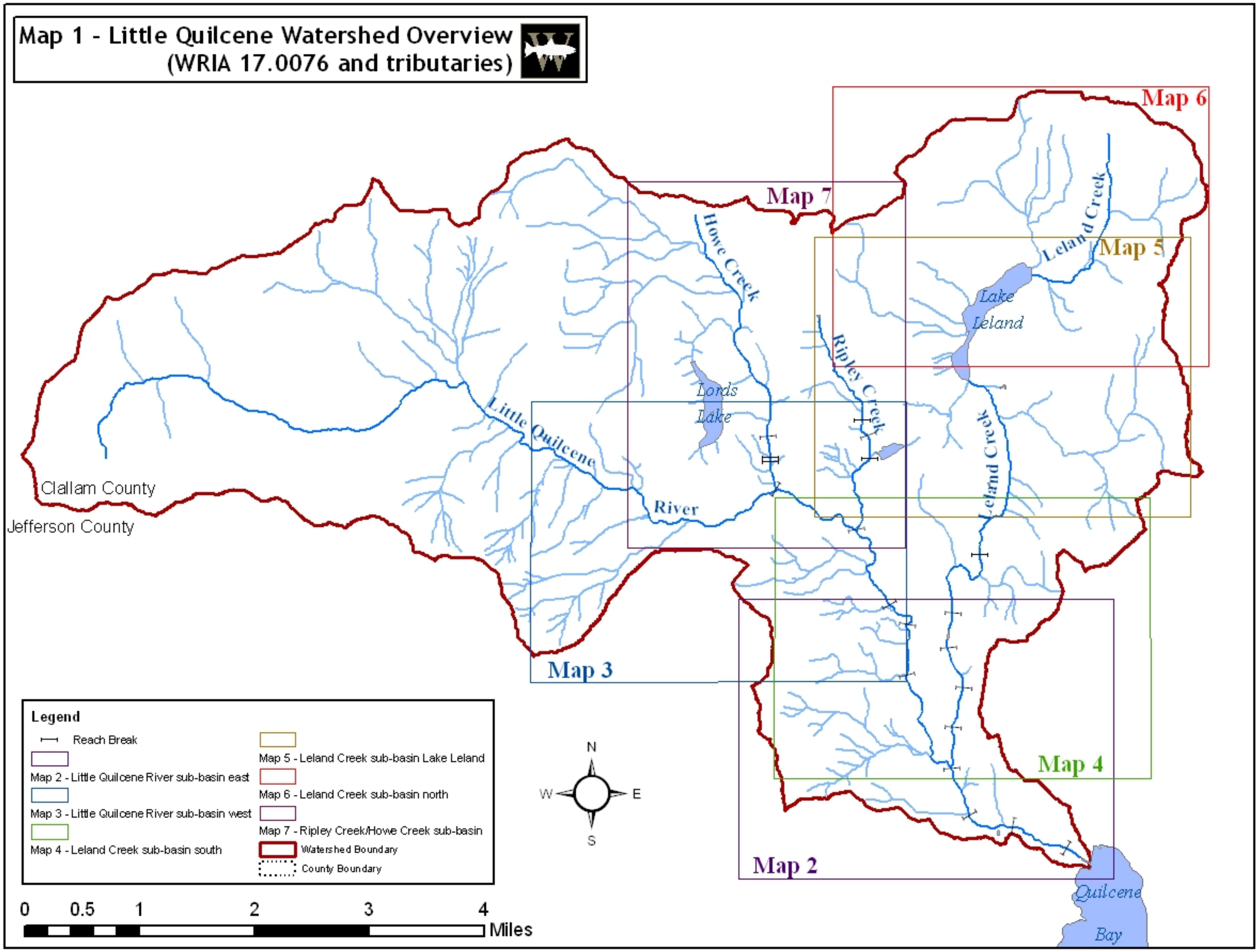
No artificial bank or channel modifications were observed in this reach. Five beaver dams were noted prior to survey termination, the largest measuring 3.5 ft. in height. Though it is unlikely that they are significant barriers to fish movement, these beaver dams may impede local migration during periods of low flow. Additional beaver dams exist upstream toward the end of the reach at the upper Lords Lake Loop Road crossing.

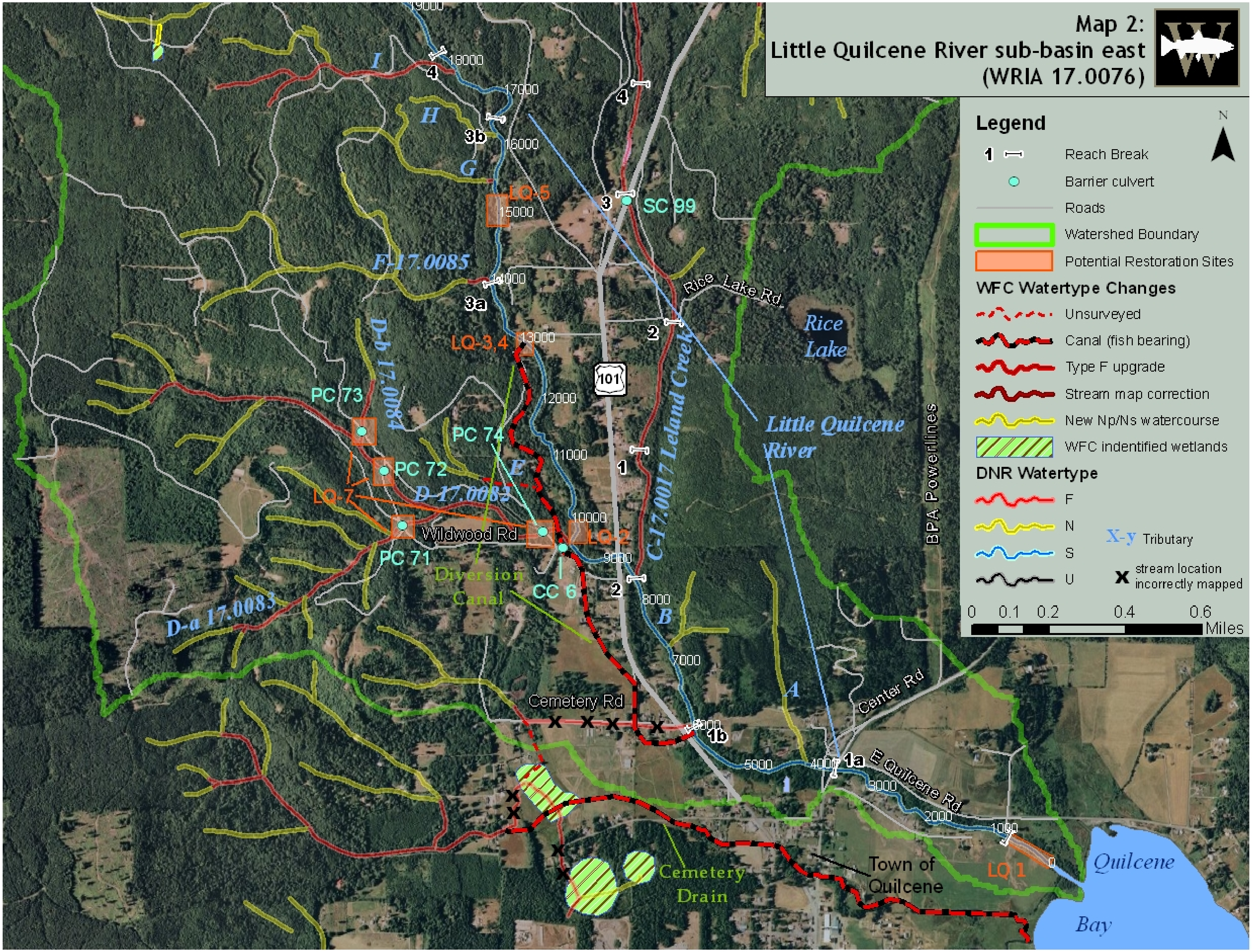
Two ~50-ft. long split channels were noted at ~140 ft. and ~1,030 ft. upstream from the start of the reach. Right-bank tributary *E* (17.0091, RM 0.6) enters Howe Creek ~980 ft. above the lower Lords Lake Loop Road crossing. With a bankfull width of ~3 ft. and a gradient of 1-2%, this tributary is one of the two Lords Lake Reservoir outlet channels. A 3.5-foot wide tributary with a gradient of ~1% (tributary *G*) enters Howe Creek from the left bank ~2300 ft. above the lower Lords Lake Loop Road culvert at RM 0.45.

Riparian Conditions – Streamside vegetation along this reach is dominated by invasive reed canary grass with sparsely distributed stands of old growth sitka spruce (20-40 in. dbh) and mature (20 in. diameter) cedar, hemlock, and big-leaf maple. Canopy cover averages ~30% throughout. The understory is composed primarily of salmonberry and Pacific ninebark, giving way to reed canary grass in upstream portions of the reach.

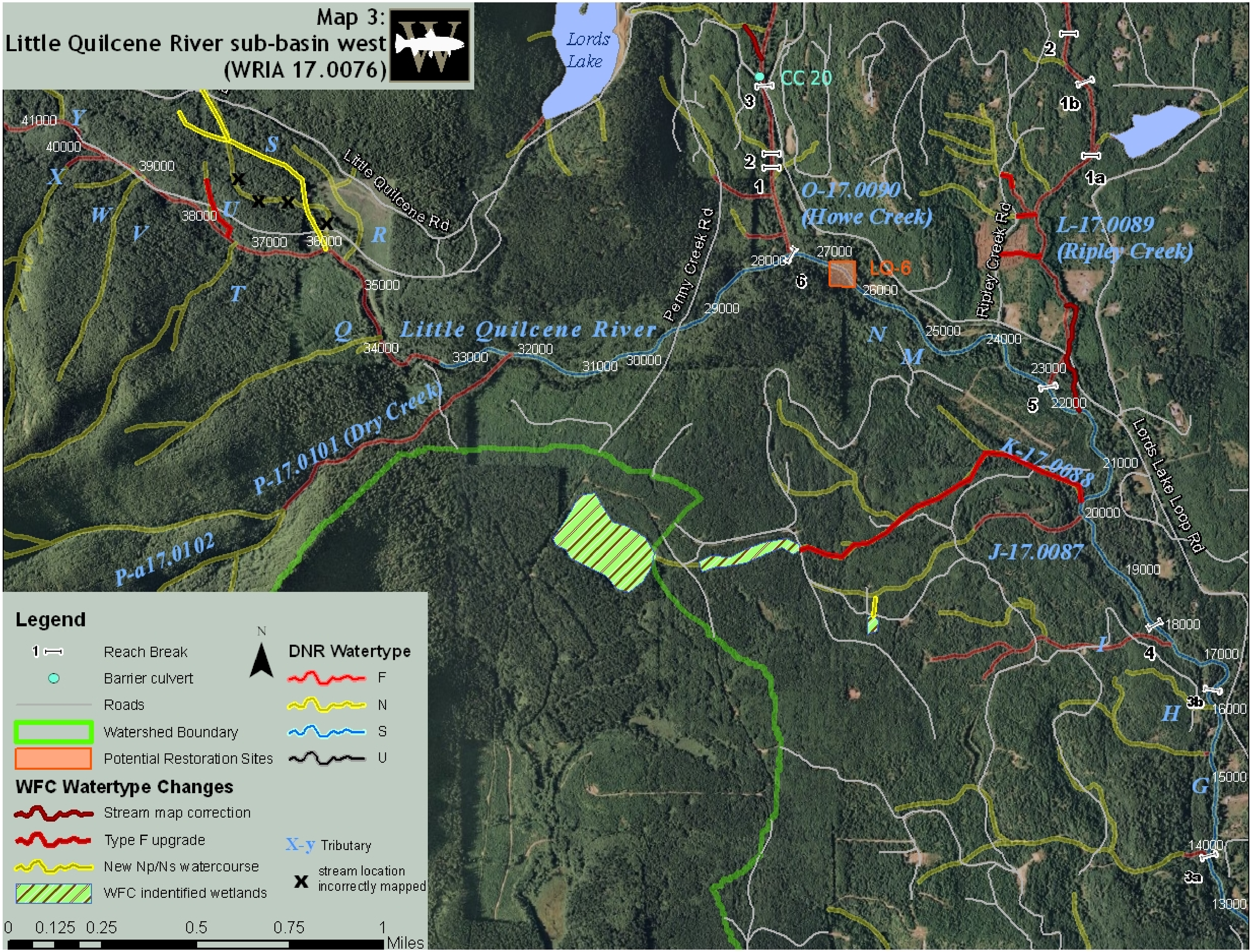
Aquatic Biota – Several small resident trout were observed in Reach 4 during the habitat reconnaissance survey. Five beaver dams were noted; two were active and three others appeared to be inactive at the time of the survey. No freshwater mussels were observed.

<u>Appendix 1:</u> **Maps 1-7: Little Quilcene – Leland Watershed rapid habitat assessment and prioritized restoration framework** (summarizing habitat and fish-use data collected by Wild Fish Conservancy Northwest, and recommended priority restoration sites throughout the lower mainstem Little Quilcene River, and Leland Creek, Ripley Creek, and Howe Creek sub-basins)

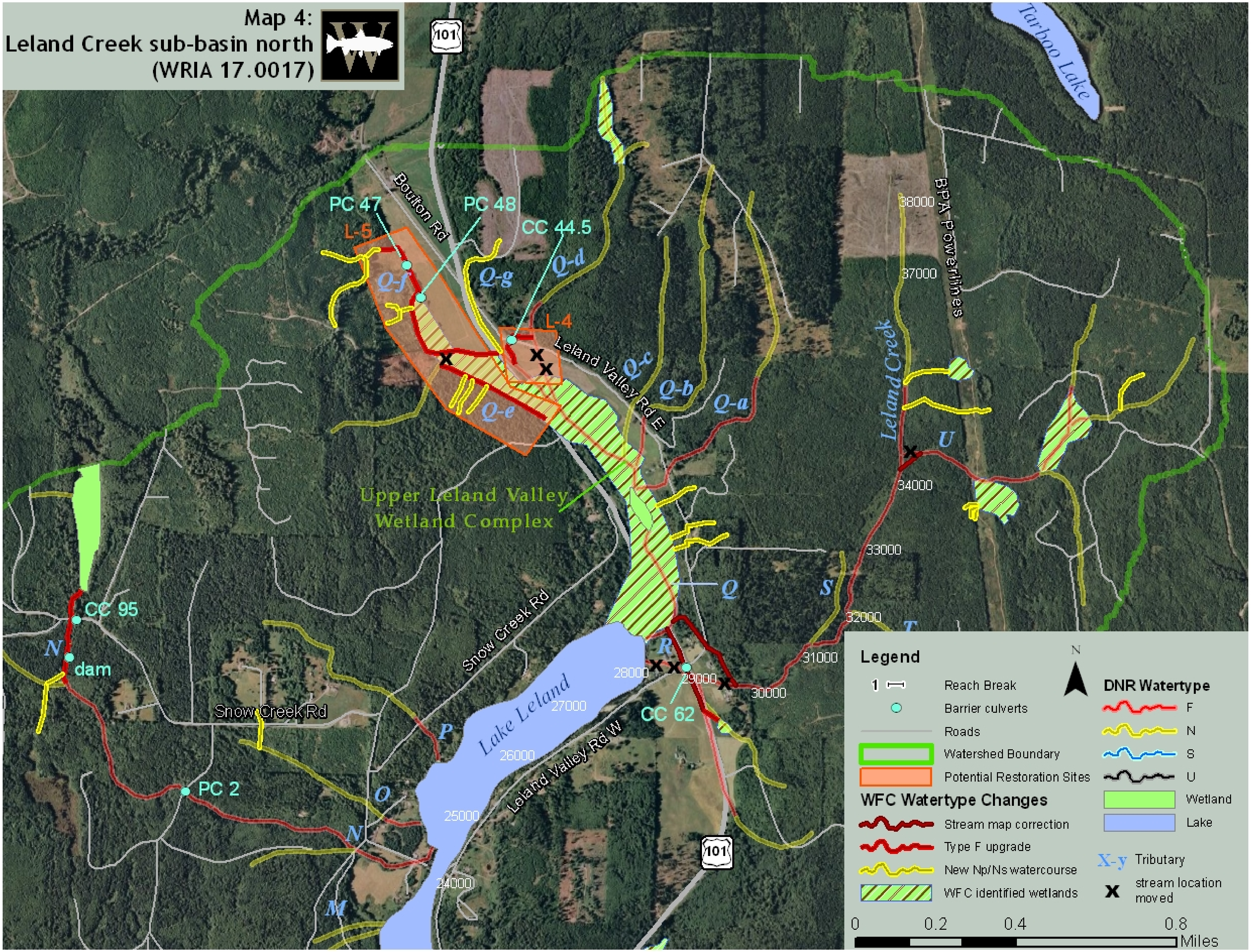


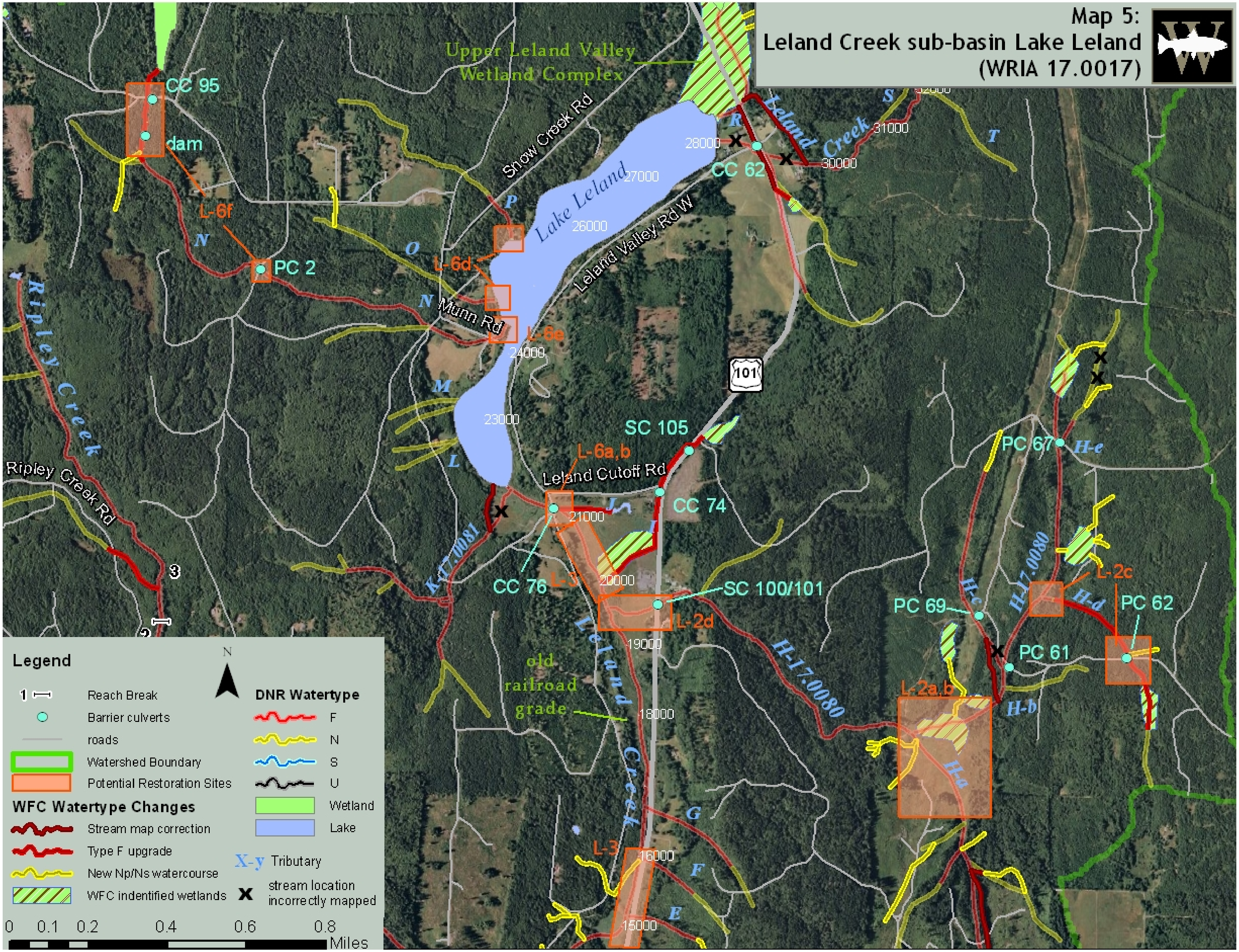


Map 2:
Little Quilcene River sub-basin east
(WRIA 17.0076)
Legend
Reach Break
Barrier culvert
Roads
Watershed Boundary
Potential Restoration Sites
WFC Watertype Changes
Unsurveyed
Canal (fish bearing)
Type F upgrade
Stream map correction
New Np/Ns watercourse
WFC indentified wetlands
DNR Watertype
F
N
S
U
X-y Tributary
stream location incorrectly mapped
0 0.1 0.2 0.4 0.6 Miles
Rice Lake Rd
Rice Lake
Little Quilcene River
C-17.0017 Leland Creek
F-17.0085
D-b 17.0084
D-17.0083
D-a 17.0083
LQ-5
LQ-3,4
LQ-7
LQ-2
LQ 1
SC 99
PC 73
PC 72
PC 71
PC 74
CC 6
Wildwood Rd
Diversion Canal
Cemetery Rd
Cemetery Drain
Center Rd
E Quilcene Rd
Town of Quilcene
Quilcene Bay
BPA Powerlines
101

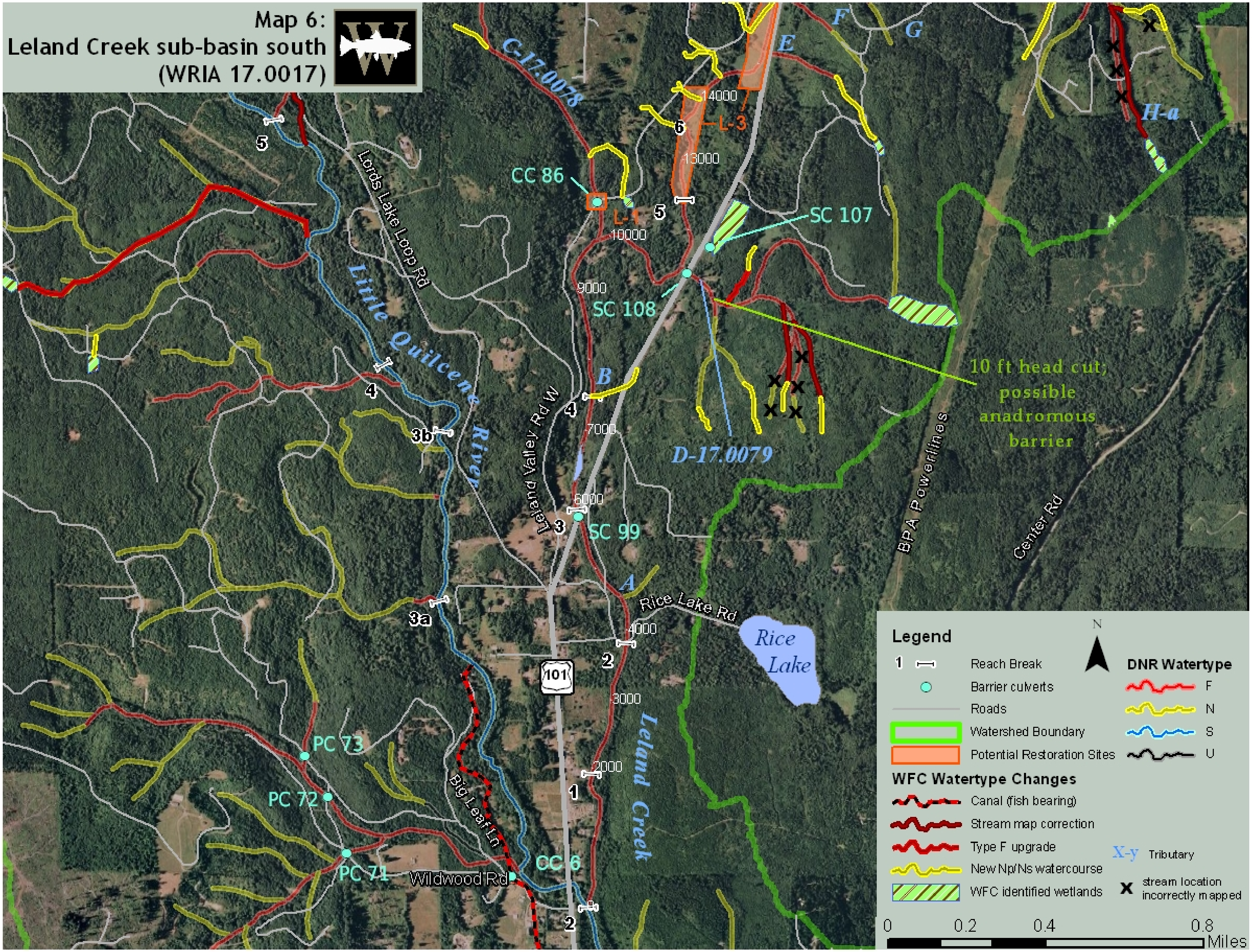


Map 3:
Little Quilcene River sub-basin west
(WRIA 17.0076)
Lords Lake
CC 20
LQ-6
Little Quilcene Rd
Penny Creek Rd
Ripley Creek Rd
Lords Lake Loop Rd
Little Quilcene River
O-17.0090 (Howe Creek)
L-17.0089 (Ripley Creek)
K-17.0088
J-17.0087
P-17.0101 (Dry Creek)
P-a17.0102
Y
X
W
V
U
T
S
R
Q
N
M
I
H
G
41000
40000
39000
38000
37000
36000
35000
34000
33000
32000
31000
30000
29000
28000
27000
26000
25000
24000
23000
22000
21000
20000
19000
18000
17000
16000
15000
14000
13000
1
2
3
1a
1b
3a
3b
4
5
6
Legend
Reach Break
Barrier culvert
Roads
Watershed Boundary
Potential Restoration Sites
N
DNR Watertype
F
N
S
U
WFC Watertype Changes
Stream map correction
Type F upgrade
New Np/Ns watercourse
WFC indentified wetlands
X-y Tributary
stream location incorrectly mapped
0 0.125 0.25 0.5 0.75 1
Miles

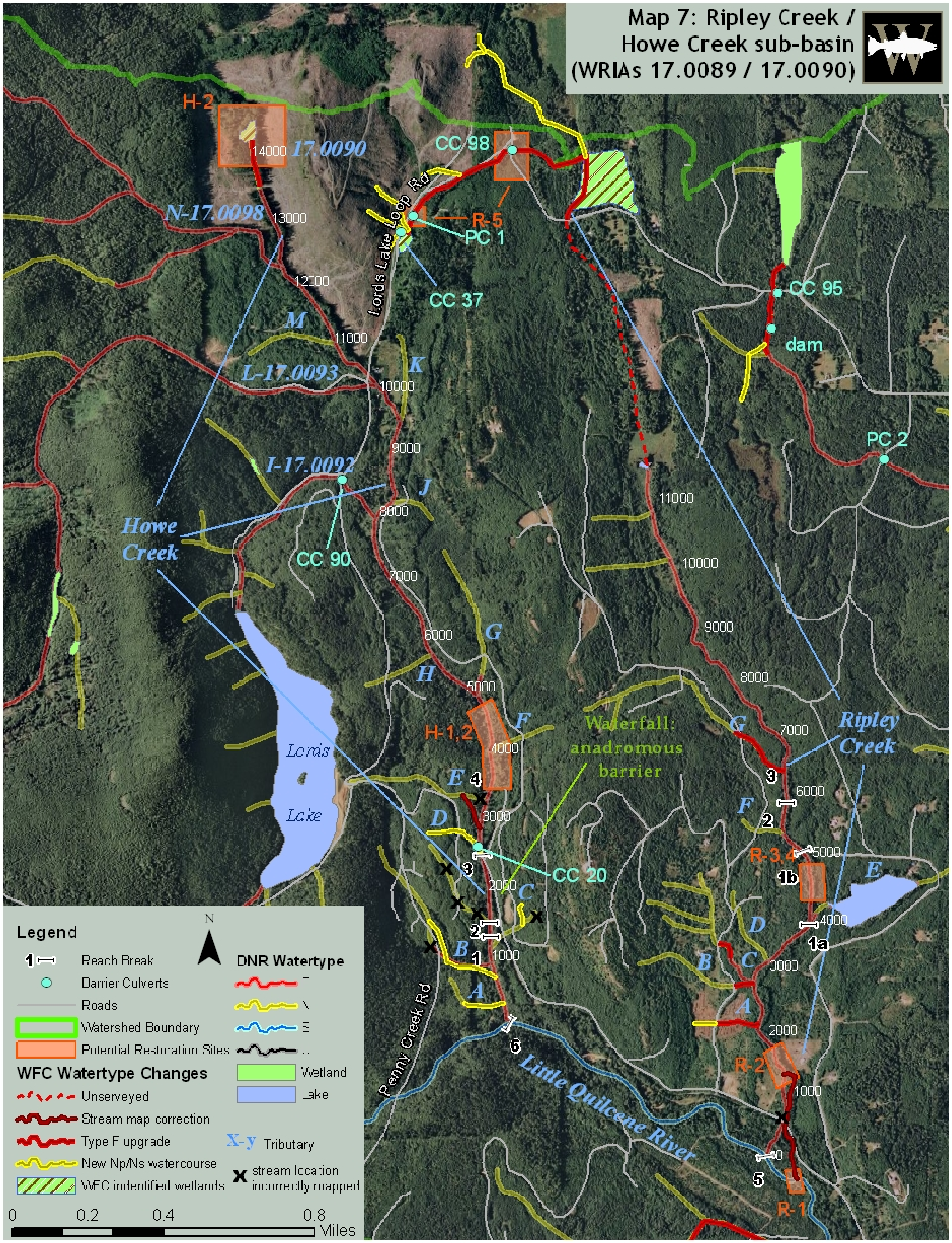

Map 4:
Leland Creek sub-basin north
(WRIA 17.0017)
Tarboo Lake
101
Boulton Rd
PC 47
PC 48
CC 44.5
L-5
L-4
Q-f
Q-g
Q-d
Q-c
Q-b
Q-a
Q-e
Leland Valley Rd E
BPA Powerlines
Leland Creek
38000
37000
34000
33000
32000
31000
30000
29000
28000
27000
26000
25000
24000
U
S
T
Q
R
P
O
N
M
Upper Leland Valley
Wetland Complex
CC 95
dam
Snow Creek Rd
PC 2
Lake Leland
Leland Valley Rd W
CC 62
Legend
Reach Break
Barrier culverts
Roads
Watershed Boundary
Potential Restoration Sites
WFC Watertype Changes
Stream map correction
Type F upgrade
New Np/Ns watercourse
WFC identified wetlands
DNR Watertype
F
N
S
U
Wetland
Lake
X-y Tributary
stream location moved
0 0.2 0.4 0.8
Miles



Map 5:
Leland Creek sub-basin Lake Leland
(WRIA 17.0017)
Upper Leland Valley Wetland Complex
Snow Creek Rd
Lake Leland
Leland Valley Rd W
Munn Rd
Leland Cutoff Rd
Ripley Creek
Ripley Creek Rd
Leland Creek
old railroad grade
101
CC 95
dam
L-6f
PC 2
L-6d
L-6e
L-6a,b
SC 105
CC 74
CC 76
L-3
SC 100/101
L-2d
CC 62
PC 67
PC 69
PC 61
PC 62
L-2c
L-2a,b
K-17.0081
H-17.0080
H-17.0080
H-a
H-b
H-c
H-d
H-e
28000
27000
26000
24000
23000
21000
20000
19000
18000
16000
15000
30000
31000
32000
Legend
Reach Break
Barrier culverts
roads
Watershed Boundary
Potential Restoration Sites
WFC Watertype Changes
Stream map correction
Type F upgrade
New Np/Ns watercourse
WFC indentified wetlands
DNR Watertype
F
N
S
U
Wetland
Lake
X-y Tributary
stream location incorrectly mapped
0 0.1 0.2 0.4 0.6 0.8
Miles



Map 6:
Leland Creek sub-basin south
(WRIA 17.0017)
C-17.0078
F
G
E
14000
L-3
6
13000
H-a
CC 86
L-1
5
10000
SC 107
9000
SC 108
10 ft head cut; possible anadromous barrier
Lords Lake Loop Rd
Little Quilcene River
B
4
7000
D-17.0079
3b
Leland Valley Rd W
6000
3
SC 99
BPA Powerlines
Center Rd
A
Rice Lake Rd
3a
4000
Rice Lake
2
101
3000
Leland Creek
PC 73
2000
PC 72
Big Leaf Ln
1
PC 71
CC 6
Wildwood Rd
2
5
Legend
Reach Break
Barrier culverts
Roads
Watershed Boundary
Potential Restoration Sites
DNR Watertype
F
N
S
U
WFC Watertype Changes
Canal (fish bearing)
Stream map correction
Type F upgrade
New Np/Ns watercourse
WFC identified wetlands
X-y Tributary
stream location incorrectly mapped
0 0.2 0.4 0.8 Miles


Map 7: Ripley Creek / Howe Creek sub-basin (WRIAs 17.0089 / 17.0090)
H-2
17.0090
N-17.0098
CC 98
R-5
PC 1
CC 37
Lords Lake Loop Rd
M
L-17.0093
K
I-17.0092
J
CC 90
Howe Creek
CC 95
dam
PC 2
G
H
H-1,2
F
E
D
CC 20
C
B
A
Waterfall: anadromous barrier
Lords Lake
Ripley Creek
R-3,4
1b
1a
R-2
R-1
Penny Creek Rd
Little Quilcene River
Legend
Reach Break
Barrier Culverts
Roads
Watershed Boundary
Potential Restoration Sites
WFC Watertype Changes
Unserveyed
Stream map correction
Type F upgrade
New Np/Ns watercourse
WFC indentified wetlands
DNR Watertype
F
N
S
U
Wetland
Lake
X-y Tributary
stream location incorrectly mapped
0 0.2 0.4 0.8 Miles

<u>Appendix 2</u>: List of Barrier Culverts identified by Wild Fish Conservancy on fish-bearing ("F" or Type 3) streams during the Little Quilcene – Leland Creek Watershed Rapid Habitat Assessment

Culvert ID[1]	Survey Date	Road name	Stream name	tributary to	latitude	longitude	estimate % passable to fish	Map #
PC 1	unsurveyed[2]	unnamed driveway off Lords Lake Loop Rd	Ripley Creek (17.0089)	Little Quilcene River (17.0076)	47.903132	-122.928088	n/a	7
PC 2	3/12/08 (wfc)	private logging spur – ORM ownership	17.0017*N*	Lake Leland (17.0017)	47.894171	-122.900160	33%	5
PC 47	4/10/08 (wfc)	private field-access road on Boulton Farm	17.0017*Q-f*	Lake Leland (17.0017)	47.9144562	-122.888568	0%	4
PC 48	4/10/08 (wfc)	private field-access road on Boulton Farm	17.0017*Q-f*	Lake Leland (17.0017)	47.9132465	-122.887721	33%	4
PC 61	4/21/08 (wfc)	unnamed logging road	17.0080	Leland Creek (17.0017)	47.879792	-122.856826	67%	5
PC 62	4/22/08 (wfc)	unnamed logging road	170080 *H-d*	17.0080	47.880285	-122.850142	0%	5
PC 67	4/22/08 (wfc)	unnamed logging road	17.0080	Leland Creek (17.0017)	47.8884681	-122.854338	33%	5
PC 69	4/21/08 (wfc)	BPA powerline road	17.0080 *H-c*	17.0080	47.8817499	-122.858628	33%	5
PC 71	unsurveyed	Wildwood Rd	17.0083 Wildwood Cr trib *D-a*	Little Quilcene River (17.0076)	47.83897	-122.9	n/a	2
PC 72	unsurveyed	Wildwood Rd	17.0082 "Wildwood Creek"	Little Quilcene River (17.0076)	47.84107	-122.902	n/a	2
PC 73	unsurveyed	Wildwood Rd	17.0084 Wildwood Cr trib *D-b*	Little Quilcene River (17.0076)	47.84261	-122.903	n/a	2

PC 74	unsurveyed	Big Leaf Lane	17.0082 “Wildwood Creek”	Little Quilcene River (17.0076)	47.83891	-122.892	n/a	2
CC 6	8/28/97	Wildwood Rd	“Wildwood Diversion Canal”	Little Quilcene River (17.0076)	47.8383064	-122.892944	non-fish (state) 33% (wfc)	2
CC 20	8/28/97 (state)	Lords Lake Loop Rd	Howe Creek (17.0090)	Little Quilcene River (17.0076)	47.8784103	-122.923271	67%	7
CC 37	8/28/97 (state) 3/12/08 (wfc)	Lords Lake Loop Rd	Ripley Creek (17.0089)	Little Quilcene River (17.0076)	47.9024391	-122.928749	100% (state) 33% (wfc)	7
CC 44.5	1/18/08 (wfc)	Leland Valley Rd East	17.0017*Q-d*	Lake Leland (17.0017)	47.91173	-122.883	33%	4
CC 62	9/4/97 (state) 1/18/08 (wfc)	Leland Valley Rd West	17.0017*R*	Lake Leland (17.0017)	47.899532	-122.872109	100% (state) 33% (wfc)	5
CC 74	9/4/97 (state) 1/24/98 (wfc)	Leland Cut-off Rd	17.0017*I*	Leland Creek (17.0017)	47.8862228	-122.877205	non-fish (state) 33% (wfc)	5
CC 76	9/4/97 (state)	Leland Valley Rd West	Leland Creek (17.0017)	Little Quilcene River (17.0076)	47.8855705	-122.883141	100%	5
CC86	9/4/97 (state)	Leland Valley Rd West	17.0078	Leland Creek (17.0017)	47.863670	-122.887604	0%	6
CC 90	8/28/97 (state)	Lords Lake Loop Rd	17.0092 (Lords Lake outlet)	Howe Creek (17.0090)	47.8926468	-122.931664	67%	7
CC 95	10/22/98 (state) 1/24/08 (wfc)	Snow Creek Rd	17.0017*N*	Lake Leland (17.0017)	47.9006577	-122.906677	non-fish (state) 67% (wfc)	5
CC 98	10/22/98 (state) 3/12/08 (wfc)	Snow Creek Rd	Ripley Creek (17.0089)	Little Quilcene River (17.0076)	47.9057732	-122.922394	unknown – recommend “B” – level analysis	7
SC 99	7/30/03 (state)	US Hwy 101	Leland Creek (17.0017)	Little Quilcene River (17.0076)	47.8519249	-122.887833	33%	6

SC 100	7/29/03 (state)	US Hwy 101	17.0080	Leland Creek (17.0017)	47.8817177	- 122.876724	67%	5
SC 101	7/29/03 (state)	US Hwy 101	17.0080	Leland Creek (17.0017)	47.8817177	- 122.876724	67%	5
SC 105	7/29/03 (state)	US Hwy 101	17.0017*l*	Leland Creek (17.0017)	47.8877428	- 122.875442	67%	5
SC 107	7/30/03 (state)	US Hwy 101	unnamed wetland	Leland Creek (17.0017)	47.8624008	- 122.881198	67%	6
SC 108	7/30/03 (state)	US Hwy 101	17.0079	Leland Creek (17.0017)	47.8624008	- 122.881198	67%	6

[1] Culvert ownership is reflected in the ID: Private Culvert, County Culvert, State Culvert.
Further information can be accessed through the Washington Dept. of Fish and Wildlife SSHEAR database.

[2] WFC field personnel did not have access to private property to conduct a barrier assessment survey of culvert PC 1;
cursory examination concluded that the PC 1culvert was a partial barrier

Appendix 3: Contact List for Little Quilcene / Leland Valley landowners potentially receptive to watershed restoration activities

Each of the following residents were contacted directly by WFC staff during fieldwork activities for the Rapid Habitat Assessment, and indicated some degree of willingness to participate in future restoration activities on their properties. Details of their degree of interest and the specific restoration activity addressed are provided below (see also Part II: Restoration Recommendations, and Appendix 4: Prioritized Restoration Matrix)

1. Robert Alexander

Phone:	(360) 774-1194
mail address:	PO Box 163 Quilcene, WA 98376
physical address:	384 / 554 Big Leaf Lane, Quilcene
Jefferson County parcel #'s:	702111032, 702113007

Bob is a property owner adjacent to the Wildwood Diversion Canal inlet channel on the Little Quilcene River. At the behest of downstream property owners who exercise this water-right, he manages flow in the canal by opening or closing a river-return side channel (via rip-rap and sand bags) just below the right-bank diversion entrance at the north end of Big Leaf Lane (a private road). He reacted very favorably to the idea of screening the inlet to prevent juvenile salmon from entering the diversion canal, but expressed concern that, once-installed, routine maintenance would be discontinued leaving the work of clearing the screen in his hands (see LQ #3a of Part II: Restoration Recommendations, and Map 2, Appendix 1 for the diversion canal location).

2. Peter Brackney

Phone:	(360) 765-3181
mail address:	PO Box 579 Quilcene, WA 98376
physical address:	121 Wildwood Road, Quilcene
Jefferson County parcel #'s:	932700024

WFC staff have not spoken with this Quilcene resident. His name was referenced by Robert Alexander (#1, above) for annual maintenance of the cobble push-up dam that diverts Little Quilcene River flow into the Wildwood Diversion Canal (see Part II: LQ #3b and Map 2 for the location of the canal inlet and diversion).

3. John and Heidi Burbank

Phone:	(360) 774-2690
mail address:	PO Box 475 Port Hadlock, WA 98376
physical address:	3080 / 3081 Leland Valley Road West, Quilcene
Jefferson County parcel #'s:	702021015, 702021020

John and Heidi own property that includes the confluence of the 17.0082 tributary to Leland Creek. This tributary has a barrier culvert (CC #86, Appendix 2) as described in Part II: L-1. They are excellent stewards of the stream corridor through their property, keen to learn of opportunities to enact conservation easements and initiate restoration for the benefit of fish and riparian wildlife.

4. Richard Burge

Phone:	(360) 765-3815
mail address:	1261 Leland Valley Road East, Quilcene, 98376
physical address:	1261 Leland Valley Road East, Quilcene
Jefferson County parcel #'s:	802244009

Dick Burge managed the Point Whitney Shellfish Laboratory for 15 years as a WDFW employee. As founding member and current Conservation Vice-President for the Wild Steelhead Coalition (www.wildsteelheadcoalition.org) he is a staunch advocate for anadromous fish habitat throughout Western Washington. His residence is located at the upper Leland Creek (non barrier) culvert crossing of Leland Valley Road East, just across Highway 101 from Lake Leland. Dick has attempted to organize the Leland community to support the return of anadromous fish, but met with resistance from some landowners. He expressed interest in assisting with future grassroots opportunities to restore anadromous fish and their habitats to Leland Lake and its tributaries.

5. Ron Frantz

Phone:	(360) 765-3971
mail address:	290333 US Highway 101, Quilcene, WA 98376
physical address:	290333 US Highway 101, Quilcene
Jefferson County parcel #'s:	802362007, 802362012

The Frantz family owns and operates a custom maple wood mill on their rural residential property and pasture, adjacent to Highway 101 at the mouth of the 17.0080 Leland tributary (Map 5). Leland tributary 17.0017*I*, entering the wetland below Lake Leland (with a recommended upgrade to fish-bearing Type 3 habitat as a result of WFC water typing efforts) is also located in livestock pasture on their property. Ron granted WFC personnel permission to conduct spawning surveys on the 17.0080 tributary, and may be encouraged to participate in a restoration of the lower tributary reaches (see Leland Creek #3d, Part II).

6. Charles and Donna Greenert

Phone:	(360) 765-4020
mail address:	PO Box 337, Quilcene, WA 98376
physical address:	302 Ripley Creek Road, Quilcene
Jefferson County parcel #'s:	802353004

The Greenerts own property and livestock (horse) pasture spanning Ripley Creek upstream from the Lords Lake Loop culvert crossing (in Reach 1, sub-reach 1A). During the course of WFC salmon spawning surveys, this reach was determined to be a significant stronghold for wild coho. The Greenerts have been pro-active in fencing livestock away from the riparian corridor, and maintaining natural vegetation throughout the reach. They are excited about having in salmon in "their" stream reach, and in project ideas that would enhance the already-excellent spawning habitat here, including planting of streamside conifer trees.

7. Charlotte Reeves

Phone:	(360) 765-3920
mail address:	PO Box 399, Quilcene, WA 98376
physical address:	293513 US Highway 101, Quilcene
Jefferson County parcel #'s:	702114019,

Charlotte owns residential property located on the left-bank of Leland Creek at the Little Quilcene River confluence. Both fall chum and coho salmon were observed spawning in numbers adjacent to her landscaped yard, which extends to the river's edge. *If approached in a manner sensitive to her needs and wishes*, she may be open to the planting of riparian trees and shrubs to provide pool cover.

8. Robert and Penn Rosen

Phone:	(360) 765-0505
mail address:	301 Munn Road, Quilcene, WA 98376
physical address:	301 Munn Road, Lake Leland, Quilcene
Jefferson County parcel #'s:	802261012

Bob and Penn live at the mouth of a Lake Leland tributary at the eastern end of Munn Road. Landscaping with non-native vegetation and bank armoring is prevalent along the channel through their property, as well as neighboring residences. They were somewhat receptive to the possibility of salmon returning to Lake Leland, and this stream (17.0017*N*, Map 4) is the largest fish-bearing (Type 3) tributary along the west shore of the lake, with excellent spawning, rearing, and summer refuge potential for anadromous and resident fish upstream (refer to Part II: L-6e for details on streams entering Lake Leland).

9. Bonnie Selvar

Phone:	(360) 765-3877
mail address:	PO Box 207, Quilcene, WA 98376
physical address:	292986 US Highway 101, Quilcene
Jefferson County parcel #'s:	702111017

Bonnie is a property owner on the left bank of the Little Quilcene river directly opposite the entrance to the Wildwood Diversion Canal (Reach 3, sub-reach 3A). She is keenly interested in providing safe habitat for salmon that spawn along her river frontage. As with many river-side rural residences along the Little Quilcene, landscaping on her property extends to the river's edge. She may be amenable to potential restoration activities that would protect her property from flooding while simultaneously diversifying the adjacent spawning habitat (Part II: LQ-3b).

10. Pat Yarr

Phone:	(360) 765-4353 / (360) 301-1381 mobile
mail address:	
physical address:	780 Boulton Road, Quilcene
Jefferson County parcel #'s:	802141002, 802141005, 802144003

Pat is the operations manager for Boulton Farms, located at the intersection of Boulton Road and Highway 101. He is a relation to the owner, John Boulton of 3590 East Quilcene Road, Quilcene. Two western headwater tributaries of the upper Leland Valley wetland complex transit the property (17.0017Q-e and Q-f, Map 4, Appendix 1). Pat has previously assisted WDFW with in-stream nest-box propagation of salmon eggs/fry in upper Andrews Creek for the Snow Creek Wild Coho Recovery Program, and may be amenable to barrier culvert replacement (PC #47 and PC #48, Appendix 2), riparian protection and channel restoration activities along these ditched, fish-bearing (Type 3) channels flowing through Boulton Farm property that discharge to the head of Lake Leland.

Appendix 4. Prioritized Restoration Matrix

Reach	Tier	Timeline	Actions	Rational	Potential Funding Sources	Potential Partners
LQ - 1	I	Fall 2008-Spring 2009	Riparian planting in the HCSEG restoration site	PEI could organize local volunteers for planting projects in the reach, or write grants for planting materials	Volunteers, HCSEG funds, Fish America Foundation	HCSEG, Jefferson Conservation District, HCCC
LQ – 2	III	Summer 2009-2010	Investigate bank erosion site	Restore channel complexity, restore riparian cover	Community Salmon Fund, Fish America Foundation	Jefferson Conservation District, local landowners
LQ - 3	I	Summer 2009	Screen Wildwood irrigation diversion	Provide increased juvenile coho survival	Community Salmon Fund, SRFB, Fish America Foundation	Jefferson Conservation District, local landowners
LQ - 4	I	Summer 2009	Reconfigure diversion dam for irrigation canal. Restore complexity to plane-bed channel downstream of diversion. Eliminate recurring use of heavy equipment in the wetted stream	Annual maintenance of cobble push up dam at the site has simplified habitats downstream	Community Salmon Fund, SRFB, NOAA Coastal Fund	Jefferson Conservation District, local landowners, Wild Fish Conservancy
LQ - 5	I	Summer 2009-2010	Engineered log jam feasibility assessment. Planting project to assist landowners	Restore channel complexity, restore riparian cover	Community Salmon Fund, SRFB, Fish America Foundation	Jefferson Conservation District, local landowners, Wild Fish Conservancy
LQ – 6	III	Fall 2008-2009	Information signage, land owner outreach	Reduce the incidence of substrate manipulation by stream users	Community Salmon Fund, Fish America Foundation	Local landowners
LQ - 7	I	Summer 2009-2010	Replace culvert at Big Leaf Lane	Potentially blocking fish passage to more than 1 mile of anadromous fish habitat	Community Salmon Fund, Fish America Foundation, Family Forest Fish Passage Program	Jefferson Conservation District, local landowners, Wild Fish Conservancy

L - 1	II	Summer 2009-2010	Replace culvert at West Leland Valley Road	Blocking fish passage to 950 feet of anadromous fish habitat	Community Salmon Fund, Fish America Foundation, Family Forest Fish Passage Program, Jefferson County capital funds	Jefferson County, Wild Fish Conservancy
L -2	II	Fall 2008-2011	Riparian restoration and habitat re-connection	Suite of actions in Leland Creek headwaters would restore habitat functions in the basin	Community Salmon Fund, Fish America Foundation, Family Forest Fish Passage Program	Jefferson Conservation District, local landowners
L - 3	I	Summer 2009-2010	Riparian restoration through the removal of non-native vegetation and conifer plantings	Water quality issues (temperature) have compromised fish habitat value in Leland Creek	Community Salmon Fund, Fish America Foundation	Jefferson Conservation District, local landowners
L - 4	III	2009-2012	Channel reconnection, livestock fencing, riparian restoration	Channel disconnect is blocking fish passage to 1400 ft of potential fish habitat	Community Salmon Fund, Fish America Foundation, Family Forest Fish Passage Program	Jefferson Conservation District, local landowners
L - 5	III	2009-2010	Riparian restoration, channel naturalization	Restore habitat complexity	Community Salmon Fund, Fish America Foundation	Jefferson Conservation District, local landowners
L - 6	II	2009-2012	Suite of habitat restoration in Lake Leland and Tributaries	Suite of actions in Leland Lake and its headwaters would restore habitat functions in the basin	Community Salmon Fund, Fish America Foundation	Jefferson Conservation District, WDFW, local landowners
L - 7	IV	N/A	Culvert replacement	Restore juvenile fish passage at low flow	Jefferson County capital funs, WSDOT	Jefferson County, WSDOT
R - 1	IV	N/A	Move large wood (logging slash) impediment to fish passage	Enhance adult salmon access into Ripley Creek	N/A	N/A
R - 2	I	2009-2010	Native plantings, large wood supplementation	Increase pool habitat, restore mature riparian forest that contributes to channel complexity	Community Salmon Fund	Jefferson Conservation District, Wild Fish Conservancy

R -3	II	2009-2010	Riparian restoration through the removal of non-native vegetation and conifer plantings	Increase pool habitat, restore mature riparian forest that contributes to channel complexity	Community Salmon Fund, Fish America Foundation	Jefferson Conservation District, local landowners
R - 4	III	Fall 2008-2010	Landowner outreach	Raise awareness of beaver ponds as an integral component of the landscape	Community Salmon Fund	Local landowners
R - 5	III	2009-2012	Culvert replacement	Culvert impedes fish passage for resident trout	FFFPP	Jefferson Conservation District, local landowners
H - 1	III	2009-2012	Riparian Restoration	Increase pool habitat, restore mature riparian forest that contributes to channel complexity	Fish America Foundation	Jefferson Conservation District, local landowners
H - 2	III		Landowner outreach	Raise awareness of beaver ponds as an integral component of the landscape	Fish America Foundation	Local landowners

Appendix 5: Glossary of acronyms for the Little Quilcene – Leland Watershed Rapid Habitat Assessment and Prioritizated Restoration Framework

CFS - cubic feet per second

Measure of flow rate given by the volume of water moving past a given point in a second of time

CREP – Conservation Reserved Enhancement Program

A voluntary land retirement incentive program that helps agricultural producers to protect their environmentally sensitive lands. CREP is administered by the USDA Farm Service Agency, but usually directed by county government. In Jefferson County, WA, CREP is managed through the Land and Water Conservation Department.

CC / SC / PC – County Culvert, State Culvert, Private Culvert

See table of barrier culverts identified by WFC survey crews for details (Appendix 2).

DBH – diameter at breast height

The foresters' measurement for tree trunk and log diameter standardized at 4.5 ft. above the base of the tree on the uphill side.

ELJ – engineered log jam

Collections of woody debris that re-direct stream flow and provide bank stability. ELJs are patterned after stable, naturally-occurring log jams likely to be found in a given watershed.

ESA – Endangered Species Act of 1973 (United States)

ESU – Evolutionarily Significant Unit

A population of organisms (i.e. species) that is considered distinct from similar populations for the purposes of conservation. The ESU is considered under the Endangered Species Act to be "substantially reproductively isolated from other conspecific populations", and to "represent an important component in the evolutionary legacy of the species".

GIS – Geographic Information System

A system of electronic/computer hardware and software used for storage, retrieval, mapping and analysis of geographic data including the operating personnel and collected spatial data (see GPS).

GPS – Global Positioning System

A satellite-based navigation system that allows users to determine their exact geographic position via a hand-held data-reception unit.

GMA – Growth Management Act (chapter 36.70A RCW)

Adopted by the Washington State Legislature in 1991 (with subsequent amendments), the GMA is a response to the finding by the state that uncoordinated and unplanned growth and development posed a threat to the environment, sustainability, and quality of life in Washington. The GMA (unique among the states) requires state and local governments to manage growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans and implementing them through capital investments and regulations.

HCCC – Hood Canal Coordinating Council

A watershed-based council of governments established in 1985 in response to community concerns about water quality problems and natural resource issues in the Hood Canal watershed.

The council consists of Jefferson, Kitsap and Mason Counties, Port Gamble S'Klallam and Skokomish Native American tribes, and various state and federal regulatory agencies (http://hccc.wa.gov).

HCSEG – Hood Canal Salmon Enhancement Group
One of 14 regional fisheries enhancement groups (RFEG) in the state of Washington, designated by the state in 1991 to include watershed citizens in local salmon enhancement efforts (www.hcseg.org).

JCCD – Jefferson County Conservation District

JLT – Jefferson Land Trust
A private, non-profit, grass-roots organization helping to preserved open space, working lands, and conserve habitat in Jefferson Count, Washington (www.saveland.org).

JST – Jamestown S'Klallam Tribe

LiDAR – Light Detection and Ranging
An optical remote sensing technology the measures the properties of scattered light to collect topographic data.

LWD – Large Woody Debris
A log with a minimum mid-point diameter of 10 cm, and a minimum length of 2 meters that protrudes into the bankfull width of the channel.

NWIFC – Northwest Indian Fisheries Commission
An organization of Point No Point Treaty member tribes that provides services and support for tribal fisheries and natural resource management (www.nwifc.wa.gov).

NMFS – National Marine Fisheries Service, a division of NOAA

NOAA - National Oceanic and Atmospheric Administration

NRCS – National Resource Conservation Service, a division of USDA

OHV – off-highway vehicle

ONF – Olympic National Forest

ONP – Olympic National Park

ORM – Olympic Resources Management
The timber and forestry investment subsidiary of Pope Resources LLP (www.orm.com).

PEI – Pacific Ecological Institute
A non-profit corporation with a mission to provide innovative solutions that enhance the efficient use of resources, and thereby foster a sustainable future (www.peiseattle.com).

PGST – Port Gamble S'Klallam Tribe

PNPTC – Point No Point Treaty Council

RM – river mile

RCW – Revised Code of Washington

SCSCI – Summer Chum Conservation Initiative
A WDFW implementation plan to recover summer chum salmon in the Hood Canal and Strait of Juan de Fuca region (http://wdfw.wa.gov/fish/chum/chum.htm) .

SSHEAR – Salmonid Screening, Habitat Assessment, and Restoration
A division of WDFW that provides guidance and oversight for locating, assessing, and prioritizing fish passage problems (culverts, dams, and fishways).

SSHIAP – Salmon and Steelhead Habitat Inventory and Analysis Program
A spatial information database that is co-managed by WDFW and NWIFC that characterizes salmonid stocks and habitat conditions in the state of Washington (http://wdfw.wa.gov/hab/sshiap).

TAG – Technical Advisory Group
A group of technical experts from federal, state, local, and tribal governments who convene with the purpose of identifying the habitat limiting factors within a given WRIA.

TFW – Timber, Fish and Wildlife
A 1987 non-binding agreement between timber industry stakeholders (tribes, loggers, environmentalists, government agencies, research staff etc.) to avoid lengthy litigation regarding timber harvest practices. Signatory parties agreed in principal to the use of best available science to protect watershed health and ecosystem functionality, while allowing timber harvest to proceed.

USDA – United States Department of Agriculture

USDOI – United States Department of the Interior

USFS – United States Forest Service, a division of the USDA

USFWS – United States Fish and Wildlife Service, a division of USDOI

WDFW – Washington State Department of Fish and Wildlife

WDNR – Washington State Department of Natural Resources

WDOE – Washington State Department of Ecology

WFC – Wild Fish Conservancy Northwest
A non-profit organization dedicated to the recovery and conservation of the region’s wild fish and aquatic ecosystems (www.wildfishconservancy.org).

WSDOT – Washington State Department of Transportation

WRIA – Water Resources Inventory Area

Watershed planning at the state and local level is referenced and organized around the 62 major watershed basin units recognized by Washington Department of Ecology (WDOE).

WAC – Washington Administrative Code

Codified collection of Washington State regulations and statutes issued by the executive branch.

WHIP – Wildlife Habitat Incentives Program

A voluntary cost-share program for private landowners who want to develop and improve wildlife and aquatic habitat. Funding and technical assistance for WHIP are provided by USDA NRCS.

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