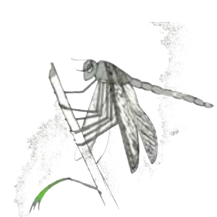
Tillamook River Coho Restoration Strategy;
Habitat Assessment and Limiting Factors Analysis

Demeter Design



Tillamook River Coho Restoration Strategy;
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Data Analysis and Reporting Conducted by Demeter Design Inc.
Habitat Data Prepared by Demeter Design Inc.
Habitat Data Collected by Demeter Design Inc. and Bio-Surveys LLC.
Production Modeling Prepared by Bio-Surveys LLC.
Landslide Potential Analysis Conducted by Oregon Department of Forestry

Tables & Figures Cont.

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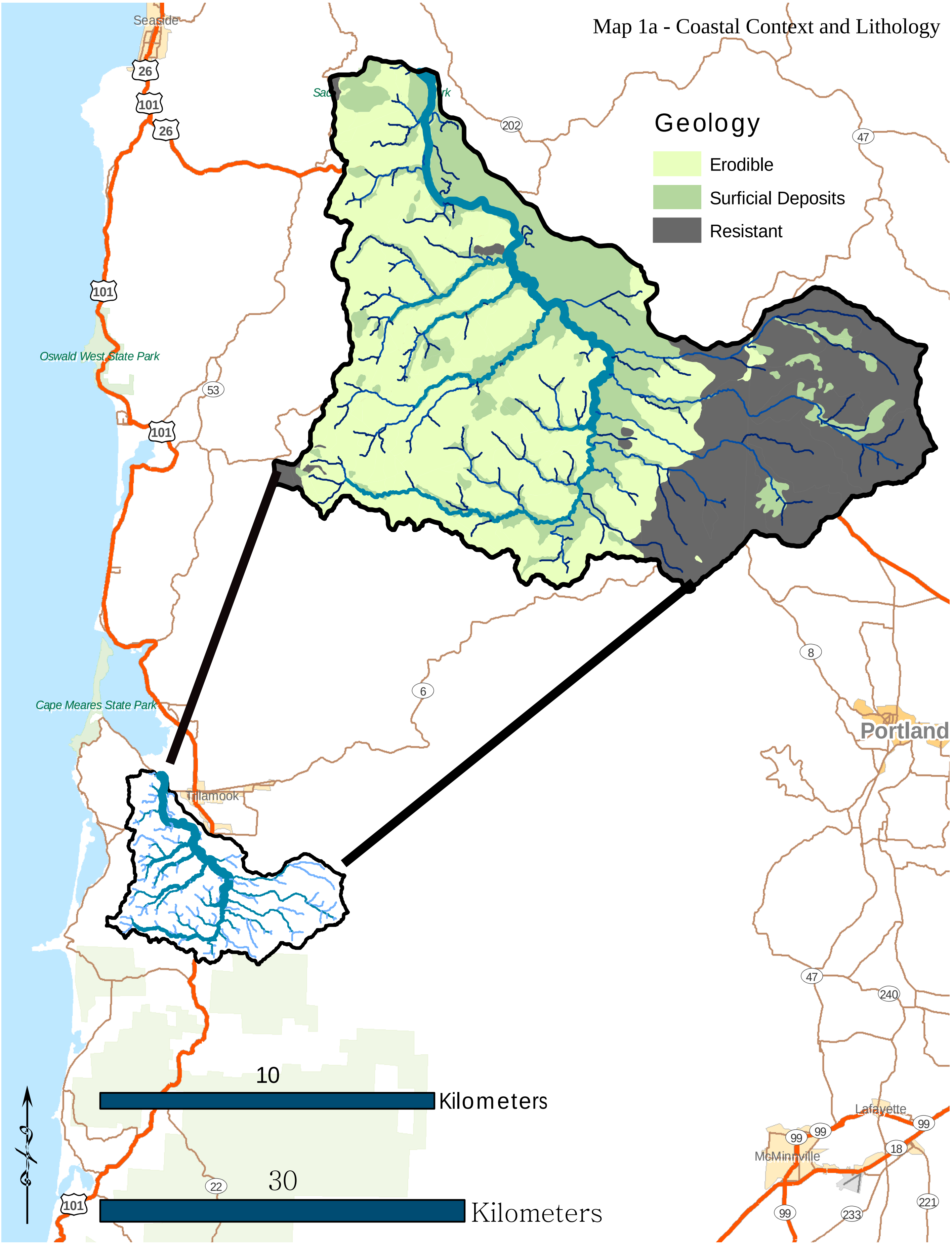
Maps

Maps Cont.

Appendices

Section 1 - Introduction



Tillamook River Limiting Factors Analysis Summary

In 2007, the Oregon Department of Fish and Wildlife (ODFW) identified the Tillamook River watershed as a priority region for data collection and potential restoration. Further, the Oregon Watershed Enhancement Board (OWEB) sponsored a project in the Tillamook Bay Watershed (TBW) during which basin-wide data was synthesized at the 7th field level and watersheds were identified as priorities for outreach, restoration, or conservation. The Tillamook River watershed consistently arose as a top priority for both outreach and restoration as a result of this Data Synthesis. The Tillamook Bay Watershed Council (TBWC) needed a detailed restoration plan as an outreach tool for private non-industrial landowners living in the 7th fields identified as priorities. The TBWC restoration committee confirmed the need for a Limiting Factors Analysis (LFA) similar to those conducted in Oregon's mid-coast region during the winter of 2007. To accomplish this and the other afformentioned needs, data collection for the LFA began in the spring of 2008 during which spawning and rearing habitat for multiple salmonid species was identified and ranked using the methods outlined in the materials and methods section of this document. Species of interest included Coho, Chum, Steelhead, and to a lesser extent, Lamprey.

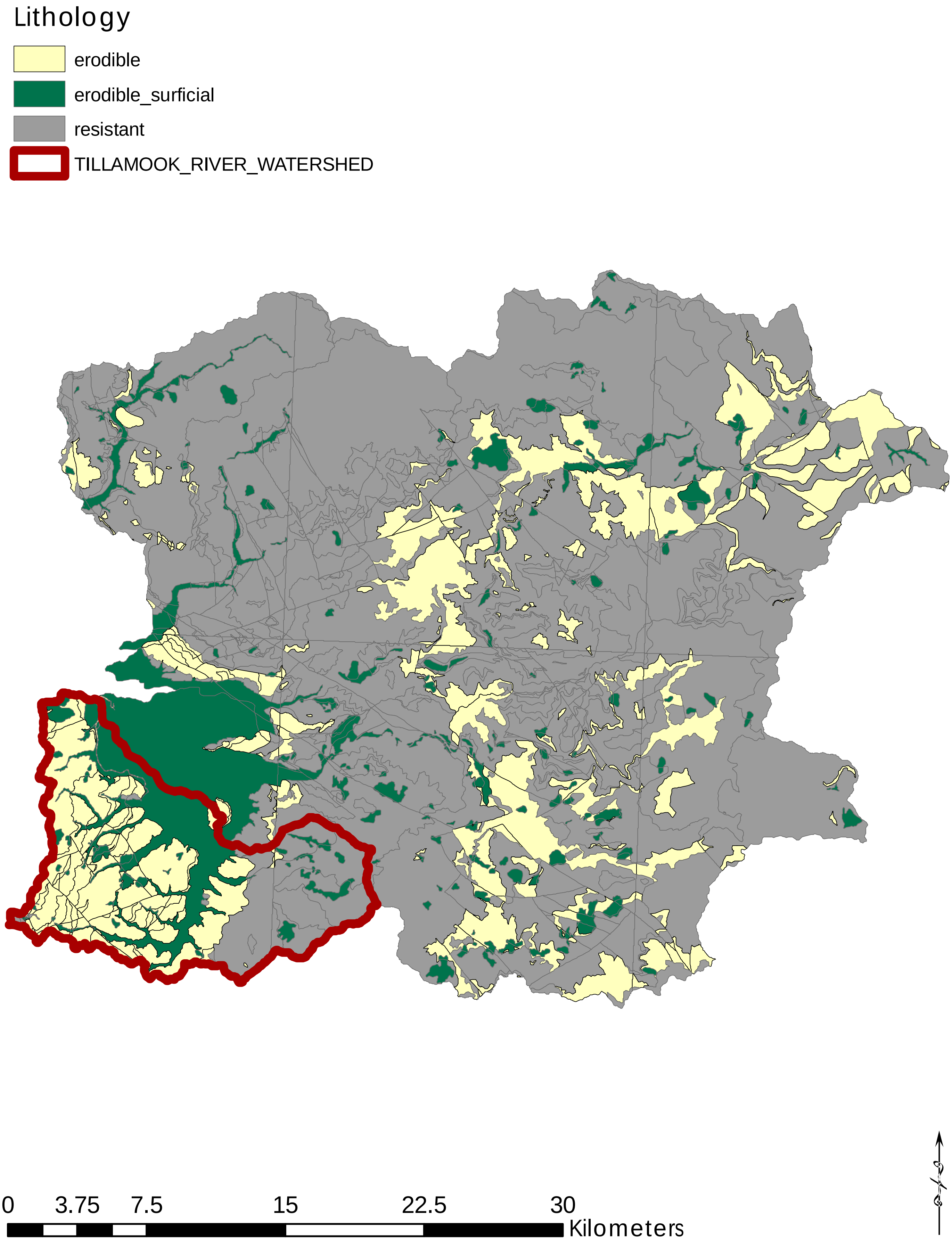
The goal of the LFA was to identify issues that currently limit the production and survival of Coho, Chum, and Steelhead salmon, and to a lesser extent Lamprey, within the basin and to develop actions aimed at returning system function to pre-European conditions to the extent possible. This document provides watershed restoration actions aimed at enhancing Coho production and survival within the Tillamook River watershed. The Tillamook River (1710020308) is the southernmost of the five rivers which feed the Tillamook Bay Watershed. Covering 38,930 acres, the Tillamook River watershed includes two 6th field watersheds and supports forest lands, multiple dairies, and many private homesteads (77%, 15%, and 4% of the total area respectively). The remaining area consists of parks, public facilities, and industry. The majority (87%) of the forestry lands within the Tillamook River watershed are owned and managed by industrial private timber corporations. A smaller area (13%) is managed by the Oregon Department of Forestry (ODF), the United States Forest Service (USFS), and the Bureau of Land Management (BLM). Large portions of the lower watershed have been diked to increase the area open for dairy production. This has resulted in significant deviations from historical conditions. The lithology of the Tillamook River is unique among the TBW 5th fields (refer to *Map 1b - TBW Context and Lithology* on page 9 and *Map 1c - Tillamook River Geology* on page 10). The western extent of the watershed is underlain by a sandstone, siltstone, and mudstone geology which results in low gradient streams with broad floodplains. Most streams west of highway 101 would historically have extensive wetland habitat and many still do although the mainstem in this area is often entrenched and disconnected from its floodplain. The sandstone and siltstone geology also result in tannic flows during summer months giving the appearance of turbidity. Gravels are much less abundant in the western tributaries than in the eastern tributaries which are dominated by a volcanic geology. The eastern extent of the Tillamook River watershed is characterized by higher gradient streams, a larger substrate size, narrower floodplains, and abundant gravels. The lower watershed is dominated by surficial alluvial deposits resulting in low gradient streams and large floodplains. Douglas-fir and western hemlock are the predominant vegetation throughout higher elevations. Open pastures dominate the lower elevations. Red alder and big-leaf (Oregon) maple are common riparian trees throughout the watershed. Large portions of the lower watershed were historically dominated by Sitka spruce wetlands, but few small stands remain.

Materials & Methods

Please refer to “Midcoast Limiting Factors Analysis, A Method for Assessing 6th Field Sub-basins for Restoration” for detailed information on the protocol used in this assessment. Additional analysis was included to address the following issues: the Tillamook River is significantly larger than the scale for which the protocol was originally developed (a 5th field as opposed to a 6th field); land-use and ownership within the watershed is mixed (dairy, forestry, public, rural residential, and industry); the underlying geomorphology is very complex (multiple erodible lithologies mixed with volcanics); finally, the data, analysis, and conclusions are reported in a manner intended to satisfy the multiple stakeholders involved in the project. For these reasons the following additions were made to the report: the format of the report was organized by creek as opposed to topic to allow the TBWC and other partners working within the basin to more easily conduct landowner outreach using the Coffee Klatch process and to facilitate project development; a synoptic description of each creek was provided in addition to the data tables to make the document accessible to non-technical readers; photo-documentation and GIS analyses were used as part of a weight of evidence approach and are included within the text; and Chum and Lamprey were historically abundant within the watershed and issues associated with their spawning, rearing, and migration were also addressed to a limited degree.

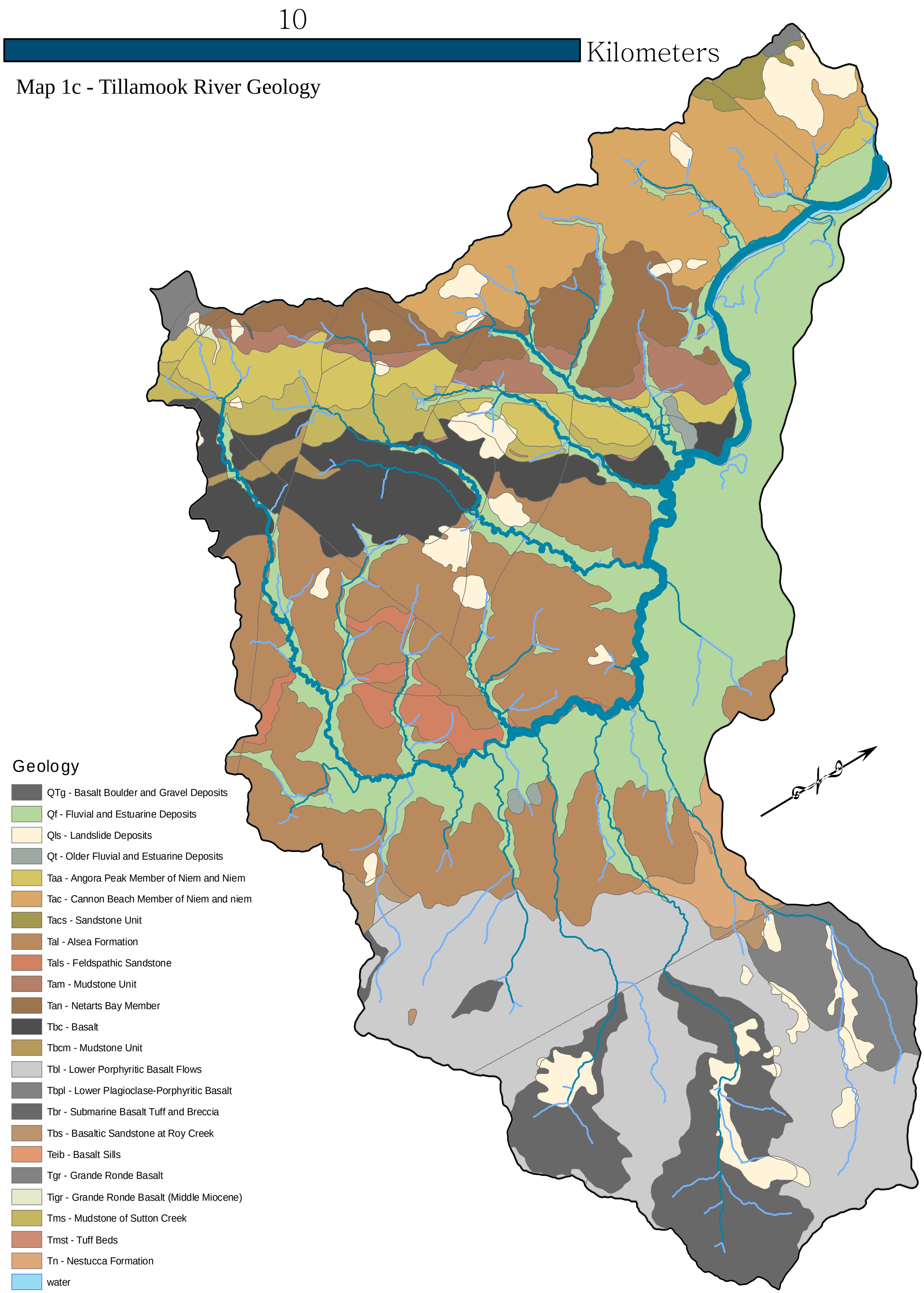
The following questions guided this analysis:

- What are the physical characteristics of the watershed?
    - How have historical land-use practices altered these characteristics?
    - How do current land-use practices impact the watershed?
- What is the current level of system function?
    - How do and what species of fish currently use the system?
        - What is the extent and timing of fish population losses?
        - What factors are limiting Coho production and survival?
            - At a creek scale.
            - At a watershed scale.
            - In neighboring 5th fields.
    - Are temperature problems apparent?
        - Where are temperature refugia located?
        - Where and how do temperature problems originate?
    - Are fish passage barriers present?
    - Is fine sediment impairing spawning, rearing, or migration?
    - Where are the spawning areas located?
    - Where are the summer and winter rearing sites located?
- Will system function benefit from habitat restoration?
    - What instream projects would improve habitat function for all life stages?
    - What hill-slope projects support instream work?



Map 1b - TBW Context and Lithology

Map 1c - Tillamook River Geology



Habitat Quality & Function

The restorative actions suggested in this document are based on qualitative and quantitative data collected during this and past habitat studies. Where the analysis calls for professional judgement of impairment, a weight of evidence approach utilizing all available data is used. For instance, specific limiting factors are identified by comparing habitat data collected with the Aquatic Inventories (AQI) and Environmental Monitoring Assessment Program (EMAP) protocols to reference and benchmark standards in addition to the LFA protocol. Photo-documentation and maps are used as supporting evidence. This section is organized by stream (or stream segment as with the mainstem) and further segmented into 6 sections: overview, spawning habitat, summer rearing habitat, winter rearing habitat, anchor or potential anchor sites, and potential restoration projects.

Stream Summaries include

- Channel Morphology
- Riparian Condition
- Spawning Resources
- Summer Rearing Habitat
- Winter Rearing Habitat
- Large Wood Recruitment Potential

Analyses presented in this document include the following:

- Spawning gravel abundance and quality
- Channel Habitat Type (CHT) Classification based on the OWEB Watershed Assesment Manual
- Coastal Landscape and Analysis Modeling Study (CLAMS) Intrinsic Potential (IP) modeling for salmonids
- Key metrics derived from AQI data available for the basin
- Habitat Limiting Factors Modeling
- GIS Analysis of riparian condition using remote sensing data provided by CLAMS
- GIS data summaries organized by 7th Field HUC

Water Quality

Continuous temperature data was converted to 7 day average maximums and peak values using analytical software provided by the Oregon Department of Environmental Quality (ODEQ). Analyzed bacterial data was provided by the ODEQ and was based on multiple years of bacterial grab samples throughout the Tillamook River watershed. Finally, it is hypothesized that the interactions between high summer temperatures and elevated bacteria levels result in increased incidences of parasites and disease which can lead to summer mortality. Please refer to *Figure 1a - Tillamook River Bacteria* on page 12. Evaluation of sedimentation is currently underway by Demeter Design under contract to the Tillamook Estuaries Partnership (TEP); completion of the report is expected in 2009.

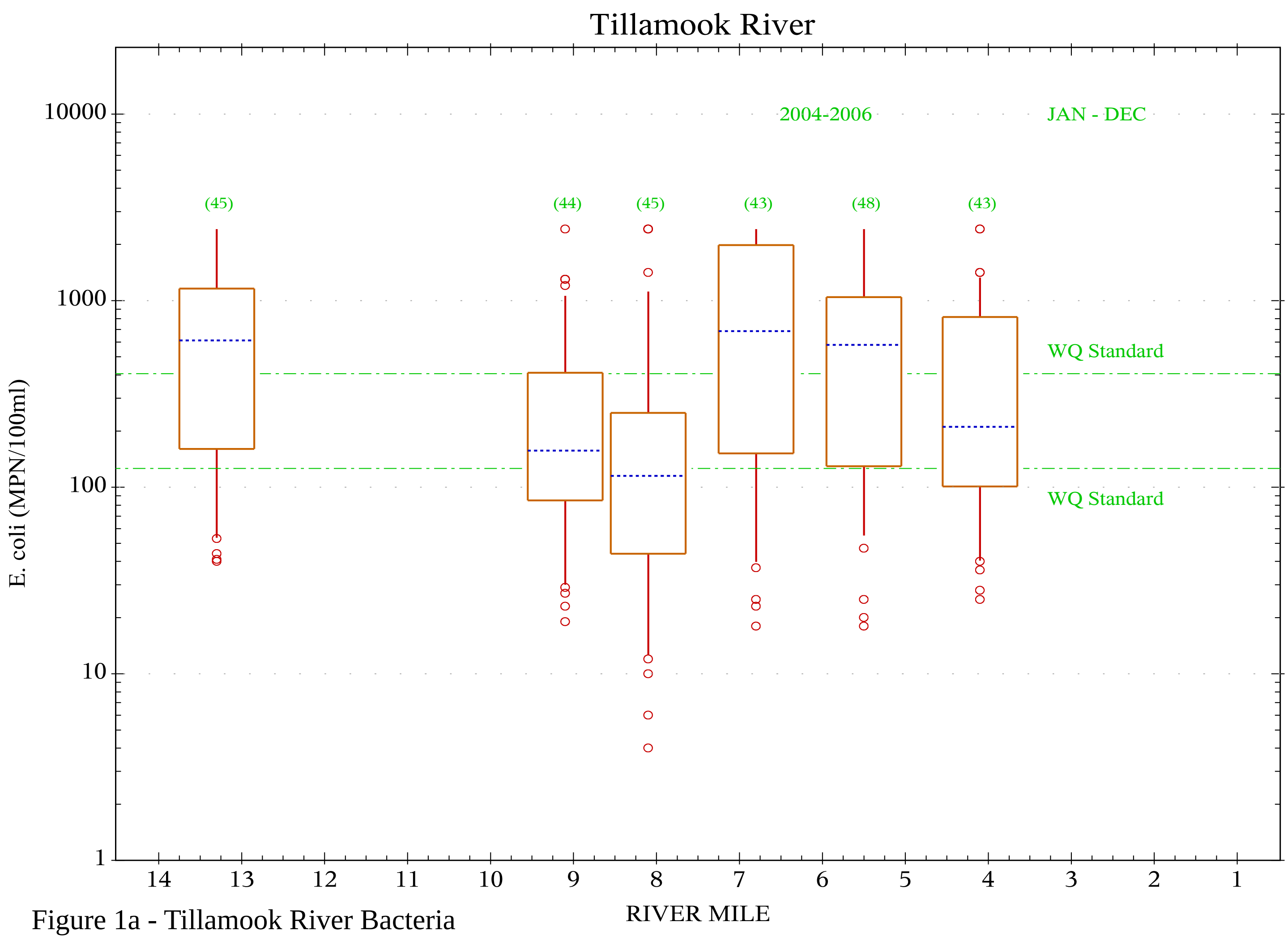


Figure 1a - Tillamook River Bacteria

Anchor Habitat

For the purpose of this document anchor sites are defined as those sites providing all the components necessary for salmonid production and survival. The term anchor is generally used to describe streams (assumed reference condition) that, were all other production within the relative area to fall, could provide a population which would reseed neighboring streams. All reaches providing significant (judgment based) spawning, summer rearing, and winter rearing habitat are classed as anchors. They are further subdivided into high, moderate, or low function anchors. Anchor length is based on GIS analysis of the BLM hydro layer. The percent length is equal to the length divided by the total Coho distribution of the watershed (~89 km) which is based on the RBA data.

High function indicates that habitat quality is similar to that of minimally disturbed (reference condition) sites. When quantifiable data (such as AQI or EMAP data) was not available then qualitative judgements were made using the same parameters generally used in assessing habitat quality (i.e. floodplain connection, riparian condition, or wood volumes).

Moderate function anchors are those sites still providing all the components necessary for all life-stages but one parameter (such as gravel sorting or cover) is not meeting habitat benchmarks. Low function anchors are sites where fish spawning and rearing occurs but is limited by significant habitat alterations (i.e. stream cleaning or logging to the channel) occurred and are perpetuated by current land-use management practices. Potential anchor sites are those which would naturally contain all the habitat parameters to support spawning, summer and winter rearing for Coho, and are one restoration project away from providing these parameters. It is possible that a high function potential anchor site is a higher priority for restoration than a low function anchor site. *Map 2b - Anchors, Branch Habitat, CCA* on page 26 displays the location and extent of each anchor and potential site. Additionally habitat units within each anchor or potential anchor are identified and reported in tables presented in the anchor section of each stream summary.

Critical Contributing Areas & Secondary Branch Habitat

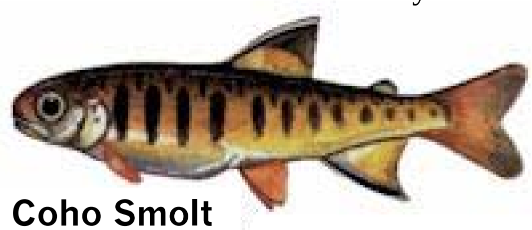
Critical contributing areas (CCA) are defined for the purposes of this assessment as major tributaries which contribute significant habitat resources to the major fish bearing stream reaches. They are illustrated along with anchor sites and branch habitat on page 26 in *Map 2b - Anchors, Branch Habitat, CCA.* Secondary branch habitat is defined for the purposes of this assessment as major tributaries which provide additional rearing and spawning habitat to the major stream channels described above.

Fish Utilization

Five species of Pacific salmon are native to the Tillamook River; Chum, Coho, fall Chinook, winter Steelhead, and Cutthroat trout. The Tillamook Bay Watershed has historically supported abundant salmon and shellfish fisheries resources. Historically, extensive freshwater wetland and slackwater habitat enhanced the survival of salmon by providing abundant overwinter habitats. Prior to stream cleaning activities, the Tillamook lowlands contained a significant amount of large wood and lowland forests. By 1939, much of this wood had been removed and the lowland forests fragmented and converted to grazing land. Within the tidal reaches of the watershed, many sloughs were drained and filled. These modifications have reduced the salmon productivity of the Tillamook River watershed, and the larger TBW.

Coho Salmon

By the early 1940's wild Coho production fell to less than have of historic numbers, from an annual average of nearly 310 adults per square mile to <130.[1] During the 1930's gill net catch of coho averaged about 46,000 fish. By the late 1980's the combined harvest of naturally-produced Tillamook Bay coho was estimated to average 3,500 coho annually. Juvenile Coho abundance surveys were conducted by Bio-Surveys for 2005-2007. Juvenile Coho abundance is presented in *Table 1c - Coho Inventory*. Additionally, fish utilization by anchor was derived by overlaying GIS layers representing anchor extent and location with data layers for all three years of juvenile snorkel surveys. Snorkel surveys were used to determine the extent of Coho distribution and thus the extent of LFA surveys.



Coho Smolt

Spawning Male Coho

Stream	2005	2005 % Total	2006	2006 % Total	2007	2007 % Total
Mainstem	12650	33.3	7838	20.5	14888	18.9
Beaver	856	2.3	425	1.1	2144	2.7
Bewley	8781	23.1	8713	22.8	12563	15.9
Esther/Tomlinson	2063	5.4	1125	2.9	10594	13.4
Fagan	31	-	-	-	-	-
Fawcett	2619	6.9	3769	9.9	8775	11.1
Joe	81	-	-	-	-	-
Killam	513	1.3	2606	6.8	4944	6.3
Mills	1825	4.8	1913	5	2038	2.6
Munson	4450	11.7	3506	9.2	9419	11.9
Pleasant Valley	194	-	1431	3.8	2388	3
Simmons	3081	8.1	6463	16.9	10375	13.1
Sutton	38	-	-	-	-	-
Basin Total	37181	96.9	37788	98.9	78125	98.9
*Estimates do not include basins with less than 1% of the total						

Table 1c - Coho Inventory (20% Bias Included)

1 (Lichatowich and Nicholas 1991)

Steelhead Salmon

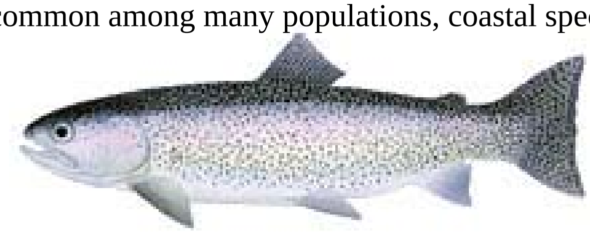
Steelhead utilization historically would occur throughout the basin as their habitat parameters are similar to Coho. It is expected that Steelhead would spawn more in the eastern resistant drainages rather than the western tributaries and would utilize higher gradients than Coho. Further, barriers which deter Chum and to a lesser extent Coho may not pose adult barriers to Steelhead. Finally, lake habitat or streams blocked to downstream migration by landslides could potentially be used by Rainbow trout, the freshwater form. It is possible that Steelhead prefer cooler waters than Coho salmon (streams not exceeding 54° F) and that this is why they seek out higher gradient streams. If this is true than it is likely that Steelhead would have rarely used the mainstem Tillamook River to a large degree for spawning.

Juvenile Steelhead

Spawning Male Steelhead

Cutthroat Trout

Cutthroat utilization historically would have occurred throughout the basin well past Coho utilization. Generally Coast Cutthroat can spawn in more variable habitat than other salmonids. Generally preferring headwater tributaries unsuitable to other species, competition for spawning resources is minimal however Cutthroat use of the Tillamook River overlaps almost all of Coho and Steelhead distribution. Juvenile predation of Coho and Steelhead is high by Cutthroat trout. Although hybridization of Rainbow and Cutthroat trout is common among many populations, coastal species do not interbreed.



Sea-run Cutthroat Trout

Resident Cutthroat Trout

Chinook Salmon

Chinook utilization historically would be limited to the mainstem. Chinook salmon prefer larger gravels and more water flow than other salmonids. Their populations have been greatly reduced throughout the west coast and their status within the Tillamook River is unclear. Spring chinook are generally restricted to spawning in mainstem channels and large tributaries of the TBW and rearing within tidal and estuarine habitats.
Fall chinook have a wider range within the basin due to higher winter flows. Fall chinook populations of the TBW have not seen as drastic a decline as other salmon.

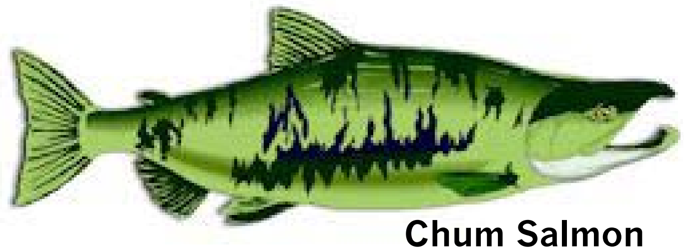
Chinook Smolt

Chinook Salmon

Chum Salmon

Chum salmon like Chinook prefer a larger substrate size than Coho, Steelhead, or Cutthroat and would likely utilize the mainstem and the lowest reaches of the eastern tributaries. Chum were the most abundant salmon species in the watershed and are currently more abundant in the TBW than elsewhere in Oregon. This abundance was likely a result of the extensive freshwater and estuarine habitat historically available. Changes to this habitat have had a severe impact on chum salmon populations in the TBW.

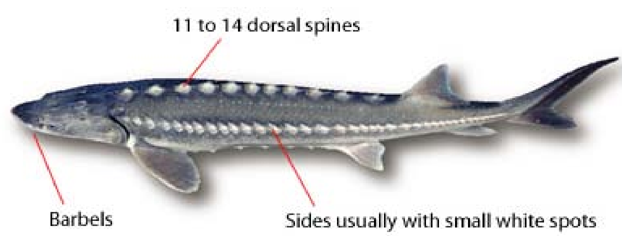
Chum Smolt



Chum Salmon

Sturgeon

Sturgeon utilization historically would be limited in the Tillamook River as they prefer a cobble substrate with swift currents for spawning. It is possible that Sturgeon spawning in the Trask would rear in the estuarine environment of the lower Tillamook. Additionally Sturgeon have longer life spans than salmonids and accumulate toxins (such as herbicides or pesticides used extensively in forestry, agriculture, and by private homeowners) which in turn limit egg production and survival.



Lamprey

Lamprey (Brook and Pacific) would historically utilize the entire Tillamook River watershed limited only by gradient. Brook lamprey can utilize a sandy substrate that salmonids cannot. Pacific lamprey generally require a larger spawning substrate. Both species prefer lower gradient streams and it is likely that their production would be highest in the mainstem Tillamook River. Additionally, like Sturgeon, lamprey are more susceptible to environmental pollutants as they too accumulate these toxins in their bodies to a greater degree than salmonids. Additionally wetland and backwater habitat is critical to the survival of their young. It is likely that there has been a significant decrease in the survival of juvenile lampreys as a result of channel downcutting, simplification, and wetland loss.

Coho Production Modeling

Potential Coho production was modeled using the ODFW Carrying Capacity Model - Version 5.0 provided by Tom Nickelson of the ODFW Research Division. The foundations of this model are the ODFW AQI inventories which quantify the abundance of summer habitat. Much of this survey data is dated and fails to represent current habitat conditions. A significant habitat change from 1997 is the decline in beaver dams. To account for this, beaver pond surface area was replaced with new data where appropriate. Channel characteristics were developed using the historical data from the upstream and downstream channel.

The modeling also relies on spawning gravel inventories conducted by Bio-Surveys & Demeter Design. Spawning gravels used by Coho were measured (in square meters) and classified into three categories of gravel quality: good, fair, or poor. Good quality gravels are those gravels that are well sorted, not embedded with sands and fines, and resting on a surface of gravels (as opposed to bedrock or sand). Fair gravels are well sorted but sands and fines are present in low quantities and are not necessarily resting on a bed of gravels. Poor gravels exhibit high sand and sediment loading and may also be expressed in shallow depositions. In addition, other anthropogenic variables are considered in the modeling exercise that may effect the habitats ability to function for salmonid rearing seasonally (i.e., water temperature, bacterial loading).

ODFW Survival Rates		Alsea Watershed Study Survival Rates	
Life stage	Survival rate	Life stage	Survival rate
Egg to smolt	0.32	Egg to smolt	0.03
Spring to smolt	0.46	June to Smolt	0.06
Summer to smolt	0.72	Fall to smolt	0.11
Winter to smolt	0.9	Winter to smolt	0.29

Table 1a - Life Stage Survival Rates

Habitat type	Fish/sq m	Habitat type	Fish/sq m
Lateral Scour Pools	1.74	Cascades	0.24
Mid-channel Scour Pools	1.74	Rapids	0.14
Dam Pools	1.84	Riffles	0.12
Alcoves	0.92	Glides	0.77
Beaver Ponds	1.84	Trench Pools	1.79
Backwaters	1.18	Plunge Pools	1.51

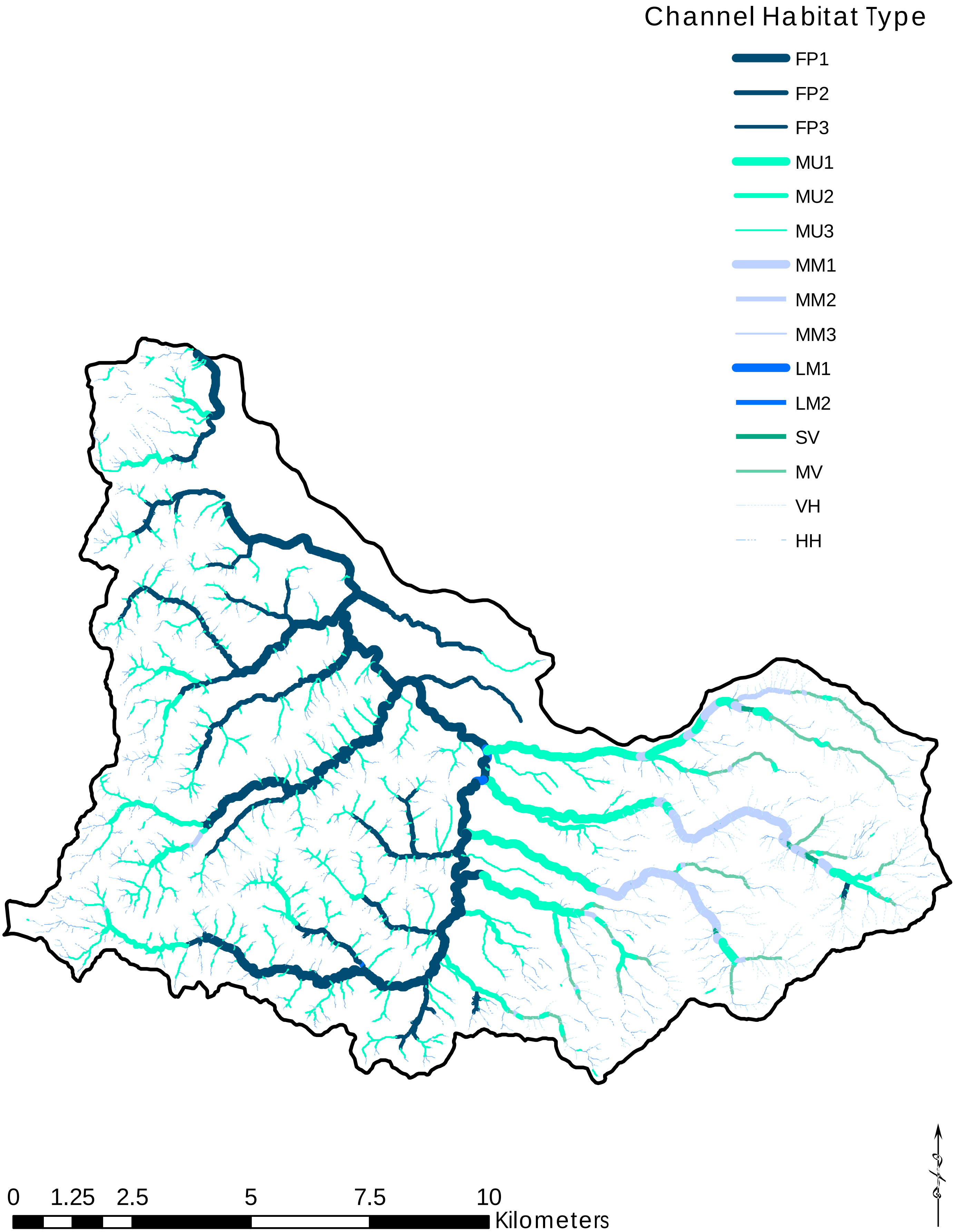
Table 1b - Coho Rearing Densities by Habitat Type (ODFW)

Channel Habitat Type Modeling

Channel habitat type (CHT) classification was completed using a modified version of the guidelines contained in the OWEB Watershed Assessment Manual (WAM). Definitions are included in the table below. All classifications were based on digital GIS data derived from the CLAMS using Mean Gradient, Valley Width Index (VWI), and Mean Annual Stream Flow as input parameters. Small modifications were made to the classification system to classify stream segments within the Tillamook River watershed with parameters outside those provided by the OWEB WAM. For example, no code was provided for unconfined, moderate gradient, low flow streams although streams of this type are abundant in the Tillamook River. Additionally, all small channel with a gradient above 6% were assumed to be confined. The resolution of the digital elevation model (DEM) used to generate the CLAMS hydro layer is such that the accuracy of the VWI for small, steep streams is unlikely to be accurate. Field truthing of these values indicates that these high gradient, headwater drainages are almost universally confined, as is implicitly implied in the WAM. CHTs can be found in *Table 1d - Channel Habitat Types.*

Code	CHT Name	Gradient	Confinement	Flow
ES	Small Estuary	<1%	Unconfined to Moderately Confined	Small to Medium
EL	Large Estuary	<1%	Unconfined to Moderately Confined	Large
FP1	Low Gradient, High Flow, Unconfined	<1%*	Unconfined	High*
FP2	Low Gradient, Medium Flow, Unconfined	<1%*	Unconfined	Medium*
FP3	Low Gradient, Low Flow, Unconfined	<1%*	Unconfined	Low*
LM1	Low Gradient, Moderately Confined, High Flow	<1%	Moderately Confined	High*
LM2	Low Gradient, Moderately Confined, Medium Flow	<1%	Moderately Confined	Medium
LM3	Low Gradient, Moderately Confined, Low Flow	<1%	Moderately Confined	Low
LC1	Low Gradient, Confined, High Flow	<1%	Confined	High*
LC2	Low Gradient, Confined, Medium Flow	<1%	Confined	Medium
LC3	Low Gradient, Confined, Low Flow	<1%	Confined	Low
MU1	Moderate Gradient, Unconfined, High Flow	1-6%	Unconfined	High*
MU2	Moderate Gradient, Unconfined, Medium Flow	1-6%	Unconfined	Medium
MU3	Moderate Gradient, Unconfined, Low Flow	1-6%	Unconfined	Low
MM1	Moderate Gradient, Moderately Confined, High Flow	1-6%	Moderately Confined	High*
MM2	Moderate Gradient, Moderately Confined, Medium Flow	1-6%	Moderately Confined	Medium
MM3	Moderate Gradient, Moderately Confined, Low Flow	1-6%	Moderately Confined	Low
MC1	Moderate Gradient, Confined, High Flow	1-6%	Confined	High*
MC2	Moderate Gradient, Confined, Medium Flow	1-6%	Confined	Medium
MC3	Moderate Gradient, Confined, Low Flow	1-6%	Confined	Low
SV	High Gradient, Narrow Valley	>6-16%	Variable*	High*
MV	High Gradient, Narrow Valley	>6-16%	Variable	Medium
HH	High Gradient Headwater, Variable Confinement	>6-16%	Variable	Low
MH	Moderate Gradient Headwater, Variable Confinement	1-6%	Variable*	Low
VH	Very High Gradient Headwater, Variable Confinement	>16%	Variable*	Low
AF	Alluvial Fan	1-5%	Variable	Small to Medium
BC	Bedrock Canyon	1->20%	Confined	Variable

Table 1d - Channel Habitat Type Classification System *Additions



Map 1d - CHT Modeling

Aquatic Inventories Data

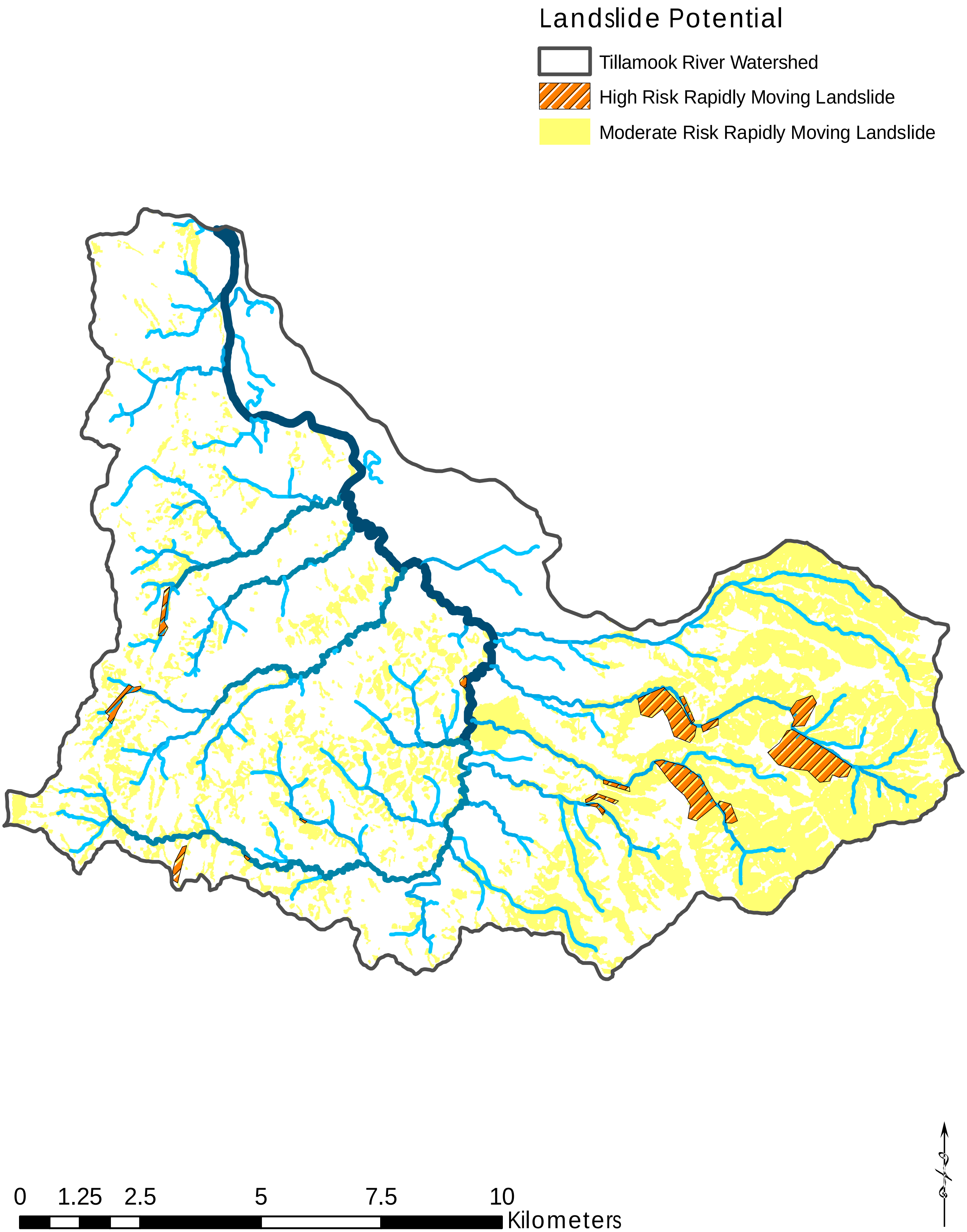
AQI data was used to compare current habitat conditions to expected minimally disturbed conditions. One way to make this comparison is to use reference data collected from other watersheds within the same ecoregion. There are several concerns associated with this approach: first, very few places have not been influenced by human presence; secondly those undisturbed areas that have are difficult to access and therefore the data is often limited; a third drawback is that reference data may be collected outside of Coho distribution and it is often the case that larger streams are more impacted by human activities than smaller streams; finally many disturbances cross watershed boundaries so that even when a watershed has not been logged, for example, it may have been burned from a fire which started many miles away. Even more to the point many species of concern use a broad range of habitat and are not limited to a single watershed therefore the impacts they face are dependent on the function of many watersheds and habitat types. An alternative approach is to use habitat benchmarks rather than reference. This is the primary comparison made in this document. Benchmarks were determined by ODFW habitat biologists using available data and professional judgement. These benchmarks attempt to characterize averages but more importantly low breaks for metrics such as the expected number of key pieces for large woody debris (LWD) or the expected shade values for a system. *Table 1e - AQI Benchmark Metric Data* below summarizes the core metrics and their benchmarks used in the analysis. For definitions of the habitat metrics listed in the table below please refer to, "AI - A Guide to Interpreting Stream Survey Reports" available through ODFW.

Parameter	Definition	Low	High
%Pools	Channel area (%) represented by pool habitat	< 19	> 45
Deep pools/km	Pools > 1m deep/km of main channel	0	> 3
% Slackwater pools	Area (%) beaver ponds, backwaters, alcoves, or isolated pools	0	> 7
% Secondary channels	Area (%) secondary channels	< 0.8	> 5.3
Pieces LWD/100m	# of LWD pieces > 0.15m diameter X 3m length/100m	< 8	> 21
Volume LWD/100m	Cubic meters of LWD > 0.15m diameter X 3m length/100m	< 17	> 58
Key pieces LWD/100m	# LWD pieces > 60 cm diameter X > 12 meters long/100m	< 0.5	> 3
%SAFN in riffles	Surface area (%) composed of < 2mm diameter particles	< 8	> 22
%Gravels in riffles	Surface area (%) composed of 2-64mm diameter particles	< 26	> 54
%Bedrock	Channel bottom surface area (%) composed of solid bedrock	< 1	> 11
# conifers > 50 cm dbh	Conifers >50 cm dbh within 30m both sides of stream/305m	< 22	> 153
# conifers > 90 cm dbh	Conifer > 90 cm dbh within 30m both sides of stream/305m	0	> 79
%Shade	% of 180 degree sky shaded	< 76	> 91

Table 1e - AQI Benchmark Metric Data

Landslide Potential

Unstable slopes have the potential to deliver critical substrate and wood resources to the stream channel. Large quantities of woody debris are critical to the development of complex aquatic habitat and interactive floodplains. A GIS evaluation of landslide potential was conducted by an ODF Geo-Technical expert. 1:24,000 USGS topographic quadrangles, extent of fish presence, and professional judgment were used to complete this assessment. Hillslopes are ranked (High - striped, Medium - yellow, and Low - white) according to the amount of steep slopes and the likelihood of a landslide reaching a fish stream, refer to *Map 1e - Landslide Potential* on page 21.

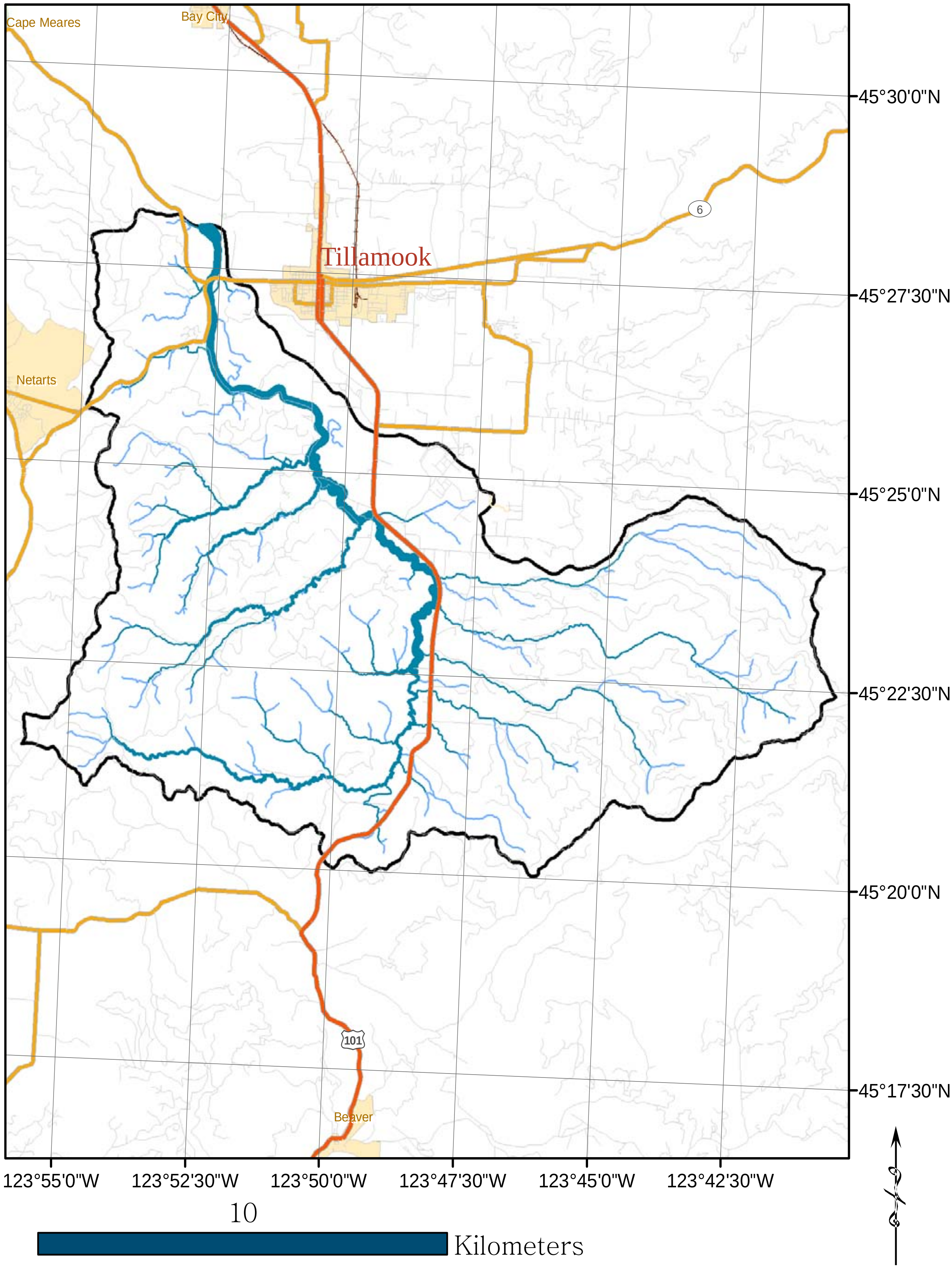


Map 1e - Landslide Potential

Resources Used in Developing the Coho Restoration Plan

- ODFW AQI surveys conducted in the Tillamook River watershed between 1990 and 2006
- RBA summer snorkel surveys of the Tillamook River Watershed conducted in 2005, 2006, and 2007
- Coho habitat assessment model developed by ODFW Research Division. This model evaluates the quantity of spawning gravel, egg deposition rates, and amount of aquatic habitat by season in order to identify which seasonal habitat and Coho life stage limit the production of smolts from a stream section (referred to as the smolt production bottleneck).
- ODF landslide assessment maps, which identify failure-prone headwater slopes that are considered to be potential sources of wood and substrate to the aquatic corridor
- TMDL and associated data for the TBW developed by the ODEQ to address bacteria and temperature
- CLAMS hydrography layer, which contains reach specific information on channel gradient, annual flow, valley width, and intrinsic potential for Coho and Steelhead
- CLAMS vegetation layer, which contains comprehensive information on forest cover and vegetation throughout the watershed
- USGS geology layers developed for the watershed
- National Wetlands Inventory (NWI) layers developed by the United States Fish and Wildlife Service (USFWS)
- Continuous temperature recordings gathered by ODEQ and TEP
- A field assessment conducted by Demeter Design Inc and Bio-Surveys LLC in 2008
- A Data Synthesis of the TBW conducted in 2008 by Demeter Design which collected, analyzed, and summarized a wide variety of datasets at the 7th field scale

Section 2 - Basin-wide Results



Map 2a - Tillamook River Context

Current Coho Populations

The status of Oregon Coast Coho in the greater TBW was assessed in 2005, 2006, and 2007 by the Tillamook Estuaries Partnership (TEP) using the Rapid Bio-Assessment (RBA) snorkel inventory. During the three years of the study, the distribution and abundance of juvenile Coho and Steelhead indicates that the TBW is not seeded to capacity. The Tillamook River watershed supported ~12.5% of the total juvenile Coho population of the TBW in 2005, ~6% of the population in 2006, and ~11% in 2007. The proportional decrease from 2005 to 2006 reflects a population wide increase of over 100% in the population wide juvenile estimate (291,264 juveniles in 2005 vs. 616,394 juveniles in 2006), while the population within the Tillamook River remained relatively constant with 36,522 juveniles in 2005 vs. 38,144 juveniles in 2006. Abundance increased roughly two fold in 2007 when the counts reached 78,944. This was in contrast to the Trask and Kilchis Rivers which decreased from 2006 to 2007, the Miami River which remained relatively constant, and the Wilson River which increased but much less dramatically. A detailed discussion of Coho utilization of the greater TBW is outside the scope of this document, but has been comprehensively discussed in a prior report. The total expanded Coho estimate for the Tillamook River watershed in 2005 was 36,522 summer parr. Based on these numbers, escapement is estimated at 292-332 adult Coho (assuming a 1:1 male/female ratio, and 8.8%-10.0% egg to summer parr survival rate and 2,500 eggs per female). The total expanded Coho estimate for the basin in 2006 was 38,144 summer parr. Based on these numbers, escapement is estimated at 305-347 adult Coho. The total expanded Coho estimate for the basin in 2007 was 78,944 summer parr and escapement is estimated at 632-718 adult Coho.

Juvenile Coho are broadly distributed throughout the Tillamook River watershed. Juvenile salmonid densities in the mainstem Tillamook River were greatest at the mouth of Simmons, Killam, Fawcett, and Munson creeks. These creeks may provide cold water refugia although continuous temperature data indicates that all eastern tributaries exceed 64° F. The most productive stream reaches are the Upper Mainstem Tillamook River and Bewley Creek. Both of these reaches are dominated by an erodible geology although they do contain fractional resistant substrate. Beaver, Sutton, and Esther are the remaining erodible creeks but exhibit minimal productivity. Simmons, Fawcett, Munson, and Killam creeks are all major producers and drain the volcanic geology dominated eastern portion of the watershed. Pleasant Creek had the highest average juvenile rearing density in 2006 (1.3 fish/sqm) in the basin, although it contained only 1 mile of potential habitat. Mills Creek also exhibited a relatively high density (1.1 fish/sqm) in 2006. Although a number of smaller tributaries were surveyed, none were significant producers. Densities in Esther/Tomlinson during 2007 were extremely high, possibly reflecting the high winter rearing potential associated with those streams (refer to discussion in Production Modeling). Summarized results are displayed in *Table 1c - Coho Inventory*. Core Areas are those areas where Coho spawn or rear and, within the Tillamook River watershed, include ~56 miles of stream habitat: the upper and lower mainstem Tillamook River, Beaver, Bewley, Esther, Fawcett, Killam, Mills, Munson, Pleasant Valley, and Simmons creeks.

Coho anchor, secondary branch, and critical contributing habitats are depicted in map *Map 2b - Anchors, Branch Habitat, CCA* on page 27. Habitat metrics found within these areas are presented in the tables on the following two pages. Additionally, this information is also presented in the stream summary section.

Stream	Good	Fair	Poor	Good	Fair	Poor
Mainstem	225.29	1925.42	146.88	21.23%	82.92%	74.79%
Beaver	0.00	6.41	2.79	0.00%	0.3%	1.42%
Bewley	23.04	291.72	30.47	2.17%	12.56%	15.51%
Esther/Tomlinson	1.67	37.63	14.68	0.15%	1.62%	7.47%
Fagan	0.00	0.00	0.00	0.00%	0.00%	0.00%
Fawcett	123.10	15.98	0.00	11.60%	0.68%	0.00%
Joe	0.00	0.37	0.00	0.00%	0.00%	0.00%
Killam*	225.38	3.34	0.00	21.24%	0.14%	0.00%
Mills	94.85	12.26	1.58	8.93%	0.52%	0.80%
Munson	295.71	28.80	0.00	27.86%	1.24%	0.00%
Pleasant Valley*	18.58	0.00	0.00	1.75%	0.00%	0.00%
Simmons*	53.42	0.00	0.00	5.03%	0.00%	0.00%
Sutton	0.00	0.00	0.00	0.00%	0.00%	0.00%
Basin Total	1061.05	2321.93	196.40	100.00%	100.00%	100.00%
* Access to a significant portion of the stream was not possible estimates may be low						

Table 2a - Spawning Gravel Inventory by Stream (Square Meters)

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
A - Killam (1)	782.19	0.88%	NA***	NA***	NA***
B - Killam (2)	2644.54	2.97%	NA***	NA***	NA***
C - Fawcett (1)	440.85	0.49%	82.06	25.90	2.31
D - Fawcett (2)	3162.49	3.55%	80.24	18.90	5.05
E - Simmons (1)	411.83	0.46%	72.77	38.56	2.20
F - Simmons (2)	3059.12	3.43%	78.27	14.30	5.22
G - Mainstem (2)	1974.57	2.21%	27.21	20.42	0.91
H - Munson (1)	441.96	0.50%	34.33	33.16	0.12
I - Munson (2)	609.60	0.68%	32.25	29.96	1.46
J - Munson (3)	280.42	0.31%	51.39	30.60	2.23
K - Mills	601.17	0.67%	70.51	7.47	3.14
L - Bewley (1)	1575.80	1.77%	73.22	40.48	2.20
M - Bewley (2)	1120.09	1.26%	80.12	66.25	13.02
N - Mainstem (1)	1058.74	1.19%	32.42	56.54	0.36
O - Mainstem (3)	2147.62	2.41%	29.81	38.82	13.08
NON-ANCHOR	68846.67	77.22%	47.94	54.02	3.90

Table 2b - Habitat by Anchor

*Length (M) is derived from the BLM Hydro layer

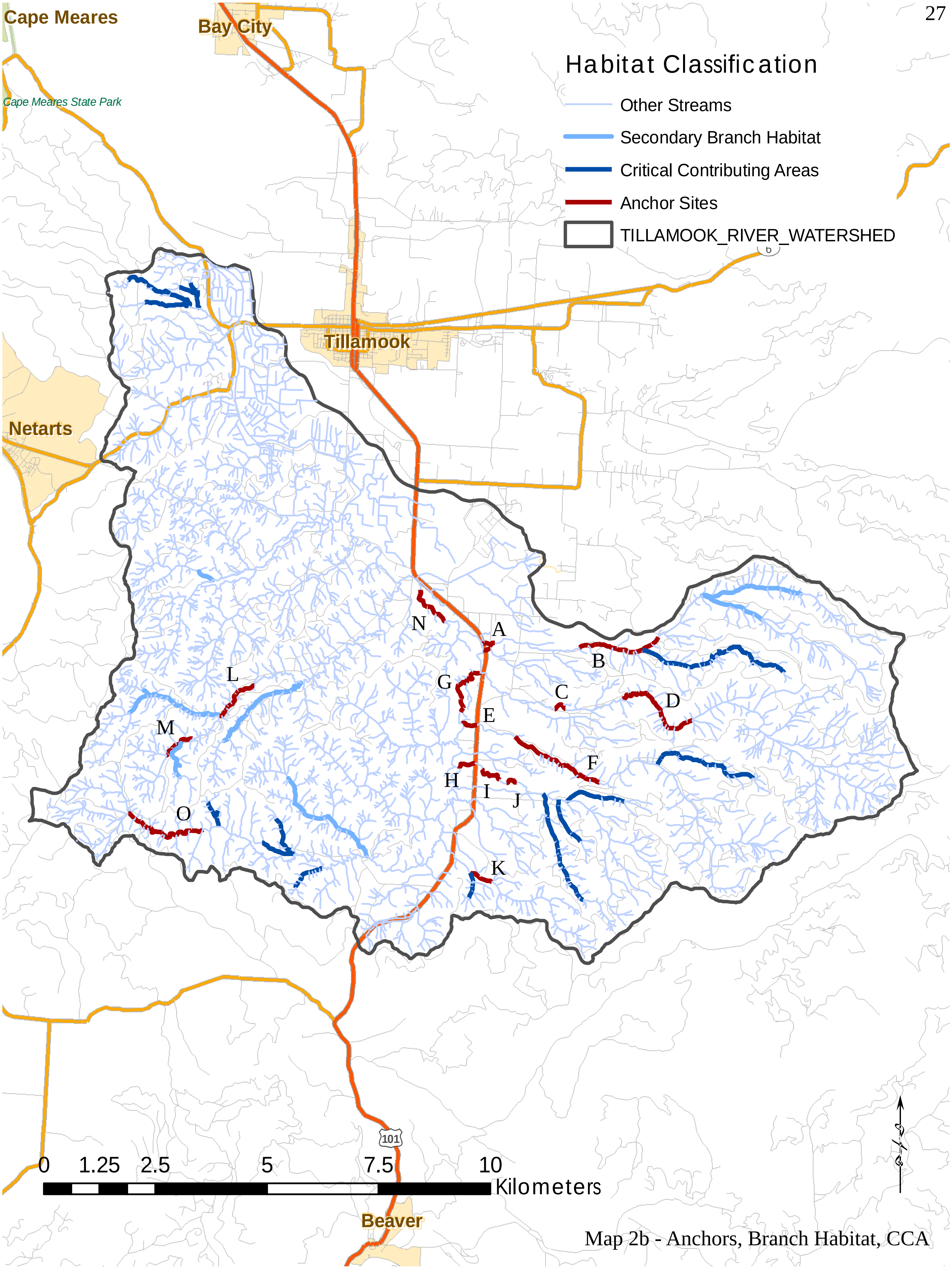
** %Length = Length/Observed Coho Distribution in RBA Surveys

Anchors are titled by letter beginning from the mouth upstream.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
A - Killam (1)	78.78	7.42%	3.34	0.14%	0.00	0.00%
B - Killam (2)	121.80	11.48%	0.00	0.00%	0.00	0.00%
C - Fawcett (1)	0.00	0.00%	0.00	0.00%	0.00	0.00%
D - Fawcett (2)	76.27	7.19%	3.90	0.17%	0.00	0.00%
E - Simmons (1)	31.12	2.93%	0.00	0.00%	0.00	0.00%
F - Simmons (2)	22.29	2.10%	0.00	0.00%	0.00	0.00%
H - Munson (1)	121.98	11.50%	0.00	0.00%	0.00	0.00%
I - Munson (2)	49.05	4.62%	1.67	0.07%	0.00	0.00%
J - Munson (3)	3.34	0.32%	0.00	0.00%	0.00	0.00%
K - Mills	8.36	0.79%	6.69	0.29%	0.00	0.00%
L - Bewley (1)	23.04	2.17%	115.29	4.97%	0.00	0.00%
M - Bewley (2)	0.00	0.00%	94.76	4.08%	7.25	3.69%
N - Mainstem (1)*	83.64	7.72%	1620.63	69.80%	32.50	16.55%
G - Mainstem (2)	0.00	0.00%	25.27	1.09%	0.00	0.00%
O - Mainstem (3)*	52.88	4.88%	13.57	0.58%	12.83	6.53%
NON-ANCHOR	410.77	37.92%	436.79	18.81%	143.82	73.23%

Table 2c - Spawning Gravel Inventory by Anchor (Square Meters)

*** Demeter Design classified Anchors N and O as such; Bio-Surveys did not agree with this classification.**



Map 2b - Anchors, Branch Habitat, CCA

Coho Production Modeling

The production modeling was conducted four times; once for each of the two models including summer rearing for the mainstem Tillamook River from Yellow Fir Bridge downstream to the head of tide (without temperature limits) and once for each of the two models not including this habitat (temperature limits). Although three years of juvenile Coho inventory data indicate that salmonid rearing occurs throughout the freshwater mainstem, Coho abundance data was collected in June before summer peak temperatures. When all the mainstem habitat downstream of Yellow Fir Bridge to the head of tide is considered usable summer rearing habitat, the rearing capacity of the entire mainstem is 263,784 juvenile Coho versus 63,960 juvenile Coho when this habitat is considered unsuitable due to temperature limitations.

Additionally, there are contradictory findings as a result of this modeling effort. Both models indicate that the primary limiting factor under current conditions is summer habitat. The deviation between the two models occurs if temperature does not limit summer potential; the ODFW model indicates that winter rearing habitat would limit production while the OSU model indicates that spawning habitat would limit production. More to the point, the last limiting factor using the ODFW model is spawning habitat while the OSU model indicates that the last limiting factor is winter habitat; these findings directly contradict each other. There are several likely causes of this finding. First and foremost, the difference between summer rearing potential and spawning potential using the OSU study is very small and is likely within the range of error of the model. Error is difficult to quantify for this type of model. Although Monte Carlo modeling may be able to provide estimates, this has not yet been conducted. Secondly, it is possible that the gravels within the mainstem were incorrectly characterized. If the abundant lower mainstem gravels were classified as good as opposed to fair spawning potential would increase by roughly 50% thus normalizing the findings between the two models. A third likely cause is that the OSU model was built using data collected in the Alsea watershed which is dominated by a Tyee (erodible) geology. The Tillamook River contains no Tyee geology and is very complex with a mix of basalts and sand/silt/mudstones. The gravels inventories are not sandstone gravels but rather volcanic gravels. It is likely that the ODFW model, which was built using data collected throughout the Oregon coast, is more representative of the actual conditions of the Tillamook River. A fifth explanation is that erodible watersheds are more prone to disturbance (and the resulting impacts are more systemic) than are resistant watersheds. As production values within the Alsea watershed are on the extreme low end of the ODFW model it is possible that past land-use impacts within that watershed are driving the model and thus are not an accurate characterization of the volcanic drainages within the Tillamook River watershed. Further, it is likely (based on previous sediment work in Tyee watersheds) that downcutting in Tyee dominated systems has a more prolonged impact on spawning gravels due to the minimal spawning substrate supplied by headwater drainages as opposed to the large bedload supplied in volcanic drainages. Finally, it is unclear however what the spawning capacity of the Tillamook River watershed would be were wood volumes increased to reference and thus gravels better sorted.

Life stage (season)	Rearing capacity	ODFW Model	AWS Model
Spawning (# eggs)	1892562.5	605620	51099.19
Spring (# fish)	no data	no data	no data
Summer (# fish)	550143.73 - *350259.22	396103.48 - * 252186.64	61065.95 - *38878.77
Winter (# fish)	309689.99	278720.99	88881.03

Table 2d - Watershed Rearing Capacity and Potential Smolt Production *With Temperature Limitations

ODFW Coho Production Model Seasonal Limitation		AWS Coho Production Model Seasonal Limitation	
Temperature Limits	W/O Temperature Limits	Temperature Limits	W/O Temperature Limits
Summer - 1	Winter - 1	Summer - 1	Spawning - 1
Winter - 2	Summer - 2	Spawning - 2	Summer - 2
Spawning - 3	Spawning - 3	Winter - 3	Winter - 3

Table 2e - Limiting Factors

Using the ODFW model, winter rearing habitat would become the primary limiting factor for Coho production (and likely the production of other species) were temperature limitations addressed. Using the OSU model, spawning would become the primary limiting factor were temperature limitations resolved. It is important to note that spawning is naturally limited in many of the western tributaries as a result of lithology while winter rearing limitations are the result of land-use impacts. Due to the uncertainties associated with modeling historic wetland habitat condition and rearing potential, a rough-cut analysis of the impact of lowland restoration activities on winter rearing potential was performed. Detailed modeling of the impacts of restoring connectivity to ~21 acres of the Fagan & Esther creek wetlands was conducted by Bio-Surveys. Historical wetlands associated with Esther and Fagan creek (historically estuarine but disconnected by tide-gates and dikes) were evaluated to understand the impact of wetland loss on winter rearing potential. The historical rearing capacity of these wetlands is estimated at 51,000 Coho. The Esther & Fagan creek wetlands are relatively small (21 acres) compared to more actively managed agricultural fields which are disconnected by diking and tidegates. These results were extrapolated to the greater watershed, in which ~1463 acres of wetlands are disconnected, using the following assumptions.

1) The modeled area of Fagan and Esther creeks was 85,166 square meters or 21 acres

2) The rearing capacity of these areas was ~51,00 fish or 1.67 fish/square meter

3) The total historic wetland area now disconnected from the river system is equal to 1463 acres

4) Winter rearing potential in Fagan and Esther is representative of all wetland habitat in the lower Tillamook River which is ~1.5 fish/sq meters. This is a conservative estimate lower than most pool habitats and lower than what was found in the Fagan and Esther creek analysis. This is also considered "fully seeded".

Two numbers were generated using these assumptions. The high end estimate assumes that all of the disconnected wetland was historically equally functional. Under this assumption, restoring historic wetland conditions would result in an increase in winter rearing potential of ***~8.5 million fish within the Tillamook River watershed***. The low end estimate assumes that only 10% of the disconnected wetland was historically functional. Using this assumption, restoring historic wetland conditions would result in an increase in winter rearing potential of ***~850,000 fish***. Even using conservative estimates, ***restoring wetland habitat would result in a fourfold increase over current winter rearing potential.*** Additionally, the Tillamook River could provide much of the winter rearing habitat for the Trask River, the confluence of which is between the Esther and Fagan wetlands. Reconnection of these wetlands has the potential to increase the production not only of the Tillamook River but of the Trask River as well.

Finally, the production modeling was based on dated AQI data, some of which was no longer relevant. For instance, beaver dams are not as common presently as they were when the majority of the data was taken and adjustments were made to the model to account for this.

Stream	Spawning	Summer	Winter
Beaver Creek	3250	19044.22	11602.72
Beaver/Bear Creek	0	46461.88	4560.6
Beaver/Trib D	0	1418.81	983.37
Bewley Creek	147062.5	68004.77	32518.87
Bewley/Trib D	0	5250.49	13135.58
Bewley/Trib E	0	5137.91	3141.54
Esther Creek	6583.33	4236.27	2974.06
Fawcett Creek	109250	24164.21	14647.06
Joe Creek	166.67	17163.87	10091.32
Killam Creek	189208.33	14746.63	10733.35
Mills Creek	84541.67	974.08	733.11
Munson Creek	258416.67	8130.54	4210.19
Pleasant Creek	15500	2165.98	1629.3
Simmons Creek	44500	12764.26	12195.61
Sutton Creek	0	0	0
Tillamook R	1020520.83	263844.26 - *63959.75	130097.5
Esther/Tomlinson Creek	13562.5	882.63	495.99
Trib C	0	20660.15	1814.88
Trib E	0	8047.28	13558.67
Totals	1892562.5	323213.71	269123.72

Table 2f - Rearing capacity *With Temperature Limitations

Stream	Spawning	Summer	Winter
Beaver Creek	1040	13711.83	10442.45
Beaver/Bear Creek	0	33452.55	4104.54
Beaver/Trib D	0	1021.54	885.03
Bewley Creek	47060	48963.43	29266.98
Bewley/Trib D	0	3780.35	11822.02
Bewley/Trib E	0	3699.29	2827.38
Esther Creek	2106.67	3050.11	2676.65
Fawcett Creek	34960	17398.23	13182.36
Joe Creek	53.33	12357.99	9082.19
Killam Creek	60546.67	10617.57	9660.02
Mills Creek	27053.33	701.34	659.8
Munson Creek	82693.33	5853.99	3789.17
Pleasant Creek	4960	1559.5	1466.37
Simmons Creek	14240	9190.27	10976.05
Sutton Creek	0	0	0
Tillamook R	326566.67	189967.86 - *46051.02	117087.75
Esther/Tomlinson Creek	4340	635.49	446.39
Trib C	0	14875.31	1633.39
Trib E	0	5794.04	12202.81
Totals	605620	232713.87	242211.35

Table 2g - Potential smolt production (ODFW Survival Rates) *With Temperature Limitations

Stream	Spawning	Summer	Winter
Beaver Creek	87.75	2113.91	3329.98
Beaver/Bear Creek	0	5157.27	1308.89
Beaver/Trib D	0	157.49	282.23
Bewley Creek	3970.69	7548.53	9332.91
Bewley/Trib D	0	582.8	3769.91
Bewley/Trib E	0	570.31	901.62
Esther Creek	177.75	470.23	853.55
Fawcett Creek	2949.75	2682.23	4203.71
Joe Creek	4.5	1905.19	2896.21
Killam Creek	5108.63	1636.88	3080.47
Mills Creek	2282.63	108.12	210.4
Munson Creek	6977.25	902.49	1208.32
Pleasant Creek	418.5	240.42	467.61
Simmons Creek	1201.5	1416.83	3500.14
Sutton Creek	0	0	0
Tillamook R	27554.06	29286.71 - *7099.53	37337.98
Esther/Tomlinson Creek	366.19	97.97	142.35
Trib C	0	2293.28	520.87
Trib E	0	893.25	3891.34
Totals	51099.19	35876.72	77238.51

Table 2h - Potential smolt production (OSU Survival Rates) *With Temperature Limitations

Temperature

Thermal problems are pervasive throughout the Tillamook River watershed. Eleven years of watershed-wide continuous temperature monitoring revealed that the entire Tillamook River mainstem exceeds water quality standards. This data is summarized in *Table 2j - 7 Day Average Maximums and Temperature Limits*. High water temperatures interact with bacteria, which in the Tillamook River is as pervasive as temperature, to magnify the impact of parasites and other diseases on juvenile Salmonids. This interaction, along with direct mortality as a result of temperature, reduces the quality of summer habitat throughout the basin. The Tillamook River mainstem from the mouth to the headwaters and Fawcett Creek from the mouth to the headwaters were both identified as water quality limited under section 303(d) of the Clean Water Act (CWA) and a Total Maximum Daily Load (TMDL) was developed to address both temperature and bacteria within the larger TBW.

		Spawning	*Sub-lethal*	*Near Lethal*
Site Name and Year	**Temperature °F**	**Days > 55°F**	**Days > 64°F**	**Days > 68°F**
Mainstem at Yellow Fir Road 2006	66.6	104	8	1
Mainstem at Yellow Fir Road 2000	63.6	103	4	0
Mainstem at Yellow Fir Road 1997	62.7	54	0	0
Mainstem at Killam 1997	64.8	53	13	0
Mainstem at Bewley Creek Road 2006	70.4	110	60	8
Mainstem at Bewley Creek Road 2000	68.3	113	48	4
Mainstem at Bewley Creek Road 1997	67.3	102	43	3
Mainstem at Beaver Creek 1998	71.1	112	61	36
Mainstem Above Lab Acres 1997	63.2	54	1	0
Mainstem at RM 14.89 1999	74.3	176	20	20
Sage Creek at RM 0.4 2006	65.4	43	7	0
Sage Creek at RM 0.1 2006	63.6	37	1	0
Sutton Creek at the Mouth 1998	68.9	122	59	12
Munson Creek at Hwy 101 1998	63.7	100	7	0
Fawcett Creek at Hwy 101 1007	63.2	53	4	0
Simmons Creek at Hwy 101 1998	63.8	85	6	0

Table 2i - 7 Day Average Maximums and Temperature Limits

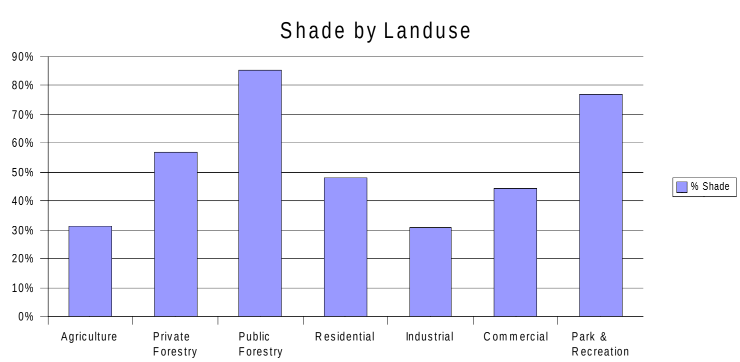
As stream temperature is primarily determined by solar input, channel shade is a useful surrogate for evaluating the causes of thermal problems. The high water temperatures found throughout the Tillamook River mainstem are the result of excess solar inputs throughout the stream network. Degraded riparian conditions throughout the basin contribute to high stream temperatures which constitute a prime limiting factor to summer survival rates. Please refer to the TMDL for a detailed discussion of how increased solar input contributes to increased stream temperatures as well as current and potential conditions within the Tillamook River watershed.

ODFW has collected data from 46 reference reaches with minimal anthropogenic disturbance throughout the Coast Range Ecoregion. This data can be used to generate targets for specific habitat metrics such as shade. The median shade value for the ODFW data was 84%. This data was used along with ODFW professional judgement to create a low benchmark which for the Coast Range Ecoregion is 77%. Any area falling below 77% shade can be considered impaired by excess solar radiation. Riparian condition including shade values, vegetation, wood volumes, and erosion for the Tillamook River are presented by stream and reach in *Table 3f - Tillamook River Riparian Condition*. The results of this analysis suggest that shade values are good on lands managed for public forestry or recreation. Private forestry, agricultural, residential, industrial and commercial uses are all well below 84% shade. A related analysis was performed to summarize shade values by stream refer to *Table 2l - Shade Values by Stream*. The results of this analysis indicate that no stream within the basin is in good condition with regards to shade. This conclusion was verified during field surveys conducted for this project. In some cases, low shade values on industrial timber lands may be due to historic rather than current practices as current harvest laws often prohibit harvest of the riparian area within fish distribution. In contrast, many residential and agricultural reaches surveyed exhibited very poor riparian conditions as a result of both historical and current land-use practices. Riparian plantings have been conducted throughout the basin, primarily by TEP's Backyard Planting Program (BYPP) or the Soil and Water Conservation District (SWCD). Landowners, in a desire to keep their homes unshaded, to limit the risk of blow-down, or to maintain maximum pasture production, often do not allow for planting to occur at sufficiently dense levels to achieve desired conditions.

Land-use	% Shade
Agriculture	31.4%
Private Forestry	57.1%
Public Forestry	85.1%
Residential	48.1%
Industrial	30.9%
Commercial	44.4%
Park & Recreation	76.7%

Table 2j - Shade Values by Land-use

Figure 2a - Shade by Land-use



Stream	% Shade
BEAR CREEK	44%
BEAVER CREEK	22%
BEWLEY CREEK	53%
FAWCETT CREEK	77%
JOE CREEK	35%
LOWER TILLAMOOK RIVER	42%
MILLS CREEK	64%
MUNSON CREEK	62%
SECTION 32 TRIB	59%
SIMMONS CREEK	83%
TILLAMOOK RIVER	27%

Table 2k - Shade Values by Stream

• A 3' drop over the City of Tillamook water diversion on Fawcett Creek is a juvenile (all species) barrier and Chum deterrent/barrier. Adult Steelhead, Coho and Chinook are known to spawn above the diversion. Inadequate fish screening is also a concern with the diversion. A potential anchor site is located immediately upstream of the barrier. Improvement of this juvenile barrier should occur concurrently with improvements to upstream habitat.

• Fawcett Creek Culvert. *Although this is depicted on the map the most recent highwater event caused a blowout of this culvert. At the time this report was developed, engineering was underway for a replacement and replacement is expected to occur in 2009.

• An outdated fish ladder/box culvert structure at the mouth of Killam Creek is a juvenile (all species) and adult Chum barrier. The existing fish ladder has 1 foot rungs. Additionally, stop boards inside the culvert have roughly 2' jumps. Extremely high quality summer and winter habitat is available just above the culvert. Replacement of this barrier will increase available high quality summer and winter habitat.

• The third culvert on Pleasant Valley Creek at RM 0.5 is actively failing although still passable. Complete failure is likely in the near future. Juvenile and adult passage (all species) would be affected in this case. Replacement of this potential barrier will maintain long term function.

• A 3' diameter culvert on Fagan Creek at RM 0.6 is highly degraded although still passable. Complete failure is likely in the near future. Replacement of this potential barrier will maintain long term function.

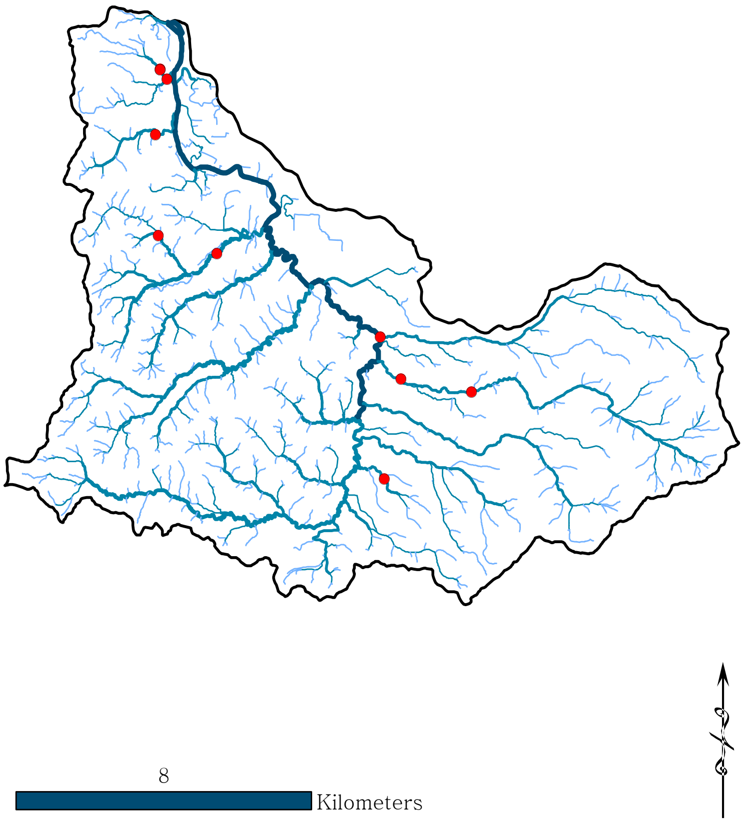
• The tidegate at the mouth of Esther & Tomlinson closes prematurely and functions as an adult and juvenile barrier under certain tidal conditions. When accessible, the habitat upstream is extremely productive for winter rearing. Replacement or modification of this barrier will increase winter habitat for Tillamook & Trask River juveniles.

• A culvert perched 2' on Tomlinson Creek just above tidal influence is a juvenile (all species) and adult Chum barrier and blocks access to cold water summer habitat. Replacement of this barrier will primarily increase summer habitat for all species.

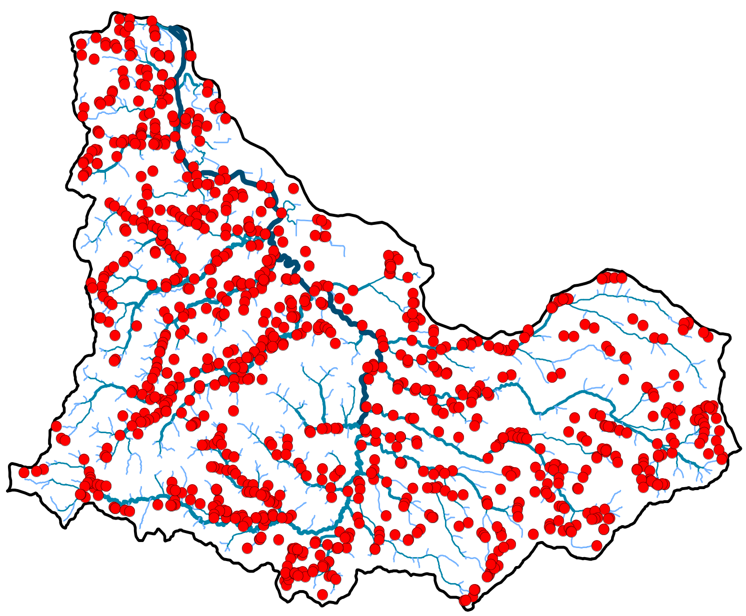
• The second culvert on Tomlinson Creek is undersized and failing. Significant spawning resources are located upstream. Replacement of this potential barrier will maintain long term function.

• The first culvert on Beaver Creek is actively failing although still passable. Complete failure is likely in the near future. Juvenile and adult passage (all species) would be affected in this case. Replacement of this potential barrier will maintain long term function.

• The first culvert on the first tributary to Bear Creek is perched above the stream channel and represents a juvenile barrier. A forested wetland provides very rare (for this creek) cold water summer habitat above the culvert. Replacement of this barrier will primarily increase summer habitat for all species.



Map 2c - Passage Barriers

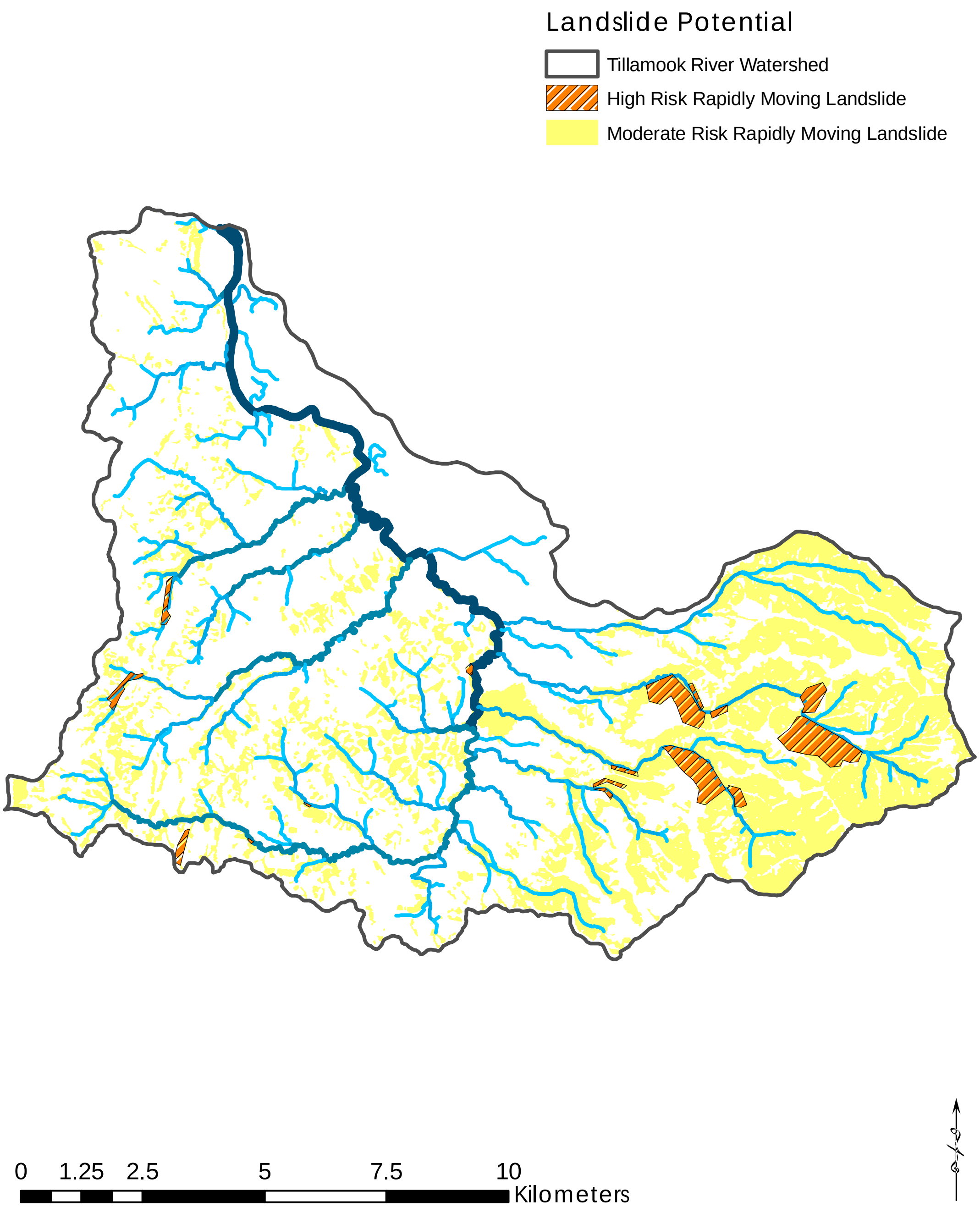


Map 2d - Road Crossings

8
Kilometers

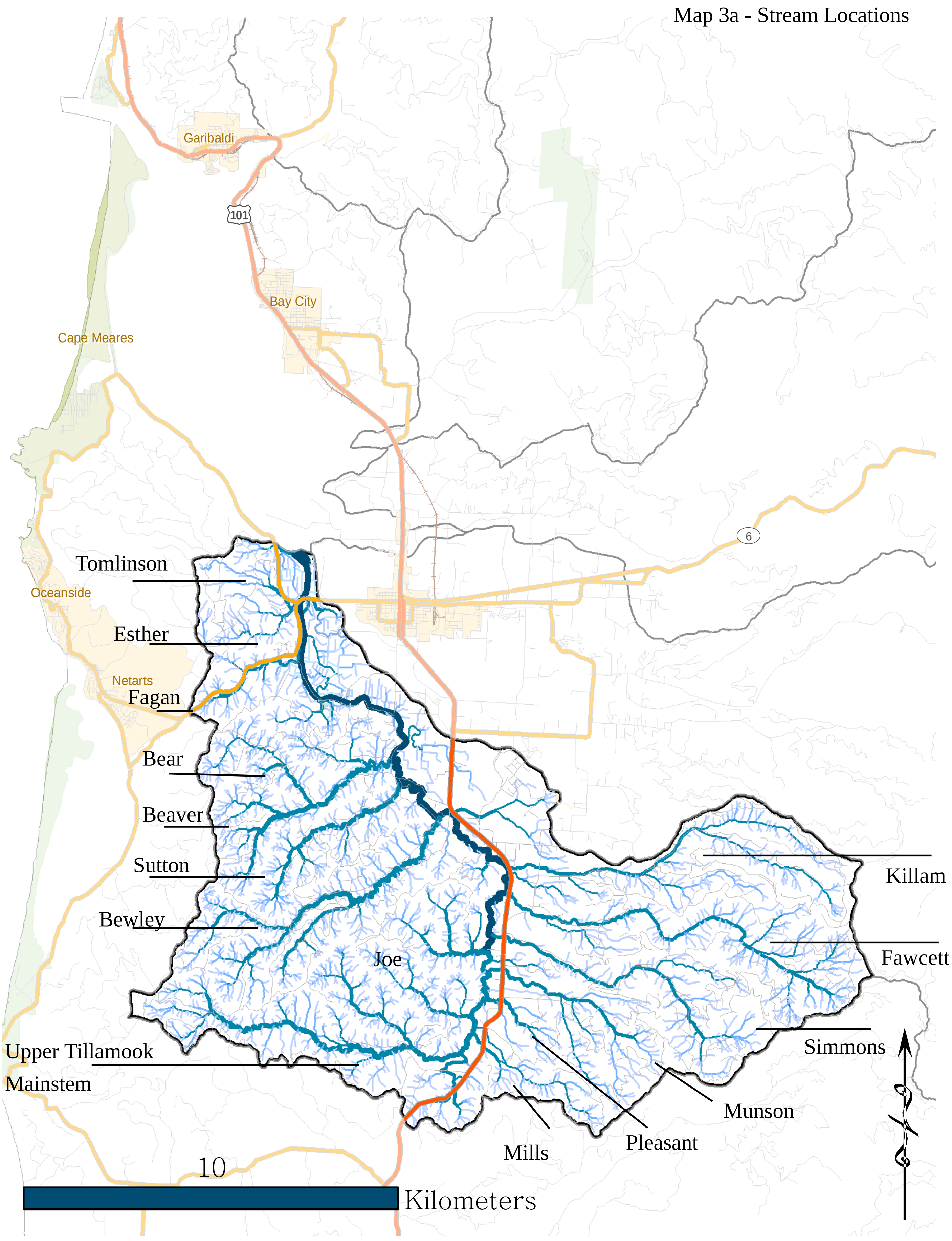
Landslide Potential

Landslides are not the dominant factor in the Tillamook River that they are throughout the rest of the TBW. In particular, landslides play a relatively small role in the lower watershed and the west tributaries. In contrast, Fawcett, Simmons, and Munson creeks all contain significant areas with the potential to contribute wood and gravel resources to the stream network. Field surveys conducted for this project reflect the importance of these gravel resources to the mainstem. Landslide prone areas on the west side tributaries are much smaller in size, but play an equally crucial role. Bewley and the upper Tillamook mainstem both contain landslide prone areas. Due to the predominance of erodible geology across the western portion of the watershed, areas with the potential to deliver gravels in this portion of the watershed are proportionally more important.

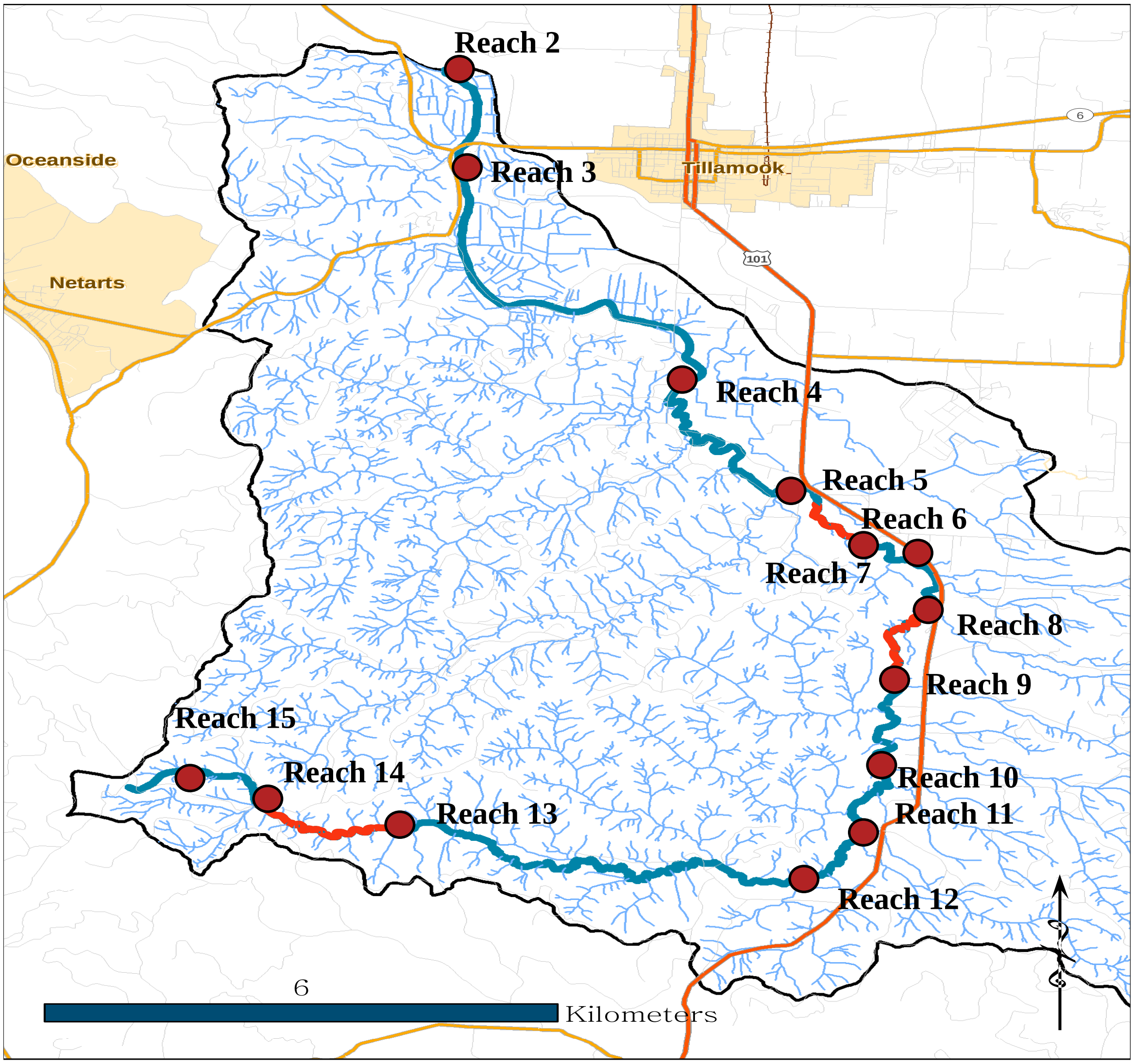


Map 2e - Landslide Potential

Section 3.0 - Stream Summaries



Map 3b - Mainstem Tillamook



Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
2	0.00	0.00	0.0
3	0.20	0.40	0.0
4	3.90	3.00	0.0
5	2.00	1.50	0.0
6	0.00	0.00	0.0
7	7.80	5.10	0.0
8	5.10	3.00	0.0
9	2.40	2.90	0.2
10	4.00	3.60	0.2
11	0.00	0.00	0.0
12	11.90	18.20	0.7
13	23.30	29.70	0.5
14	40.40	51.90	1.3
15	24.80	37.00	1.3

Table 3a - Tillamook River Wood Volumes

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
2	27.30	0.00	5.40	1.70
3	100.00	1.00	1.50	4.40
4	87.50	0.00	6.30	6.10
5	64.00	0.40	0.40	7.40
6	0.00	0.00	0.00	0.00
7	51.10	7.30	7.40	5.50
8	19.90	1.30	4.20	6.80
9	30.90	0.20	0.20	8.60
10	21.50	1.20	2.70	9.60
11	0.00	0.00	0.00	0.00
12	27.40	2.00	1.60	9.00
13	25.50	0.60	7.40	2.30
14	5.50	0.00	18.60	1.40
15	0.80	0.00	0.00	0.00

Table 3b - Tillamook River Pool Volumes

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
2	1944.7	0.0	25.0	MT	TC	0.10	0.30
3	6076.0	0.0	25.0	MT	TC	0.20	0.70
4	2650.3	0.1	25.0	CT	TC	0.40	2.00
5	1748.6	0.3	20.0	MT	TC	0.30	2.10
6	392.0	0.3	0.0	MT	TC	0.00	NA
7	551.8	0.5	20.0	MT	TC	0.30	2.70
8	2744.9	0.8	12.7	MT	CA	0.50	2.20
9	893.5	0.1	20.0	MT	US	0.90	0.60
10	2089.0	0.3	17.8	MT	CA	0.50	1.70
11	983.2	0.0	0.0	CT	TC	0.00	NA
12	7774.6	0.5	12.4	CT	TC	0.50	0.90
13	789.9	4.0	3.5	SV	CH	0.50	0.60
14	715.0	12.7	4.2	MT	TC	0.40	0.40
15	805.6	17.9	1.3	SV	CH	0.40	0.50

Table 3c -Tillamook River AQI Morphology Data

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
2	0.0	100.0	0.0	0.0	0.0	0.0
3	0.0	100.0	0.0	0.0	0.0	0.0
4	0.0	47.0	30.0	1.4	16.0	53.0
5	8.0	40.0	19.0	0.0	13.0	24.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	12.0	36.0	16.0	0.6	15.0	22.0
8	114.0	31.0	28.0	5.7	13.0	36.0
9	0.0	55.0	35.0	0.3	46.0	39.0
10	20.0	51.0	35.0	2.8	36.0	42.0
11	0.0	0.0	0.0	0.0	0.0	0.0
12	53.0	77.0	14.0	0.4	48.0	31.0
13	184.0	33.0	27.0	2.8	26.0	32.0
14	288.0	26.0	27.0	6.8	39.0	33.0
15	261.0	26.0	25.0	2.0	34.0	32.0

Table 3d - Tillamook River Sediment Values

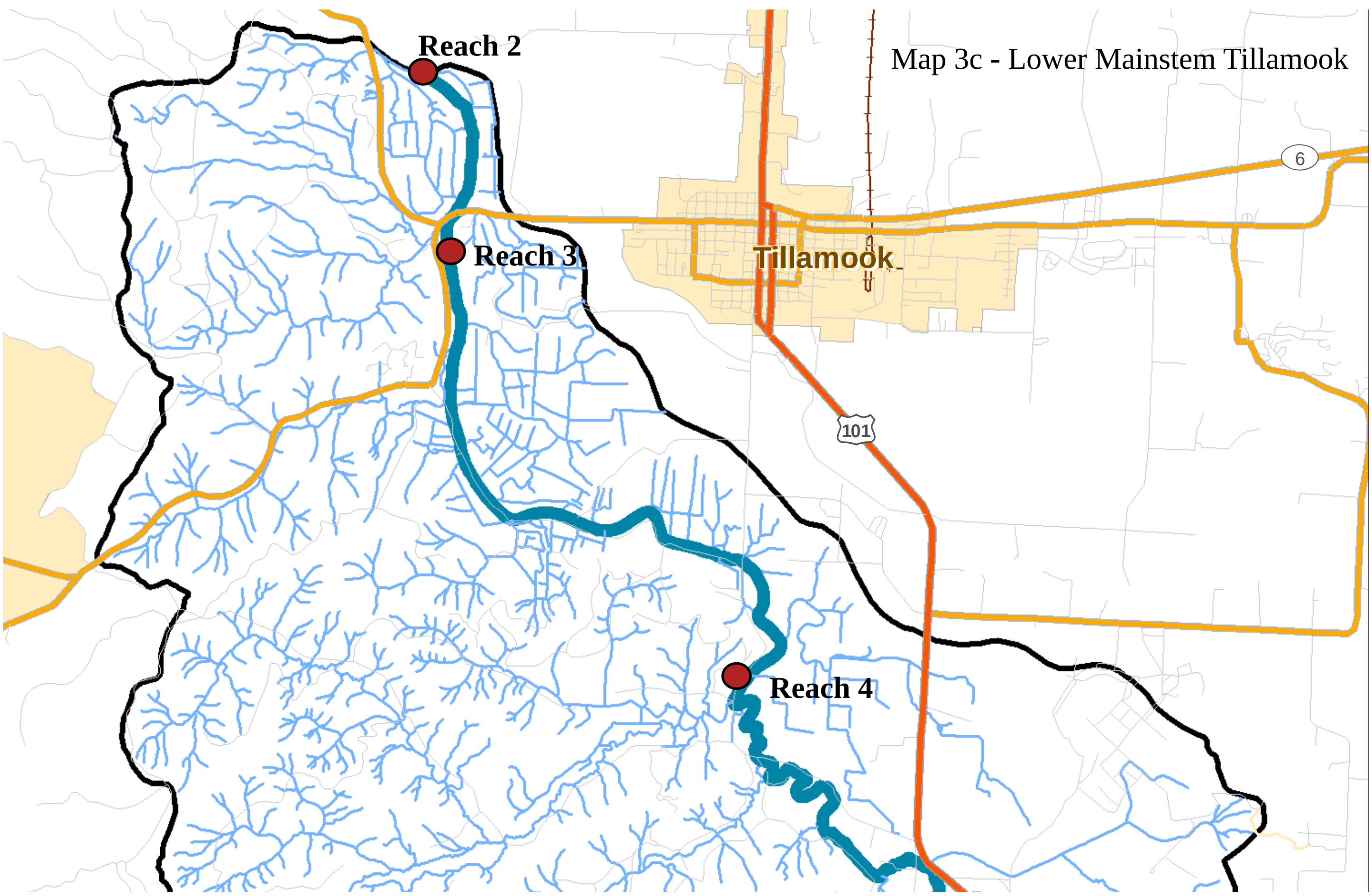
Stream	Good	Fair	Poor	Good	Fair	Poor
Mainstem	225.29	1925.42	146.88	21.23%	82.92%	74.79%

Table 3e - Tillamook River Spawning Gravel Inventory

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305m	Conifers >.90M dbh/305m	%Erosion
2	29.0	P	0	0	0.0
3	40.0	P	0	0	1.5
4	46.0	D15	0	0	55.9
5	40.0	D15	0	0	27.7
6	64.0	D15	0	0	0.0
7	80.0	D15	0	0	13.9
8	29.0	D15	20	20	18.1
9	13.0	D15	0	0	20.9
10	28.0	D15	0	0	40.4
11	0.0	G	0	0	100.0
12	29.0	D15	27	7	90.1
13	35.0	D3	0	0	36.5
14	58.0	D3	20	0	16.2
15	67.0	D15	0	0	51.3

Table 3f - Tillamook River Riparian Condition

Section 3.01 - Lower Tillamook Mainstem



Overview

The lower Tillamook River mainstem is a large low gradient stream feeding directly into the Tillamook Bay Estuary. Significant portions the Tillamook River are within tidal influence (roughly from Esther Creek upstream to the confluence with Bewley Creek). The lower Tillamook River has been extensively diked to allow for expansion of dairy farms throughout the basin. This has resulted in the loss of nearly all wetland habitat throughout the lower basin. Additionally, the lower river was historically used to transport logs to the bay for subsequent transport or milling. The result is a highly simplified lower mainstem channel with greatly reduced potential to provide high quality habitat for juvenile Coho. National wetland inventory (NWI) data was used to estimate the extent and distribution of historic wetland habitat. A GIS analysis was performed using this data to estimate wetland loss in the lower watershed. All wetlands delineated in the NWI below (north of) Bewley Creek (roughly the end of tidal influence on the mainstem) were extracted. The assumption is that these historic wetlands are likely to naturally receive either direct tidal influence or would be hydrologically connected to tidally influenced areas. GIS layers representing existing levees, aerial photography, and professional judgment were used to identify historic wetlands which are disconnected from the main channel or otherwise modified in such a way that they no longer provide useful salmonid habitat. The results of this analysis indicate that of the estimated 2100 acres of historic wetland in this area, roughly 2/3 have been disconnected or become unusable. Remaining wetland habitat is primarily composed of mainstem, tidally influenced channel which does not provide significant winter habitat due to high velocities and limited cover (refer to discussion of production modeling). Where the riparian vegetation interacts with the stream channel, some winter habitat is available. Increased wetland habitat in the lower Tillamook also has the potential to provide over winter habitat to salmonids spawned in other rivers, particularly the Trask. Although winter habitat is available in the lower watershed, it is greatly reduced in size and quality relative to historic conditions.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
2	1944.7	0.0	25.0	MT	TC	0.10	0.30
3	6076.0	0.0	25.0	MT	TC	0.20	0.70
4	2650.3	0.1	25.0	CT	TC	0.40	2.00

Table 3.01a - AQI Morphology Data

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
2	0.00	0.00	0.0
3	0.20	0.40	0.0
4	3.90	3.00	0.0

Table 3.01b - AQI Wood Volume

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
2	0.0	100.0	0.0	0.0	0.0	0.0
3	0.0	100.0	0.0	0.0	0.0	0.0
4	0.0	47.0	30.0	1.4	16.0	53.0

Table 3.01c - AQI Sediment Values

Summer Rearing

Degraded riparian conditions throughout the watershed have resulted in elevated stream temperatures which severely limit the summer habitat potential. In the lower mainstem, stream temperatures exceeding 21C have been recorded which can cause death (to salmon) after hours of exposure. Additionally, the lack of LWD and riparian vegetation result in limited over hanging cover to protect juvenile salmonids from predation. These problems are exacerbated by existing US Army Corps of Engineers regulations which prohibit planting along federally maintained dikes and levees, and restrict LWD placement to stream channels smaller than those found in this portion of the stream network. Summer habitat is essentially nonexistent in the lower watershed. Small portions of estuarine marsh habitat exists within the Tillamook River Watershed, primarily along the edges of the lower mainstem. Although tidegates in some places do allow some tidal flux, these generally do not allow inundation above the line of active pasture. The streams and drainages ditches associated with the tidegates have tidal influence, but do not provide the level of function associated with an intact, un-manipulated tidal wetland.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305m	Conifers >.90M dbh/305m	%Erosion
2	29.0	P	0	0	0.0
3	40.0	P	0	0	1.5
4	46.0	D15	0	0	55.9

Table 3.01d - AQI Riparian Condition

Winter Rearing

Isolated pockets of freshwater wetlands exist throughout the Tillamook River watershed. In the lowland, these are primarily abandoned dairy pastures cut-off from tidal influence by dikes and levees. Extensive beaver activity throughout the upper reaches of the western tributaries have created large freshwater impoundments. These are often beyond fish distribution (in some cases as a result of the dams themselves). Although some beaver created freshwater wetlands do not contribute significantly to salmonid rearing, they can provide rare and critical habitat for many wetland dependent species (e.g. the Red Legged frog).

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
2	27.30	0.00	5.40	1.70
3	100.00	1.00	1.50	4.40
4	87.50	0.00	6.30	6.10

Table 3.01e - AQI Pool Volume

Status	Acres	Area %
Functional	672.48	31.48%
Non-Functional	1463.95	68.52%
Total	2136.44	100.00%

Table 3.01f - Wetland Area and Function

Spawning Habitat

There are no spawning gravels present and this area is tidally influenced.

Anchor Habitat

There are no anchor sites as there is no spawning habitat.

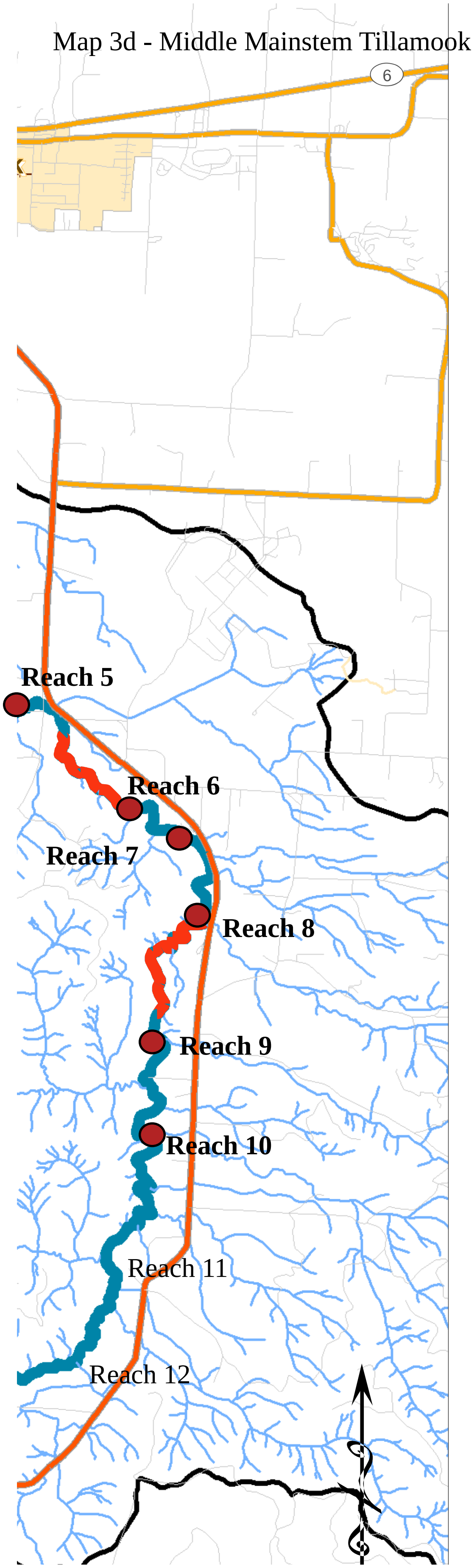
Potential Restoration Projects

• Reconnection of wetland habitat to mainstem

• Dike set-backs

• Tidegate removal/replacement

Section 3.02 - Middle Tillamook Mainstem



Overview

The middle Tillamook mainstem (from the confluence with Bewley Creek to the mouth of Mills Creek) encompasses 6 AQI reaches (5-10). Pool volume was high in every reach except 6 where %Pools did not meet benchmark criteria although it did provide some of the only riffle habitat. The middle mainstem was sluggish and tannic, and gravels were rare and commonly embedded from Munson Creek upstream to the confluence with Mills Creek. Gravels and cobbles were rarely observed in the historical terraces of reach 10 suggesting that the lack of gravels upstream of the confluence with Munson is largely a result of the erodible lithology which dominates the western extent of the watershed. The agricultural land-use impacts upstream of Munson Creek are severe and riparian conditions are very poor. From Killam Creek upstream to the confluence with Munson Creek, land-use on the western bank is predominantly managed for private timber while the eastern bank is dominated by rural residential land-use with scattered dairies. From Killam Creek upstream to the confluence with Fawcett Creek, the gradient allows for boulders, bedrock, and cobbles. Of the Tillamook mainstem (lower, middle, and upper) not managed for timber, reaches 8-9 (roughly from the confluence of Fawcett Creek to Munson Creek) are the least impacted by land-use, although impacts are still present. Shrub species (e.g. Twinberry, Nine Bark, Willow) dominate the riparian vegetation from Munson Creek upstream to well past Mills Creek. Large conifers are absent from the stream bank in all reaches but 8. Riparian condition and recruitment potential could be greatly improved on the eastern bank through riparian planting of coniferous species.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
5	1748.6	0.3	20.0	MT	TC	0.30	2.10
6	392.0	0.3	0.0	MT	TC	0.00	NA
7	551.8	0.5	20.0	MT	TC	0.30	2.70
8	2744.9	0.8	12.7	MT	CA	0.50	2.20
9	893.5	0.1	20.0	MT	US	0.90	0.60
10	2089.0	0.3	17.8	MT	CA	0.50	1.70

Table 3.02a - AQI Morphology Data

Spawning Habitat

Spawning gravels are primarily provided by four eastern tributaries which originate in resistant drainages: Killam, Fawcett, Simmons, and Munson creek. Reach 6 provides the vast majority of all the spawning habitat not only in the middle mainstem but in the entire Tillamook River watershed. Almost 2/3 (~1700 square meters) of all spawning gravels (all species) were observed in reach 6. Numerous Lamprey Redds (94 in total) were observed downstream of Munson Creek. Although the focus of this assessment is Coho production, this section of the mainstem is extremely important for other species including Chinook, Chum, Steelhead, and Lamprey.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
5	8.0	40.0	19.0	0.0	13.0	24.0
6	0.0	0.0	0.0	0.0	0.0	0.0
7	12.0	36.0	16.0	0.6	15.0	22.0
8	114.0	31.0	28.0	5.7	13.0	36.0
9	0.0	55.0	35.0	0.3	46.0	39.0
10	20.0	51.0	35.0	2.8	36.0	42.0

Table 3.02b - AQI Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
5	2.00	1.50	0.0
6	0.00	0.00	0.0
7	7.80	5.10	0.0
8	5.10	3.00	0.0
9	2.40	2.90	0.2
10	4.00	3.60	0.2

Table 3.02c - AQI Wood Volumes

Summer Rearing Habitat

From Mills Creek downstream to Munson Creek shade values were low and channel incision was nearly ubiquitous. Water quality standards for the mainstem are exceeded upstream of Mills at Yellow Fir bridge for temperature. Although pool volume is high, summer rearing habitat is limited by excess summer water temperatures. Shade values (%Shade) are below the benchmark for all reaches. This is consistent with recent surveys.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305m	Conifers >.90M dbh/305m	%Erosion
5	40.0	D15	0	0	27.7
6	64.0	D15	0	0	0.0
7	80.0	D15	0	0	13.9
8	29.0	D15	20	20	18.1
9	13.0	D15	0	0	20.9
10	28.0	D15	0	0	40.4

Table 3.02d - AQI Riparian Condition

Winter Rearing Habitat

The potential for winter rearing habitat is high throughout the middle mainstem but current winter rearing habitat is moderate to low. Almost all winter rearing occurs on the channel margins and there is no backwater and minimal side channel habitat largely as a result of low wood volumes. Complexity increases where vegetation interacts with the stream channel. The potential for floodplain connection is high and could be achieved through wood placement. Channel complexity is very low as a result of downcutting, lack of LWD, and terrace/hill-slope confinement. CHT modeling indicates that this part of the mainstem should be unconfined. LWD volume are below benchmarks for all reaches in this segment with almost no key pieces present.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
5	64.00	0.40	0.40	7.40
6	0.00	0.00	0.00	0.00
7	51.10	7.30	7.40	5.50
8	19.90	1.30	4.20	6.80
9	30.90	0.20	0.20	8.60
10	21.50	1.20	2.70	9.60

Table 3.02e - AQI Pool Volume

Anchor Habitat

A low functioning anchor (1) occurs on the middle mainstem. This potential anchor has abundant gravels, no wood, minimal pools and is severely impacted by land-use. Although this reach provides 2/3 of the spawning gravels within the entire Tillamook River Watershed, Bio-Surveys disagreed with the classification of this section as an anchor.

A second low functioning anchor site (2) occurs between the confluence of Simmons Creek upstream to Fawcett Creek (~reach 5-8). Well sorted gravels are rare likely due to lack of LWD, but the potential for floodplain connection exists and gravels are present. Currently the channel is entrenched, and has poor to moderate riparian conditions (% Shade is well below benchmarks). The long term potential for restoration is very high in this section for multiple species including Chum, Steelhead, Chinook, and Lamprey. Although the % Pools is just above the low benchmark it is likely that given the low gradient and broad floodplain of the mainstem, historical pool volume would be much greater than the high benchmark. Current function is mixed with spawning habitat function high to moderate in reach 6 through half of reach 7 and low in reach 8. Summer rearing is low above reach 7 although the mixing action of the rapid in reach 7 could potentially mitigate some of the impacts of excess temperatures thus increasing summer rearing potential in reach 6 and the lower part of reach 7. Wood placement would increase rearing habitat through floodplain connectivity and would also sort gravels being delivered from Munson and Simmons creek. Existing pools would benefit from wood placement as well due to increased cover from predation, complexity, and hydraulic roughness. Summer juvenile rearing densities were lower in this anchor than in non-anchor sites in 2006 and 2007. One hypothesis for this is that surveyors observed juveniles migrating to cooler waters in 2005 while in 06/07 surveyors did not observe this migration due to timing. In other words, although all RBA surveys occurred before summer peak temperatures, the 2005 surveys may have occurred at the onset of increased summer temperatures.

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
G - Mainstem (2)	1974.57	2.21%	27.21	20.42	0.91
N - Mainstem (1)*	1058.74	1.19%	32.42	56.54	0.36

Table 3.02f - Habitat by Anchor

* Bio-Surveys disagreed with the classification of this section as an anchor

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
G - Mainstem (2)	0.00	0.00%	25.27	1.09%	0.00	0.00%
N - Mainstem (1)	83.64	7.72%	1620.63	69.80%	32.50	16.55%

Table 3.02g - Gravel Inventory by Anchor

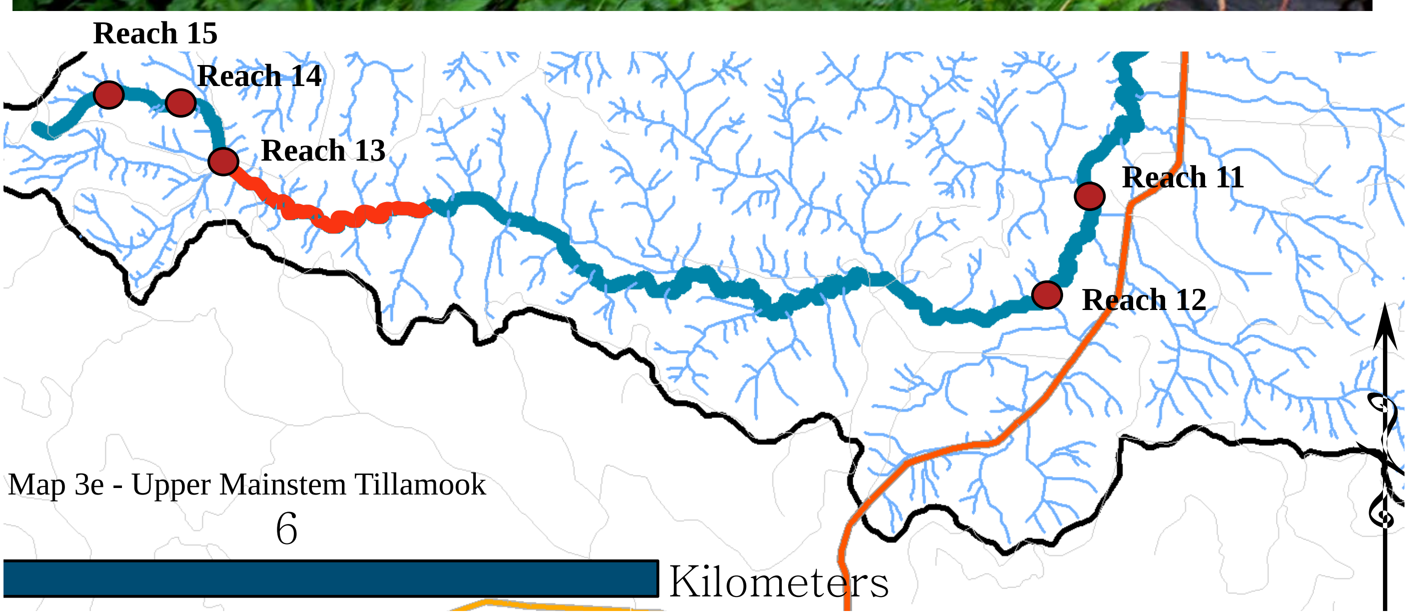
Potential Restoration Projects

• Wood placement in the anchor to increase spawning and rearing habitat

• Riparian plantings focused on improving LWD recruitment potential downstream of Munson Creek

• Riparian plantings focused on increasing shade upstream of Munson Creek

Section 3.03 - Upper Tillamook Mainstem



Overview

The upper Tillamook mainstem (upstream from confluence with Mills Creek) originates in a minor outcrop of resistant basalts and quickly begins to drain an erodible lithology ~1/2 mile from the headwaters resulting in significant, although not abundant, gravel deposits commonly embedded with sands and fines. Gradients within the erodible reaches of the upper mainstem (within Coho distribution) are almost always below 5%. Historical beaver terraces are common although many are not maintained and the mainstem does not access its floodplain regularly. Sinuosity (defined as stream length divided by valley length) is high where forestry is the dominant land-use. Once the stream enters agricultural and rural residential land-uses downstream, historic channel straightening and manipulation becomes common and the stream has less chance to meander. AQI data for the upper Tillamook mainstem includes 5 reaches (11-15). Large conifers are rare along the streambank and recruitment potential is low. All 5 reaches are confined by hill-slope or terrace. CHT modeling indicates that this segment should be unconfined up to the middle of reach 12.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
11	983.2	0.0	0.0	CT	TC	0.00	NA
12	7774.6	0.5	12.4	CT	TC	0.50	0.90
13	789.9	4.0	3.5	SV	CH	0.50	0.60
14	715.0	12.7	4.2	MT	TC	0.40	0.40
15	805.6	17.9	1.3	SV	CH	0.40	0.50

Table 3.03a -Tillamook River AQI Morphology Data

Spawning Habitat

LWD Volume is above the benchmark for reaches 12-15 (roughly at the boundary of land managed for private forestry). Spawning gravels in theses reaches are better sorted than in reach 11 where LWD is low (although hydraulic roughness is high as a result of riparian shrubs). Additionally, spawning habitat is often present as a result of gradient changes even when large wood is not immediately present. Two hypotheses could explain the lack of spawning gravels in reach 11: it is possible that the gradient (~0%) of reach 11 would rarely allow for natural gravel sorting or that a lack of LWD, and as a result of this floodplain connectivity, reduces the potential for gravel sorting. It is possible that were the mainstem allowed to meander through private non-forestry ownership that small, local, gradient changes would become present thus allowing for additional spawning habitat.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
11	0.0	0.0	0.0	0.0	0.0	0.0
12	53.0	77.0	14.0	0.4	48.0	31.0
13	184.0	33.0	27.0	2.8	26.0	32.0
14	288.0	26.0	27.0	6.8	39.0	33.0
15	261.0	26.0	25.0	2.0	34.0	32.0

Table 3.03b - Tillamook River Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
11	0.00	0.00	0.0
12	11.90	18.20	0.7
13	23.30	29.70	0.5
14	40.40	51.90	1.3
15	24.80	37.00	1.3

Table 3.03c - Tillamook River Wood Volumes

Summer Rearing Habitat

AQI shade values (%Shade) are below benchmarks throughout all reaches surveyed. Recent surveys indicate that reaches 14 and 15 have improved and may be at benchmarks, but the lower reaches remain exposed. Riparian vegetation consists of mixed conifer/hardwoods and is in variable condition. From Mills Creek to the Yellow Fir bridge crossing, shade values are high and riparian communities are relatively intact with a mixed hardwood/conifer community dominating and a willow/shrub community sub-dominating. Upstream of the Yellow Fir bridge crossing to ~2.5 miles past the beginning of private forestry ownership (temperature boundary) the quality of the riparian community decreases drastically and could benefit from riparian work (See *Map 4a - Restoration Projects*). Stream temperatures consistently exceed water quality standards (64° F) at Yellow Fir bridge. The lack of shade is compounded by low gradients, slack-water, and a consistent west to east trajectory which maximizes solar exposure. The temperature problem which becomes lethal in the lower mainstem originates at the temperature boundary. Summer habitat quality is limited due to these thermal issues. High quality rearing habitat is only available in the uppermost section of the upper mainstem upstream of the temperature boundary. Low gradients and the combined effects of small woody debris and interactive shrub communities provide relatively high quality winter habitat upstream of the temperature boundary. Riparian plantings from Yellow Fir bridge to the temperature boundary would improve the quality of summer rearing habitat not only within the upper mainstem but in the entire Tillamook River.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305m	Conifers >.90M dbh/305m	%Erosion
11	0.0	G	0	0	100.0
12	29.0	D15	27	7	90.1
13	35.0	D3	0	0	36.5
14	58.0	D3	20	0	16.2
15	67.0	D15	0	0	51.3

Table 3.03d - Tillamook River Riparian Condition

Winter Rearing Habitat

The quantity of pool habitat (%Pools) is above the ODFW benchmarks in reaches 12 and 13. This conforms to the observed distribution of summer rearing. Floodplain connection in this lower section is also low except during extreme (100 year events, etc.) floods. Winter habitat quantity could be increased through wood placement aimed at improving floodplain connectivity. Although additional wood might choke out some gravels by trapping fine sediments, wood volume is extremely important in the upper mainstem for rearing habitat.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
11	0.00	0.00	0.00	0.00
12	27.40	2.00	1.60	9.00
13	25.50	0.60	7.40	2.30
14	5.50	0.00	18.60	1.40
15	0.80	0.00	0.00	0.00

Table 3.03e - Tillamook River Pool Volumes

Anchor Habitat

Although current habitat function is high upstream of the temperature boundary and could be considered a functioning anchor the habitat quality below this boundary is so low that the upper mainstem could only become an anchor with multiple treatments (generally potential anchor sites are those within one treatment of functioning condition). However the current production of the upper mainstem is such that restoration of this area should be considered a high priority, despite the significant lack of gravels and the expected minimal spawning habitat which might be obtained through wood placement. Further, the impacts of the excessive solar radiation received below the temperature boundary should be addressed systematically throughout the basin and restoration aimed at improving riparian function should be considered a high priority. Finally, although the channel below the private forestry boundary is extremely entrenched, it is possible that wood placement would result in local gradient breaks which might provide additional spawning habitat but more importantly would improve winter rearing through increased channel complexity, which is non-existant on the mainstem below the private forestry boundary. Development of channel margin wetland habitat would result in increased summer ground water deliveries somewhat mitigating downstream solar sources. Bio-Surveys disagreed with the classification of this area as an anchor.

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
O - Mainstem (3)*	2147.62	2.41%	29.81	38.82	13.08

Table 3.03f - Habitat by Anchor

* Bio-Surveys disagreed with the classification of this area as an anchor.

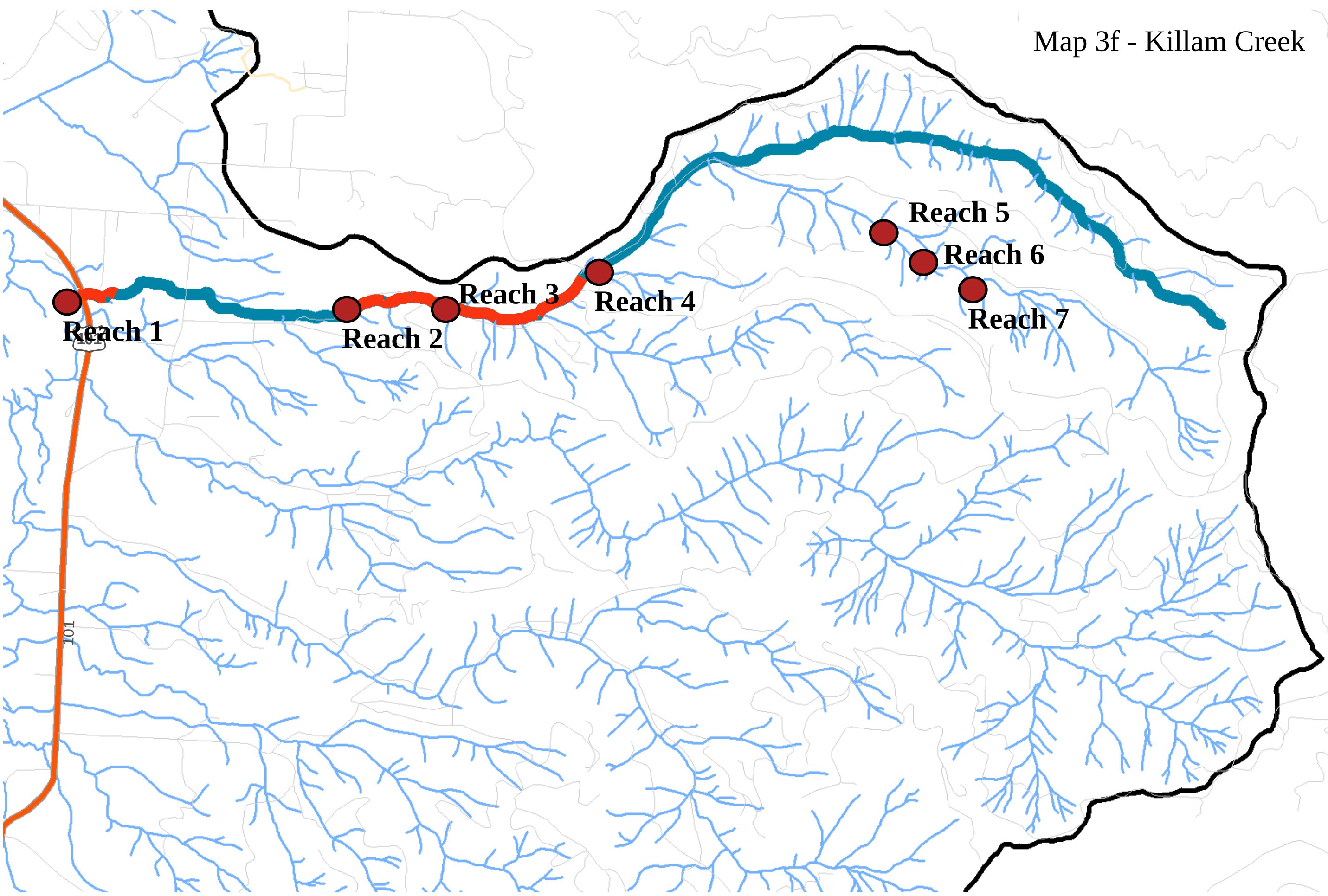
Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
O - Mainstem (3)	52.88	4.88%	13.57	0.58%	12.83	6.53%

Table 3.03g - Gravel Inventory by Anchor

Potential Restoration Projects

- Riparian planting with an emphasis on riparian community complexity
- Riparian setbacks of non-forestry land to allow for increased channel migration
- Fencing to reduce browse from non-native ungulates
- Wood placement below private forestry to increase channel complexity

Section 3.04 - Killam Creek



Overview

There are no significant eastern tributaries downstream of Killam Creek. Draining a volcanic lithology Killam Creek provides abundant gravels, although a lack of LWD limits sorting in higher gradient areas. Riparian condition is good throughout the entire Killam Creek drainage. Denial of access to a significant length (~1 mile) of rural residential property between the mouth and the diversion make it impossible to precisely characterize the habitat quality and channel morphology but aerial photography indicates that riparian condition remains good throughout this segment. The stream channel immediately above the section to which access was denied is characterized by a cobble dominated substrate, channel incision, and a relative lack of sinuosity. Riparian condition is low with shade values estimated at 60%. The mouth of Killam Creek flows through an undersized (by 50% relative to bankfull widths) closed-bottom concrete box culvert. Although a fish ladder is present, the majority of the flow bypasses the fish ladder to drop ~3' (juvenile salmonid spp./adult Chum salmon barrier) into the middle Tillamook mainstem. Additionally each rung of the fish ladder has a drop of roughly 1' (juvenile salmonid spp. barrier/Chum salmon deterrent). Further, full spanning stop boards within the culvert are barriers with drops of ~2 feet at low flow (juvenile salmonid spp. barrier/Chum salmon deterrent). A tributary joins Killam Creek upstream of the diversion and constitutes important spawning and rearing habitat for ~1,200' of its length.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	2402.0	2.4	20.0	MT	US	0.20	0.90
2	809.0	2.8	6.3	CT	CT	0.20	1.20
3	1350.0	3.2	18.8	MT	US	0.20	0.70
4	3132.0	6.9	7.6	CT	CA	0.10	0.90
5	593.0	13.6	2.5	MV	HS	0.10	1.10
6	384.0	11.2	5.3	CT	CT	0.10	0.90
7	1151.0	15.5	2.1	MV	HS	0.10	1.10

Table 3.04a -Killam Creek AQI Morphology Data

Spawning Habitat

Spawning habitat is abundant in the braided channel upstream of the mouth. Although snorkel surveys did not find high abundances of juvenile salmonids, it is possible that this was the result of the channel complexity and not due to a fundamental lack of spawning habitat. Multiple pools are present in one transect (a horizontal cross section of the stream channel) and upwards of 50 pools were found in a very small area but snorkel surveys only occurred on 1 pool (10 pools should have been snorkeled). Upstream of the municipal water diversion spawning potential is high but sorting is rare. Large wood is needed to increase spawning habitat.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	133.0	22.0	49.0	2.0	18.0	55.0
2	106.0	17.0	39.0	4.0	15.0	50.0
3	308.0	10.0	42.0	5.0	6.0	44.0
4	1195.0	3.0	41.0	2.0	4.0	56.0
5	440.0	0.0	39.0	11.0	5.0	70.0
6	171.0	1.0	35.0	23.0	NA	NA
7	431.0	9.0	34.0	27.0	35.0	50.0

Table 3.04b - Killam Creek Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	1.80	4.90	NA
2	3.60	2.30	NA
3	3.40	3.00	NA
4	5.40	10.10	NA
5	7.90	15.30	NA
6	12.20	13.90	NA
7	35.90	125.70	NA

Table 3.04c - Killam Creek Wood Volumes

Stream	Good	Fair	Poor	Good	Fair	Poor
Killam*	225.38	3.34	0.00	21.24%	0.14%	0.00%

Table 3.04d - Spawning Gravel Inventory

Summer Rearing Habitat

Thermal problems severely limit (if not eliminate) available summer habitat within the mainstem Tillamook River. Improving juvenile access to the cold water thermal refugia that Killam Creek provides should be considered a top priority. Although Killam Creek water temperatures exceed 64° F for 13 total days in the summer, temperatures on the mainstem Tillamook not only exceed 64° F for 60 days but the 7 day average maximum exceeds the lethal limit of 70° F. While fish are biologically stressed when water temperatures exceed 64° F for several weeks, temperatures of 70° F cause direct mortality. Additionally, the length of time the mainstem exceeds 64° F is sufficient to also cause mortality due to lowered immunity to parasites and oxygen stress. Abundant spawning habitat is located immediately downstream from the confluence with Killam Creek on the mainstem but summer rearing habitat is limited as a result of these issues. Killam Creek could provide extensive summer rearing habitat were these passage barriers to be addressed.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305m	Conifers >.90M dbh/305m	%Erosion
1	79.0	D30	NA	NA	7.9
2	92.0	D30	NA	NA	3.9
3	98.0	D30	NA	NA	2.0
4	99.0	D30	NA	NA	1.2
5	99.0	D15	NA	NA	3.6
6	100.0	D15	NA	NA	0.0
7	96.0	D30	NA	NA	4.6

Table 3.04e - Killam Creek Riparian Condition

Winter Rearing Habitat

Winter rearing habitat is high for those fish spawned in the high functioning anchor (refer to discussion below) on Killam Creek (as opposed to those spawned on the mainstem as migration is prevented by the culvert) but scour has reduced pool volume outside of this area. There is extensive floodplain disconnection outside of the anchor.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	9.80	2.59	6.20	NA
2	9.20	20.60	32.70	NA
3	8.53	2.94	0.00	NA
4	1.34	0.73	3.00	NA
5	7.38	0.00	0.00	NA
6	3.29	0.00	0.00	NA
7	4.53	0.00	1.10	NA

Table 3.03f - Killam Creek Pool Volumes

Anchor Habitat

There are two anchors within the Killam Creek drainage. A high function anchor site occurs immediately upstream of the mouth (the culvert) on Killam Creek. A mature willow thicket influenced by beaver activity has resulted in a complex unconfined braided channel with excellent spawning, summer and winter rearing habitat, and excellent floodplain connectivity. A tributary enters Killam Creek directly upstream of the mouth. Interaction between highway 101 and a volcanic outcropping have created a large freshwater wetland complex adjacent and connected to Killam Creek. This is a unique habitat feature within the watershed and provides an extremely significant quantity of high quality winter habitat in the Tillamook River watershed.

A low function anchor site begins downstream of the diversion at the forestry-agriculture interface. Primarily owned by the City of Tillamook with some private forestry ownership, the riparian conditions within this anchor are very good and there is excellent potential for future LWD recruitment. Past restoration projects were observed in the anchor and include boulder weirs and wood placement. These projects have resulted in significant aggradation. A second placement of LWD is necessary however to develop an interactive floodplain, scour pools, and sort spawning gravels. The potential in the upper Killam Creek anchor site is incredibly high due to the uniquely broad floodplain and the high LWD and gravel recruitment potential. The reach of the anchor downstream of the municipal water diversion is significantly confined by roads on both sides of the creek. The road to the south is the primary road used to access the diversion. The northern road is no longer used or maintained but houses the municipal water pipe. Bank erosion is a high on the northern road and to achieve proper riparian function the diversion pipe and northern road must be removed. 2005 Coho rearing densities are lower in both the potential anchor and the anchor site than in non-anchor sites. It is likely that densities were incorrectly estimated for the anchor site as a result of the complex pool habitat (refer to previous discussion). However, it is probable that the current spawning habitat available to Coho greatly exceeds (despite being minimal) the available rearing habitat and that the fish spawned in the potential anchor migrated downstream due to a lack of rearing habitat.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
A - Killam (1)	78.78	7.42%	3.34	0.14%	0.00	0.00%
B - Killam (2)	121.80	11.48%	0.00	0.00%	0.00	0.00%

Table 3.04g - Gravel Inventory by Anchor

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
A - Killam (1)	782.19	0.88%	NA	NA	NA
B - Killam (2)	2644.54	2.97%	NA	NA	NA

Table 3.04h - Habitat by Anchor

Potential Restoration Projects

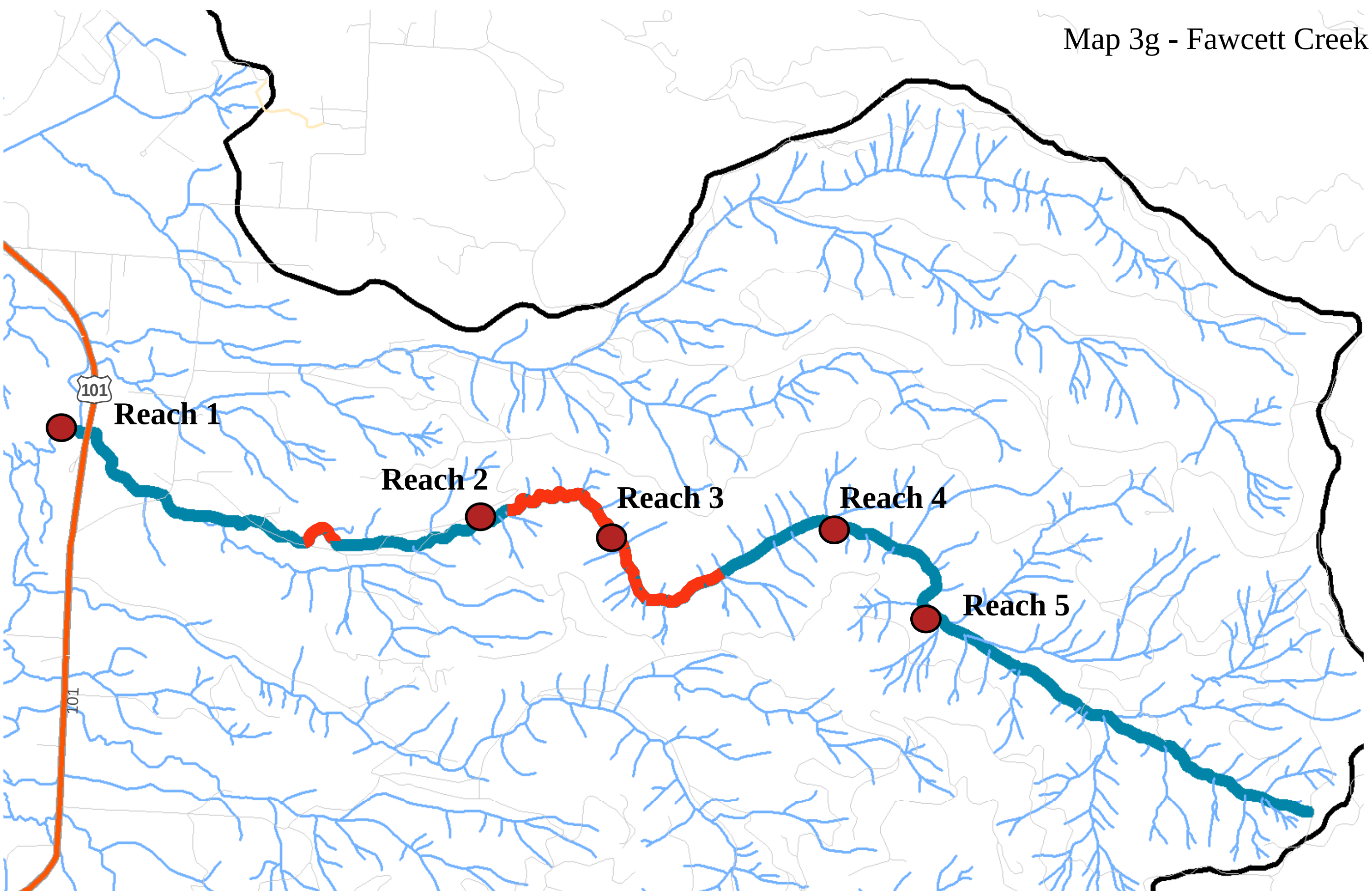
• Wood placement in the potential anchor site for floodplain reconnection and gravel sorting and increased channel complexity

• Removal of the road running on the northern bank to allow for floodplain connection and increased channel complexity

• Culvert removal/update to allow for juvenile and Chum passage to summer rearing habitat

• The high function habitat and its role as a municipal drinking water supply make Killam Creek a top priority for conservation

Section 3.05 - Fawcett Creek



Overview

Fawcett Creek has the potential to support a large Coho population but it is highly impacted by past and current land-use practices. The mouth of Fawcett Creek has the potential for excellent off channel habitat development by supplying the groundwater inputs needed to sustain alcoves or side channels. Additionally gravel deliveries from the upper basin, low gradients, and the potential for floodplain connection could result in spawning habitat were large wood placement to occur at the mouth. Fawcett Creek is always confined by terrace or hill-slope which, below a municipal water diversion, is largely a result of land-use practices. A debris flow during the winter of 2007/2008 resulted in the input of excess sands and fines reducing the quality of the minimally available spawning habitat. This debris flow appears to be the result of an improperly decommissioned road; undersized culverts were not removed and this appears to have changed the ground water regime which caused slumping and ultimately a landslide. Riparian conditions on Fawcett Creek are moderate and shade is minimal below the City of Tillamook water diversion. This municipal water diversion is antiquated and functions as a juvenile passage barrier with a 3' drop at low flow. Land-use impacts to the stream and riparian buffers were common downstream of the water diversion (e.g. LWD removal, degraded riparian vegetation, herbicide applications, and in one case a full spanning artificial dam which functions as a juvenile barrier). Changes to land-use practices and placement of LWD in conjunction with riparian work are needed to restore function to this section, although the potential remains for a future anchor habitat were this to occur. Upstream of the water diversion the potential for restoration effectiveness increases drastically. Although scour is still evident resistant outcrops prevent further downcutting and, in conjunction with abundant hill-slope delivery, has resulted in a more accessible floodplain than downstream of the diversion.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	3595.3	2.5	20.0	MT	US	0.60	1.80
2	1018.5	2.3	3.2	MT	CA	0.50	0.80
3	1988.5	3.7	2.5	MT	US	0.50	0.50
4	1267.9	6.9	1.2	MV	CH	0.40	NA
5	1387.7	9.3	3.0	MT	US	0.50	1.00

Table 3.05a - Fawcett Creek AQI Morphology Data

Spawning Habitat

Spawning habitat is limited in Fawcett Creek due to scour events which significantly reduced wood volume, gravel sorting, and floodplain connection. While spawning occurs from the mouth to ~6 miles upstream before a debris flow prevents passage, it is limited by poor sorting. Spawning has historically occurred beyond this landslide before terminating at a lake. Few conifers are present from the mouth to the middle of the second potential anchor. Conifers upstream of this point provide a good source of long term LWD recruitment, although wood placement is recommended for immediate gravel sorting.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	2714.0	40.0	24.0	2.0	39.0	23.0
2	1003.0	37.0	23.0	2.7	34.0	28.0
3	1876.0	41.0	20.0	7.2	43.0	26.0
4	622.0	36.0	20.0	9.0	47.0	23.0
5	2114.0	35.0	22.0	7.1	37.0	41.0

Table 3.05b - Fawcett Creek AQI Sediment Data

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	2.90	1.90	0.0
2	12.10	16.50	0.7
3	9.70	11.00	0.4
4	21.80	23.20	0.4
5	34.90	38.30	1.7

Table 3.05c - Fawcett Creek Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Fawcett	123.10	15.98	0.00	11.60%	0.68%	0.00%

Table 3.05d - Fawcett Creek Spawning Gravel Inventory

Summer Rearing Habitat

Shade is high throughout Fawcett Creek but there are few large conifers present on the lowest two reaches. Pool volume is very low and off channel habitat is virtually nonexistent in this section resulting in poor winter and summer habitat. In 1997 water temperatures on Fawcett Creek exceeded 64° F for four days.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	72.0	D15	15	0	22.4
2	84.0	D15	12	0	25.8
3	80.0	D15	46	0	9.0
4	84.0	D15	15	0	18.6
5	84.0	D15	41	0	18.4

Table 3.05e - Fawcett Creek Riparian Condition

Winter Rearing Habitat

All reaches of Fawcett are below benchmarks for %Pools, and % Secondary Channels, suggesting a lack of adequate summer and winter rearing habitat. This is consistent with the field observations of channel scour.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	16.60	3.70	0.00	3.00
2	20.20	0.20	0.00	2.00
3	9.90	0.80	0.00	3.40
4	15.50	1.20	0.00	4.30
5	15.70	5.40	0.00	4.00

Table 3.05f - Fawcett Creek Pool Volume

Anchor Habitat

A short, low-function potential anchor site is located at the mouth of Fawcett Creek. Groundwater upwelling, a broad floodplain (disconnected from channel), and land-use practices could allow for extensive spawning, summer, and winter rearing habitat with minor restoration activity. This potential anchor is a small section of private, residential land with a very low floodplain and good sinuosity. No well sorted gravels were observed. AQI surveys indicate that LWD volume is below benchmarks, consistent with recent surveys. AQI surveys indicate good shade values, but recent land use impacts have degraded riparian conditions.

A long low-function potential anchor site originates at the diversion and continues upstream to the debris jam. Well sorted gravels are scarce, off channel habitat and complex pools rare, and floodplain connection is poor. AQI surveys indicate that LWD volume and % Pools are both below benchmarks. This is consistent with recent surveys which reflect a simplified stream channel with limited rearing habitat. It is expected that LWD placement would improve conditions. 2006 Coho rearing densities were lower in this potential anchor than in non-anchor sites on Fawcett Creek suggesting that the minimal pool habitat prevents emergent fry from staying in this potential anchor.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
C - Fawcett (1)	0.00	0.00%	0.00	0.00%	0.00	0.00%
D - Fawcett (2)	76.27	7.19%	3.90	0.17%	0.00	0.00%

Table 3.05g - Fawcett Creek Spawning Gravel Inventory by Anchor

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
C - Fawcett (1)	440.85	0.49%	82.06	25.90	2.31
D - Fawcett (2)	3162.49	3.55%	80.24	18.90	5.05

Table 3.05h - Fawcett Creek Habitat by Anchor

Potential Restoration Projects

• Instream placement and riparian improvement
• Culvert replacement
• Water diversion replacement

Section 3.06 - Simmons Creek

Map 3h - Simmons Creek

Overview

Simmons Creek is dominated by a cobble substrate and poorly sorted gravels, and is always confined by terraces and/or hill-slopes. The historic floodplain is very broad but the current channel is incised and contains minimal off channel habitat. Riparian condition is poor from the mouth to highway 101 exhibiting minimal future recruitment potential. A small spring fed tributary enters Simmons within 20 meters of the mouth. Field surveys suggest that historically the mouth of Simmons consisted of multiple braided channels and wetland habitat (much like the mouth of Killam Creek) but that channel entrenchment has created a simplified single channel. There is potential to restore function in this reach but riparian setbacks, large wood placement, and plantings would need to occur (which may be limited by land-use practices). Simmons passes through a properly sized concrete box culvert. A historical lumber mill was located immediately to the east of highway 101 (on both sides of the stream) but the property is currently rural residential. A remnant dike and settling pond is present on the north side of Simmons Creek. Landowner accounts indicate that small splash dams were built on Simmons Creek to clear debris that accumulated on a yearly basis. This is consistent with existing scour. The current lack of LWD in the system may also be a result of the limited LWD recruitment potential.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	3375.8	1.8	18.9	MT	US	0.70	0.60
2	3490.4	4.4	1.8	MV	CH	0.70	1.10
3	473.8	1.5	3.3	MT	UA	0.50	0.30
4	1516.0	21.7	1.4	SV	CH	0.70	0.40

Table 3.06a - Simmons Creek AQI Morphology Data

Spawning Habitat

Current spawning habitat within the area surveyed (access was denied to ~1 mile of stream) is minimal although potential is high. Additionally snorkel survey (for which access was granted) results imply that gravel quantity is much greater than LFA surveys estimated. An alternate hypothesis is that the juveniles observed in Simmons Creek had entered the creek seeking cold-water, however snorkel surveys were conducted in early summer prior to the temperature peak this hypothesis is less likely. Past AQI surveys indicate that LWD values are within benchmarks but recent field surveys suggest that multiple high water events since 1995 have flushed a significant component of the wood out of the system both scouring the channel and limiting gravel sorting.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	454.0	29.0	45.0	1.0	19.0	56.0
2	1393.0	22.0	31.0	5.3	18.0	41.0
3	4.0	36.0	41.0	0.0	28.0	43.0
4	1157.0	13.0	17.0	19.1	20.0	40.0

Table 3.06b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	17.40	13.90	0.4
2	26.20	32.20	1.0
3	26.00	28.50	0.7
4	27.90	30.20	0.6

Table 3.06c - Wood Volumes

Stream	Good	Fair	Poor	Good	Fair	Poor
Simmons*	53.42	0.00	0.00	5.03%	0.00%	0.00%

Table 3.06d - Spawning Gravel Inventory

Summer Rearing Habitat

Pool volume is low (%Pools below benchmarks) and floodplain connectivity is poor throughout Simmons Creek limiting rearing habitat. Additionally, riparian condition on rural residential and agricultural ownership is moderate with less than 60% shade provided primarily by shrubs and alders. Shade values on private timber ownership are good although no conifers above 50 cm DBH were observed.

Reach	% Shade	Dominant Veg	Conifers > .50M dbh/305M	Conifers > .90M dbh/305M	% Erosion
1	75.0	D15	0	0	30.1
2	89.0	D15	0	0	14.9
3	84.0	D15	0	0	10.4
4	94.0	D15	0	0	17.1

Table 3.06e - Riparian Condition

Winter Rearing Habitat

Winter rearing habitat is currently minimal with %Pools below benchmarks and no current side channel habitat, although potential is high. Multiple storm events have scoured the system to bedrock downstream of the forestry boundary. This suggests that key pieces are needed throughout the stream network to catch any debris moved during these high water events. In addition to providing winter rearing habitat, increased floodplain connectivity through wood placement might result in mitigated flood impacts on lands not managed for timber.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	17.00	0.00	7.70	3.80
2	15.00	2.00	4.10	3.80
3	14.00	0.00	16.40	0.00
4	4.40	0.00	2.50	0.90

Table 3.06f - Pool Volume

Anchor Habitat

There is potential to support all lifestages of Coho salmon from the mouth of Simmons Creek to highway 101 but this anchor is currently functioning very poorly. The substrate is cobble dominated, with minimal spawning resources (due to lack of sorting). The historic floodplain is very broad, but the current channel is incised and has minimal off-channel habitat. As a consequence, spawning, summer, and winter rearing habitat is currently minimal, although potential is high. Riparian condition is poor throughout this section, with minimal future recruitment potential. AQI surveys indicate that LWD volume is below benchmarks. Measured % Pools is not consistent with recent surveys, suggesting a change in conditions.

A second low-functioning anchor site begins at the forestry-agriculture interface. Well sorted gravels are limited, complex pools and floodplain interaction is rare, although the potential exists for all three to increase dramatically. Riparian condition as well as potential for future recruitment and floodplain connection is high however. AQI surveys indicate that LWD volume is below benchmarks. % Pools is below benchmarks. This is consistent with recent surveys which reflect a simplified stream channel with limited rearing habitat. Gravels counted for this survey are low, but this is likely a result of access denial to a large stretch of Simmons; the gravels counted for this survey are not sufficient to produce the numbers of juvenile Coho observed.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
E - Simmons (1)	31.12	2.93%	0.00	0.00%	0.00	0.00%
F - Simmons (2)	22.29	2.10%	0.00	0.00%	0.00	0.00%

Table 3.06g - Simmons Creek Spawning Gravel Inventory by Anchor

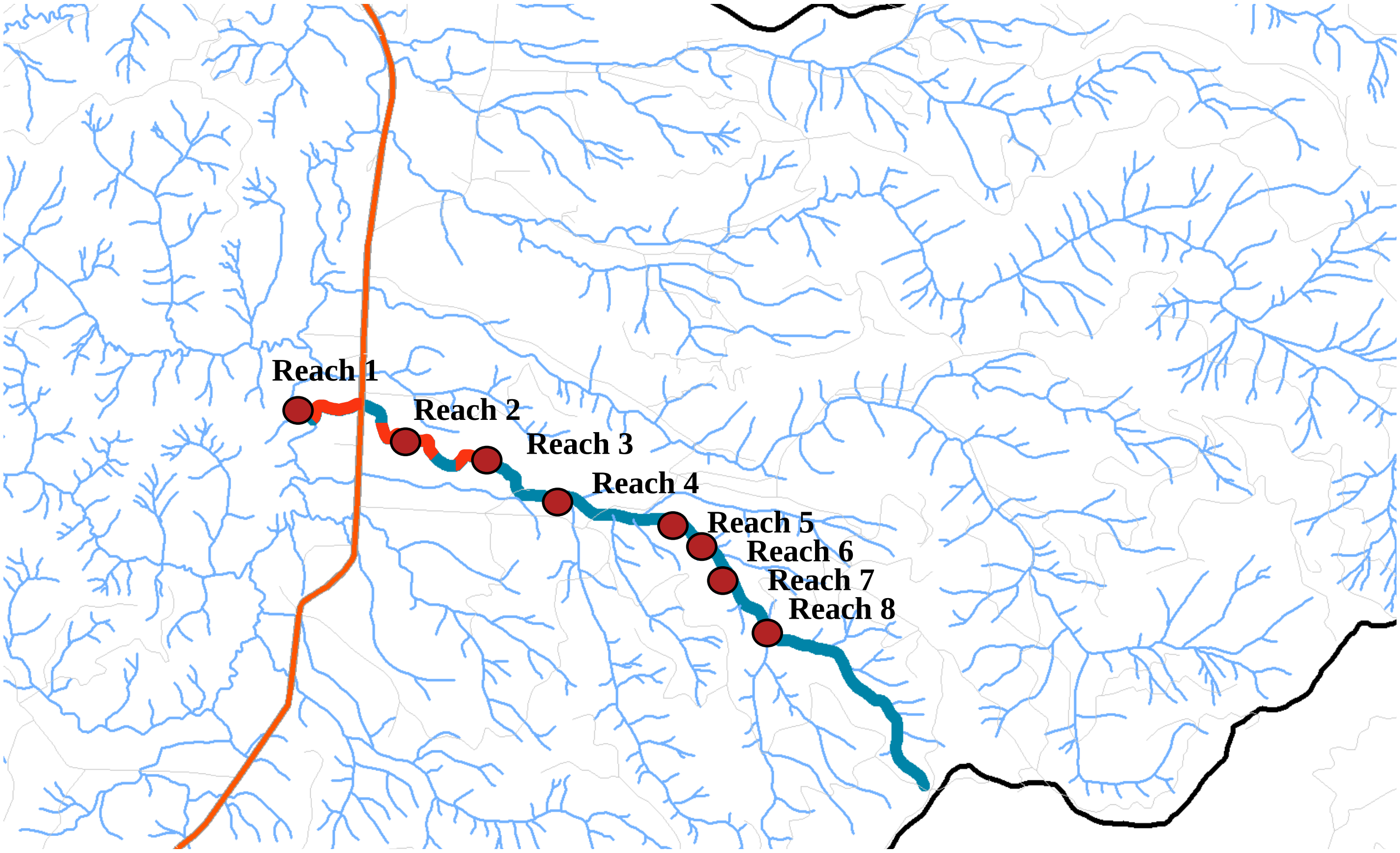
Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
E - Simmons (1)	411.83	0.46%	72.77	38.56	2.20
F - Simmons (2)	3059.12	3.43%	78.27	14.30	5.22

Table 3.06h - Simmons Creek Habitat by Anchor

Potential Restoration Projects

- Lower anchor channel redesign
- Instream wood placement
- Removal of fish weir. Although surveyors were denied access to the reach of stream containing this weir a landowner has suggested this as a potential project.

Section 3.07 - Munson Creek



Map 3i - Munson Creek

Overview

Munson Creek is dominated by a resistant geomorphology and is the last significant upstream eastern tributary which provides significant gravels to the mainstem Tillamook River. Similar to the three eastern tributaries downstream of Munson Creek, land-use is dominated at the mouth by mixed rural residential and agriculture with forestry (private and public) dominating the higher gradient reaches. Munson Creek is confined by hill-slope or terraces as a result of downcutting and land-use practices; CHT modeling suggests that the lowest reaches should be unconfined. Although AQI surveys indicate that LWD volumes are low throughout all of Munson, recent field surveys suggest otherwise. Channel roughness in the first high function anchor is provided by living willows and beaver impoundments neither of which are accounted for in AQI wood volumes. Immediately upstream of the first willow-beaver complex, wood volumes are reduced as is documented in the AQI surveys. High LWD volumes in the second anchor are attributed to windthrow having occurred after the AQI surveys were conducted in addition to beaver activity. Immediately upstream of the second anchor wood volumes fall again and are low until a recent wood placement project (2007). This LWD placement project was recently completed along with fish passage improvements on a reach of stream with forestry and non-forestry ownership. Although the wood placed added complexity to the higher gradient reach, a recent timber harvest severely degraded an otherwise intact riparian condition in a reach which could have been considered a potential anchor. The mature conifer forest was thinned drastically; water temperatures on Munson Creek had already exceeded water quality standards prior to this operation. Downstream shade and future LWD recruitment potential are poor to moderate (conifers are rare in reaches 1 and 3) and this thinning reduced that potential further.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	921.8	1.3	20.0	MT	US	0.30	0.40
2	877.6	1.8	20.0	CT	TC	0.40	0.60
3	522.7	2.2	18.0	MT	US	0.40	0.60
4	710.8	2.9	14.8	CT	CA	0.30	0.60
5	488.1	5.5	6.0	MT	US	0.30	0.50
6	132.5	84.8	1.0	MV	CH	0.40	NA
7	296.2	7.4	1.9	MV	CH	0.40	0.30
8	1213.5	12.5	1.1	MV	CH	0.30	0.50

Table 3.07a - Munson Creek AQI Morphology Data

Spawning Habitat

Spawning habitat potential is high and is in similar condition to Killam, Fawcett, Simmons creek. Downcutting and minimal key pieces have resulted in poor sorting throughout most of the stream however sorting is good from the mouth to highway 101 (anchor 1) as a result of a willow-beaver complex and in two other anchors which occur intermittently upstream. It is likely that a minor increase in spawning habitat will result from the 2007 wood placement although this placement occurred so high in the watershed that it is unlikely to have any significant impact on salmonid populations. Were this wood to migrate downstream and allowed to settle in lower gradient reaches with broader floodplains (unlikely given current non-forestry land-use practices) then more spawning habitat may be made available and the size of anchor 3 may increase.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	4.0	45.0	29.0	0.0	37.0	30.0
2	0.0	47.0	25.0	0.0	34.0	29.0
3	2.0	38.0	28.0	0.0	28.0	29.0
4	54.0	37.0	29.0	0.1	29.0	32.0
5	253.0	31.0	25.0	0.3	31.0	26.0
6	50.0	14.0	12.0	47.2	19.0	18.0
7	386.0	29.0	23.0	9.7	25.0	24.0
8	466.0	24.0	23.0	11.9	29.0	30.0

Table 3.07b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	4.00	1.50	0.0
2	10.80	6.10	0.3
3	9.60	9.90	0.7
4	17.20	14.30	0.2
5	29.00	30.90	1.4
6	39.90	62.70	1.9
7	48.50	38.80	0.3
8	30.20	17.60	0.1

Table 3.07c - Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Munson	295.71	28.80	0.00	27.86%	1.24%	0.00%

Table 3.07d - Gravel Inventory

Summer Rearing Habitat

AQI surveys indicated that shade is below benchmarks for the lowest three reaches however recent surveys found that shade is high throughout the functional anchor sites. Unfortunately a large reach of previously intact mature riparian forest was recently thinned. Additionally pool volume is low except in the three anchor areas.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	29.0	D30	0	0	46.6
2	46.0	D30	122	0	34.3
3	58.0	D15	0	0	40.2
4	75.0	D30	0	0	46.4
5	75.0	C50	61	0	43.4
6	67.0	M50	0	0	0.0
7	84.0	C50	122	0	39.1
8	83.0	D30	0	0	9.2

Table 3.07e - Riparian Condition

Winter Rearing Habitat

AQI Pool volume (%Pools) and side channels are both above benchmarks throughout the first 4 reaches surveyed. Slack water pool volume is particularly high in reach 2.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	30.10	0.20	4.00	3.10
2	38.10	16.20	8.30	4.60
3	22.80	0.00	4.80	1.50
4	37.10	0.00	8.40	1.50
5	11.50	0.00	3.90	0.00
6	0.00	0.00	0.00	0.00
7	11.50	0.00	11.80	0.00
8	2.20	0.00	6.30	0.00

Table 3.07f - Pool Volume

Anchor Habitat

There are two high function anchors and one small (280 meters) moderate function anchor identified. A highly functional anchor site originates at the mouth of Munson Creek and extends to highway 101. Abundant bedload delivery interacts with a dense, mature willow community to form complex habitat. Well sorted spawning gravels, riparian cover, and high quality summer and winter habitat are abundant. Few conifers are present however and almost all shade is provided by the shrub community. A local landowner is currently using a section of this anchor as a ford for his vehicles.

A second highly functional anchor site occurs midway between the mouth and Munson Creek Falls. It is strongly influenced by past and present beaver activity. Large spruce are common throughout anchor 2 and many have recently fallen into the stream due to the windstorm in 2007 resulting in additional channel complexity and floodplain connectivity, as are well sorted gravels and complex pool habitat. Recruitment potential and current riparian condition is also very high.

The final anchor is located below a recent wood placement project. Although function within the LWD placement project will likely improve over time, it is not included in the third anchor due to a reach between the two areas that is impacted by land-use practices. Monitoring of the reach where wood placement occurred is recommended to validate the classification of anchor habitat. It is likely that all of Munson Creek below the falls could be an anchor if function is restored and land-use practices change. The wood placement project occurred in a reach that would likely need multiple LWD placements to achieve the desired results; if this wood placement raises the status of this reach to an anchor site then other reaches on Munson Creek should be considered potential anchors with the only limiting factor being land-use.

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
H - Munson (1)	441.96	0.50%	34.33	33.16	0.12
I - Munson (2)	609.60	0.68%	32.25	29.96	1.46
J - Munson (3)	280.42	0.31%	51.39	30.60	2.23

Table 3.07g - Munson Creek Habitat by Anchor

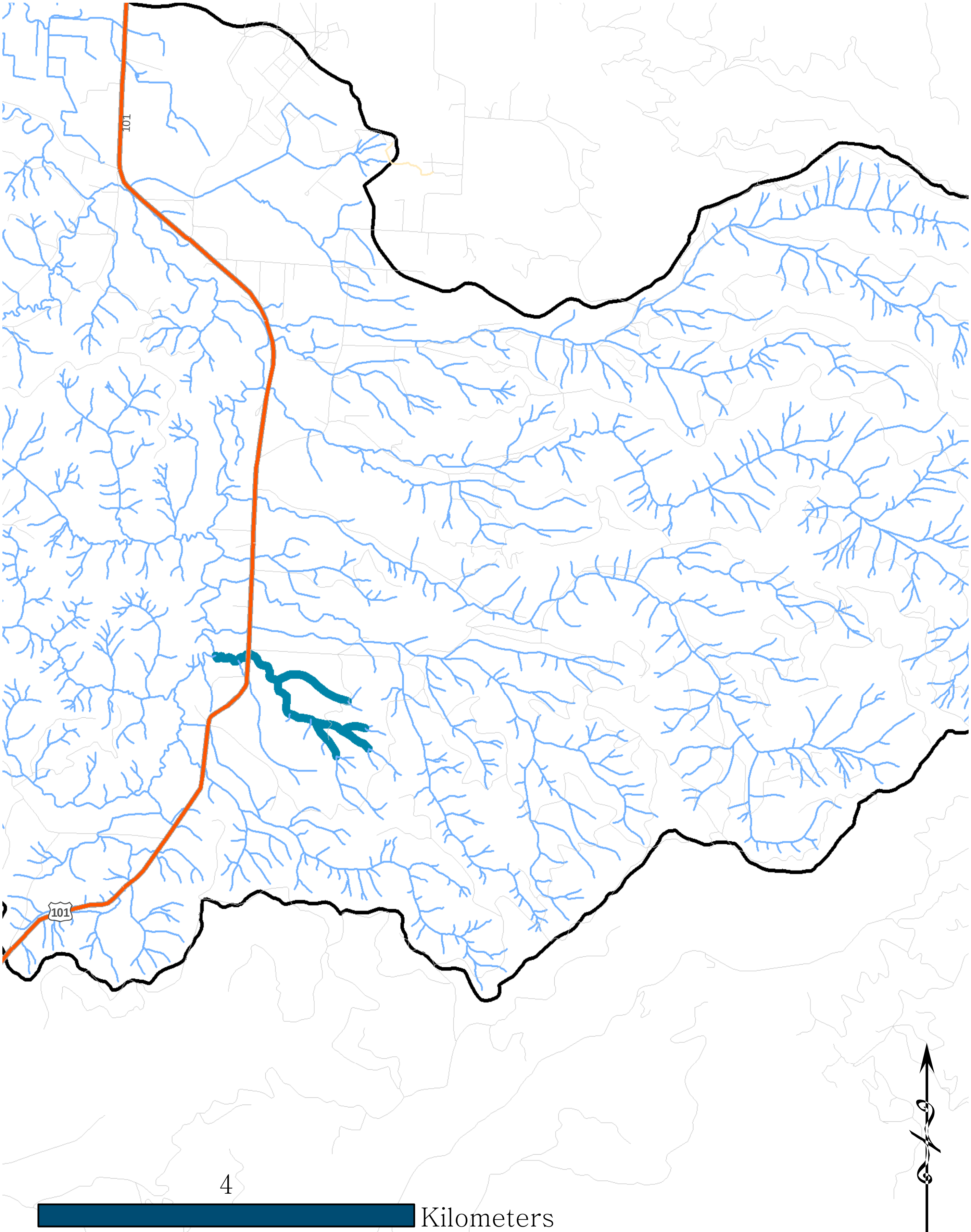
Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
H - Munson (1)	121.98	11.50%	0.00	0.00%	0.00	0.00%
I - Munson (2)	49.05	4.62%	1.67	0.07%	0.00	0.00%
J - Munson (3)	3.34	0.32%	0.00	0.00%	0.00	0.00%

Table 3.07h - Munson Creek Spawning Gravel Inventory by Anchor

Potential Restoration Projects

• Instream placement on upper anchor

Section 3.08 - Pleasant Creek



Map 3j - Pleasant Creek

Overview

Pleasant Creek is the smallest stream surveyed for this assessment but represents a high percentage of production potential. The headwaters of Pleasant Creek drain a resistant valley but is too small to provide substantial bedload to the mainstem Tillamook River. Although the lithology layer indicates the majority of the stream channel is surficial and alluvial deposits, the parent material is of a volcanic nature. Well sorted gravels are abundant in the lowest reach from the mouth to highway 101. Land-use impacts similar to those found on Mills Creek have resulted in a riparian condition which is poor to moderate on land managed for agriculture and residential uses. Riparian condition is much improved on forestry land. A culvert at RM 0.5 is actively failing and needs replacing.

Spawning Habitat

Spawning habitat is abundant on Pleasant Creek. The moderate to low gradients and abundant bedload found throughout Coho distribution allow for gravel sorting despite land-use practices which, as they have on other streams, might have reduced this habitat. Further, a small (2 meters wide at most) tributary of Pleasant Creek also provides spawning habitat although not nearly as much as the mainstem.

Stream	Good	Fair	Poor	Good	Fair	Poor
Pleasant Valley*	18.58	0.00	0.00	1.75%	0.00%	0.00%

Table 3.08a - Gravel Inventory

Summer Rearing Habitat

Rearing habitat improves on land managed for forestry with abundant pool habitat. Juvenile Coho densities are very high in this area although this is partly an artifact of the small stream size. Rearing habitat in rural residential and agricultural ownership is mixed. Pools are present but are not complex. Riparian condition is poor to moderate with many invasive weeds present along the banks, few conifers of substantial size, and deep entrenchment. Once land-use becomes forestry riparian conditions improve.

Winter Rearing Habitat

The small stream size improves winter rearing potential; although complex pools and side channel habitat is not abundant on non-forestry land it is likely that fewer Coho would be washed out during high flows than on a larger stream in similar condition.

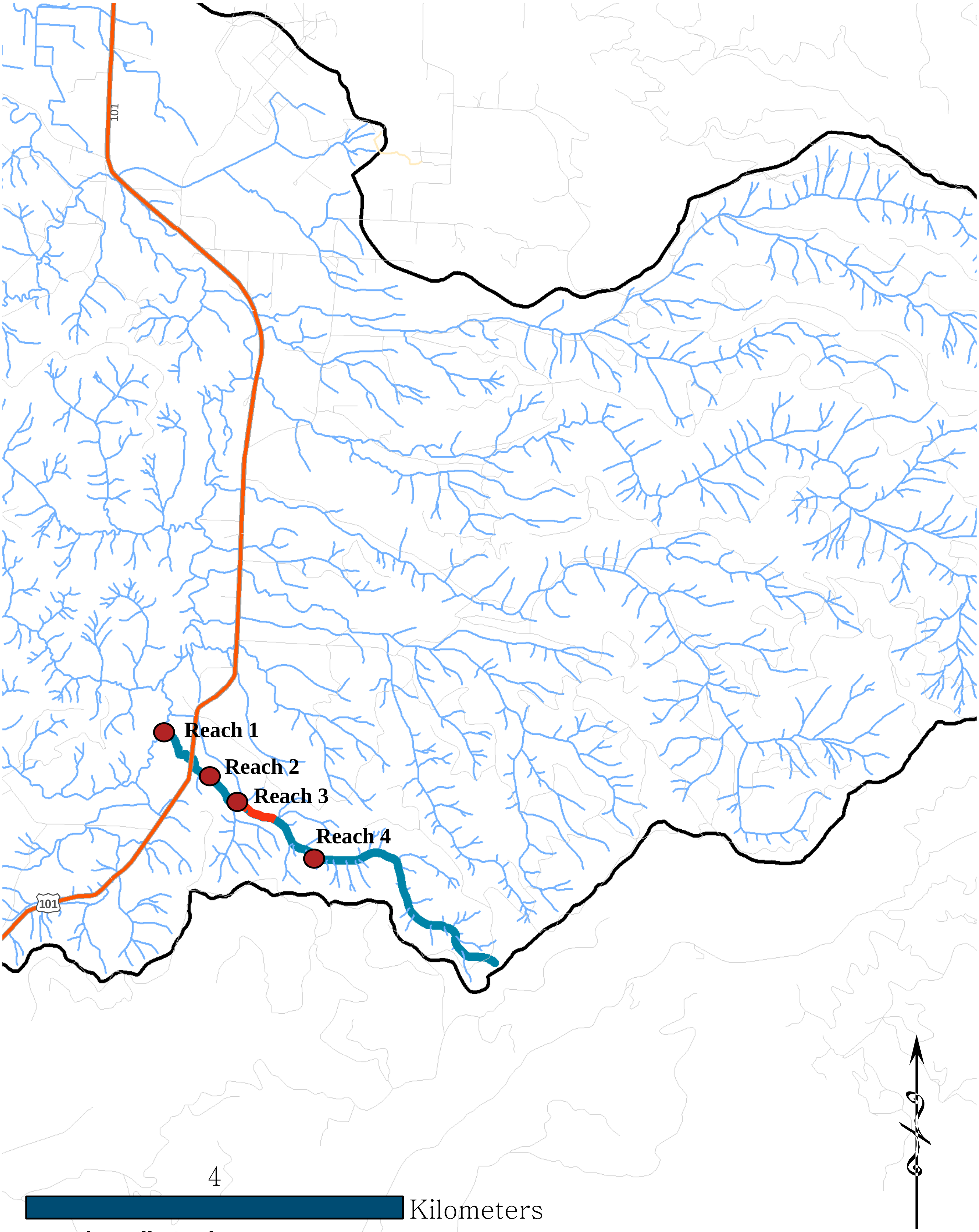
Anchor Habitat

Although the high function of Pleasant Creek merits conservation actions, no anchors were delineated in this stream.

Potential Restoration Projects

• Conservation of this stream is a high priority

Section 3.09 - Mills Creek



Map 3k - Mills Creek

Overview

Mills Creek is the final upstream eastern tributary and drains a resistant valley, although it is too small to provide significant gravels to the mainstem Tillamook. From the mouth to highway 101 Mills Creek flows through active agricultural land. Riparian condition is extremely poor, lacks riparian setbacks, and streamside herbicide applications were frequent. BYPP has planted a section east of the highway and this area is recovering. Pools and woody debris are limited and the channel entrenched although the stream is sinuous. Mills Creek passes through an adequate concrete box culvert before continuing through residential property and finally into forestry ownership. Entrenchment and poor riparian conditions continue until the confluence with a major tributary. This tributary contains freshwater wetland habitat with extensive beaver influence and potential cold water resources (no temperature data is available). Conifers are very rare in all reaches with riparian habitat being predominantly hardwoods. Future recruitment potential for conifers is very low, but the dense hardwood stands do provide shade in forestry dominated stream reaches.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	655.3	0.8	20.0	CT	TC	0.30	0.80
2	466.4	2.4	18.8	CT	CA	0.40	0.50
3	709.6	4.9	13.3	MT	US	0.20	0.30
4	464.0	9.3	2.4	MV	CH	0.30	0.40

Table 3.09a - Mills Creek AQI Morphology Data

Spawning Habitat

Although land-use impacts are present, the gradient, stream size, and contributing geology (volcanic) allow for well sorted spawning gravels at the mouth. LWD volume is below benchmarks in the first three reaches. Upstream of the mouth where gradients are higher and wood volumes remain low, spawning gravels are rare.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	10.0	22.0	30.0	1.0	14.0	32.0
2	12.0	29.0	31.0	0.0	23.0	36.0
3	158.0	31.0	30.0	0.3	41.0	33.0
4	77.0	27.0	25.0	13.7	34.0	35.0

Table 3.09b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	0.80	0.50	0.0
2	8.30	5.10	0.0
3	15.60	12.60	0.5
4	34.00	33.60	0.3

Table 3.09c - Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Mills	94.85	12.26	1.58	8.93%	0.52%	0.80%

Table 3.09d - Gravel Inventory

Summer Rearing Habitat

Shade values are below benchmarks for reach 1, but very close in reaches 2-4. The natural growth expected over a 10+ year period accounts for the good shade values observed during recent surveys. This shade is almost always provided by hardwoods and future conifer recruitment potential is low.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	75.0	D15	0	0	30.1
2	89.0	D15	0	0	14.9
3	84.0	D15	0	0	10.4
4	94.0	D15	0	0	17.1

Table 3.09e - Riparian Condition

Winter Rearing Habitat

AQI surveys indicated that pool volume was high as was channel complexity (% Slack Pools was high for reach 1 & 2, % Secondary Channels were high for all reaches, and % Pools were above benchmarks for the first two reaches, and below for the next two). However, recent surveys found that pool and side channel habitat was low for all reaches. Reach 1 is essentially a riffle with no pool habitat. It is likely that land-use practices have reduced this habitat resulting in channel entrenchment. Juveniles produced in Mills Creek must seek summer and winter habitat elsewhere in the watershed due to the lack of pools.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	23.80	2.90	2.90	0.00
2	17.60	0.10	4.80	0.00
3	5.80	0.00	4.80	0.00
4	3.90	0.00	9.90	0.00

Table 3.09f - Pool Volume

Anchor Habitat

A moderate function potential anchor site originates on the main channel just past the confluence with the main tributary (roughly reaches 2 and 3). Beaver activity and a dense hardwood community provide good floodplain connectivity although coniferous woody debris recruitment potential is very low. Well sorted gravels are rare. Stream function appears to be improving naturally and conservation of this stream reach is a priority. The high % Secondary Channels is consistent with the channel complexity observed in the Anchor Site. AQI surveys indicate that LWD volume is below benchmarks. % Pools is below benchmarks. Rearing densities were very high in 2007 and 2006. This may reflect an upstream migration of juveniles from the abundant well sorted gravels present near the mouth of Mills.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
K - Mills	8.36	0.79%	6.69	0.29%	0.00	0.00%

Table 3.09g - Mills Creek Habitat by Anchor

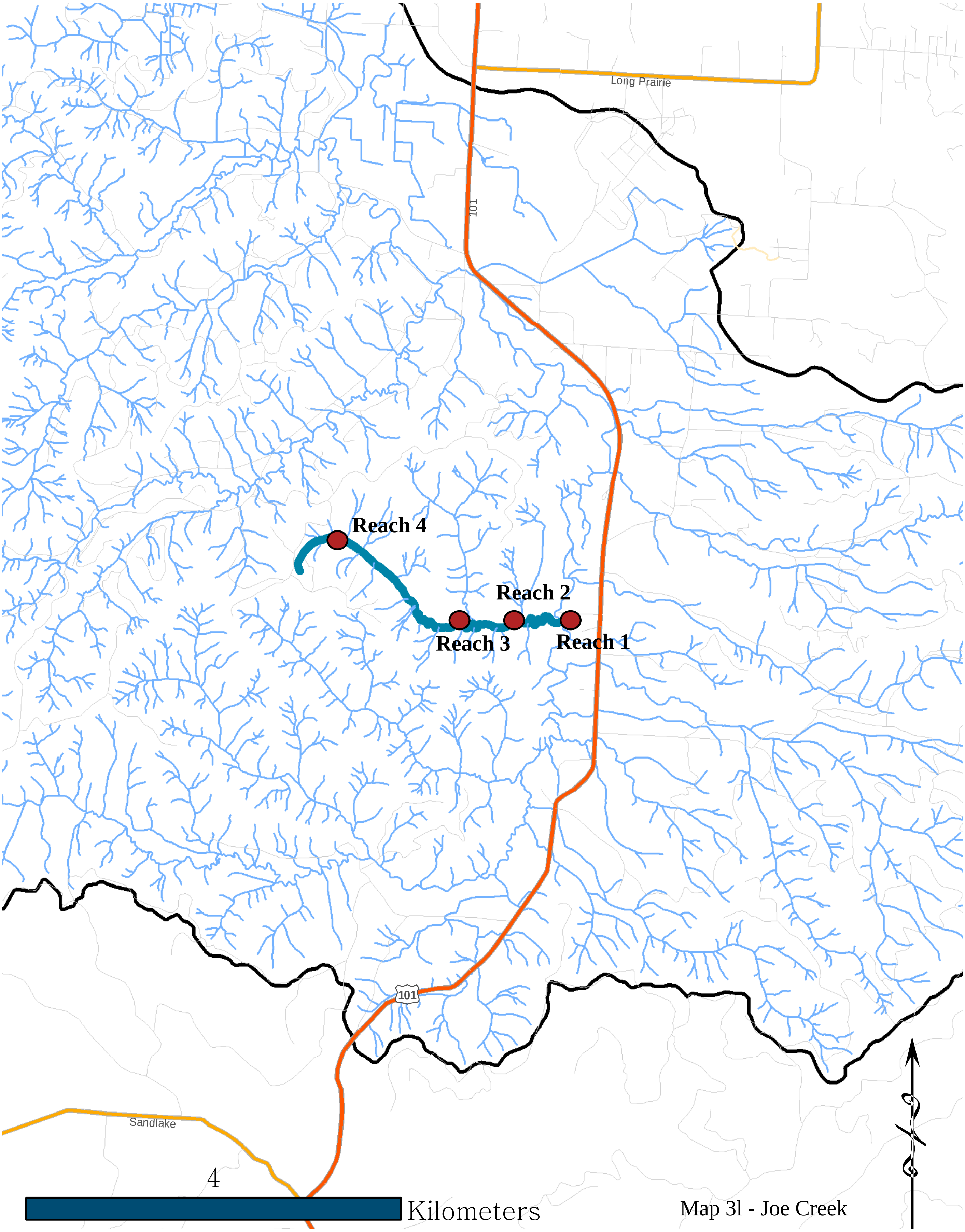
Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
K - Mills	601.17	0.67%	70.51	7.47	3.14

Table 3.09h - Mills Creek Spawning Gravel Inventory by Anchor

Potential Restoration Projects

• Changes in land use (i.e. conservation and riparian set backs) could improve conditions.

Section 3.10 - Joe Creek



Map 3l - Joe Creek

Overview

Joe Creek is the last upstream western tributary, drains a highly erodible geology, and is strongly influenced by past and present beaver activity (beaver activity is present from the mouth to the headwaters). Sinuosity is very high, and channel entrenchment is common where beaver are not actively maintaining dams. The furthest downstream reach of Joe Creek is managed for agriculture and is almost completely unshaded. Some riparian planting has recently occurred but it is not sufficiently dense, complex, or deep enough to improve stream function. Additionally numerous invasive species (Blackberry, Scotch Broom, and Invasive Iris) are present. Recent surveys indicate that much of the hydraulic roughness is provided by small wood embedded in the stream channel or bank (as is true with many west side tributaries in the Tillamook River watershed).

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	508.2	0.6	20.0	CT	TC	0.30	1.50
2	516.2	0.8	15.0	CT	CA	0.30	0.80
3	1857.6	0.9	1.0	WF	US	0.10	NA
4	310.6	2.1	4.0	MT	US	0.10	0.30

Table 3.10a - Joe Creek AQI Morphology Data

Spawning Habitat

Spawning potential for Coho is almost nonexistent in this stream, although Brook Lamprey were observed. It is likely that Joe Creek would historically provided abundant rearing habitat for fish spawning in other tributaries or the mainstem Tillamook River.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	0.0	79.0	17.0	0.0	76.0	20.0
2	0.0	84.0	14.0	0.0	83.0	15.0
3	0.0	91.0	9.0	0.0	91.0	9.0
4	0.0	89.0	11.0	0.0	89.0	11.0

Table 3.10b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	6.30	2.50	0.0
2	8.70	6.80	0.5
3	26.70	9.40	0.2
4	16.40	5.00	0.0

Table 3.10c - Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Joe	0.00	0.37	0.00	0.00%	0.00%	0.00%

Table 3.10d - Gravel Inventory

Summer Rearing Habitat

Shade values are low throughout Joe Creek. Discussions with local land managers indicate that planting of many species is limited to those tolerant of wetlands and saturated soils (ie willows and spruce). Conifers are very rare throughout Joe.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	26.0	D30	0	0	27.0
2	54.0	G	0	0	74.0
3	35.0	G	20	0	9.1
4	26.0	D3	0	0	64.0

Table 3.10e - Riparian Condition

Winter Rearing Habitat

Winter rearing potential is high due to the slow water and numerous beaver impoundments. Pool volume is lowest where beaver dams are not maintained (% Pools is below benchmarks in reaches 1& 3 and above benchmarks in reaches 2 & 4). LWD volume is below benchmarks for all but reach 4. Additionally the poor riparian condition and significant lack of shrubs may limit beaver activity in the future as food supplies run short.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	20.10	20.10	4.70	6.30
2	9.70	7.30	3.20	4.90
3	42.20	40.40	1.20	7.90
4	7.80	7.80	0.00	0.00

Table 3.10f - Pool Volume

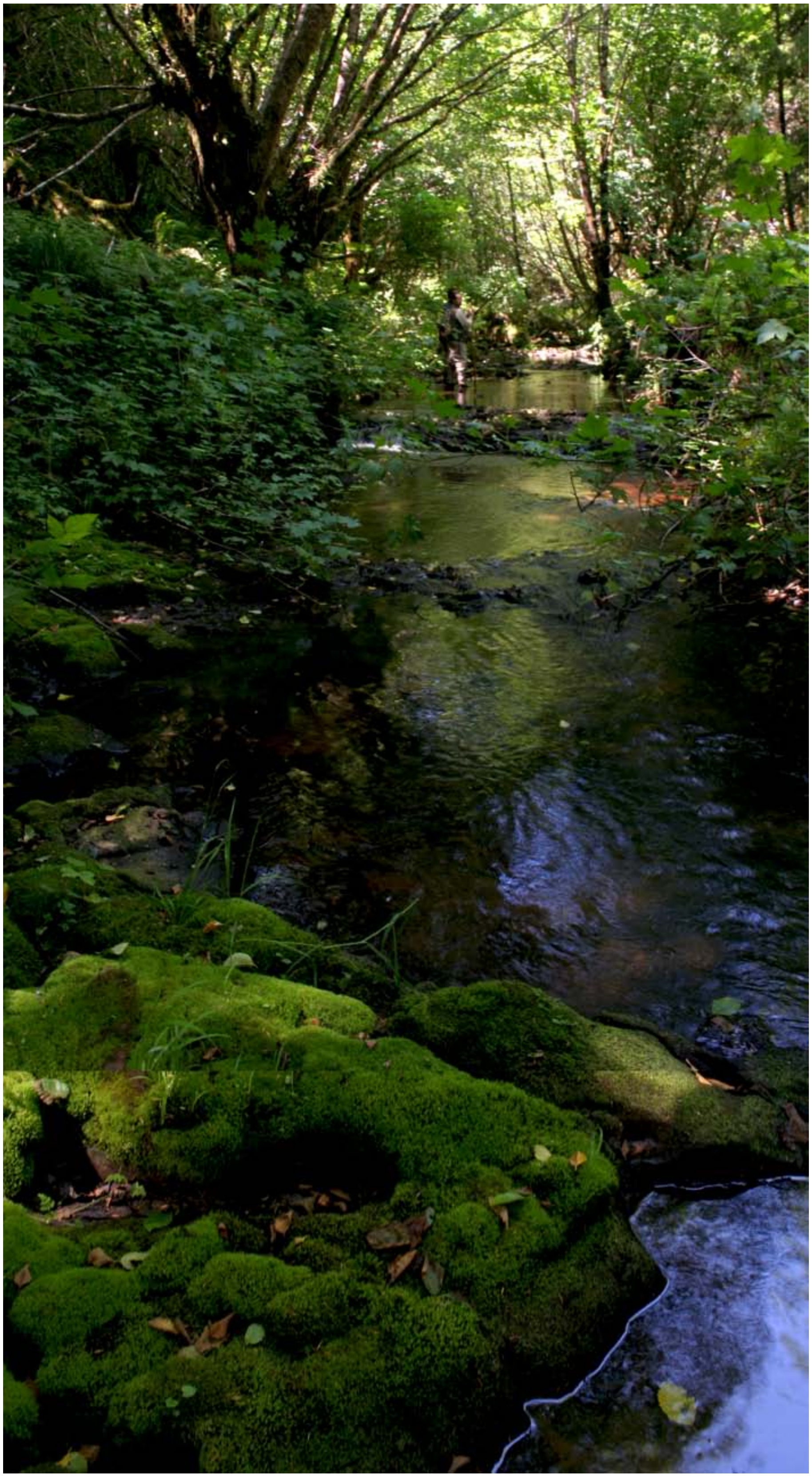
Anchor Habitat

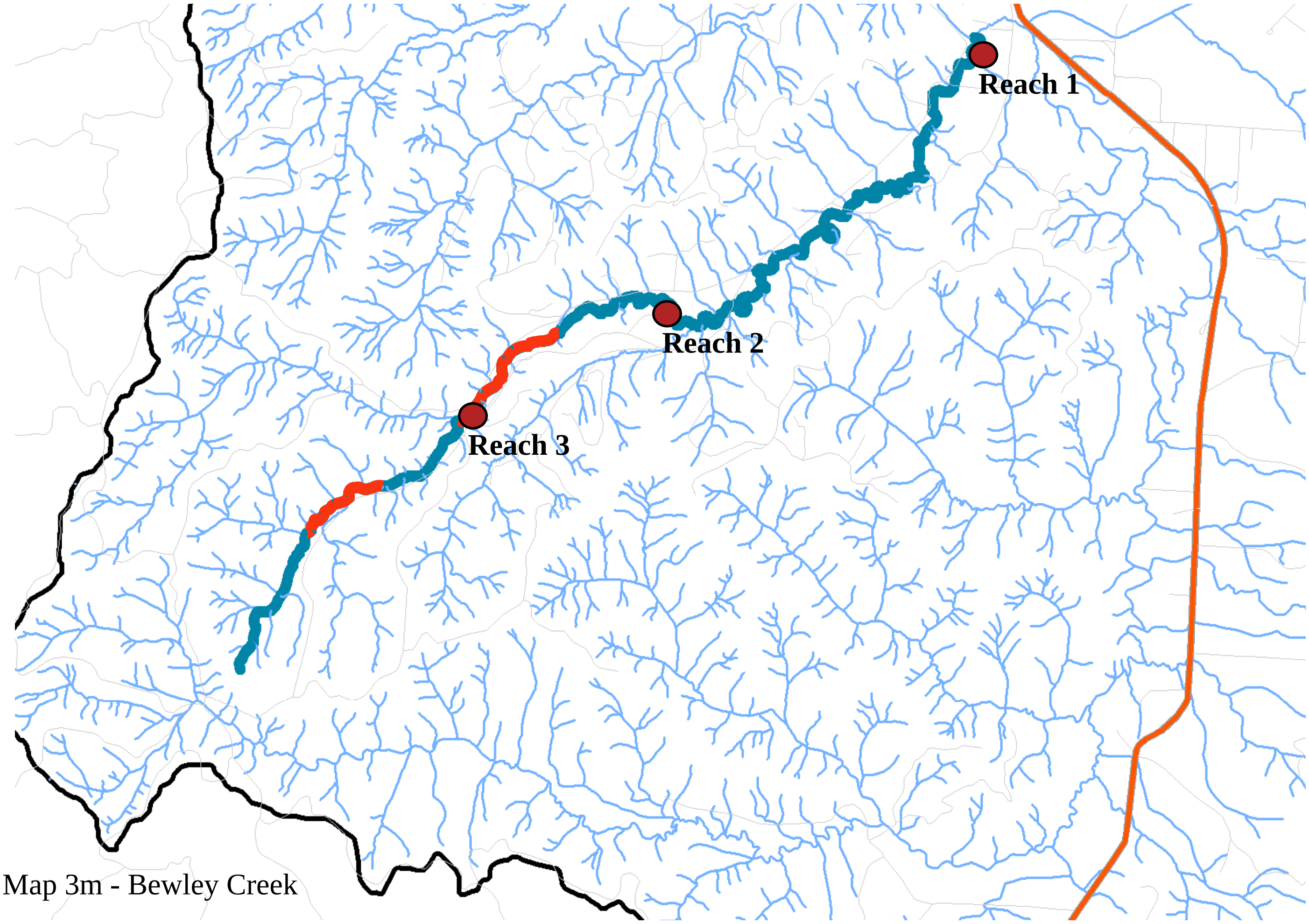
It is unlikely that any spawning habitat would be available on Joe Creek given the lithology and gradients.

Potential Restoration Projects

• Planting of hydrophilic shrubs and trees to address shade concerns

Section 3.11 - Bewley Creek





Map 3m - Bewley Creek

Overview

Bewley Creek is the largest western tributary and drains a mixed lithology (predominantly erodible with resistant outcroppings). Entering the mainstem downstream of Killam Creek and at the head of tide, Bewley Creek contains the longest functional reach within the entire Tillamook River watershed. Land-use from the mouth to the forestry boundary are mixed rural residential and agricultural. These reaches are characterized by low gradients, a sinuous channel, and a poor to moderate riparian canopy. The entire stream is confined by hillslope or terrace. CHT modeling indicates that reaches 1 & 2 should be unconfined. While agricultural and residential ownership riparian conditions are low, conditions on forestry ownership are good with well sorted spawning gravels, complex pools, and side channel habitat frequent. LWD recruitment potential is good on land managed for forestry. Spawning gravels (basalt and sand/silt/mudstone) begin to appear at the confluence with Coates Creek, one of three tributaries providing important spawning and rearing habitat. The second tributary providing this habitat meets with Bewley upstream of the road crossing upgraded in the summer of 2008 by Stimson Lumber. In addition to providing some spawning and rearing habitat, this tributary has an active slump (with an associated spring) near the upper end of Coho distribution which can provide future inputs of LWD. Bewley Creek is often entrenched upstream of this tributary junction and the condition of the riparian area suggests that multiple timber harvests (to the channel) severely depleted the potential for LWD inputs and thus floodplain connectivity. A third major tributary meets with Bewley Creek and is characterized by an extensive series of beaver dams which have impounded the mouth. Fish passage is possible through this dam but does not appear to happen every year (estimated at 1 in 4). Nonetheless the winter rearing potential is very high, and conservation is a priority.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	4035.7	0.3	16.3	CT	TC	0.70	2.30
2	1864.9	0.6	3.9	MT	CA	0.80	1.50
3	2562.8	1.7	2.2	MV	CH	0.70	1.00

Table 3.11a - Bewley Creek AQI Morphology Data

Spawning Habitat

LWD volume is well below benchmarks in reach 1, close but below in reach 2, and well above in reach 3 and this was validated by recent surveys. Spawning gravels sort when resistant materials are most present and gradients are greater than .5%. Three tributaries also provide significant spawning habitat.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	31.0	62.0	17.0	9.0	40.0	35.0
2	26.0	45.0	32.0	13.8	26.0	52.0
3	60.0	55.0	35.0	4.1	39.0	51.0

Table 3.11b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	10.30	7.30	0.1
2	16.40	15.50	0.6
3	27.50	33.00	1.2

Table 3.11c - Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Bewley	23.04	291.72	30.47	2.17%	12.56%	15.51%

Table 3.11d - Gravel Inventory

Summer Rearing Habitat

Given the riparian conditions of upper Bewley Creek it is unlikely that thermal problems exist (no temperature data) however it is likely that they are present downstream of forestry ownership as a result of minimal shade (% Shade is well below in reach 1, close in reach 2, and above in reach 3). Although the AQI data available indicates that shade values are high for most of upper Bewley, large swaths of private non-industrial ownership remain unshaded for ~1/4 mile. More data is needed to determine if this is causing temperature impairment. Summer rearing habitat in the lower mainstem is degraded with grass being the dominant vegetation, high erosion, low shade values. This is reflected by the low summer Coho abundance.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	35.0	G	30	10	44.9
2	71.0	D30	61	0	1.4
3	79.0	D15	0	0	1.1

Table 3.11e - Riparian Condition

Winter Rearing Habitat

The potential for high quality winter rearing habitat is high on non-forestry land although current floodplain connection is low (entrenchment and bedrock exposure are common). While pool volume is high (% Pools are above benchmarks) throughout Bewley Creek, side channels are rare as is entrenchment. NWI data indicates that significant wetland habitat was present along the channel margins in reaches 1 & 2 but this was not observed during recent surveys.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	26.70	0.10	0.00	8.60
2	56.80	2.40	0.00	5.50
3	66.00	22.00	0.00	4.80

Table 3.11f - Pool Volume

Anchor Habitat

A moderate function anchor site originates just past the confluence with Coates Creek and continues to where the stream reaches the first major road crossing. Spawning gravels are available and well sorted, riparian condition and recruitment potential is high, but floodplain interaction and complex pool habitat could be improved through the addition of key pieces of LWD. Small woody debris, which provides hydraulic roughness to the channel, is abundant but does not influence channel morphology in the way that larger woody debris does. Historical wetland data indicates that this section had abundant channel margin wetlands, which are now absent.

A second high function anchor site begins where beaver activity has reconnected the channel to its floodplain. Riparian function is high, and well sorted spawning gravels are present as well as summer and winter rearing habitat. The anchor continues to a major split in the stream. Past this point, the stream channel begins to puddle. AQI surveys indicate that LWD volume is below benchmarks. This is consistent with recent surveys which indicate that there are few key pieces. Most LWD volume is provided by very small pieces which may provide roughness but have limited impact on channel morphology. Beaver are also active in this area.

In 2005 rearing densities were below average in the first anchor (near the mouth) and above average in the upper anchor suggesting that the lower anchor is not functioning to potential. 2006 rearing densities were lower in anchor sites than in non-anchor sites (both anchors). A recent debris jam has formed around a large spruce which fell during the 2007 windstorm. It has created a very large dammed pool with the potential to increase rearing habitat and reconnect the floodplain. Current function is considered moderate. Additionally, historical wetland data indicates that abundant channel margin wetlands were present; these were not observed during the survyes conducted during this project.

Anchor	Good (Sq. M)	%Total	Fair (Sq. M)	% Total	Poor (Sq. M)	% Total
L - Bewley (1)	23.04	2.17%	115.29	4.97%	0.00	0.00%
M - Bewley (2)	0.00	0.00%	94.76	4.08%	7.25	3.69%

3.11g - Bewley Creek Spawning Gravel Inventory by Anchor

Anchor	Length (M)*	%Length**	%Shade	%Pools	LWD Volume/100M
L - Bewley (1)	1575.80	1.77%	73.22	40.48	2.20
M - Bewley (2)	1120.09	1.26%	80.12	66.25	13.02

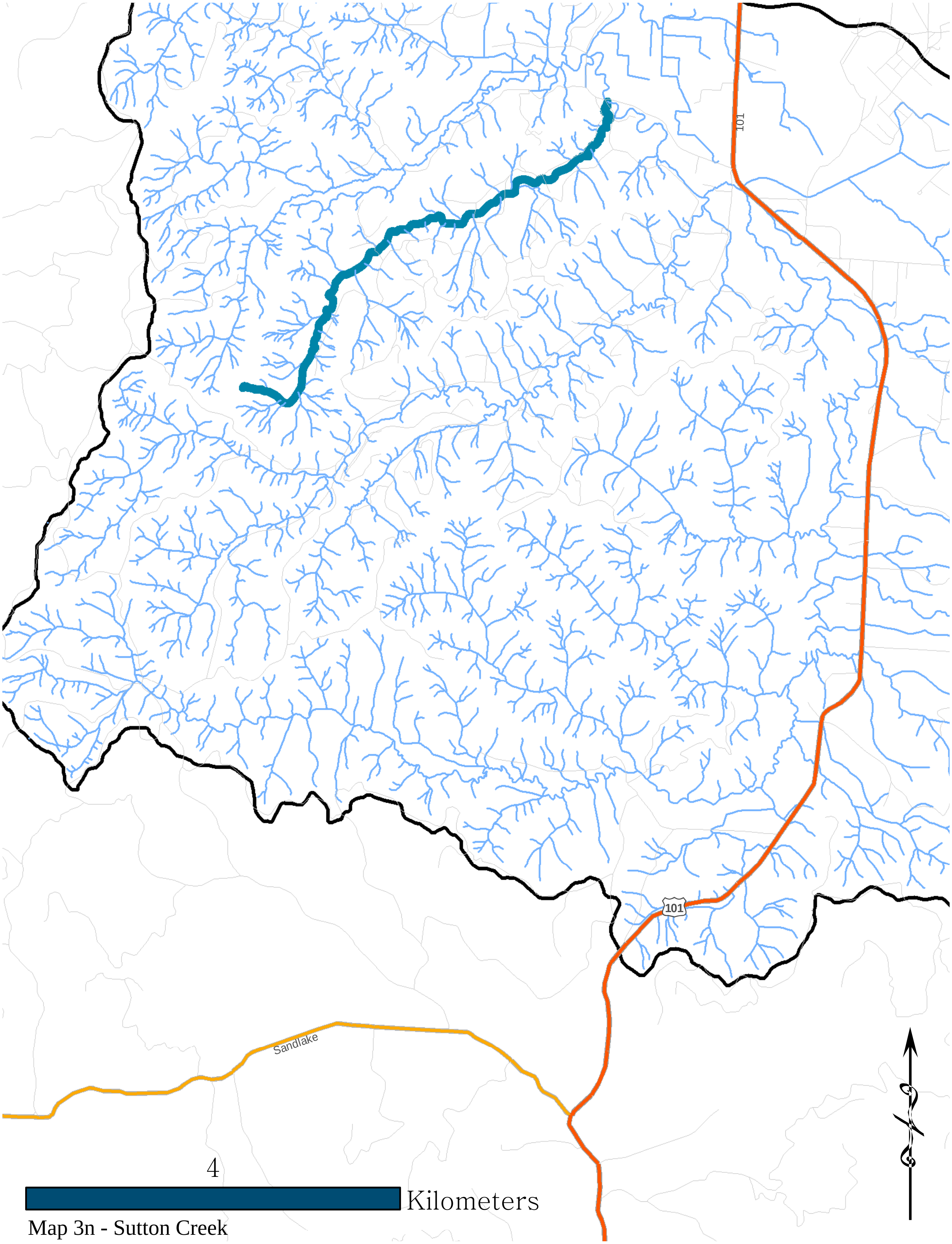
Table 3.11h - Bewley Creek Habitat by Anchor Table

Potential Restoration Projects

• Wood Placement in the lower anchor

• Riparian Planting in the non-forested reaches

Section 3.12 - Sutton Creek



Map 3n - Sutton Creek

Overview

Sutton Creek drains a highly erodible geology and is strongly influenced by past and present beaver activity. Beaver activity continues throughout the stream into the headwaters. The lowest section of Sutton Creek is tidally influenced and much of the stream length includes associated channel margin freshwater wetlands.

Spawning Habitat

Spawning potential for Coho is almost nonexistent.

Stream	Good	Fair	Poor	Good	Fair	Poor
Sutton	0.00	0.00	0.00	0.00%	0.00%	0.00%

Table 3.12a - Gravel Inventory

Summer Rearing Habitat

Riparian condition is poor through much of Sutton Creek (primarily the non-industrial portion).

Winter Rearing Habitat

Winter rearing potential is high due to the slow water, woody debris, and beaver impoundments.

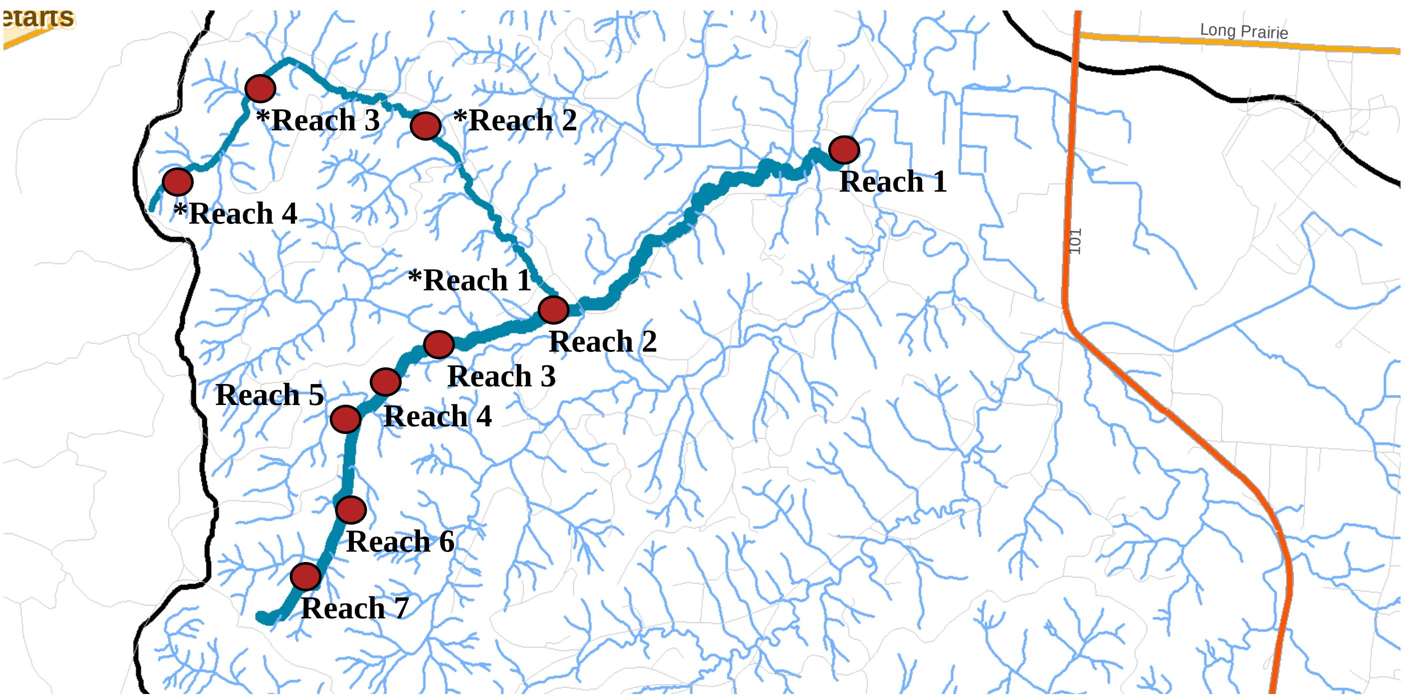
Anchor Habitat

There are no anchor sites on Sutton Creek as there is no spawning gravel present.

Potential Restoration Projects

None

Section 3.13 - Beaver and Bear Creek



Map 3o - Beaver and Bear Creek

Beaver and Bear drain a highly erodible geology and are influenced by past and present beaver activity. Beaver creek and Bear creek join together prior to entering the mainstem through a double side-hinged muted tidal relief tidegate. The tidegate appears to be functional but may need long term maintenance (doors appear to not open completely, although still passable). The lower reach of Beaver creek is tidally influenced and pool volume is therefore dependent on tide stage and tidegate function. Tidegate removal and wetland restoration would significantly increase available pool habitat. Channel incision is high on Beaver creek, although sinuosity has been maintained to some degree. LWD volume is low throughout all reaches on Beaver creek, although, as in other west side tributaries, recent surveys indicate that much of the hydraulic roughness is provided by small but abundant wood which is often embedded in the stream channel or bank. Recruitment potential in Beaver creek is relatively good, although the minimal spawning substrate minimizes the importance of this. All but reach 4 is confined by hillslope or terrace. CHT modeling indicates that reaches 1 and 2 should be unconfined. Coho distribution on Beaver creek terminates in a beaver dam that is no longer maintained. If this dam fails spawning potential may increase.

Bear creek is partially diverted into an artificial channel. The natural channel runs on the western side of a pasture and receives cold water inputs from a forested freshwater wetland thus providing rare summer habitat. The culvert connecting the natural channel and the wetland is perched and constitutes a juvenile barrier. The artificial channel has a passable culvert, but becomes dry in the summer. Reaches 3 and 4 of Bear Creek are higher gradient and outside of Coho distribution. Reach 1 is dominated by agriculture, and is predominantly a manipulated agricultural drainage ditch. Analysis of remote sensing data indicates that reach 3 is conifer dominated. Recruitment potential on Bear creek is good but as in Beaver creek the importance may be small. All but reach 2 are confined by hillslope or terrace. CHT modeling indicates that reach 1 should be unconfined. Bear creek terminates in a series of beaver dams and associated wetland complexes within industrial timberland.

Reach	Length M	Slope %	VWI	Valley Type	Channel Form	Channel Height M	Terrace Height M
1	2855.8	0.2	20.0	CT	TC	0.30	1.00
2	1271.4	0.5	20.0	CT	TC	0.40	1.50
3	248.5	0.6	7.0	CT	TC	0.30	1.40
4	385.2	1.6	12.7	WF	US	0.20	0.20
5	653.0	2.3	4.3	MT	CA	0.20	0.30
6	381.4	3.1	1.0	MV	CH	0.30	NA
7	348.9	6.2	1.0	MV	CH	0.20	NA
1*	1964.5	0.6	20.0	CT	TC	0.30	1.40
2*	1330.6	0.6	5.8	WF	UA	0.10	0.20
3*	1037.1	1.5	4.5	CT	CA	0.20	0.50
4*	220.4	16.3	1.0	MV	CH	0.20	NA

Table 3.13a - Beaver and Bear* Creek AQI Morphology Data

Spawning Habitat

Historically spawning potential for Coho would be limited to a small tributary (not Bear) of Beaver Creek. Nearly all spawning takes place in a short reach (~ 200 meters) of this tributary where gravels sort out despite channel incision and land-use impacts. This tributary is currently impounded by beaver dams at the forestry-agriculture interface. Spawning gravels are present in the agricultural land-use of this tributary and were present historically to the headwaters. Beaver presence limits this streams ability to provide spawning habitat although their presence is cyclical and it is expected that spawning habitat would historically be opened after storm events would breech poorly or non-maintained dams. Bear LWD volume is below benchmarks in reaches 1-3 and above in reach 4.

Reach	# Large Boulders	% SAFN	% Gravels	% Bedrock	% SAFN Riffles	% Gravels Riffles
1	19.0	96.0	2.0	0.0	77.0	12.0
2	1.0	91.0	7.0	0.0	78.0	14.0
3	0.0	74.0	21.0	0.0	70.0	26.0
4	0.0	90.0	8.0	0.0	69.0	22.0
5	4.0	69.0	22.0	0.1	60.0	27.0
6	13.0	63.0	24.0	1.0	51.0	30.0
7	0.0	73.0	20.0	0.0	65.0	24.0
1*	0.0	89.0	7.0	0.0	70.0	15.0
2*	0.0	93.0	5.0	0.0	65.0	25.0
3*	0.0	96.0	4.0	0.0	96.0	4.0
4*	0.0	75.0	23.0	0.0	80.0	20.0

Table 3.13b - Sediment Values

Reach	# LWD Pieces/100M	LWD Volume/100M	Key Pieces LWD/100M
1	0.70	0.70	0.0
2	0.50	0.20	0.0
3	23.30	12.60	0.0
4	18.80	11.50	0.7
5	29.00	15.10	0.2
6	36.70	35.80	0.2
7	26.90	20.70	0.0
1*	0.60	0.10	0.0
2*	3.10	0.90	0.0
3*	12.10	9.50	0.1
4*	28.10	14.90	0.0

Table 3.13c - Beaver and Bear* Creek Wood Volume

Stream	Good	Fair	Poor	Good	Fair	Poor
Beaver	0.00	6.41	2.79	0.00%	0.3%	1.42%

Table 3.13d - Gravel Inventory

Summer Rearing Habitat

Riparian condition is poor and shade levels low throughout the agricultural field which make up non-industrial section of the stream channel. Shade is well below benchmarks throughout all reaches. This is due to land-use impacts in the lower two reaches, and Beaver activity in the upper five. Likewise, large conifers are very rare, although smaller conifers are present. The % Pools metric on Bear Creek are below benchmarks in reaches 1, 3, and 4, and above in reach 2. Shade values are below benchmarks in reaches 1 and 2 and above in reaches 3 and 4 for Bear. Large conifers were observed in reaches 2 and 4 of Bear.

Reach	% Shade	Dominant Vegetation	Conifers >.50M dbh/305M	Conifers >.90M dbh/305M	%Erosion
1	8.0	G	0	0	31.2
2	10.0	G	0	0	82.8
3	28.0	C15	0	0	77.8
4	10.0	C15	61	61	2.2
5	33.0	D30	30	0	71.6
6	87.0	D30	152	91	74.6
7	82.0	D30	244	244	67.6
1*	16.0	G	0	0	57.9
2*	52.0	G	15	0	46.2
3*	84.0	D30	0	0	95.0
4*	96.0	C30	122	0	100.0

Table 3.13e - Riparian Condition

Winter Rearing Habitat

Beaver Creek %Pools are below benchmarks for reaches 1 and 2, and above for the remaining 5 reaches. Recent surveys indicate that reach 2 however contains abundant pool habitat suggesting increases in either beaver activity, wood debris, or both. Reach 2 of Bear Creek is composed of large wetland complexes and Beaver impoundments.

Reach	% Pools	% Slack Pools	% Secondary Channels	# Deep Pools/1000M
1	6.00	5.30	4.90	1.40
2	1.20	0.00	4.20	0.80
3	82.80	59.70	1.90	0.00
4	94.50	94.50	2.70	8.30
5	43.00	32.90	0.60	1.70
6	40.80	0.00	0.00	0.00
7	18.40	0.00	13.80	0.00
1*	1.80	0.00	2.70	0.50
2*	16.10	15.90	0.00	2.30
3*	0.70	0.00	0.50	0.00
4*	0.00	0.00	21.30	0.00

Table 3.13f - Pool Volume

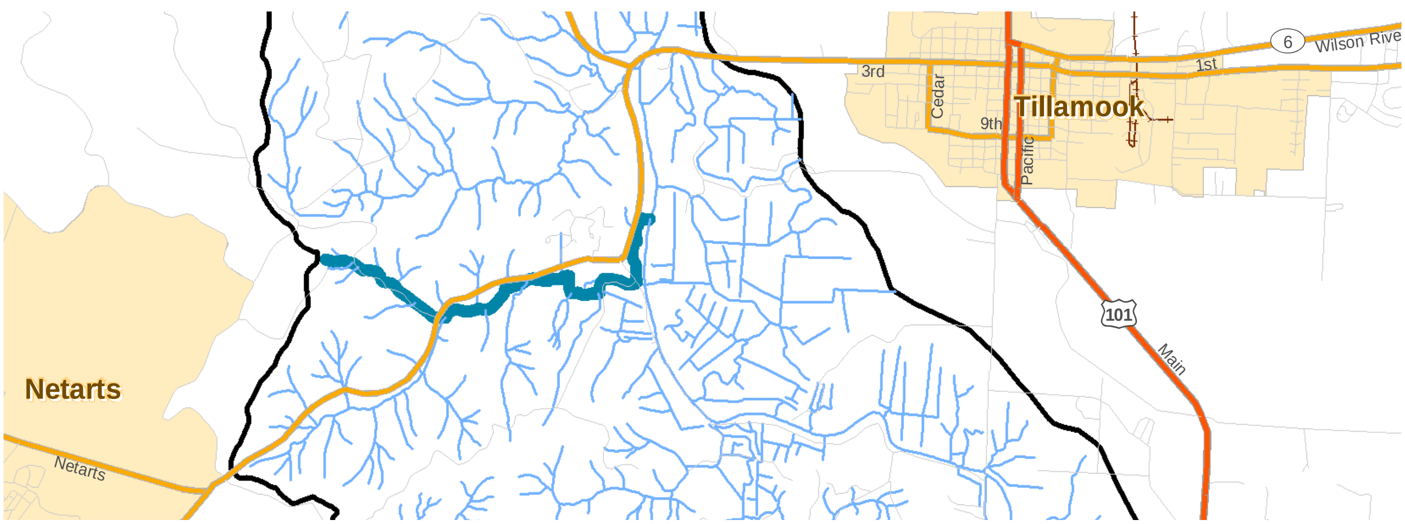
Anchor Habitat

There are no anchor sites on Beaver or Bear Creek as there is no spawning gravel present.

Potential Restoration Projects

• Restoration of the lowest section of Beaver/Bear tidal wetland has the potential to open up much needed saltwater and freshwater wetland habitat to the lower watershed. This would provide over wintering habitat to Juvenile Coho and Steelhead, as well as critical spring/summer rearing habitat to juvenile Chum and Chinook.
• Planting to address temperature issues
• Riparian set-back to allow for greater channel migration

Section 3.14 - Fagan



Map 3p - Fagan Creek

Overview

Fagan Creek drains a highly erodible geology, and is influenced by past and present Beaver activity. The lower section of Fagan is tidally influenced, and much of the stream length includes associated channel margin freshwater wetlands. A series of levees and dikes have been constructed along lower Fagan to support historic (i.e. not current) agricultural uses. Restoration of Lower Fagan has the potential to open up much needed saltwater and freshwater wetland habitat to the lower watershed. This would provide over wintering habitat to Juvenile Coho and Steelhead, as well as critical spring/summer rearing habitat to juvenile Chum and Chinook. The mouth of Fagan is near the confluence of the Tillamook Mainstem with the Trask Mainstem. It is possible that juvenile salmonids from spawning rich but rearing poor tributaries of the Trask could utilize Fagan. Numerous properties adjacent to Fagan have similar potential to provide off channel habitat to the lower watershed.

Spawning Habitat

Spawning potential for Coho is almost nonexistent in this stream.

Stream	Good	Fair	Poor	Good	Fair	Poor
Fagan	0.00	0.00	0.00	0.00%	0.00%	0.00%

Table 3.14a - Gravel Inventory

Summer Rearing Habitat

Riparian condition is poor through much of Sutton (primarily the non industrial portion).

Winter Rearing Habitat

Winter rearing potential is very high if wetland connectivity is restored but current function is low due to land-use (diking, etc.).

Anchor Habitat

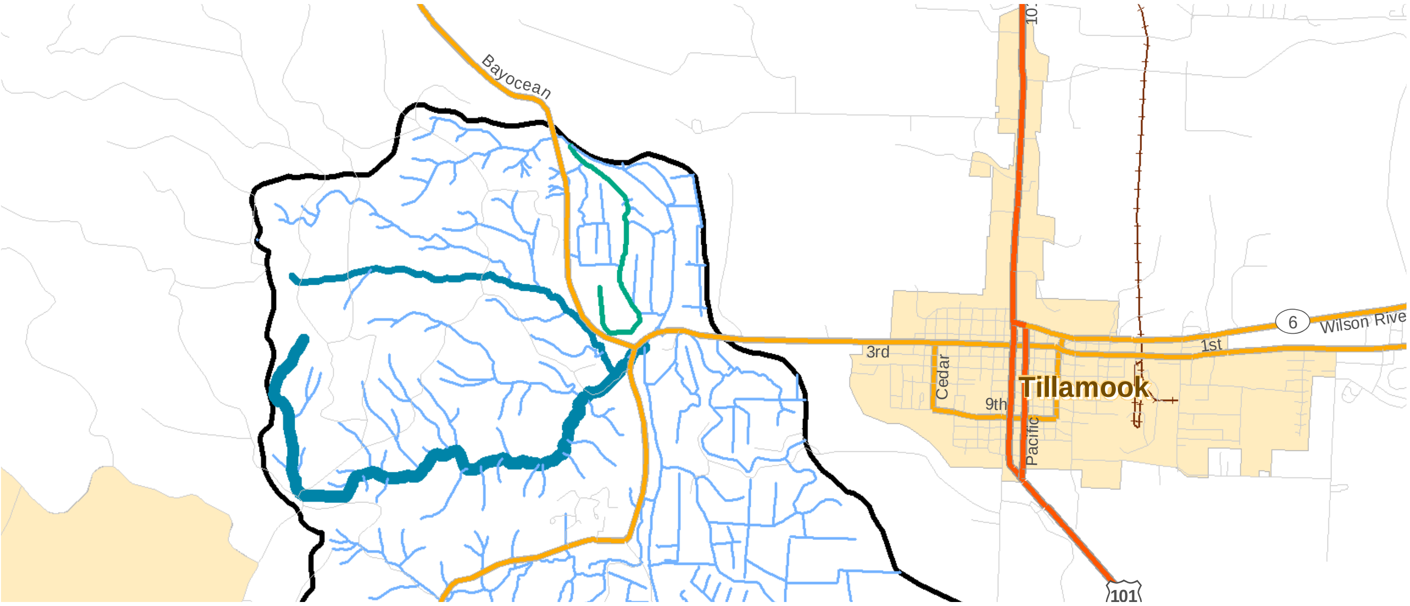
There are no anchor sites on Fagan Creek as there is no spawning habitat present.

Potential Restoration Projects

- Wetland restoration
- Culvert replacement

Section 3.15 - Esther and Tomlinson Creek

Map 3q - Esther and Tomlinson Creek



Overview

A series of levees and dikes have been constructed along lower Esther and Tomlinson to support historic and current agricultural uses. Both stream channels have been highly manipulated to force them into their current configuration. Historically, the channels flowed separately into a series of sloughs and tidal marshes adjacent to the Mainstem Tillamook. Currently Tomlinson has been rerouted to flow behind a road and dike to join Esther just before passing through a top hinged MTR tidegate. The tidegate is not functioning properly, and was observed to be completely closed despite >1m of stream height remaining between the upstream pasture and water level. This conclusion is supported by the erratic juvenile abundance data which show very few fish in 2005 & 2006, and a huge spike in 2007. Fish passage appears to be the primary issue for this stream complex. Tomlinson runs laterally along a dike, and passes through two culverts and skirts a county road (Cape Meares Loop) and agricultural field before entering industrial timberland. The first culvert is ~ .65 m above the stream channel and constitutes a juvenile barrier. The second culvert is undersized and failing. The stream channel is small (~2 m active channel), generally entrenched, and lacks good riparian vegetation until it enters timberland. Despites this, the natural gradient and contributing geology (mostly volcanic) develop well sorted spawning gravels, and moderate quantities of simple pool habitat. Coho distribution ends at a bedrock falls shortly after the channel enters industrial timberland.

Spawning Habitat

Esther has significantly less spawning potential than Tomlinson. Gravels are sparse, and well sorted gravels are even rarer.

Stream	Good	Fair	Poor	Good	Fair	Poor
Esther/Tomlinson	1.67	37.63	14.68	0.15%	1.62%	7.47%

Table 3.15a - Gravel Inventory

Summer Rearing Habitat

Shade and riparian condition is poor throughout the lower stream section (managed for agriculture). Riparian condition improves (although conifers are rare) upon entering timberland, with moderate amounts of woody debris. The upper reaches of Esther have recently been harvested. Extensive blowdown was observed at this point which has exposed the southern edge of the stream to solar input. This pattern was observed throughout the Tillamook River Watershed where minimal stream buffers were left on steep slopes.

Winter Rearing Habitat

Restoration of Lower Esther and Tomlinson has the potential to open up much needed saltwater and freshwater wetland habitat to the lower watershed. This would provide over wintering habitat to Juvenile Coho and Steelhead, as well as critical spring/summer rearing habitat to juvenile Chum and Chinook.

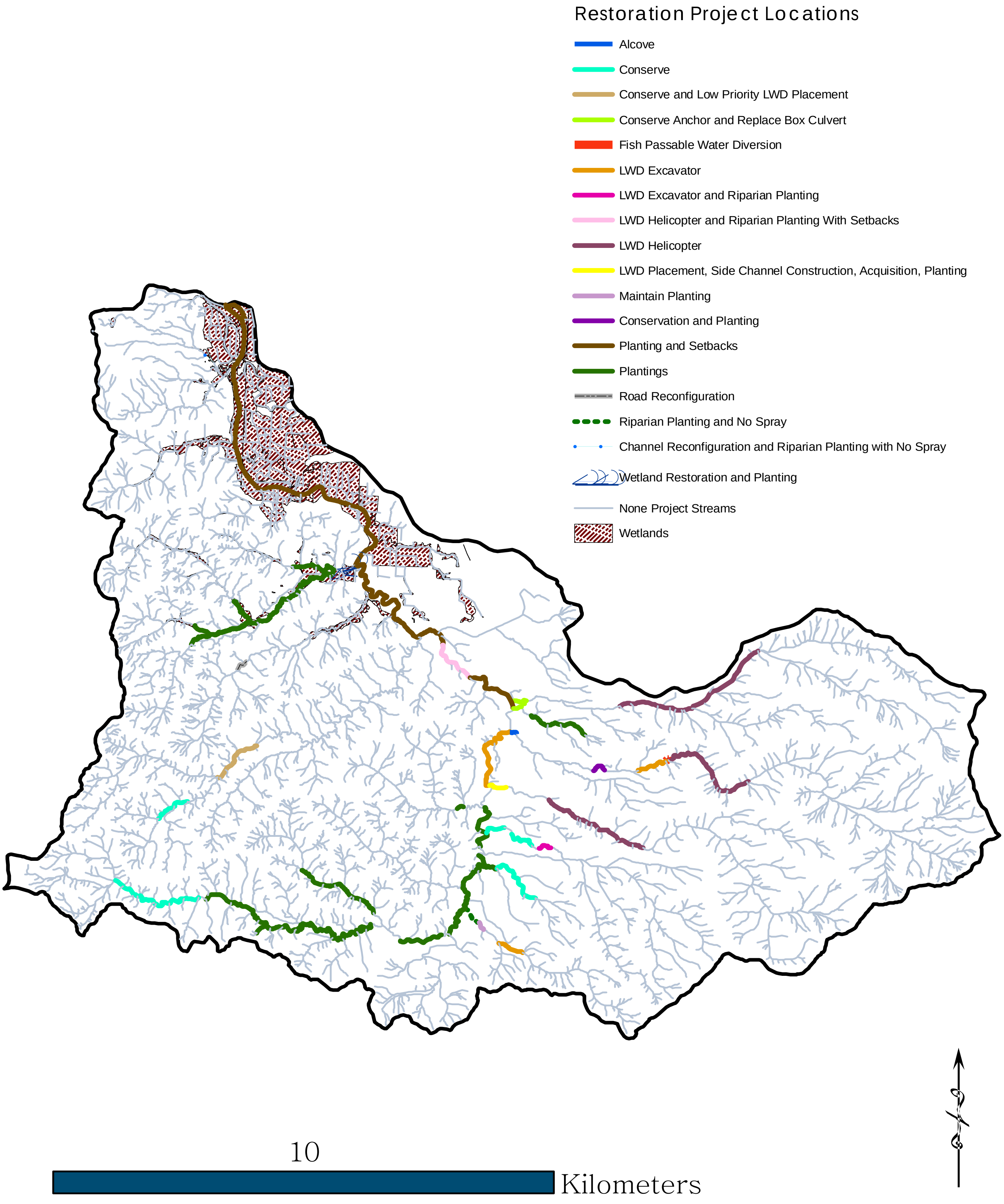
Potential Restoration Projects

- Dike removal
- Tide gate removal
- Culvert removal

Anchor Habitat

No anchor habitat exists

Section 4 - Restoration and Conservation Priorities



Although many projects are focused on specific stream reaches, there are important watershed scale actions which have the potential to dramatically improve conditions. First and foremost is the importance of headwater management. Non-fishbearing, headwater drainages constitute the majority of a stream network but do not receive the protections accorded to fish bearing streams. Headwater function is necessary to ensure proper inputs of LWD, gravels, and cold water. Preservation of high and moderate function areas should be prioritized as should areas having received restorative actions. CCA's and areas at risk for rapidly moving landslides should also be conserved. The following constitute restoration projects prioritized at two scales; long-term and short-term priorities. Long-term priorities are those projects considered biologically necessary for long-term Coho survival but will likely face serious logistical concerns which will take more coordination than short-term priorities of equal biological importance. Short-term priorities are those which are required to immediately support Coho populations and will likely have few barriers to implementation. This list is not necessarily exhaustive. Projects are named spatially by project type. Please note that in all cases where active restoration is needed, conservation is always recommended as a follow-up. Each project contains the following information:

- Problem
- Solution
- Expected Results
- Potential Problems

Upper Fawcett (D) Anchor Instream Placement - High - Short-term Priority

- Problem – Lack of adequate levels of LWD resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection.
- Solution – Instream wood placement (Helicopter)
- Expected Results – Increased gravel abundance and complex habitat within the anchor.
- Potential Problems – The City of Tillamook maintains a water diversion below the Anchor. A trash rack may be necessary to protect the structure.

Upper Killam (B) Anchor Instream Placement - High - Short-term Priority

- Problem – Lack of adequate levels of LWD, resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection.
- Solution – Instream wood placement (Helicopter)
- Expected Results – Increased gravel abundance and complex habitat within the anchor.
- Potential Problems – The City of Tillamook maintains a water diversion below the Anchor.

Upper Simmons (F) Anchor Instream Placement - High - Short-term Priority

- Problem – Lack of adequate levels of LWD, resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection.
- Solution – Instream wood placement (Helicopter)
- Expected Results – Increased gravel abundance and complex habitat within the anchor.
- Potential Problems – Downstream landowners may not be amenable to restoration.

Middle Fawcett (C) Anchor Instream Placement & Riparian Improvement - Low - Short-term Priority

• Problem – Lack of adequate levels of LWD, resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection. Riparian condition is poor.
• Solution – Instream wood placement (Excavator), riparian planting, landowner education.
• Expected Results – Increased gravel abundance and complex habitat within the anchor and improved landowner stewardship.
• Potential Problems – Adjacent landowners may not be amenable to restoration.

Upper Mills (K) Anchor Instream Placement - Medium - Short-term Priority

• Problem – Lack of adequate levels of LWD, resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection.
• Solution – Instream wood placement (Excavator)
• Expected Results – Increased gravel abundance and complex habitat within the anchor.
• Potential Problems – Downstream landowners may not be amenable to restoration.

Lower Simmons (E) Anchor Instream Placement and Channel Redesign - High - Short-term Priority

• Problem – Gravels and floodplain connection are rare due to past land use practices. Current land use must be modified to reach potential.
• Solution – LWD Placement (Excavator). Alcove or side channel construction where a fed spring tributary meets the main channel (side channel construction is preferable).
• Expected Results – Increased spawning gravels, increased main channel high quality summer and winter habitat, and increased off channel summer and winter habitat.
• Potential Problems – Current land-use (agricultural and residential) must be modified to accommodate improved functions. Landowners may not be amenable to restoration.

Middle Bewley (L) Anchor Instream Placement - Medium - Short-term Priority

• Problem – Although functional, lack of key pieces of LWD limit floodplain interaction and complex pools.
• Solution – Instream LWD placement (Excavator).
• Expected Results – Increased complex habitat within the anchor will provide improved winter habitat.
• Potential Problems – Excavator access from the adjacent road may damage the riparian community.

Middle Tillamook Mainstem (G) Anchor Instream Placement & Riparian Planting - High - Short-term Priority

• Problem – Lack of adequate levels of LWD, resulting in little well sorted spawning gravel, complex pools habitat, and floodplain connection. Riparian conditions are not ideal along the East side of the stream
• Solution – Instream wood placement (Helicopter). Complex riparian plantings including a significant shrub component.
• Expected Results – Increased gravel abundance and complex habitat within the anchor.
• Potential Problems – Private landowners may not be amenable to restoration; downstream landowners may not approve of LWD placement.

Upper Tillamook Mainstem (O) Riparian Planting - High - Short-term Priority

• Problem – Thermal problems are pervasive throughout the Tillamook River, and severely limit summer rearing potential.
• Solution – Riparian Plantings, including a mix of shrubs, conifers (primarily Spruce) and Willow.
• Expected Results – Improved shade and decreased downstream temperatures, as well as long term maintenance of recruitment potential.
• Potential Problems – Private, non industrial landowners may be unwilling to participate.

Lower Joe Creek Riparian Planting & Invasive Removal - Low - Short-term Priority

• Problem – Thermal problems are pervasive throughout the Tillamook River, and severely limit summer rearing potential. Invasives (esp. Invasive Irises) are present near the mouth and have the potential to spread downstream
• Solution – Riparian plantings, including a mix of shrubs, conifers (primarily Spruce) and Willow, and invasive species removal.
• Expected Results – Improved shade and decreased downstream temperatures, as well as long term maintenance of recruitment potential. Prevention of invasive spread.
• Potential Problems – Private, non industrial landowners may be unwilling to participate.

Bear Creek Culvert Replacement - Low - Short-term Priority

• Problem – The current culvert configuration blocks access to important summer rearing habitat.
• Solution – Remove the existing culvert and add a new passable culvert to the north side of the road which will connect the natural and artificial stream channels (artificial is passable).
• Expected Results – Increased summer habitat potential; improved summer survival.
• Potential Problems – No problems are anticipated.

Esther/Tomlinson Tidegate Modification & Wetland Restoration - High - Long-term Priority

• Problem – The current tidegate is not functioning properly and blocks fish passage under inappropriate conditions. Additionally, a large portion of the land currently blocked by the dike does not appear to have ever been used for agricultural purposes.
• Solution – Replace the tidegate with a functional side hinge muted tidal relief tidegate. Modify the existing dikes to open the unused land to tidal influence. Acquisition of the unused land is recommended as well.
• Expected Results – Fish will be able to access Esther creek under normal tidal conditions. Tomlinson will no longer be influenced by a tidegate.
• Potential Problems – Dike/levee modification and land acquisition are potentially very expensive. Acquisition may not be viewed favorably by all members of the public.

Tomlinson Culvert Replacement & Riparian Improvement - High - Long-term Priority

• Problem – One culvert of Tomlinson is a juvenile barrier, a second is actively failing and will block passage by all species/ages.
• Solution – Replace both with appropriately sized culverts.
• Expected Results – Juveniles will be able to access potential summer habitat; long term passage will be preserved.
• Potential Problems – No potential problems are expected.

Lower Watershed Wetland Restoration - High - Long-term Priority

• Includes a suite of projects; additional specific projects are included that are contained within this group such as the Tomlinson and Fagan projects.
• Problem – Modification of historic wetlands in the lower watershed has greatly decreased available winter rearing habitat for Coho & Steelhead, and summer rearing habitat for juvenile Chinook a& Chum.
• Solution – Acquisition & restoration of wetland properties as available.
• Expected Results – Increased wetland area will increase available summer and winter rearing habitat for the species listed above, as well as provide habitat for other non-salmonid, wetland dependent species.
• Potential Problems – Much of the land identified for restoration is currently in active agricultural use. Conversion of agricultural property may be opposed by local interest groups.

Beaver Creek Culvert Replacement - Low - Short-term Priority

• Problem – The current culvert is failing and will eventually block access to all upstream habitat.
• Solution – Remove the existing culvert with a new culvert.
• Expected Results – Preserve long term function by providing access to upstream habitat for all species.
• Potential Problems – No problems are anticipated.

Upper Tillamook Mainstem (O) Tributary Riparian Planting - High - Short-term Priority

• Problem – Historical land use impacts to riparian vegetation greatly decrease the riparian habitat quality in this section. Shade is very low.
• Solution – Complex riparian plantings with a shrub and conifer component; riparian setbacks.
• Expected Results – Improved shade, increased long term potential to provide summer and winter habitat.
• Potential Problems – Landowners may not be amenable to restoration.

Tillamook Mainstem Riparian Planting - High - Short-term Priority

• Includes a suite of projects; additional specific projects are included that are contained within this group.
• Problem – Thermal problems are pervasive throughout the Mainstem, and limit summer rearing potential.
• Solution – Riparian plantings, including a mix of shrubs, conifers (primarily Spruce) and Willow.
• Expected Results – Improved shade and decreased downstream temperatures, as well as long term maintenance of recruitment potential.
• Potential Problems – It is important that an adequately sized (greater than one plant width) buffer be established. Existing laws governing levee maintenance do not allow plantings.

Lower Mills Riparian Planting - Medium - Short-term Priority

• Problem – Severe land use impacts greatly decrease the habitat quality in this section. Herbicide applications may be causing direct mortality. Beaver are absent from this area and it is possible that they are actively being trapped.

• Solution – Complex riparian plantings with a shrub and conifer component, riparian setbacks, cessation of beaver trapping, cessation of herbicide application.

• Expected Results – Improved shade, increased potential for Beaver recolonization, increased long term potential to provide summer and winter habitat.

• Potential Problems – Landowners may not be amenable to restoration.

Bear/Beaver Riparian Planting - Low - Short-term Priority

• Problem – Land-use impacts to riparian vegetation greatly decrease the habitat quality in this section. Shade is very low.

• Solution – Complex riparian plantings with a shrub and conifer component; riparian setbacks.

• Expected Results – Improved shade, increased long term potential to provide summer and winter habitat.

• Potential Problems – Landowners may not be amenable to restoration.

Killam Culvert Replacement - Medium - Long-term Priority

• Problem – The current culvert/fish ladder at Hwy 101 is undersized and is a juvenile barrier (all species) as well as an adult Chum and Lamprey barrier. LWD placement should be considered concurrently within the upstream anchor.

• Solution – Replace the culvert to meets ODFW size and fish passage requirements.

• Expected Results – Increased access to upstream cold water summer rearing habitat for juveniles, and spawning resources for Chum and Lamprey.

• Potential Problems – The undersized culvert and Hwy 101 are interacting to trap gravels and form a large freshwater wetland complex which is very functional

Fawcett Culvert Replacement - High - Short-term Priority

• Problem – The undersized culvert at South Prairie Road is actively failing and will eventually block passage to all species/ages. *Failed in November of 2008

• Solution – Replace the culvert with a properly sized bridge. LWD placement and alcove construction should be considered to preserve the current level of function.

• Expected Results – Preserve long term function by providing access to upstream habitat for all species.

• Potential Problems – The undersized culvert is trapping gravels which are very rare throughout Fawcett. The culvert replacement should be designed to maintain or improve the current level of function.

Fawcett Water Diversion Replacement - High - Short-term Priority

• Problem – The current diversion structure associated with a municipal water supply is a 3 foot drop under most flow conditions. This represents a juvenile (all species) barrier, and an adult Chum and Lamprey barrier.

• Solution – Replace the existing diversion structure with one that at a minimum meets ODFW fish passage requirements.

• Expected Results – Improved access to upstream cold water resources for juveniles of all species.

• Potential Problems – Fish passage requirements may not be sufficient to meet the needs of Pacific Lamprey.

Pleasant Creek Culvert Replacement - Medium - Short-term Priority

• Problem – The current culvert is failing and will eventually block access to upstream habitat.

• Solution – Replace the existing culvert with a new culvert.

• Expected Results – Preserve long term function by providing access to the high quality upstream habitat for all species.

• Potential Problems – No problems are anticipated.

Fagan Culvert Replacement - Low - Short-term Priority

• Problem – The current culvert is failing and will eventually block access to upstream habitat.

• Solution – Replace the existing culvert with a new culvert.

• Expected Results – Preserve long term function by providing access to upstream habitat for all species.

• Potential Problems – No problems are anticipated.

Fagan Wetland Restoration - High - Long-term Priority

• Problem – Historic wetland habitat has been disconnected by dikes and levees. Currently this wetland area is not used actively for agriculture or residential purposes.

• Solution – Restore wetland function to historic conditions.

• Expected Results – Increased winter rearing habitat.

• Potential Problems – Landowners may not be amenable to acquisition/restoration efforts.

• **Lower Killam**: A tributary joins Killam just before the mouth (the presence of the road may prevent this tributary from joining the mainstem directly on its own). A large, freshwater wetland exists at this junction, providing significant winter rearing habitat. Gravels are abundant in this section, particularly relative to its length. Much of the hydraulic roughness is provided by dense, mature Willow communities and Beaver activity. Fish counts are quite low in this section. Examination of the raw data suggests that surveyors vastly underestimated the number of pools in this reach (only 1 was sampled). Snorkel surveys are supposed to be conducted over every 5th pool. The habitat within this anchor is so complex that identification of individual pools would be problematic. Recent surveys indicate that many more than 50 pools are present in this reach. Current function is considered very high.

• **Lower Munson:** This Anchor Site begins at the mouth of Munson and extends to Hwy 101. Abundant bedload delivery interacts with a dense, mature willow community to form complex habitat. Well sorted spawning gravels, riparian cover, and high quality summer and winter habitat are abundant. AQI surveys indicate that LWD volume is below benchmarks. Although AQI surveys indicate that LWD volume is below benchmarks, much of the hydraulic roughness is provided by dense, mature Willow communities and beaver activity. AQI surveys do not effectively characterize these characteristics. % Shade is below benchmarks. This is not consistent with recent surveys. Conditions may have changed dramatically since AQI surveys were conducted. This emphasizes the importance of conservation for this Anchor, as function can be degraded more quickly than improved. Current function is considered very high.

• **Middle Munson:** This Anchor Site is present midway between the mouth and Munson Falls. It is strongly influenced by past and present Beaver activity. Large Spruce are common throughout the Anchor, and many have recently fallen into the stream due to the windstorm in 2007. Multiple channels and floodplain interaction is present throughout, as are well sorted gravels and complex pools. Recruitment potential and current riparian condition is also very high. AQI surveys indicate that LWD volume is below benchmarks. Current function is considered very high.

• **Upper Bewley:** An Anchor Site begins where Beaver activity has reconnected the channel to its floodplain. Riparian function is high, and well sorted spawning gravels are present (in moderate amounts) as well as summer and winter rearing habitat. The anchor continues to a major split in the stream. Past this point, the stream channel begins to puddle. Although AQI surveys indicate that LWD volume is below benchmarks, the values are the highest of any anchor site. AQI surveys may have underestimated the impacts of numerous embedded, small pieces of LWD observed in the stream channel. Rearing densities are consistently above non anchor sites, but not by a large degree. There is no obvious restoration treatment which would improve function in this reach. Well sorted spawning gravels pose the likely limitation to improved function. Conservation of the anchor site and its contributing headwater drainages is recommended to preserve and increase long term function. Current function is considered moderate.

Section 5 - Conclusions

Discussion

The results and conclusions presented within this document are primarily based on current habitat conditions. The current smolt production model is highly dependent upon recent habitat surveys which reflect significant anthropogenic impacts and cannot quantify the potential increase in smolt production as a result of habitat improvements. Although ecoregion wide reference data is available, there is currently no established protocol for extrapolating pre-disturbance conditions from current habitat conditions. A primary issue is the lack of undisturbed stream reaches on mainstem channels as these tend to be the areas which are colonized by humans and usually the most disturbed. This makes it difficult to estimate historical pool volume and spawning gravel abundance. The results of the production modeling are highly dependent upon these parameters. A related issue is the unknown error associated with production modeling. The strength of any computational model is dependent on both the input data and the internal assumptions. Error estimates for the AQI data have been developed by ODFW, however estimates of error associated with change over time are not available. Additionally, rearing potential by habitat type is based on unpublished data and does not include estimates of the error and associated distributions. Although not part of the published protocol, a limited analysis of pre-disturbance conditions was conducted. This analysis attempted to quantify the increase in smolt production as a result of potential wetland restoration. The very extensive wetland habitat historically present in the lower watershed (and the even more abundant wetlands in the rest of the Tillamook Bay estuary) provided large blocks of winter rearing habitat for Coho and Steelhead, as well as spring/summer rearing habitat for juvenile Chum and Chinook. The results indicated that a massive increase in winter smolt production would occur were these lower wetlands restored.

In natural conditions it is likely that most of the western tributaries would be limited by gravels given their lithology and gradient. Although fewer fish would naturally spawn in the west side tributaries, a greater percentage might survive to smolt given the abundant rearing habitat. Under this scenario, it is likely that the natural seasonal ‘bottleneck’ would always be spawning habitat. Conversely, it is likely that the spawning resources in the eastern tributaries would far outstrip their rearing capacity. Fish spawned in these tributaries might have then utilized the extensive wetland habitat available at the confluence with the mainstem, along the channel margins of the mainstem, and near the bay, although the wetland habitat in the estuary provides more winter rearing potential than summer due to the salinity. Therefore the seasonal bottleneck would have always been summer rearing. The complexity of these interactions make it more difficult to predict seasonal bottlenecks for the watershed as a whole. As the spawning potential in the western tributaries might not ever outstrip the rearing (summer or winter) potential it is possible that the excess fish spawned in the eastern tributaries would seed to capacity the pools under-utilized in the western tributaries. Two potential hypotheses have been developed: the first is that the amount of spawning material in the eastern tributaries in historical conditions will always outstrip even the most maximal pool habitat (throughout the watershed) in which case summer rearing would be the watershed limitation; the second hypothesis is that spawning would never outstrip the potential rearing habitat given the abundance of low-lying Sitka swamp habitat and wetland habitat, in which case spawning would be the seasonal limitation. Regardless, it is clear from this study that the Tillamook River watershed is not meeting potential conditions and that many improvements can be made to increase Coho smolt survival, specifically riparian planting along the mainstem and log placement in the eastern tributaries.

The primary conclusion of this analysis finds that summer temperatures (mainstem), minimal pool habitat (eastern tributaries), and lack of access to cold water (Killam Creek) are limiting Coho smolt production. Were summer habitat improved, Coho smolt production would increase by ~200,000. However, there is disagreement between the two models on the second limiting factor; the ODFW survival rates indicate that winter habitat would limit production if summer temperatures were addressed while the AWS rates indicate that spawning would limit production if summer temperatures were addressed. Summer temperature however is the consistent limiting factor using both survival rates; this is corroborated with the temperature data collected throughout the watershed. Fish distribution was compared to the temperature data and decreases in densities correlated strongly with temperature increases. Fish densities decreased downstream of of the agricultural / industrial timber interface. The mainstem from the confluence of Joe Creek to the head of tide also exceeded the sub-lethal limit of 17.8º C for periods that extended up to 61 days and although the abundance of juvenile coho increase somewhat densities are still below 0.2 fish/square meter. The contribution of colder water from the eastern drainages to the mainstem may lessen the temperature impacts, this is supported by the Coho abundance data. Additionally, the range of habitat which Coho utilize is great. The first 9 miles of the mainstem Tillamook River upstream from the head of tide is functioning Coho habitat although it is not within the normal range of suitable conditions (rather large).

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ODFW - Oregon Department of Fish and Wildlife
OWEB - Oregon Watershed Enhancement Board
TBW - Tillamook Bay Watershed
TBWC - Tillamook Bay Watershed Council
LFA - Limiting Factors Analysis
ODF - Oregon Department of Fish and Wildlife
USFS - United States Forest Service
BLM - Bureau of Land Management
HUC - Hydrologic Unit Code
CHT - Channel Habitat Type
CLAMS - Coastal Landscape Analysis Modeling Study
IP - Intrinsic Potential
AQI - Aquatic Inventories
EMAP - Environmental Monitoring Assessment Program
CCA - Critical Contributing Area
TEP - Tillamook Esutaries Partnership
ODEQ - Oregon Department of Environmental Quality
WAM - Watershed Assessment Manual
GIS - Geographic Information Systems
DEM - Digital Elevation Model
LWD - Large Woody Debris
RBA - Rapid Bio-Assessment
NWI - National Wetlands Inventory
USFWS - United States Fish and Wildlife Service
CWA - Clean Water Act
BYPP - Backyard Planting Program
SWCD - Soil and Water Conservation District