215-1031

## Section I
# APPLICANT INFORMATION
Type in the information for Sections I and II.

**Name of project:** Mill Cr Siletz Watershed Effectiveness Monitoring

**OWEB funds requested:** $138,239 **Total cost of project:** $2,948,222

**PROJECT LOCATION:**

**This project occurs in one region only.** Region 1 ☒ Region 2 ☐ Region 3 ☐ Region 4 ☐ Region 5 ☐ Region 6 ☐

**This project occurs in multiple regions. Check all that apply.** Region 1 ☐ Region 2 ☐ Region 3 ☐ Region 4 ☐ Region 5 ☐ Region 6 ☐

**This project occurs statewide / in all regions.** ☐

**This project occurs at (check one):** ☐ **Site unknown at this time** ☒ **A single site** ☐ **Multiple sites**

| Watershed Name(s) | County or Counties |
|---|---|
| Mill Creek – Siletz | Lincoln |

| Township, Range, Section(s) (e.g., T1N, R5E, S12) | Longitude, Latitude (e.g., -123.789, 45.613) (required for federal/state reporting) | Watershed code(s) – Please note the 10-digit hydrologic unit code, previously 5th Field HUC |
|---|---|---|
| T9S, R9W, S22-24, 25-28, 35-36 | -123.773, 44.76 | 1710020405 |

| **Applicant** | **Project Manager** |
|---|---|
| **Name:** Paul Engelmeyer | **Name:** Stacy Polkowske |
| **Organization:** Midcoast Watersheds Council | **Organization:** ODFW |
| **Address:** 23 N Coast Hwy | **Address:** 810 SW Alder St, Unit C |
| Newport, OR 97365 | Newport, OR 97365 |
| **Phone:** 541-265-9195 | **Phone:** 541-265-8306 x264 |
| **Fax:** 541-265-9351 | **Fax:** 541-867-0311 |
| **Email:** mcwc@midcoastwatershedscouncil.org | **Email:** stacy.a.polkowske@state.or.us |

**Fiscal Agent**

| |
|---|
| **Organization:** Midcoast Watersheds Council |
| **Address:**23 N Coast Hwy |
| Newport, OR 97365 |
| **Phone:**541-265-9195 |
| **Fax:**541-265-9351 |
| **Email:** tanya@lincolnswcd.org |
| **Contact Person:** Tanya Jorgenson |

## CERTIFICATION:

I certify that this application is a true and accurate representation of the proposed work for watershed restoration and that I am authorized to sign as the Applicant or Co-Applicant. By the following signature, the Applicant certifies that they are aware of the requirements (***see Application Instructions***) of an OWEB grant and are prepared to implement the project if awarded.

Applicant Signature: Paul Engelmeyer Date: 10/10/14

Print Name: Paul Engelmeyer Title: Board chair

Co-Applicant Signature: Stacy Polkowske Date: 10/18/14

Print Name: Stacy Polkowske Agency: ODFW

## Section II
# PROJECT INFORMATION

1. **Abstract.** In the space provided, and in 150 words or fewer, state 1) the problem, 2) the proposed solution, 3) other partners involved, and 4) how OWEB funds will be used.

   The Mill Cr Watershed is a Life Cycle Monitoring site operated by ODFW with fish population data from 1997 - present. We have developed an 8-year extensive and robust effectiveness monitoring plan to quantify the effects of a watershed-scale large wood placement on fluvial geomorphic response, aquatic habitat, benthic macroinvertebrates, overwinter survival of juvenile coho, and overall coho smolt production for the watershed. This study is an unprecedented effort that will help inform future in-stream restoration priorities, large wood placement design, land use management, coastal coho recovery goals and objectives, and limiting factors analysis for coho salmon production. Partners include Plum Creek Timber, ODFW (multiple programs), Oregon DEQ, Oregon State University and The Confederated Tribes of the Siletz Indians. OWEB funds will be used for in-house personnnel, contracted services, travel, and materials.

2. **Was this application submitted previously?** ☒ Yes ☐ No
   If yes, what was the application number? **The work proposed in this application was originally included with the restoration application #215-1004 in the Effectiveness Monitoring insert, submitted April 2014. The restoration component to place large wood throughout the watershed has been recommended for funding by the regional review team and is expected to be fully funded.**

3. **Is this project a continuation of a previously OWEB-funded project(s)?** ☐ Yes ☒ No
   If yes, what was the application number(s)?

4. **Does this application propose a grant for a property in which OWEB previously invested funds for purchase of fee title or a conservation easement; or is OWEB currently considering an acquisition grant for this property?** ☐ Yes ☒ No
   If yes, what is the grant number(s)?

5. **Project Partners.** Show all anticipated funding sources, and indicate the dollar value for cash or in-kind contributions. Be sure to provide a dollar value for each funding source. If the funding source is providing in-kind contributions, briefly describe the nature of the contribution in the Funding Source Column. Check the appropriate box to denote if the funding status is secured or pending. In the Amount/Value Column, provide a total dollar amount or value for each funding source.

| Funding Source<br>Name the Partner and what their contribution is. | Cash | In-Kind | Secured (x) | Pending (x) | Amount/Value |
|---|---|---|---|---|---|
| **OWEB – personnel, contracted services, travel, materials** | $138,239 | $ | ☐ | ☒ | $138,239 |
| **Landowner(s) or other partners:** Plum Creek Timber – project support, forest hydrologist, field crews | $ | $43,400 | ☒ | ☐ | $43,400 |
| ODFW – Salmon Life Cycle Monitoring Program | $ | $2,613,350 | ☒ | ☐ | $2,613,350 |
| ODFW – Aquatic Habitat Inventories Program | $ | $88,000 | ☒ | ☐ | $88,000 |
| ODFW – Western Oregon Stream Restoration Program (Habitat Restoration Biologist) | $ | $14,000 | ☒ | ☐ | $14,000 |
| ODEQ – Macroinvertebrate sampling & analysis | $ | $33,233 | ☒ | ☐ | $33,233 |
| OSU College of Forestry – geomorphic monitoring | $ | $8,000 | ☒ | ☐ | $8,000 |
| CTSI – project support, data sharing and collaboration | $ | $10,000 | ☐ | ☒ | $10,000 |
| **Total Estimated Funds (add all amounts in the far-right Column):** | | | | | *$2,948,222 |

*The total should equal the total cost of the project on page 1 of the application.

6. **Have any conditions been placed on other funds that may affect project completion?**

☐ **Yes** ☒ **No**

**If yes, explain:**

* The next eight questions, 7 through 14, are required for federal reporting purposes. OWEB receives a portion of its funds from the federal government and is required to report how its grantees will use those funds. Please respond as applicable.

7. **Salmon/Steelhead Populations Targeted and Expected Benefits to Salmon/Steelhead**
The information provided will be used to by OWEB to better meet federal and state reporting requirements. Completion of this section is required but will not be used to evaluate this application for funding.

☐ This project is **NOT** specifically designed to benefit salmon or steelhead.

► **If you check this box, STOP here and GO TO Question #8**

**7 a) Targeted Salmon/Steelhead Populations**: Select one or more of the salmon ESUs (Evolutionary Significant Unit) or steelhead DPSs (Distinct Population Segment) that the project will address/benefit For species where the ESU/DPS name is not known or determined, use the species name with unidentified ESU (e.g., Chinook salmon – unidentified ESU). Additional information on the designation and location of the salmon/steelhead populations can be found at http://www.nwr.noaa.gov/maps_data/species_population_boundaries.html.

| **Chinook Salmon** (*Oncorhynchus tshawytscha*) | | **Coho Salmon** (*O. kisutch*) | |
|---|---|---|---|
| ☐ | Deschutes River summer/fall-run ESU | ☐ | Lower Columbia River ESU |
| ☐ | Lower Columbia River ESU | ☒ | Oregon Coast ESU |
| ☐ | Mid-Columbia River spring-run ESU | ☐ | Southern Oregon/Northern California ESU |
| ☐ | Oregon Coast ESU | ☐ | unidentified ESU |
| ☐ | Snake River Fall-run ESU | **Steelhead** (*O. mykiss*) | |
| ☐ | Snake River Spring/Summer-run ESU | ☐ | Klamath Mountains Province DPS |
| ☐ | Southern Oregon and Northern California Coastal ESU | ☐ | Lower Columbia River DPS |
| ☐ | Upper Klamath-Trinity Rivers ESU | ☐ | Middle Columbia River DPS |
| ☐ | Upper Willamette River ESU | ☒ | Oregon Coast DPS |
| ☐ | unidentified ESU | ☐ | Snake River Basin DPS |
| **Chum Salmon** (*O. keta*) | | ☐ | Washington Coast DPS (SW Washington) |
| ☐ | Columbia River ESU | ☐ | Upper Willamette River DPS |
| ☐ | Pacific Coast ESU | ☐ | Steelhead/Trout unidentified DPS |
| ☐ | unidentified ESU | | |

**7 b) Expected Benefits**: Write a brief description of the goals and purpose of the project and how it is expected to benefit salmon/steelhead or salmon/steelhead habitat. This answer should be no longer than 2000 characters, which is approximately 330 words. **See Application Instructions for examples and ideas on how to calculate the number of words or characters in your answer.**

The multi-faceted monitoring of the project will evaluate how the physical and biological instream conditions change after watershed-scale LW placement and how those changes translate into fish production in the watershed. The results of this study will benefit future in-stream restoration priorities, large wood placement design, land use management, coastal coho recovery goals and objectives, and limiting factors analysis for coho salmon.

8. **Is the project identified as an essential or needed project in an assessment or recovery plan?**

☒ **Yes** ☐ **No**

If yes, provide name of the Plan, Watershed Assessment or Recovery Plan. If this project was not identified in a Plan, enter NONE below.

State of Oregon. 1997. The Oregon Plan for Salmon and Watersheds. Salem, Oregon

ODFW. 2007. Oregon Coast Coho Conservation Plan for the State of Oregon. Oregon Department of Fish and Wildlife. Salem, Oregon

Lorion, C. and S. Polkowske. 2014. Mill Creek (Siletz) Watershed Effectiveness Monitoring Plan. Oregon Department of Fish and Wildlife. Newport, Oregon.

9. **Report the total stream miles and/or acres that will be monitored under this application.** If monitoring the same location or stream reach multiple times, do not sum the area or length metrics for each monitoring event. For example if the project monitors a 13-mile stream reach twice per year for 3 years, report the metric only as 13 stream miles. If there is more than one type of monitoring and the locations monitored will overlap, report the total miles and/or acres for all types (i.e., do not double count areas of overlap).

   15 Total stream miles to be monitored or assessed

   8000 Total acres to be monitored or assessed

10. **Is this project a part of a comprehensive monitoring strategy/program?** See explanation below*

   ☒ **Yes** ☐ **No**

   If yes, provide the name of the comprehensive monitoring strategy/program. If this project is not part of a comprehensive monitoring strategy/program, enter NONE below.

   Lorion, C. and S. Polkowske. 2014. Mill Creek (Siletz) Watershed Effectiveness Monitoring Plan. Oregon Department of Fish and Wildlife. Newport, Oregon.

11. **Are other organizations cooperating with this monitoring project by concurrently conducting field work on other components of a Comprehensive Monitoring Strategy or Program?** See explanation below*

   ☒ **Yes** ☐ **No**

   If yes, list the organization names and identify the number:

| Cooperating Organization Names |
|---|
| Oregon State University - College of Forestry |
| Oregon State University - Dept. of Fisheries and Wildlife - Stream Lab |
| Oregon Department of Environmental Quality |
| Plum Creek Timber |
| Oregon Department of Fish & Wildlife - Life Cycle Monitoring Program |
| Oregon Department of Fish & Wildlife - Aquatic Habitat Inventory Program |
| Oregon Department of Fish & Wildlife - Western Oregon Stream Restoration Program |
| Confederated Tribes of the Siletz Indians |

   8 # of cooperators (number of cooperators shown in table above)

**The intent of questions 10 and 11 are to capture information on larger-scale or comprehensive monitoring efforts conducted by multiple entities (usually under an overarching or cooperative plan). The assumption is cooperating entities are working together to collect various aspects of integrated information (usually concurrently). For example, an OWEB funded project collected the salmon abundance/distribution data component of a salmon habitat restoration plan while other entities were collecting water quality, and/or habitat attribute data for the same comprehensive plan. Question 10 asks for the name of the plan(s) and question 11 asks for the name of the other entities involved in the cooperative collection of the data called for in that plan. If these questions are not relevant to this project enter 'None' for question 10 and for 11 answer 'None' for the cooperator names and answer 0 for the number of cooperators.*

**12. Identify the type of monitoring proposed. (See Instructions for descriptions.) Check all that apply.**

| | | |
|---|---|---|
| ☒ Baseline | ☐ Implementation | ☐ Status and Trend |
| ☒ Effectiveness of Restoration | ☐ Effectiveness of Forest Management Strategies | ☐ Other: |

**12.a) Are you monitoring a specific project(s)?**

Please identify the OWEB Grant # 215-1004

**OR** if you are monitoring a non-OWEB project, identify main project funder and year project was completed

If monitoring is not related to a specific project(s) select ☐ None

**13. Identify the parameters that will be measured. (See Instructions for descriptions.) Check all that apply.**

| | |
|---|---|
| ☒ Adult fish presence/absence/abundance/distribution survey(s) | ☒ Riparian vegetation |
| ☒ Juvenile fish presence/absence/abundance/distribution survey(s) | ☒ Spawning surveys |
| ☐ Salmon/steelhead harvest monitoring | ☐ Upland vegetation |
| ☒ Instream habitat surveys | ☒ Water quality |
| ☒ Macroinvertebrates | ☒ Water quantity |
| ☐ Noxious weeds | ☒ Other: Fluvial Geomorphology |
| ☐ Other Biological Monitoring (bird counts, amphibian surveys) | |

**13.a) If you checked Water Quality above, exactly which parameters will you be monitoring? Check all that apply.**

| | | |
|---|---|---|
| ☐ Bacteria | ☐ pH | ☒ Temperature |
| ☐ Dissolved Oxygen | ☐ Pesticides | ☐ Toxics |
| ☐ Nitrates | ☐ Phosphorus | ☐ Turbidity |
| ☐ Heavy Metals (name): | ☐ Nutrients (name): | |
| ☐ Other (explain): | | |

**13.b) If you checked Riparian or Upland Vegetation above, exactly which parameters will you be monitoring? Check all that apply.**

| | | |
|---|---|---|
| ☐ Canopy cover | ☐ Invasive species presence/absence | ☐ Plant survival |
| ☐ Percent cover | ☒ Other (explain): Riparian condition per AQI protocol | |

**14. What is the format in which the data will be stored? Check all that apply.**

| | | | |
|---|---|---|---|
| ☒ Spreadsheet | ☒ Database | ☒ GIS layers | ☒ Other (name): Geomorphic Response model |

## Section III
# SPECIFIC MONITORING PROJECT ACTIVITY

These essay questions and their answers are designed to step you and reviewers through a logical process from understanding and identifying the problem to measuring for success. **Refer to the Application Instructions for clarification and helpful examples.**

You may use the application form to respond to the questions, using additional sheets of paper as necessary **OR** answer the questions on separate pages. Be sure to include the question numbers and text of the questions before you begin typing your answers to assist the reviewers in evaluating your application.

Use 8½" x 11" paper. A double-sided application and materials are optional except for oversize maps and designs or multiple sets for reviewers. All materials should be **single-spaced** wherever possible, **unstapled** and **unbound**, except for sets of maps/photos/designs (see Page 3 of the application instructions for assembling multiples for reviewers). Use an 11-pt type size to answer the questions and a 10-pt type size for the tables. Use bullets where appropriate. Use **bold face** and *italics* for emphasis only. Do not use color highlights for text emphasis or in tables as the highlight turns black when the application is scanned. If the project involves multiple sites, be specific for each.

**M1** What is the present situation? Describe the issue or opportunity the project seeks to address.

**Project Background:**
The effectiveness monitoring project presented in this application is designed to evaluate the physical and biological effects of a large wood (LW) placement using an integrated, collaborative research approach. The effectiveness monitoring proposed in this Monitoring Grant was originally part of an OWEB Restoration Grant submitted in April 2014 (#215-1004). The Restoration Grant included a watershed-scale large wood placement component and an extensive effectiveness monitoring component to quantify the physical and biological response of the system. The review team separated the restoration and the effectiveness monitoring activities. The restoration work was recommended for funding and was ranked high enough to be funded. The review team suggested that the effectiveness monitoring components be resubmitted as a Monitoring Grant in October 2014.

The LW placement planned for the Mill Cr Watershed will total approximately 7.5 miles of stream which is the majority of coho fish distribution in the watershed. The LW implementation timeline has been delayed from the original start date of summer of 2015 to the summer of 2016 to ensure that all of the pre-implementation effectiveness monitoring can take place. A small portion of the LW placement will occur during the summer of 2015 in three geomorphic response study reaches established by researchers from Oregon State University (OSU). This is because the funding and resources (graduate student) for this monitoring component was secured prior the OWEB Restoration Grant submission from a separate source and could not be extended to accommodate a 2016 placement.

This Monitoring Grant application is accompanied by the "Mill Creek (Siletz) Watershed Effectiveness Monitoring Plan" (a.k.a. Monitoring Plan), which describes the proposed effectiveness monitoring activities in greater detail. The Monitoring Plan is referenced throughout this grant application to provide the reviewers more information on any given section if desired.

**Present Situation:**
Mill Creek flows into the mainstem Siletz River near river mile 49, just upstream of the town of Logsden. The Mill Creek Watershed covers ~8,000 acres most of which are owned and managed by Plum Creek Timber (PCT). The Confederated Tribes of the Siletz Indians (CTSI) also own and manage a small portion of the timber lands in the watershed. This basin is currently under intensive forest management with harvest cycles of ~30 years. It is assumed that the current forest management practices will continue throughout the timeline of this project and beyond. Plum Creek does not have any major harvests planned during the timeframe of this project. The CTSI will be doing some harvesting every year throughout the watershed, but these harvest units do not straddle or run adjacent to the large wood treatment reaches. There are a few small rural residential and agricultural holdings in the lower watershed that have less than 10% of the stream network running through them.

Mill Creek is representative of many small basins on the central Oregon coast with a long history of industrial timber ownership. Historic land management practices have removed the majority of the large-class conifers in the riparian area, limiting the abundance of natural recruitment of instream wood on the landscape. In addition, splash damming, log drives and stream cleaning were also common practices across the coast range that reduced stream complexity and beneficial habitats for native fish and other aquatic organisms. The current watershed conditions of Mill Creek still exhibit its legacy of land management. Recent stream surveys have documented very little in-stream wood, reaches of incised stream channels, stream bed scour to bedrock in some locations, and a riparian area that is limited in mature conifers. At a larger spatial scale, the Siletz River coho population failed a viability analysis in the 2005 Oregon Coastal Coho Assessment conducted by the state of Oregon, with stream complexity identified as the primary limiting factor. Nevertheless, nearly all of the Siletz River basin received the highest score for relative Salmonid Ecosystem Value in the recent ODFW Coastal Multi-Species Conservation and Management Plan, reflecting its potential to support diverse salmonid populations and highlighting the importance of restoration in this watershed.

The Mill Creek Watershed consists of Cerine Creek, South Fork Mill Creek (SF Mill Cr), North Fork Mill Creek (NF Mill Cr), Gunn Creek, the mainstem Mill Creek, and two unnamed tributaries (*see* Location map). The local geology is dominated by sedimentary sandstone with some basaltic intrusions, namely in the NF Mill. The stream gradient ranges from very low (0-3%) in the lower reaches where fish use is highest to steeper slopes (4-16%) as the streams climb towards the ridges. The watershed has both unconstrained and constrained stream channels with unconstrained, multi-terrace channels dominating the lower gradient reaches. Stream channels in the Mill Creek watershed are generally very malleable and have shown strong responses to previous instream restoration actions.

There have been some previous large wood placement projects in the Mill Creek Watershed. A small LW placement was done in upper Gunn Creek in 1995 that included two sites over 0.1 miles. A 1996 LW placement in mainstem Mill Creek was done by Georgia Pacific (previous owner before PCT) staff and included several sites over ~2.5 miles. The majority of these LW sites are currently decayed, busted up and/or dysfunctional. Finally, a 2009 LW placement was done in collaboration with ODFW and PCT in the lower reach of the NF Mill Cr. This project included 6 sites over the lower 0.75 miles. These LW sites are in good working condition capturing and sorting bed load.

ODFW Life Cycle Monitoring and Fish Population Data

The Mill Creek watershed is one of seven Salmonid Life Cycle Monitoring (LCM) sites managed by ODFW on the Oregon coast. In the late 1990s, as part of the Oregon Plan for Salmon and Watersheds, ODFW began monitoring survival and downstream migration of salmonid fishes at the NF Nehalem River, Mill Creek (Siletz), Mill Creek (Yaquina), Cascade Creek (Alsea), West Fork Smith River, and Winchester Creek. A seventh coastal LCM site, located on the East Fork Trask River, was added in 2004. In addition to these sites, the LCM project has monitored smolt out-migrant numbers in several other coastal streams, including ongoing monitoring in upper Lobster Creek and Tenmile Creek on the central Oregon coast. Monitoring at LCM sites is designed to meet three primary objectives: 1) estimate abundance of adult salmonids and downstream migrating juvenile salmonids, 2) estimate marine and freshwater survival rates for coho salmon, and 3) evaluate effects of habitat modification on the abundance of juvenile salmonids.

The fish data collected at the Mill Cr LCM site includes annual estimates of the number of coho smolt out-migrants and adult coho salmon returns. Adult fish are trapped at a ladder adjacent to a waterfall 0.25 miles upstream of the mouth. The waterfall is a partial migration barrier, and so adult salmon spawner estimates are made using well-established mark-recapture methods. Juvenile salmonid out-migrants are captured using a rotary screw trap located less than 150 feet upstream from the waterfall and adult fish trap. Steelhead smolt and cutthroat trout out-migrant abundance are estimated annually at the smolt trap in addition to coho salmon smolt numbers. Juvenile trapping at this site began in the spring of 1997, and adult trapping was initiated in the fall of 1997.

In addition to the core data collection that occurs at all LCM sites, Mill Creek has been the subject of additional ODFW research and monitoring that provide further background for basin-level research on coho salmon. To complement overall freshwater survival estimates at this site, coho overwinter survival estimates have been made by tagging juvenile coho salmon in the fall and then examining smolts captured the following spring for three years starting in 2010. At Mill Creek, smolt weight information has also been collected weekly

each season since 2007, providing seven years of coho smolt body condition data to complement the long-term smolt length information for this and other LCM sites. Finally, there is extensive information on the coho salmon spawning distribution in Mill Creek from fall spawning surveys used to make adult coho mark-recapture population estimates. Since 2010, survey effort has been expanded to include 95-100% of the spawning habitat in Mill Creek.

Fish Use and Distribution

The Mill Creek Watershed provides spawning and rearing habitat for coho salmon, steelhead, cutthroat trout, Pacific lamprey, western brook lamprey, and several sculpin species. Chinook salmon also spawn in Mill Creek in some years. There are approximately 15 miles of stream accessible to anadromous fish which includes a wide range of stream sizes and gradients. Coho salmon use pockets of spawning and rearing habitat in the upper (steeper) reaches of the watershed depending on flow conditions, but the majority of spawning and rearing occur lower in the watershed where the stream gradients are <4% (totaling 9.8 miles). There are no unnatural fish passage barriers in the watershed. There is a natural waterfall on the NF Mill Cr approximately 1.2 miles upstream from the forks with the SF Mill Cr.

Limiting Factors

Long-term monitoring at Mill Creek has shown that there is a positive relationship between adult spawner abundance and coho smolt production when spawner abundance is low, but that smolt production quickly reaches a plateau as spawner abundance increases. This pattern indicates that habitat conditions are generally the limiting factor for coho salmon smolt production in Mill Creek. Previous ODFW aquatic habitat inventories (AQI) and recent stream surveys noted a low abundance of wood throughout the watershed, a lack of off-channel habitats and that the majority of pools have little or no structure or protective cover. The Habitat Limiting Factors Model (HLFM) was used to analyze full-basin AQI stream habitat data for summer 1993 and winter 1998 to estimate the potential seasonal carrying capacity based on average rearing densities for different habitat types (alcoves, pools, riffles, glides, etc.). This modeling exercise suggests that winter rearing habitat is the primary habitat type limiting coho production in the watershed. This finding is consistent with assessments of the Siletz River basin overall, where stream complexity (specifically overwinter habitat) is the primary limiting factor for coho salmon.

Water temperature may also play a role as a limiting factor. Cerine Creek is on ODEQ's 303(d) list for exceeding core cold water habitat criterion (7-day average of daily maximum greater than 16°C) in the summer. All of the mainstem Mill Cr is on the 303(d) list for exceeding the core cold water habitat criterion and the spawning criterion (7-day average of daily maximum greater than 12.8°C) from October 1-June15 in the lower 1.7 stream miles.

Another potential limiting factor is the abundance and availability of aquatic macroinvertebrates for foraging fish. Little is known about the prey resources (fish food) in the Mill Creek watershed and how invertebrate abundance and diversity may play a part in the overall fish production of the system.

**Project Opportunity:**

This project leverages the vast array of ODFW fish population data described above, plus several strategic partnerships, to take a comprehensive look at the effects of a watershed-scale LW placement on stream habitat conditions and fish populations. Existing data and ongoing monitoring at Mill Creek and other ODFW monitoring sites will provide basin-level response data at a much lower cost and shorter time scale than would typically be possible. Furthermore, collaboration between multiple agencies and research groups will allow us to investigate the factors underlying the fish population responses to the LW placement, drawing links between physical and biological processes affected by the restoration project. This is an exceptional opportunity to document how LW placement affects the stream ecosystem and fish production at a site that is representative of many managed watersheds in the Oregon coast range.

The primary element that makes this project unique is the 17 years of background fish population data from the Mill Creek LCM site. The long period of pre-treatment monitoring and established relationship between adult spawner abundance and smolt production provide a baseline that will make it feasible to detect treatment effects after the LW placement. In addition, the other LCM sites on the coast have similar long-term data sets and can be used as multiple reference sites for the study. Although the other LCM sites may not track with Mill Creek exactly, together they will support a Before-After-Control-Impact (BACI) study design that is unusually robust for watershed-scale field studies of this kind.

The project partners in this study bring additional expertise, resources and opportunities that expand the project's scope to include several complementary study objectives. These objectives leverage the ODFW fish population data to further describe how the watershed treatment of large wood changes the channel morphology, aquatic habitat, prey resources (fish food), and overwinter survival of juvenile coho. Rarely do all these elements align to create a long-term, large-scale watershed study that incorporates robust data sets and sound science applications from committed, highly trained professionals.

The time for this type of study is now. OWEB and other restoration funding entities have spent millions of dollars on in-stream LW placement since the 1990s with the assumption that it helps produce more fish. Although there have been previous studies that have looked at the relationship between large wood and fish production, most have only looked at a reach scale or were short in duration. Most of these past studies have shown an increase in juvenile abundance (density) around individual large wood structures, but this does not necessarily translate to smolt abundance at the watershed level. This study offers OWEB and others interested parties the opportunity to answer the important question of how large-scale stream restoration affects watershed-level salmon smolt production.

This is a golden opportunity to evaluate one of the most common, widespread restoration practices on the coastal landscape in a way that has never been possible before. Given the project location, size and experimental design, the results of this study will be applicable to a significant portion of the industrial forest landscape in the Oregon coast range and the Coastal Coho ESU area. Specifically, managed watersheds located on the west slope of the coast range dominated by sedimentary geology. This includes the majority of the watersheds of the central Oregon coast and select watersheds on the north and south coast.

This is a long-term study with 1-2 years pre-implementation monitoring and 6 years of post-implementation monitoring. It is prudent to start this project now so that we can start answering these relevant and important questions in a timely and useful manner. The results of this study will help inform future in-stream restoration priorities, LW placement design, land use management, coastal coho recovery goals and objectives, and limiting factors analysis for coho production.

**M2** What are you proposing to do? Supply sufficient detail to match the project's complexity and technical difficulty so that its technical viability can be evaluated.

We are proposing a rigorous and diverse effectiveness monitoring study that will evaluate the effects of a watershed-scale LW placement project. We are proposing to evaluate the physical response of the LW placement by focusing on local-scale geomorphic responses and watershed-scale changes in stream habitat. The biological response to the LW placement will be examined by monitoring the overwinter survival of juvenile coho salmon, sampling benthic macroinvertebrate communities, and estimating watershed-scale production of coho salmon and other salmonid out-migrants.

The geomorphic response monitoring will look at changes in stream geomorphology, sediment transport and hydrologic processes in intensively monitored reaches. The response in aquatic habitat and riparian condition will be documented through AQI winter habitat surveys and analyzed with the Habitat Limiting Factors Model (HLFM). The potential change in available food resources for rearing salmonids will be determined by monitoring benthic macroinvertebrate biomass and taxonomic composition. ODFW will continue current juvenile coho salmon tagging efforts to assess potential changes in overwinter survival. Finally, ongoing LCM activities at Mill Creek will be used to evaluate the effects of LW placement on the production of coho smolts and other salmonid out-migrants. Following are more detailed descriptions of the Effectiveness Monitoring (EM) measures.

EM 1: Geomorphic Response (Monitoring Plan pages 13-14)
OSU Associate Professor, Dr. Catalina Segura and her graduate student will implement the geomorphic study. The sampling design consists a watershed-wide geomorphic classification into channel types, observing detailed geomorphic changes of three plane bed study reaches, flow measuring and modeling, and erosion and

deposition monitoring one year before and one year after summer 2015 partial LW treatment, then 3 years after the summer 2016 full basin treatment.

This component is essential to understand how simple, plane-bed stream channels change with the introduction of large wood. We will get a better understanding of how and where pools scour, fines settle out, gravels accumulate and stream flow changes after large wood treatment. Water temperature loggers will be used extensively in the geomorphic reaches to document the change in water temperature before and after treatment. This information will inform future large wood project design and expected outcomes based on large wood placement location, scale and stream condition. The three geomorphic study reaches encompass a variety of stream channel sizes present in the watershed and include the mainstem Mill Cr, SF Mill Cr and Cerine Cr. This variety in stream size will allow the geomorphic results to be scalable and increase the applicability of the modeling efforts.

The geomorphic study reaches will be included in other monitoring efforts planned for the watershed including aquatic habitat inventory surveys, macroinvertebrate sampling, and spawning surveys. This will allow us to use the detailed information on geomorphic change as a base layer to help describe how the habitat units, prey resources and spawning changed in these reaches.

EM 2: Winter Rearing Habitat (pages 15-16)
To evaluate the effects of LW placement on stream habitat, seasonal MidCoast Watershed Council (MCWC) staff will conduct full-basin aquatic habitat surveys (AQI) in Mill Creek. The MCWC AQI crew will be trained and mentored by ODFW Corvallis AQI Program staff and follow ODFW protocols. All surveys will be conducted during the winter because winter habitat availability is the primary limiting factor for coho smolt production in Mill Creek. A single pre-treatment habitat survey will be conducted during the winter before the LW addition to characterize current habitat conditions and LW abundance. Two post-treatment full-basin surveys will be conducted in Mill Creek. The first post-treatment survey will occur one year following the LW addition to characterize immediate changes in stream habitat. A second post-treatment survey will be conducted 6 years after the LW placement to capture the longer-term effects of the LW treatment on winter rearing habitat after adjusting to high flow events and having more time to interact with the stream channel.

The AQI data will be housed at ODFW Corvallis where ODFW staff will analyze the data as in-kind match, including running the Habitat Limiting Factors Model (HLFM).

EM 3: Benthic Macroinvertebrate Response (pages 16-19)

This effort will be conducted by OSU, ODEQ and ODFW staff. We propose collecting benthic macroinvertebrate samples in July during the summer period when macroinvertebrate samples used for habitat/water quality monitoring are typically collected. A benthic macroinvertebrate collection site will be established in each of the 5 Mill Creek restoration reaches. Sites will be randomly selected in the downstream half of the 0.7 to 3.6 mile stream reaches in which large wood will be added, and will consist of a section of stream 40 times the wetted channel width. By placing these collection sites in the lower portions of each restoration reach, we will be assessing the cumulative effects of the multiple wood placements in each of these tributaries. Our study design includes control replicates equal in number to sites where macroinvertebrates will be collected in Mill Creek. The 5 control sites will reflect the stream size, slope, aspect and substrate of the treatment sites and be located in proximity to Mill Creek (i.e. in an adjacent 6$^{th}$ Field Watershed). Paired watershed studies at Hinkle, Alsea and Upper Trask watersheds have identified the critical importance of multi-year assessments that establish control (i.e., untreated) sites to provide a context for annual variations inherent in streams. By incorporating the physical measures of stream conditions from the AQI surveys into our analyses, we will be able to look at the relationships between physical and biological changes due to large wood addition.

Pebble counts will also be done at each of the benthic sampling locations to further characterize the substrate at each sampling location.

EM 4: Overwinter Survival (pages 19-21)
Because the primary limiting factor for coho production in the Mill Cr Watershed is thought to be winter rearing habitat, overwinter survival of juvenile coho salmon would be one of the most direct measures of project effects. Coho salmon overwinter survival in the Mill Creek basin will be determined by tagging a representative group of juvenile coho salmon in late summer and early fall to estimating the number of fish that survive to the spring out-migration period. Fish will be tagged with either a passive integrated transponder (PIT) tag or a visible implant elastomer (VIE) tag, depending on their body size. All coho smolts captured during the spring smolt trapping season will be examined for tags and the total number of tagged smolt out-migrants will be estimated based on the number of tag recoveries, smolt trap efficiency, and estimated tag loss rates. Overwinter survival estimates have already been made for three years pre-treatment. Two additional years of pre-treatment data will be collected in addition to six years of post-treatment data.

Starting in fall 2014, a PIT tag antenna array will be in place in lower Mill Creek. This array will allow us to monitor the number of PIT-tagged fish that leave the watershed during the winter before the smolt trap is installed and will also refine estimates of spring coho smolt out-migrants. The location of the array near the smolt trap is ideal because it will capture the out-migrating smolts just before they leave the watershed. The natural falls just below the smolt trap and array will not allow any juvenile coho salmon to re-enter the watershed once they migrate out. This will eliminate any double counting of juveniles once they go downstream.

The Confederated Tribes of the Siletz Indians (CTSI) has been seining the mainstem Siletz and the Siletz Estuary from March to September to characterize the presence, location and abundance of rearing juvenile salmon throughout the lower Siletz watershed and estuary, including coho. They are planning to continue this work during the timeframe of the Mill Creek study. We will collaborate with their Aquatic Projects Leader, Stan van der Wetering, to augment the smolt out-migration data generated from Mill Creek. CTSI will wand juvenile coho with a PIT-tag reader or look for a VIE tag to identify and record any Mill Creek fish. This opportunity could give some information on where the juvenile coho go once they leave the Mill Creek Watershed.

EM 5: Coho Smolt Production (pages 21-23)
Annual monitoring of coho smolts and other salmonid out-migrants will be conducted at Mill Creek and five control sites using standard LCM project methods. Salmonid out-migrants will be caught using a five foot rotary screw trap or motorized inclined plane trap. Smolt traps are operated continuously from the beginning of March until the end of the coho smolt outmigration period, typically in mid to late June. Population estimates for coho salmon smolts and other salmonid out-migrants are based on mark and recapture information for each species, and are made using a Bayesian statistical model implemented in program R. For steelhead and cutthroat trout, estimates are made for several different length classes due to differences in trap efficiency for fish of different sizes. For each species and size class, fork length measurements are made on up to 25 fish per week, allowing characterization of the size structure of the out-migrant population.

Additional field data collection:
Continuous temperature monitors will be strategically placed throughout the LW treatment reaches, including the macroinvertebrate sampling locations. We do not have a specific effectiveness monitoring objective to evaluate how the stream temperature changes after large wood placement. ODFW has had continuous temperature loggers at the LCM site and at each tributary junction with the mainstem for several years. These data will be used to provide baseline information and provide background information on the watershed condition over the length of the study.

ODEQ and ODFW also plan to collaborate on additional sampling aimed at assessing reach-scale changes in fish assemblages following the LW placement. Fish would be sampled in early summer, at the same time and in the same reaches as benthic macroinvertebrates, as well as in control reaches outside the Mill Creek basin. Single-pass electrofishing will be used to characterize the fish assemblage using standard ODEQ methods. This work will provide additional data on resident species that will complement LCM smolt trapping data, and could potentially be used more broadly as a cost-effective restoration monitoring tool. This work will be done as inkind match by ODEQ staff. We did not include the fish assemblage monitoring component as a specific

EM objective in the monitoring plan or the grant application. ODEQ will execute this monitoring in close collaboration with the other EM objectives and the results will be synthesized with results from the overall study.

**M3** What are the project's monitoring objectives? Tie monitoring objectives to watershed restoration objectives. If effectiveness monitoring is proposed, provide a specific hypothesis or monitoring question.

The goals of the effectiveness monitoring (EM) are:

1) To determine the degree to which the project's restoration treatments meet its overall purpose including 1) enhance in-stream ecological function and condition, 2) address the limiting habitat factor for fish production, and 3) increase fish production in the Mill Creek Watershed.
2) To understand the relationship between channel geomorphology, aquatic habitat, benthic macroinvertebrate assemblages, and fish production following large wood placement in an actively managed watershed.
3) To evaluate the temporal and spatial recovery of watershed functions after instream restoration.
4) To determine the applicability of the Habitat Limiting Factors Model (HLFM) as a restoration planning and assessment tool.
5) To provide scientifically-sound data to help guide other similar projects and advance the understanding of watershed restoration and fish production; and to disseminate that information to other practitioners, resource managers, decision-makers, and scientists.

To achieve these goals, effectiveness monitoring will focus on five monitoring objectives:

**EM Objective 1: Describe short-term geomorphic responses to large wood placement for 1 and 3 years after treatment.**

Hypothesis: The watershed-scale large wood placement will result in more complex geomorphology.

a) Higher spatial variability in shear stress and velocity.
b) Changes in the spatial distributions of flow velocity and shear stress will be related to changes in available winter and summer habitat for coho salmon.
c) Spatial variability of surface grain size distributions will increase after LW placement.
d) Total model bed load will decrease (i.e. increases storage behind structures) but the spatial variability will increase.
e) Spatial patterns in erosion and deposition recorded in scour chains will indicate an increase in aggradation and a decrease in erosion after the LW introduction.

**EM Objective 2: Quantify changes in winter rearing habitat following large wood placement 1 and 6 years after treatment.**

Hypothesis: The watershed-scale large wood placement will increase the quantity and quality of winter rearing habitat available to coho salmon and other salmonids.

**EM Objective 3: Assess benthic macroinvertebrate biomass and taxonomic composition in years 1, 3 and 6 after treatment. To determine the effects of large wood treatment, sampling sites will be located in Mill Creek and in an untreated control watershed.**

Hypotheses:

1) Benthic macroinvertebrate abundance and composition, measured as density, biomass, and diversity will respond to the large wood enhancement.
2) Invertebrate taxonomic composition and metrics will change to reflect changes in hydraulic complexity and substrate composition after wood placement.

**EM Objective 4: Investigate how large wood placement affects juvenile coho salmon overwinter survival for 6 years after treatment.**

Hypothesis: The watershed-scale large wood placement will increase overwinter survival (parr to smolt) rates for juvenile coho salmon.

**EM Objective 5: Determine if large wood placement affects the annual abundance of coho salmon smolts and other salmonid out-migrants for 6 years after treatment.**

Hypothesis: The watershed-scale large wood placement will result in an increase in the annual abundance of coho smolts.

**M4** Describe in detail and provide the citation for the protocols that will be used.

EM 1: Geomorphic Response

Geomorphic classification: Dr. Segura and her graduate student will conduct a watershed-wide geomorphic classification into channel types (Montgomery and Buffington, 1997). The initial approach will be based on available LiDAR information followed by a large scale geomorphic survey.

Geomorphic observations: They will take detailed information in channel geometry in three plane bed reaches. The length of each reach will be approximately 20 times its bankfull width. At least 10 cross-sections per reach will be surveyed and detailed information in grain size distributions (i.e. pebble counts) will be taken over several locations of the channel bed.

Flow modeling: They will model shear stress, mean vertical velocity, and depth in the mentioned three reaches before and after LW additions. A 2d modeling system (MD-SWMS) developed by the US Geological Survey (McDonald et al. 2006) will be used.

Erosion and deposition monitoring: They will install a grid of scour chains in the 3 study reaches before and after the LW placement to monitor erosion and deposition. The grids will have at least 15 chains per site.

They will analyze the flow modeling results to investigate variability in the spatial distributions of shear stress, velocity, and depth before and after LW placement. Flow modeling results will also be analyzed together with grain size information to compute bed load intensity. These modeled bed load distributions will be compared with results obtained from the chain scour monitoring to understand the limitations of the model. The data will be analyzed together with fish population information to determine the flow features that related the best to fish population dynamics.

EM 2: Winter Rearing Habitat

To evaluate the effects of large wood placement on stream habitat, full-basin habitat surveys will be conducted in Mill Creek using ODFW Aquatic Inventories (AQI) Project protocols (Moore et al. 2007). The ODFW Habitat Limiting Factors Model (HLFM) as described by Nickelson et al. (1992) and Nickelson (1998), and updated in 2007 (Anlauf et al. 2009) will be used as a predictive model to estimate current carrying capacity for juvenile coho salmon based on pre-treatment winter habitat surveys, as well as the expected change in carrying capacity following large wood placement. An HLFM carrying capacity estimate will also be made using post-treatment winter habitat survey data, and comparisons with actual smolt abundance will provide a quantitative link between observed habitat changes and coho production. Changes in stream habitat will be placed in context by comparing them with trends at randomly selected AQI surveys (the "control" sites) in similar mid-coast streams (geology, size, slope, etc.) that do not undergo any habitat restoration during the Mill Creek project timeframe.

EM 3: Benthic Macroinvertebrate Response

Benthic sampling field methods: At each site, eight 1-$ft^2$ benthic macroinvertebrate sub-samples will be collected and composited from riffles in study reaches that are 40X the wetted channel width. ODEQ will provide two staff to lead the field work for benthic sampling. We propose to team with ODFW LCM and local district crews to collect the samples for each site. One ODEQ staff with extensive benthic monitoring experience will be paired with one ODFW staff without extensive benthic monitoring experience. This will give us two teams of two each to collect samples at each site. Initially, each crew will work together for each Surber sample. At the discretion of the ODEQ crew leader, crews may split up to collect sub-samples separately following completion of at least two full samples, to improve collection efficiency. However, because sampler variability could have a potential for introducing undesired variability, each crew member will provide the same number of subsamples to each composite

sample. The ultimate goal is for ODEQ to pass on its knowledge and experience in benthic macroinvertebrate sampling to ODFW staff. This will allow ODFW staff to develop internal capabilities to perform similar sampling for other projects and increase monitoring efforts among ODFW, ODEQ, and other entities (USFS, Watershed Councils, etc.).

Benthic lab work: OSU's Stream Lab and ODEQ staff will analyze the benthic samples. Based on protocols developed at Alsea, Trask and Hinkle Creek watershed studies, each composite sample will be frozen in dry ice in the field then defrosted in the lab after which:

- ½ the composite will be picked (i.e. non-invertebrate bits removed), dried in drying oven, weighed for biomass
- ½ the composite will placed in alcohol preservative; invertebrates will be identified for desired metrics, taxonomic ordination, and models (biological condition + habitat)

Samples collected from the geomorphic study reaches will be processed in the same way, but because only biomass will be determined from these samples, the half of the sample normally reserved for identification will be preserved and held, so that additional funding can be sought if there is a compelling reason to analyze these samples further.

Ordination techniques will be used to illustrate changes in macroinvertebrate assemblage composition. Taxa will also be assigned to various habits, functional feeding groups, and tolerances. Shifts in these metrics may be observed as overlays in ordination space, or as summaries of each metric across treatments and controls.

The potential shift in sediment tolerance in macroinvertebrate assemblages will be assessed with ODEQ's Fine Sediment Stressor ID model (http://www.deq.state.or.us/lab/techrpts/docs/10-LAB-005.pdf) and the Fine Sediment Biotic Index (Relyea et al 2012). Both of these models attempt associate tolerances to fine sediment conditions in streams throughout Oregon or the Pacific Northwest, then use the abundances of taxa observed within each sample to estimate an overall assemblage-level preference for (or tolerance of) fine sediments.

Benthic biomass will be compared before and after treatment, as well as between treated and control sites using repeated measures Analysis of Variance (ANOVA). This conservative approach will take into account the necessity of resampling the same locations over repeated years. Repeated measures ANOVA can also be used to compare invertebrate metrics such as the proportion of relevant functional groups (e.g. shredders), or proportion of particular taxonomic groups (e.g. chironomid midges) the years following large wood placement.

EM 4: Overwinter Survival

Fish to be tagged will be collected in randomly selected reaches throughout the basin selected using a Generalized Random Tessellation Stratified design (GRTS, Stevens 2002). This method will be used to create a spatially balanced, random point distribution within a sampling frame that encompassed the entire rearing distribution of coho salmon in the Mill Creek drainage. A sampling reach 20 times the active channel width will be established at each random point, and all habitat units within that reach will be sampled using a combination of beach seining and electrofishing. All coho parr captured will be anesthetized, measured for fork length and weight, and then marked with either a PIT tag or VIE tag depending on their fork length. Fish under 65 mm FL will be tagged with visible implant elastomer material in the dorsal fin, and fish 65 mm FL and large will be tagged with a 12.5 mm PIT tag in the body cavity. To evaluate potential overwinter loss of VIE tags, a sub-sample of fish receiving PIT tags will also receive a VIE tag. Overwinter survival estimates will be based on tag recoveries at the smolt trap and the adjacent PIT tag antenna array in the spring. The total number of tagged smolt out-migrants will be estimated based on the number of tag recoveries, smolt trap efficiency, and estimated tag loss rates.

A Before-After, Control-Impact (BACI) sampling design (Stewart-Oaten et al. 1986) will be used to test for changes in overwinter survival following the addition of large wood. Overwinter survival is not routinely measured at other LCM sites, but long-term data is available at the Lobster Creek monitoring sites (Alsea basin). These sites in upper Lobster Creek were originally part of a paired watershed study examining effects of habitat modification on salmonid populations and overwinter survival (Solazzi et al.

2000). ODFW has continued to estimate overwinter survival at the paired sites since that study concluded in 1994. Due to the close proximity of the two Lobster Creek sites, a single aggregate value from the two sites for years corresponding to data collection at Mill Creek will be used in the BACI analysis.

EM 5: Coho Smolt Production
Monitoring of coho smolts and other salmonid out-migrants will be conducted at Mill Creek and five control sites using standard LCM project methods (Suring et al. 2012). The control sites are other ODFW smolt monitoring sites at the East Fork Trask River, Mill Creek (Yaquina basin), Lobster Creek (Alsea basin), Cascade Creek (Alsea basin), and Tenmile Creek (direct ocean tributary). These sites vary in habitat conditions, land-use patterns, and geological setting, but all experience similar temporal trends in precipitation, temperature, and adult coho salmon abundance as the Mill Creek (Siletz) site where the wood addition will take place. There are also no major recent or planned modifications in stream habitat at these sites, as have occurred at the West Fork Smith River LCM site in the Umpqua basin.

A Before-After, Control-Impact (BACI) sampling design (Stewart-Oaten et al. 1986) will be used to test for changes in smolt production following the addition of large wood. The availability of long-term smolt production data for several LCM sites on the Oregon coast will allow the use of an asymmetrical design with multiple control sites (Underwood 1994). Data collection began in different years at the different sites, but smolt estimates are available from 1998 to present for the treatment stream and four of the five control sites. Smolt estimates from the paired watersheds in Lobster Creek will be pooled due to the close proximity of the two sites. Data collection did not commence at the East Fork Trask River until 2005, but the pre-treatment period will cover 12 years from 2005 to 2016. The post-treatment period will initially include the 6 years from 2017 to 2022, but we also plan to test for changes on a longer time scale as data collection continues at these sites.

ANOVA will be used to test for interactions among locations and treatment periods, indicating whether there was a significant change in smolt production in Mill Creek relative to controls following the large wood addition. Data analysis will primarily focus on coho salmon smolts, but tests will also be conducted for steelhead smolts (defined as migrants $\geq$ 120 mm fork length, Suring et al. 2012) and the most abundant size classes of cutthroat trout. Changes in stream habitat are primarily expected to result in changes in smolt abundance, but comparisons of coho smolt size and weight before and after the treatment will also be made to evaluate potential effects on individual fish growth and condition.

Detailed descriptions of the each EM sampling design, protocols used, data analysis, and associated references are available in the Monitoring Plan.

**M5** Describe in detail the sampling design used to choose your sampling locations.

LW Placement sites – Unique to this project, the specific LW placement sites will be identified using the information from the pre-treatment full-basin AQI survey scheduled to occur during winter 2015/2016. The AQI survey will detail the location, size (area), and type of existing winter habitat units (pools, riffles, glide, beaver ponds, side channels, etc.) to be considered in the LW site selection. LW will be placed in existing pools, tributary junctions, side channels and backwaters, old beaver dam sites, and other locations that will likely increase the area of winter habitat. Prior to placement, the project manager will conduct a summer stream survey to add any additional sites that may have been underestimated at high flows such as deep summer pools. The methodology of site selection will be well documented to provide a clear, reproducible process important for the research aspect of this project and for future considerations in other LW placement projects.

EM 1: Geomorphic Response – The geomorphic classification into channel type will be done for the entire stream network within the watershed. The three plane bed "study" sites for detailed geomorphic observations have been selected in June 2014 to allow for field measurements and instrument installation that occurred in summer 2014. These three study sites were selected using previous AQI data and field observations. The flow monitoring and erosion/deposition sampling locations will be within the three study sites.

EM 2: Winter Rearing Habitat – For each of the full-basin surveys, surveyors will start at the smolt trap site in lower Mill Creek and survey all stream habitat upstream within the distribution of anadromous fish (approximately 15 miles).

EM 3: Benthic Macroinvertebrate Response – Because most of the wood placement in Mill Creek will be additions to existing pools to increase complexity, we propose having our main sampling locations in sections where this type of wood placement is being employed. However, because so much additional physical information will be collected at the 3 initially plane-bed geomorphic study reaches where wood will be added, we would like to collect some biological data at these sites as well. As a result, we will look at relationships between the physical data collected at these geomorphic study sites and macroinvertebrate biomass. We will also test whether the macroinvertebrate biomass responds in the same way to wood additions in the geomorphic study reaches as in the main Mill Creek sampling sites.

At all sites, benthic macroinvertebrates will be collected from riffle habitat using Surber samplers. Although macroinvertebrate community changes will undoubtedly occur in pools where most of the wood is being placed, we are confining our sampling to riffles because of the logistical difficulties of collecting good, quantitative macroinvertebrate samples in deep, complex pool habitat. Furthermore we anticipate changes in substrate grain sizes, hydraulics, and organic matter retention in riffles as well, reflecting changes in the restoration reaches overall, leading to changes in macroinvertebrate communities. As an additional benefit, riffle sampling is used most often in monitoring by ODEQ and watershed councils, so our data will be directly comparable to most other monitoring data and will be well-suited for use in ODEQ water and habitat quality assessment models.

EM 4: Overwinter Survival – A Generalized Random Tessellation Stratified design (GRTS, Stevens 2002) will be used to create a spatially balanced, random set of points that encompassed the entire rearing distribution of coho salmon in the Mill Creek drainage. The length of sampling reaches established at these points will be determined by channel size so that tagged fish are representative of the juvenile coho salmon population in the basin. The goal will be to sample at least 15-20 randomly selected reaches each year and tag at least 1,500 juvenile coho salmon.

EM 5: Coho Smolt Production – In 1998, ODFW opportunistically chose the LCM monitoring sites. These included sites where both downstream migrants and returning adults could be monitored (e.g. Mill Creek). Additional locations were selected to monitor downstream migrants only due to a lack of adult capture facilities (e.g.Tenmile Cr). In this study, we will select a subset of the current LCM smolt monitoring sites as controls (see below).

Control/Reference Sites –
LCM control sites: The control sites are other ODFW smolt monitoring sites at the East Fork Trask River, Mill Creek (Yaquina basin), Lobster Creek (Alsea basin), Cascade Creek (Alsea basin), and Tenmile Creek (direct ocean tributary). These sites vary in habitat conditions, land-use patterns, and geological setting, but all experience similar temporal trends in precipitation, temperature, and adult coho salmon abundance as the Mill Creek (Siletz) site where the wood addition will take place. There are also no major recent or planned modifications in stream habitat at these sites, as have occurred at the West Fork Smith River LCM site in the Umpqua basin. For now, ODFW intends to continue LCM efforts at all these sites. If this changes in the future due to program resource reallocation, ODFW higher management has committed to this study and will work diligently on ensuring that monitoring continues at some reference sites.

Overwinter survival control site: The overwinter survival control site is located in Lobster Creek Watershed in the Alsea Basin.

AQI control sites: The AQI control sites will be randomly selected AQI surveys located in similar mid-coast streams (geology, size, slope, etc.) that do not undergo any habitat restoration during the Mill Creek project timeframe. It is estimated that there will be 20 suitable control sites for each survey year. ODFW will conduct the AQI surveys for the control sites as in-kind match.

Benthic macroinvertebrate control sites: Project partners will identify and select 5 control sites for the benthic macroinvertebrate response sampling that reflect the stream size, slope, aspect and substrate of the 5 different treatment sites in the Mill Creek Watershed. They will be located in proximity to Mill Cr (i.e. in an adjacent 6th Field Watershed).

**M6** Describe how the information to be gathered augments existing available data.

Given the integrated monitoring objectives, this study will augment existing available data and fill several data gaps on how a watershed-scale large wood treatment changes the physical and biological processes within a watershed. Our aspiration is for this project to answer some very simple, yet complex questions about how a stream ecosystem changes over time after instream restoration and underscore the importance of natural recruitment of mature conifers into our coastal streams.

The relationships between LW placement, stream habitat, and fish populations have been investigated in a variety of studies in the Pacific Northwest. Studies that measured local abundance of rearing salmonids at large wood placement sites (e.g. Cederholm et al. 1997, Roni and Quinn 2001) have found significantly higher juvenile coho densities compared to controls, particularly during winter. Steelhead and cutthroat trout densities were also higher at large wood placement sites during the winter (Roni and Quinn 2001). Questions remain, however, about how local abundance relates to smolt production at the watershed scale, and whether immigration to large wood sites might explain observed increases (Riley and Fausch 1995). Since increased smolt production is often the ultimate goal of restoration work, monitoring salmonid smolt out-migrants from treated streams provides a more direct measure of project effectiveness (Roni et al. 2003). Studies that have estimated the number of salmonid out-migrants from basins before and after large wood additions have shown inconsistent results for coho salmon and other salmonid species. Some studies have found that coho smolt production increased in treated basins following restoration in which large wood addition was an important component (e.g. Cederholm et al. 1997; Solazzi et al. 2000). In other cases (e.g. Reeves et al. 1997; Johnson et al. 2005), no significant change in coho smolt production has been observed following extensive large wood additions. Results for other salmonid species also vary among studies.

Given the mixed results from previous studies and the difficulty of documenting responses to restoration, there is a strong need for well-designed, basin-scale research on the response of salmonid populations to LW placement projects (Liermann and Roni 2008, Roni et al. 2010). Mill Creek, and the other LCM sites that can serve as controls, offer an outstanding opportunity to pursue this type of research. In this study, we propose to implement a watershed-scale restoration plan centered on extensive LW placement in Mill Creek, and then use an integrated research plan designed to investigate the physical and biological responses to the LW placement. By examining relationships between the restoration treatment, stream habitat characteristics, benthic communities, and salmonid populations in Mill Creek, we expect to make a significant contribution to the knowledge base on stream ecosystem responses to LW placement. In particular, we expect to quantify the effects of LW placement on coho salmon smolt production, and document the physical and ecological changes that influence smolt abundance. Our work will also document the temporal and spatial scales at which these processes take place, providing valuable information for stream restoration and salmon recovery planning.

Finally, this project will go beyond many previous restoration studies that have focused only on fish-habitat relationships, and look at broader stream community responses to the LW placement. Benthic macroinvertebrates are abundant and diverse, and can provide valuable information about environmental conditions and change. As a result, they are widely used as indicators of stream condition and biological integrity. They also are the primary food source for juvenile coho salmon and other rearing salmonids during most of the year. Large wood placed in Mill Creek will result in significant changes in sediment sorting, hydraulics, and organic matter retention, all of which are known to influence benthic macroinvertebrate diversity and abundance. By measuring in-stream macroinvertebrate biomass and taxonomic composition, we have an opportunity to gain new understanding of how LW placement influences benthic communities, ODEQ water and habitat quality assessments, and potential food resources for rearing salmonids.

See reference citations in the Monitoring Plan.

**M7** Describe the quality control/quality assurance program for the project and who will be collecting your data.

EM 1: Geomorphic Response – Oregon State University (OSU) College of Forestry Assistant Professor, Dr. Catalina Segura is the principle investigator for this objective. She will be working with a graduate student to collect and analyze the data. Dr. Segura's research interests are focused on the interactions between fluvial geomorphic, hydrologic, and ecological processes. Her research strategy and experience includes intense field-based studies and modeling efforts of both field generated data and regionally available data sets.

EM 2: Winter Rearing Habitat – ODFW's Aquatic Habitat Inventory (AQI) Project staff have been instrumental in designing this component of the study. Kim Jones has vast experience in habitat and fish surveys, and estuary studies, and was instrumental in the development of this project before he retired. Now Charlie Stein, Kara Anlauf-Dunn and Lora Tennant are the key ODFW AQI partners offering their expertise in habitat surveys, HLFM analysis, and fish surveys. They will also train and mentor the two MCWC AQI field crew members to conduct the field work according to standard AQI protocols.

EM 3: Benthic Macroinvertebrate Response – Judith (Judy) Li, retired OSU Associate Professor of Fisheries, brought her experience with the macroinvertebrate sampling for the Alsea, Hinkle and Trask watershed studies to the sampling design and the QA/QC plan for the Mill Creek study. Shannon Hubler from ODEQ will lead the field collection of benthic macroinvertebrates according to ODEQ's field sampling methods. ODFW LCM and local district staff will assist ODEQ in the field work. OSU's Department of Fisheries and Wildlife Stream Lab Senior Faculty Research Assistant, William (Bill) Gerth will process and analyze the benthic macroinvertebrate samples.

EM 4: Overwinter Survival – ODFW's LCM crews have been tagging juvenile coho and estimating overwinter survival in Mill Creek and Lobster Creek (reference site) for several years using well-established techniques and protocols. Tagging methods follow guidelines in the following:

- PIT Tag Steering Committee. 1999. PIT tag marking procedures manual, version 2.0. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.
- Northwest Marine Technology, Inc. 2008. Visible Implant Elastomer Tag Project Manual, version 2.0. Shaw Island, WA.

EM 5: Coho Smolt Production – ODFW's Mid-Coast LCM Assistant Project Leader, Chris Lorion will continue to manage daily LCM activities using standard LCM project methods (Suring et al. 2012). These methods are based on extensive fish trapping experience by ODFW staff and have been followed and refined since 1997.

Partner Meetings: The effectiveness monitoring objectives proposed for the Mill Cr project brings together several different disciplines, programs, researchers and methods. Given the intricate and comprehensive nature of the proposed monitoring, there is a need to formally synchronize these efforts and provide an opportunity for partners to share information with each other and interested parties. The purpose of an annual partner meeting is to discuss relevant findings (restoration plans, invertebrates, fish, habitat, hydrogeology/geomorphology, land management activities), work and study plans for the next year, coordination needs, modifications to restoration and study plans, dissemination opportunities (e.g. professional meetings, scientific manuscripts, presentations, posters, technical reports, etc.), and future research needs among all research partners, OWEB, watershed councils, and interested members of the public. ODFW and the MCWC will coordinate these meetings.

Deliverables from these meetings include:

- A meeting will be held every fall, starting in 2014 through 2022. A total of 9 meetings.
- Meeting notes and presentations will be posted on the Mill Cr Project page of the MCWC and ODFW-Corvallis websites.
- A brief report of each meeting will be submitted to OWEB.

**M8** Other than a final report to OWEB, how else will the monitoring data collected through this project be used?

The data collected will be stored in several locations in varying formats (GIS, spreadsheets and databases). Once the OWEB grant is approved and the project moves forward the specific metadata requirements to ensure that the data are in compatible formats that will allow for integrated data analysis will be discussed at a partner meeting.

EM 1: Geomorphic Response – Catalina Segura and her graduate student will obtain, store and analyze the geomorphic data. A peer reviewed journal article is expected summer of 2017.

EM 2: Winter Rearing Habitat – MCWC will hire a season crew to conduct the full-basin AQI field work. This crew will be trained by ODFW AQI Program staff and use ODFW protocols. The AQI data and The Habitat Limiting Factors Model (HLFM) analysis and reporting will be completed by ODFW AQI Program staff as in-kind match to the project.

EM 3: Benthic Macroinvertebrate Response – Bill Gerth will analyze the benthic samples for biomass and taxonomic identification and interpret the results using ordination techniques and ANOVA analysis. Judy Li will take a supervisory role and provide assistance in the OSU data analysis. Shannon Hubler will analyze the lab results using ODEQ's Fine Sediment Stressor ID model and Biotic Index.

EM 4: Overwinter Survival – ODFW LCM Project Leader, Erik Suring and Assistant Project Leader, Chris Lorion will estimate the annual overwinter survival estimates, conduct the BACI analysis, and report the results.

EM 5: Coho Smolt Production – ODFW LCM Project Leader, Erik Suring and Assistant Project Leader, Chris Lorion will estimate the annual coho smolt estimates, conduct the BACI analysis, and report the results.

The resulting reports for each EM data analysis will be reported to OWEB along with a copy of any white paper, scientific manuscript or other publication. Three EM reports to OWEB are planned (see EM Timeline). In addition to the individual results, a monitoring synthesis component will accompany each OWEB report to connect the dots between fine-scale geomorphic responses to wood addition and reach-scale habitat conditions, and then link these changes to the benthic response, and fish survival and production at the basin scale. ODFW Habitat Restoration Biologist, Stacy Polkowske, will be responsible for preparing and submitting the OWEB reports.

A variety of methods will be used to communicate effectiveness monitoring results to the research community, restoration practitioners, and the general public. We expect to produce several manuscripts for publication in scientific journals, including papers focused on geomorphic modeling results, benthic macroinvertebrate community response to restoration, and restoration effects on juvenile salmonid survival and production. We also plan to develop a synthesis paper that ties together the five main research topics described in this effectiveness monitoring plan. Final results from some study components will not be available for a number of years, and so OWEB reports and presentations at scientific meetings will be used to track monitoring progress and present preliminary results. As monitoring progresses, preliminary findings will also be communicated to agency partners and local watershed councils through meetings and presentations. Watershed council meetings are open to the public and provide an excellent venue for presenting results to community members. At the end of the proposed monitoring period, when all objectives are complete, we plan to summarize the effectiveness monitoring results on a website with contact information for all the study partners.

On-site Workshops: We are also proposing to do two On-site Workshops for disseminate project information to interested public. MCWC will host and coordinate two workshops for regional practitioners, land managers, policy makers, and conservation organizations and agencies. One would be 1-2 years after log placement, the other after two fish generations.

The Mill Creek large wood and effectiveness monitoring proposal is designed to answer important questions about physical and biological responses to large wood placement that are of interest to a broad range of audiences. These workshops will provide an opportunity for project partners to share information with a more

general base of interested parties than the annual partner meetings described above. The field visit would concentrate on the physical appearance (log placement design, bedload and channel morphology responses) and on the monitoring methodology. The field visit may involve participants visiting the ODFW LCM site, and/or getting into the stream and doing hands-on activities. Examples might include quantifying the floating wood and other debris collected by a structure, doing pebble counts or other measures of substrate sorting, learning some advanced protocols for sampling invertebrates (e.g. sampling multiple substrates), or working from supplied photos to quantify over-winter log shifting.

Deliverables:

- 2 all-day workshops for approximately 40 participants each. Workshops would include partner presentations, lunch, and a field visit.
- Workshops will be held spring/summer 2018 and 2021.
- A brief report of each workshop will be submitted to OWEB.

**M9** What is the proposed schedule for the project?

OWEB monitoring funds will support monitoring activities from summer 2015 to winter 2022/2023. The different EM objectives will be monitored at different times according to the specific sampling design:

EM 1: Geomorphic Response – Summer 2014 thru Spring 2020;
EM 2: Winter Rearing Habitat – Winter 2014/2015 in geomorphic reaches only, Winter 2015/2016 – full basin, Winter 2016/2017 – full basin, and Winter 2021/2022;
EM 3: Benthic Macroinvertebrate Response – Summer 2016, 2017, 2019, and 2022;
EM 4: Overwinter Survival – Fall 2014 thru Spring 2022 (ongoing LCM activity);
EM 5: Coho Smolt Production – Spring 2015 thru Spring 2022 (ongoing LCM activity).

Continuous temperature will be monitored throughout the watershed during the study's timeframe to provide additional information on watershed background conditions that may affect the different EM objectives.

Please refer to the EM Timeline matrix in the Monitoring Plan for more details on the planned monitoring activities.

**M10** How many years is this monitoring program going to be conducted?

The OWEB funded portion of this study is an 8-year study from Summer 2015 to winter 2022/2023 (including partner inkind monitoring). Please see the timeline matrix included in the Monitoring Plan.

**M11** How will the success of the project be determined?

The success of the project will be determined by the completion of all the monitoring goals and objectives outlined in the Monitoring Plan as well as all the deliverables specified in the OWEB grant.

EM Objectives:
Objective 1: Describe short-term geomorphic responses to large wood placement for 1 and 3 years after treatment.

Objective 2: Quantify changes in winter rearing habitat following large wood placement 1 and 6 years after treatment.

Objective 3: Assess benthic macroinvertebrate biomass and taxonomic composition in years 1, 3 and 6 after treatment. To determine the effects of large wood treatment, sampling sites will be located in Mill Creek and in an untreated control watershed.

Objective 4: Investigate how large wood placement affects juvenile coho salmon overwinter survival for 6 years after treatment.

Objective 5: Determine if large wood placement affects the annual abundance of coho salmon smolts and other salmonid out-migrants for 6 years after treatment.

OWEB Deliverables:

Progress and Final OWEB Reports
- Winter 2017-18 Progress Report
- Winter 2019-20 Progress Report
- Winter 2022-23 Final Report
- Copies of all scientific manuscripts, white papers, and professional presentations.

Partner Meetings
- A meeting will be held every fall, starting in 2014 through 2022. A total of 9 meetings.
- Meeting notes and presentations will be posted on the Mill Cr Project page of the MCWC and ODFW-Corvallis websites.
- A brief report of each meeting will be submitted to OWEB.

On-site Workshops
- 2 all-day workshops for approximately 40 participants each. Workshops would include partner presentations, lunch, and a field visit.
- Workshops will be held spring/summer 2018 and 2021.
- A brief report of each workshop will be submitted to OWEB.

**M12** Provide a detailed description of project location, including location(s) where monitoring will occur. In addition, please provide geographic coordinates as described in the Section V Supplemental Information "Required Attachments" section of the application instructions, pages 10-12.

EM activities funded by OWEB dollars will take place throughout the entire Mill Creek Siletz Watershed: HUC 1710020405, Geographic coordinates: -123.773, 44.76. This includes Cerine Creek, South Fork Mill Creek (SF Mill Cr), North Fork Mill Creek (NF Mill Cr), Gunn Creek, the mainstem Mill Creek, and two unnamed tributaries. OWEB funds will also fund macroinvertebrate sampling in 5 control reaches in an adjacent watershed. These specific control reaches will be identified if and when OWEB funds are received.

## Section IV
## MONITORING BUDGET

***IMPORTANT: Read the application instructions and January 2014 Budget Categories Definitions and Policy Document.***
***Add additional lines, if necessary.***

**Totals automatically round to the nearest dollar**

| A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|
| *Itemize projected costs under each of the following categories:* | **Unit Number** | **Unit Cost** | **OWEB Funds** | **Cash Match*** | **In-Kind Match*** | **Total Costs** |
| | (e.g., # of hours) | (e.g., hourly rate) | | | | (add columns D, E, F) |
| **SALARIES, WAGES AND BENEFITS.** List position titles, include only costs of employees charged to this grant. | | | | | | |
| Pre-treatment AQI - 2 person field crew | 720 | 18 | 12,960.00 | | | 12,960 |
| Year-1 post-treatment AQI - 2 person field crew | 720 | 18 | 12,960.00 | | | 12,960 |
| Year-6 post-treatment AQI - 2 person field crew | 720 | 18 | 12,960.00 | | | 12,960 |
| MCWC Coordinator - workshop coordination, project support | 80 | 30 | 2,400.00 | | | 2,400 |
| **SUBTOTAL (1)** | | | 41,280 | 0 | | 41,280 |
| **CONTRACTED SERVICES.** Labor, supplies, and materials to be provided by *non-staff* for project implementation. | | | | | | |
| ODFW - Habitat Restoration Biologist - 50 hours/yr/7 yrs = 350 hrs | 350 | 40 | | | 14,000.00 | 14,000 |
| Plum Creek Timber - Forest hydrologist - project support - 7 years | 210 | 100 | | | 21,000.00 | 21,000 |
| Plum Creek Timber - field crew for fall pit-tagging - 80 hrs x 2 crew - 160 hrs x 7 years | 1120 | 20 | | | 22,400.00 | 22,400 |
| Confederated Tribes of the Siletz Indians - project support, data collaboration | 1 | 10000 | | | 10,000.00 | 10,000 |
| **ODFW - LCM Program** | | | | | | |
| ODFW - LCM activities in Mill Cr - Crew leader - 520 hours/yr/7 yrs = 3640 hrs | 3640 | 40 | | | 145,600 | 145,600 |
| ODFW - LCM activities in Mill Cr - Crew of 2 - 1600 hrs/yr/7 yrs = 11200 hrs | 11200 | 25 | | | 280,000 | 280,000 |
| ODFW - LCM program for 5 reference sites - 5 sites/7 years = 35 sites | 35 | 61840 | | | 2,164,400.00 | 2,164,400 |
| **ODFW - Corvallis Research AQI Program -** | | | | | | |
| ODFW - AQI surveys for habitat control sites - 20 sites/3 years = 60 sites | 60 | 1000 | | | 60,000.00 | 60,000 |
| ODFW - HLFM analysis, AQI training, project suppor over the life of the project | 7 years | 4000 | | | 28,000.00 | 28,000 |
| **Aquatic Macroinvertebrate Monitoring** | | | | | | |
| OSU - Department of Fisheries and Wildlife - Stream Lab - process samples for biomass and benthic ID: 13 composite samples/4 yrs | 4 | 8089 | 32356.00 | | | 32,356 |
| OSU - Department of Fisheries and Wildlife - Stream Lab - analyze benthic sample results: 4 years -- pre-1, post- 1, 3, & 6 | 4 | 4176 | 16704.00 | | | 16,704 |
| ODEQ - field collection and analysis for aquatic samples, fish assemblages, equipment for 4 yrs | 4 | lumpsum | | | 33,233.00 | 33,233 |
| **Geomorphic Response Monitoring** | | | | | | 0 |
| Years pre-1, post-1 & post 3 - includes instrumentaion, field work and analysis | 3 | 8610 | 17,830.00 | | 8,000.00 | 25,830 |
| | | | | | | |
| | | | | | | |
| | | | 66,890 | 0 | 2,786,633 | 2,853,523 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **TRAVEL.** Mileage, per diem, lodging, etc. Must use current State of Oregon rates. | | | | | | |
| MCWC AQI crew - 1600 miles per season | 4800 | 0.56 | 2,688 | | | 2,688 |
| | | | | | | 0 |
| **SUBTOTAL (3)** | | | 2,688 | 0 | 0 | 2,688 |
| **MATERIALS/SUPPLIES.** Refers to items that are "used up" in the course of the project. Costs to OWEB must be directly related to the implementation of this grant. | | | | | | |
| Pit-tags and tagging supplies - 2000 tagged fish/yr for 7 years | 7 | 3500 | 6,150 | | 18,350 | 24,500 |
| Outreach workshops (2) - production costs | 2 | 500 | 1,000 | | | 1,000 |
| **SUBTOTAL (4)** | | | 7,150 | 0 | 18,350 | 25,500 |
| **EQUIPMENT/SOFTWARE.** List portable equipment costing **$300** or more per unit. Must remain property of a governmental entity, tribe, watershed council, SWCD, institution of higher learning or school district. | | | | | | |
| Pit-tag antenae array | 1 | 5000 | | | 5,000 | 5,000 |
| | | | | | | |
| **SUBTOTAL (5)** | | | 0 | 0 | 5,000 | 5,000 |
| **OTHER.** Costs must be necessary and reasonable for successful completion of this grant. | | | | | | |
| Outreach workshops (2) - room rental, bus, lunch | 2 | 1100 | 2,200.00 | | | 2,200 |
| | | | | | | 0 |
| **SUBTOTAL (6)** | | | 2,200 | 0 | 0 | 2,200 |
| **[Add all subtotals, (1-6) above] CATEGORY TOTALS (7)** | | | 120,208 | 0 | 2,809,983 | 2,930,191 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GRANT ADMIN.** Not to exceed **15% of Category Totals (7) Funds.** Compute by multiplying by 0.15 or less. See the January 2014 | | | | | | |
| ☐ direct cost billing<br>X direct cost allocation<br>☐ indirect costs (if checked, attach copy of the Federal Indirect Cost Negotiation agreement) | | | 18,031 | | | 18,031 |
| **SUBTOTAL (8)** | | | 18,031 | 0 | 0 | 18,031 |

**GRANT BUDGET TOTAL** ***Totals automatically round to the nearest dollar**

| | | | | |
|---|---|---|---|---|
| **GRANT BUDGET TOTAL (9)**<br>**[Add Category Totals (7), Grant Admin Subtotal (8)]** | 138,239 | 0 | 2,809,983 | 2,948,222 |

# ATTACHMENT A

# MATCH FUNDING FORM

***Document here the match funding shown on the budget page of your grant application***

**OWEB accepts all non-OWEB funds as match**. An applicant may not use *another OWEB grant* to match an OWEB grant; this includes ODA Weed Board projects because they are funded through OWEB grants. However, an applicant who benefits from a pass-through OWEB agreement with another state agency, by receiving either staff expertise or a grant from that state agency, may use those benefits as match for an OWEB grant. (Example: A grantee may use as match the effort provided by ODFW restoration biologists because OWEB funding for those positions is the result of a pass-through agreement).

At the time of application, match funding for OWEB funds requested does not have to be *secured*, but you must show that at least 25% of match funding has been *sought*. On this form, you do not necessarily need to show authorized signatures ("secured match"), but the more match that is secured, the stronger the application. Identify the type of match (cash or in-kind), the status of the match (secured or pending), and either a dollar amount or a dollar value (based on local market rates) of the in-kind contribution.

If you have questions about whether your proposed match is eligible or not, see Allowable Match document in OGMS http://apps.wrd.state.or.us/apps/oweb/fiscal/nologin.aspx under Monitoring application or contact your local OWEB regional program representative (contact information available in the instructions to this application).

Project Name: Mill Creek Siletz Watershed Effectiveness Monitoring  Applicant: MCWC

| Match Funding Source | Type (√ one) | Status (√ one)* | Dollar Value | Match Funding Source Signature/Date* |
|---|---|---|---|---|
| Plum Creek Timber - Forest Hydrologist and field crews | ☐ cash ☒ in kind | ☒ secured ☐ pending | $43,400.00 | 10/14/2014 |
| ODFW - Habitat Restoration Biologist - project management | ☐ cash ☒ in kind | ☒ secured ☐ pending | $14,000.00 | 10/16/2014 |
| ODFW - LCM Program - Mill Cr & reference site operations | ☐ cash ☒ in kind | ☒ secured ☐ pending | $2,613,350.00 | See other page + letter |
| ODFW - AQI Program - training, analysis, reference surveys | ☐ cash ☒ in kind | ☒ secured ☐ pending | $88,000.00 | See letter + other page |
| ODEQ - field sampling, data analysis | ☐ cash ☒ in kind | ☒ secured ☐ pending | $33,233.00 | See letter |
| OSU - Catalina Segura - Geomorphic response monitoring | ☐ cash ☒ in kind | ☒ secured ☐ pending | $8,000.00 | See letter + other page |
| CTSI - project support, data + sampling coordination | ☐ cash ☒ in kind | ☐ secured ☒ pending | $10,000 | Pending - to be secured |
| | ☐ cash ☐ in kind | ☐ secured ☐ pending | | |

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Project Name: Mill Creek Siletz Watershed Effectiveness Monitoring  Applicant: MCWC

| Match Funding Source | Type (√ one) | Status (√ one)* | Dollar Value | Match Funding Source Signature/Date* |
|---|---|---|---|---|
| Plum Creek Timber - Forest Hydrologist and field crews | ☐ cash ☒ in kind | ☒ secured ☐ pending | $43,400 | |
| ODFW - Habitat Restoration Biologist - project management | ☐ cash ☒ in kind | ☒ secured ☐ pending | $14,000.00 | |
| ODFW - LCM Program - Mill Cr & reference site operations | ☐ cash ☒ in kind | ☒ secured ☐ pending | $2,613,850 | |
| ODFW - AQI Program - training, analysis, reference surveys | ☐ cash ☒ in kind | ☒ secured ☐ pending | $88,000.00 | |
| ODEQ - field sampling, data analysis | ☐ cash ☒ in kind | ☒ secured ☐ pending | $33,233.00 | |
| OSU - Catalina Segura - Geomorphic response monitoring | ☐ cash ☒ in kind | ☒ secured ☐ pending | $8,000.00 | |
| CTSI | ☐ cash ☒ in kind | ☐ secured ☒ pending | $10,000 | |
| | ☐ cash ☐ in kind | ☐ secured ☐ pending | | |

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|---|---|---|---|---|
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| ODFW - Habitat Restoration Biologist - project management | ☐ cash ☒ in kind | ☒ secured ☐ pending | $14,000.00 | |
| ODFW - LCM Program - Mill Cr & reference site operations | ☐ cash ☒ in kind | ☒ secured ☐ pending | $2,613,350.00 | |
| ODFW - AQI Program - training, analysis, reference surveys | ☐ cash ☒ in kind | ☒ secured ☐ pending | $88,000.00 | |
| ODEQ - field sampling, data analysis | ☐ cash ☒ in kind | ☒ secured ☐ pending | $33,233.00 | |
| OSU - Catalina Segura - Geomorphic response monitoring | ☐ cash ☒ in kind | ☒ secured ☐ pending | $8,000.00 | |
| CTSI | ☐ cash ☒ in kind | ☐ secured ☒ pending | $10,000 | |
| | ☐ cash ☐ in kind | ☐ secured ☐ pending | | |

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| ODFW - Habitat Restoration Biologist - project management | ☐ cash ☒ in kind | ☒ secured ☐ pending | $14,000.00 | |
| ODFW - LCM Program - Mill Cr & reference site operations | ☐ cash ☒ in kind | ☒ secured ☐ pending | $2,613,350.00 | |
| ODFW - AQI Program - training, analysis, reference surveys | ☐ cash ☒ in kind | ☒ secured ☐ pending | $88,000.00 | |
| ODEQ - field sampling, data analysis | ☐ cash ☒ in kind | ☒ secured ☐ pending | $33,233.00 | |
| OSU - Catalina Segura - Geomorphic response monitoring | ☐ cash ☒ in kind | ☒ secured ☐ pending | $8,000.00 | 10/15/14 |
| CTSI | ☐ cash ☒ in kind | ☐ secured ☒ pending | $10,000 | |
| | ☐ cash ☐ in kind | ☐ secured ☐ pending | | |

215-1031

# ATTACHMENT B

# PUBLIC RECORD CERTIFICATION

Oregon Administrative Rule 695-005-0030(4) states that "All applications that involve physical changes or monitoring on private land must include certification from the applicant that the applicant has informed all landowners involved of the existence of the application and has also advised all landowners that all monitoring information obtained on their property is public record. If contact with all landowners was not possible at the time of application, explain why."

**INSTRUCTIONS: All applicants must complete Part One. In Part One, if you check the first box, skip Part Two and sign and date in the signature box below. If you check the second box, you must complete Part Two and sign and date in the signature box below.**

## PART ONE

☐ Public land only (STOP: go to signature box and complete)

☒ Private land only, or a mix of public and private land (complete Part Two and sign and date in the signature box)

## PART TWO

☒ I certify that I have informed all participating private landowners involved in the project of the existence of the application, and I have advised all of them that all monitoring information obtained on their property is public record. The following is a complete list of all participating private landowners.

1. Plum Creek Timber
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

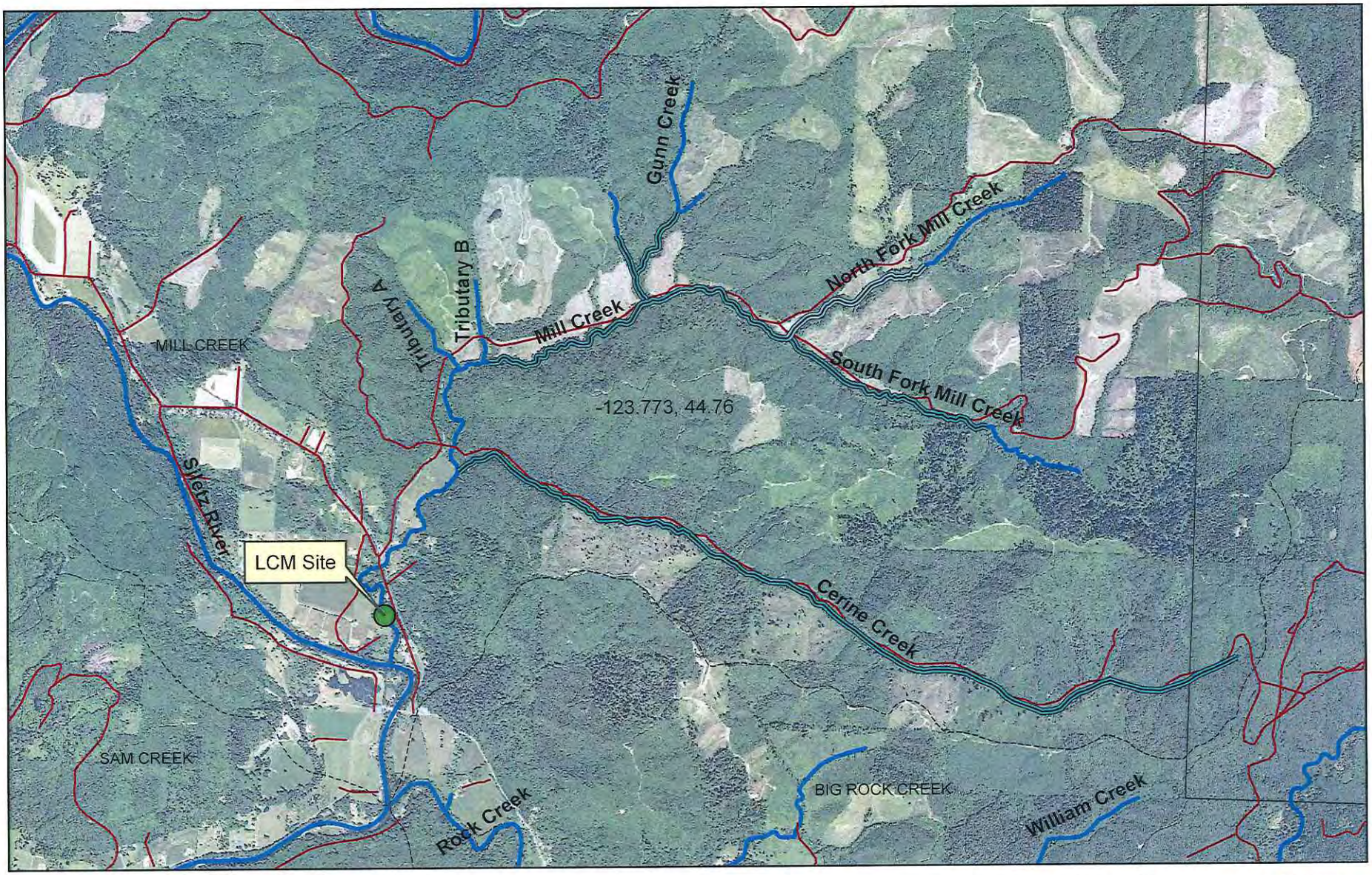
☐ I certify that contact with all participating private landowners was not possible at the time of application for the following reasons:

Furthermore, I understand that should this project be awarded, I will be required by the terms of the OWEB grant agreement to secure cooperative landowner agreements with all participating private landowners prior to expending Board funds on a property.

## APPLICANT/CO-APPLICANT SIGNATURE

| | |
|---|---|
| Paul Engelmeyer<br>Applicant Signature | 10/18/14<br>Date |
| Paul Engelmeyer<br>Print Name | chair Mid Coast W. Council<br>Title |
| Stacy Polkowske<br>Co-Applicant Signature | 10/13/14<br>Date |
| Stacy Polkowske<br>Print Name | ODFW<br>Agency |

# Mill Creek Basin LW Placement





**Legend**

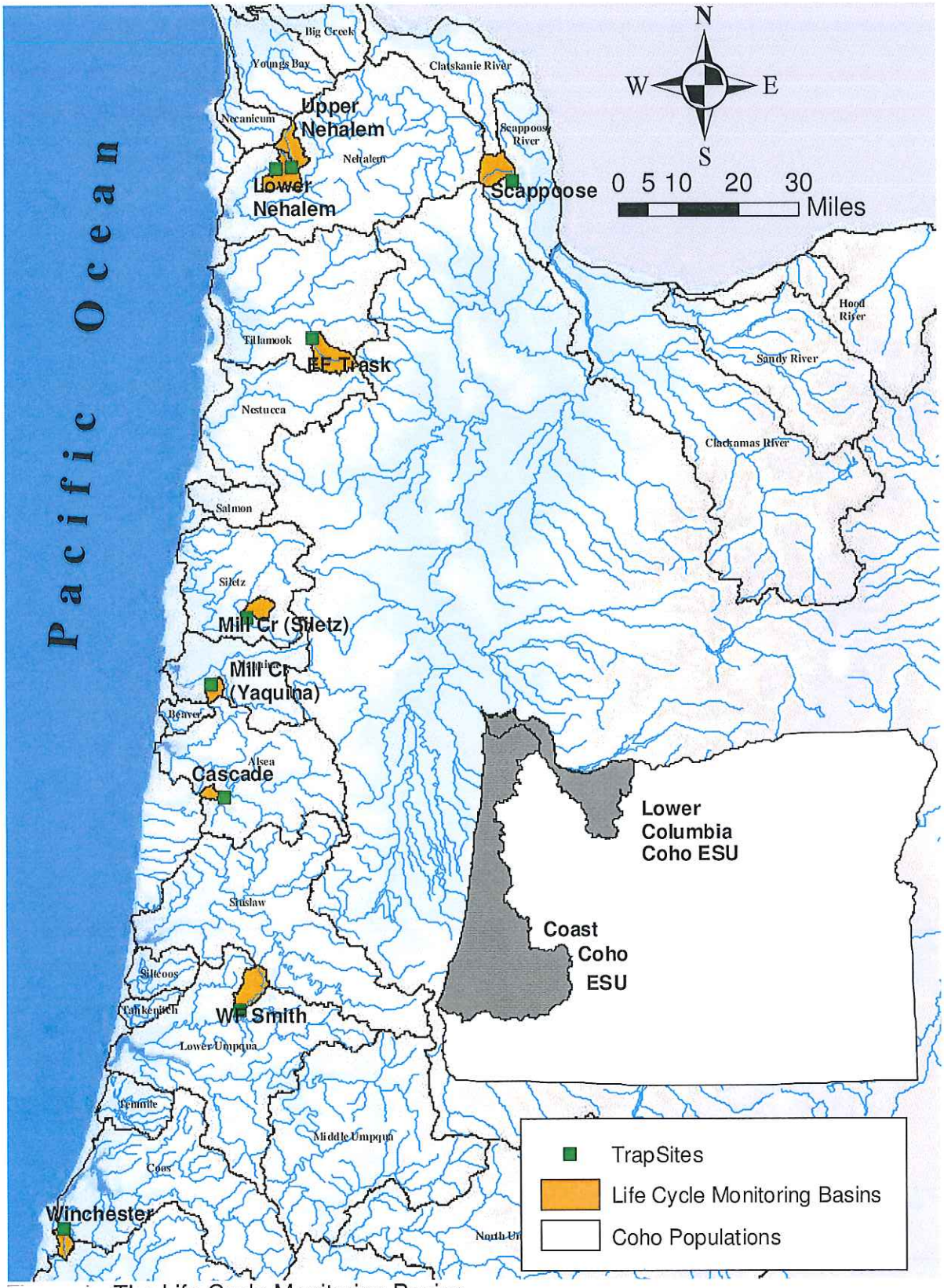
- MillCr_Siletz_LW
- fhd_coho_distribution
- roads100k
- 6th Field HUC

N
W E
S

0 0.275 0.55 1.1 Miles

Map produced by Stacy Polkowske, ODFW
Map date: April 2014
Created with ESRI ArcMap 10.1 software
Projection: Oregon Lambert Conformal Conic
Datum: NAD 1983

215-1031




The Life Cycle Monitoring Basins.

Mill Creek Watershed Photos. Photos taken January and April 2014.

1. Mill Cr LCM Site

Adult trap and waterfall

Rotary screw trap

2. Mainstem Mill Creek

Old LW site cabled to riparian alders

Example of existing LW in channel

Typical stream conditions within the treatment reach

3. Cerine Creek

A reed canary grass reach

Example of conditions in upper Cerine Cr

4. SF Mill Creek

Typical stream conditions in middle (right) and lower (left) SF Mill Cr

Lower SF Mill Cr has several active beaver dams

5. NF Mill Creek

2009 LW structure

Typical stream conditions of the NF Mill Cr

6. Gunn Cr

A previous LW site (3 logs) in upper Gunn Cr

Typical conditions of the treatment reach

Oregon
John A Kitzhaber MD., Governor

**Department of Fish and Wildlife**
Fish Division
4034 Fairview Industrial Drive SE
Salem, OR 97302
(503) 947-6201
FAX (503) 947-6202
www.dfw.state.or.us/

October 9, 2014

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem, OR 97301

Re: Mill Creek Watershed Effectiveness Monitoring Project

Dear OWEB Staff, Review Team Members, and Board:

I am writing to express support for the Midcoast Watersheds Council's proposal for effectiveness monitoring in the Mill Creek watershed of the Siletz River. This project will evaluate the effects of watershed-scale large wood placement on specific ecosystem functions and services, including coho salmon smolt production. By leveraging considerable existing monitoring data, infrastructure, and expertise, the project represents an exceptional opportunity to evaluate the effectiveness of a common restoration technique at scales of time and space that are relevant to both salmon and in-stream ecological functions.

Projects to evaluate the effectiveness of large wood placement often have been limited in time and space, making it difficult to discern how large wood placement relates to salmon smolt production at the watershed scale. The Mill Creek project is different because it integrates biological, geophysical, and habitat data at reach to watershed scales within a long-term context provided by ODFW's network of salmon life cycle monitoring sites. ODFW is pleased to be a partner in this project, contributing substantial in-kind resources, including life cycle monitoring within the watershed and at other locations. ODFW is confident that this partnership of watershed councils, industry, government agencies, and academic institutions will be successful in providing broadly applicable information to guide future restoration projects toward better, more predictable outcomes.

On behalf of ODFW, I strongly encourage OWEB to fund the effectiveness monitoring project proposed for the Mill Creek watershed. The project has far-reaching potential to inform strategic, effective projects to restore salmonid habitats in Oregon's coastal watersheds. Moreover, it exemplifies the interdisciplinary partnerships envisioned in the Oregon Plan for Salmon and Watersheds as key to maintaining and restoring the watersheds that help to sustain Oregon's fisheries and its economy.

Sincerely,

Bruce A. McIntosh
Deputy Fish Division Administrator – Inland Fisheries
Oregon Department of Fish and Wildlife

215-1031

Plum Creek Timber Company, Inc.
P.O. Box 216
Toledo, OR 97391
541-336-6227

Plum Creek
*Growing Value from Exceptional Resources*

October 10, 2014

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem, OR 97301

Project title: Mill Creek Watershed Effectiveness Monitoring

Project Timeline: Summer 2014 – Winter 2022/23

Dear OWEB:

I am sending this letter in support of the Mill Creek Watershed Effectiveness Monitoring Project. This project is well thought-out and has the potential to offer significant insight on how our collective habitat improvement efforts can help maintain and recover salmonid populations. Plum Creek has a strong commitment to sustainable forestry and environmental protection, and has been an avid supporter of the Oregon Plan for Salmon and Watersheds. We are the majority landowner in the Mill Creek basin, and we welcome this project. In addition to providing access to project cooperators, we will provide in-kind support in the form of my time and at least two weeks' worth of fish tagging support from our seasonal fish and wildlife survey crews each year.

Sincerely,

Jeff Light
Forest Hydrologist

Oregon
John A. Kitzhaber, MD, Governor

**Department of Fish and Wildlife**
Corvallis Research Lab
28655 Hwy 34
Corvallis, OR 97333
(541) 757-4263
Fax (541) 757-4102
www.dfw.state.or.us

October 14, 2014

Oregon Watershed Enhancement Board
775 Summer Street NE, Suite 360
Salem OR 97301-1290

Re: Mill Cr (Siletz) Effectiveness Monitoring Project

Dear OWEB Staff and Review Team Members,

I am writing in support of Midcoast Watersheds Council's proposal for effectiveness monitoring in the Mill Creek Watershed. This project is designed to leverage the scientific expertise of multiple partners, existing ODFW programs, and an integrated research approach to evaluate the effects of watershed-scale large wood placement on specific ecosystem functions and services. Due to the existing monitoring history and infrastructure at this site, Mill Creek provides an opportunity to conduct a robust effectiveness monitoring plan at much lower cost and shorter time scale than would typically be possible.

The ODFW Salmonid Life Cycle Monitoring (LCM) Project plans to contribute $2,613,350 as in-kind match to the project, including $2,590,000 that will be used to monitor salmonid populations in Mill Creek and five other reference sites for seven years. An additional $23,350 will be contributed in the form of supplies used to tag juvenile coho salmon and estimate overwinter survival rates. The LCM project has monitored salmonid populations at Mill Creek and the five reference sites for many years, providing a baseline for comparison that is rarely available when evaluating the effects of stream restoration on salmonid production. With these long-term data sets, multiple control sites, and a robust monitoring plan that examines multiple factors influencing smolt production, the proposed project offers an outstanding opportunity to assess the effects of habitat restoration on salmonid populations. This information will be valuable for future restoration planning as well as ODFW efforts to monitor status and trends in coastal salmonid populations.

On behalf of the ODFW LCM Project, I encourage OWEB to fund this project. This is a rare opportunity that will provide sound data to help guide similar projects and advance the understanding of watershed restoration and fish production.

Sincerely,

Erik Suring

Oregon
John A. Kitzhaber, M.D., Governor

**Department of Fish and Wildlife**
Corvallis Research Lab
28655 Highway 34
Corvallis, Oregon 97333
(541) 757-4263
FAX (541) 757-4102
Internet www: http://osu.orst.edu/Dept/ODFW

October 13, 2014

Oregon Watershed Enhancement Board
775 Summer Street NE
Suite 360
Salem, OR 97301-1290

OWEB Regional Review Team and OWEB Board Members:

The Oregon Department of Fish and Wildlife's (ODFW) Aquatic Inventories Program (AIP) intends to partner with the Mid-Coast Watershed Council (MCWC) to provide a cumulative total of $88,000 of in-kind services for habitat surveys and data analysis occurring over the next 7 years. The AIP will provide training and field manuals for 2 surveyors, will visit crews in the field, review data to assist with QA/QC, and perform analysis. An AIP biologist will also provide additional assistance as needed.

The surveys are coordinated with ODFW's Oregon Plan random habitat surveys in the mid-coast monitoring area to maximize coverage and applicability of the results. The survey work addressed in this grant application will help the MCWC collect aquatic habitat data to address limiting factors for salmon with emphasis to their response to instream restoration projects in Mill Creek (Siletz River) and its tributaries including Cerine Creek, Gunn Creek, North and South Forks Mill Creek, and an unnamed tributary. We support this effort to obtain quality baseline data which will lead to future restoration activities within the Siletz and other mid-coast basins and support management activities in the watershed.

Sincerely,

Charles Stein
Project Leader
Aquatic Inventories Project
541-757-5127
charlie.stein@oregonstate.edu

Oregon
John A. Kitzhaber, MD, Governor

Department of Environmental Quality
Laboratory and Environmental Assessment Division
3150 NW 229th, Suite 150
Hillsboro, OR 97124
Voice & TTY (503) 693-5700
FAX (503) 693-4999

Oregon Watershed Enhancement Board
Region 1 Review Team
775 Summer Street NE, Suite 360
Salem OR 97301-1290

April 15, 2014

Re: Mill Cr (Siletz) Watershed Effectiveness Monitoring Project

Dear OWEB Staff and Review Team Members,

I am writing in support of Midcoast Watersheds Council's proposal for effectiveness monitoring in the Mill Creek Watershed. We are pleased to learn of the funding of the restoration activities and strongly feel that the proposed effectiveness monitoring project offers, OWEB, other state resource management agencies, local groups, and private landowners a unique opportunity to work together.

This project is designed to leverage the scientific expertise of multiple partners, existing ODFW programs, and an integrated research approach to evaluate the effects of watershed-scale large wood placement on specific ecosystem functions and services. Due to the existing monitoring history and infrastructure at this site, Mill Creek provides an opportunity to conduct a robust effectiveness monitoring plan at much lower cost and shorter time scale than would typically be possible. The information from this study should be useful in establishing expectations for future LWD enhancement studies. It should also provide as an informative guide for establishing appropriate monitoring objectives for similar projects.

In addition, we have an opportunity to provide linkages to resource agencies with directives across both the Endangered Species Act (through listed species responses) and the Clean Water Act (water quality and watershed health). Opportunities rarely arise for agencies to work collaboratively, seek common goals and objectives, and understand how outcomes of one program relate directly to the other.

The Oregon Department of Environmental Quality will contribute $33,233 as in-kind match to the project for field sampling of macroinvertebrates and fish assemblages, equipment, training of partner organizations, and data analyses. DEQ is a strong supporter of this multi-agency effectiveness monitoring study. We have for years praised the virtues of effectiveness monitoring to watershed councils and other groups as a necessity to track the progress of achieving restoration goals. This is an opportunity for DEQ to join other agencies and local groups and provide a leadership role in ensuring a successful project.

College of Forestry ~ Research Office
Oregon State University, 109 Richardson Hall, Corvallis, Oregon 97331-5751
Phone: 541-737-2222 | Fax: 541-737-3008 | Web: forestry.oregonstate.edu

October 10, 2014

**Oregon Watershed Enhancement Board**
Region 1 Review Team
775 Summer Street NE, Suite 360
Salem OR 97301-1290

Re: Mill Creek (Siletz) Watershed Effectiveness Monitoring Project

Dear OWEB Staff and Review Team Members,

I am writing in support of the MidCoast Watersheds Council proposal for Mill Creek Watershed Effectiveness Monitoring. This project is designed to leverage the scientific expertise of multiple partners, existing ODFW programs, and an integrated research approach to evaluate the effects of watershed-scale large wood placement on specific ecosystem functions and services. Due to the existing monitoring history and infrastructure at this site, Mill Creek provides an opportunity to conduct a robust effectiveness monitoring plan at much lower cost and shorter time scale than would typically be possible.

The College of Forestry, through its Fish and Wildlife Habitat in Managed Forests (FWHMF) Research Program, has funded a 2-year project, "Modeling Geomorphic Response to Large Wood Introduction as a Strategy to Restore Fish Habitat in a Managed Forest Watershed," to support Dr. Catalina Segura's participation in the Mill Creek restoration and effectiveness monitoring project. Catalina is a faculty member in our Forest Engineering, Resources and Management Department, specializing in forest hydrology and fluvial geomorphology. Her proposal was one of 5 out of 19 evaluated by the Program Advisory Committee and recommended to the Dean for funding, beginning July 1, 2014. I am pleased to authorize the $8000 allocated for water monitoring supplies and minor equipment in the project budget as an in-kind match toward this OWEB proposal. This proposal will enable one more year of geomorphic monitoring, which will allow capturing a wider range of flow events strengthening our ability to understand the long-term response of the restoration effort.

The College of Forestry is a strong supporter of this collaborative monitoring and research partnership. Christopher Lorion and Stacy Polkowske from ODFW are co-PIs on Catalina's FWHMF project, reinforcing the synergy that will be fostered by additional OWEB investment in the Mill Creek project. This is a rare opportunity that not only enhances fish habitat, it will provide scientifically-sound data to help guide other similar projects and advance the understanding of watershed restoration and fish production. We encourage you to give this proposal full consideration.

Sincerely,

Steven D. Tesch, PhD
Director of Research

**Department of Fisheries and Wildlife**
Oregon State University, 104 Nash Hall, Corvallis, Oregon 97331-3803
**T** 541.737.4531 | **F** 541.737.3590 | fw.oregonstate.edu

Oregon Watershed Enhancement Board
Region 1 Review Team
775 Summer Street NE, Suite 360
Salem OR 97301-1290

October 7, 2014

Re: Mill Creek (Siletz) Watershed Effectiveness Monitoring Project

To the OWEB Staff and Review Team Members,

It is with great enthusiasm I support the Midcoast Watersheds Council's proposal for effectiveness monitoring in the Mill Creek Watershed. My senior research assistant Bill Gerth and I were very excited that the log placement aspect of this study has been funded, and believe the effectiveness of that effort absolutely requires well-planned monitoring of physical and biological responses. The temporal and spatial distribution of the proposed monitoring will be critical to the restoration work, and our stream ecology laboratory at Oregon State is looking forward to being a part of this multidisciplinary team.

Pre-project discussions have revealed potentially multiple changes created by the wood placement, and the proposed plans for an integrated study seek to address these possibilities. The years of previous fish life history data at Mill Creek provide a strong foundation for examining responses, but the spectrum of effects to habitats and biota will require a multidisciplinary approach. In addition to changes in physical habitat conditions, measures of fish and invertebrates will also be important in assessing how log placement affects salmonid health. The proposal's Before/After, Control and Impact (BACI) study design will provide power for statistical analysis that is not often found in monitoring-related projects.

For our part, our lab brings its 24 years experience in studying stream invertebrates throughout Oregon under a variety of management scenarios and climate regimes. Over the last decade my two senior research assistants and I have been studying ways in which stream invertebrates can reveal changes in flow, sedimentation, and stream retention following timber harvest at Hinkle Creek, the Alsea Basin, and at the Trask. For the Mill Creek restoration we have suggested sampling and analytical techniques honed in these studies to maximize efficiency and breadth of useful information. Our analyses will examine what the macroinvertebrates reveal about changes in sedimentation, water and habitat quality. Responses will be described by parametric and multivariate analyses as well as invertebrate metrics familiar to agencies and watershed councils.

Funds requested for the OSU Stream Lab will support work by Bill Gerth, senior research assistant with whom I have worked since 1992. He will collaborate with ODFW and DEQ in planning and executing field studies, have primary responsibility for invertebrate identifications and analyses, and oversee student workers who will sort samples for invertebrate biomass estimates. We will collaborate with DEQ scientists in analyzing and interpreting the results. My assistance will be donated to the project.

By assessing habitat characteristics, fish abundance and growth, and prey availability, this project has the potential to understand the *mechanisms* by which log placement can enhance salmonid production. These causal relationships will potentially provide strategies for similar projects in other watersheds, particularly in western Oregon. To better understand the full effects of wood placement at Mill Creek and the broader implications for restoration activities in the region, I highly recommend funding this proposal.

# Mill Creek (Siletz) Watershed Effectiveness Monitoring Plan
## October 2014

Mill Creek. Photo taken January 15, 2014.

**Oregon Department of Fish & Wildlife**
Christopher Lorion, Salmonid Life Cycle Monitoring Project
chris.m.lorion@state.or.us, 541-265-8306 x238

Stacy Polkowske, Habitat Restoration Biologist
stacy.a.polkowske@state.or.us, 541-265-8306 x264

With contributions from: Kara Anlauf-Dunn, Bill Gerth, Wayne Hoffman, Shannon Hubler, Kim Jones, Judith Li, Jeff Light, Catalina Segura, Erik Suring and Lora Tennant.

## Contents

## Introduction

The Mill Creek (Siletz) Watershed Restoration and Monitoring Project is designed to leverage long-term data sets and an integrated research approach to evaluate the effects of watershed-scale large wood placement on specific ecosystem functions and services, including coho salmon (*Oncorhynchus kisutch*) smolt production. Due to the existing monitoring history and infrastructure at this site, Mill Creek provides an opportunity to evaluate the effects of large wood placement on stream habitat and fish populations at a much lower cost and shorter time scale than would typically be possible. Given the project location, size and experimental design, the results of this study will be applicable to a significant portion of the industrial forest landscape in the Oregon coast range. Specifically, managed watersheds located on the west slope of the coast range dominated by sedimentary geology. This includes the majority of the watersheds of the central Oregon coast and select watersheds on the north and south coast.

The Mill Creek watershed is one of seven coastal Salmonid Life Cycle Monitoring (LCM) sites managed by the Oregon Department of Fish & Wildlife (ODFW). Intensive monitoring of salmonid populations at LCM sites began in the late 1990s as part of the Oregon Plan for Salmon and Watersheds. The three objectives for the LCM project are: 1) estimate abundance of adult salmonids and downstream migrating juvenile salmonids, 2) estimate marine and freshwater survival rates for coho salmon, and 3) evaluate effects of habitat modification on the abundance of juvenile salmonids. These objectives are accomplished through annual monitoring of adult spawner populations and juvenile salmonid out-migrants, with a particular emphasis on coho salmon.

The Mill Creek LCM site is particularly conducive to basin-scale research due to the presence of a small waterfall just 0.2 miles upstream from where Mill Creek enters the mainstem Siletz River. Although this waterfall is not a complete barrier to adult salmon migration, it allows a high percentage of fish to be trapped and tagged in a fish ladder adjacent to the falls. Observations of salmon on the spawning grounds can then be used to make robust spawner population estimates using mark-recapture methods (Suring et al. 2012). Juvenile salmonids migrating out of Mill Creek are captured using a rotary screw trap located 250 feet upstream from the waterfall, providing a solid link between adult salmon abundance and juvenile salmonid production in the 15 miles of anadromous fish habitat above the falls. Juvenile trapping at this site began in the spring of 1997, and adult trapping was initiated in the fall of 1997. As a result, there is currently 17 years of smolt out-migrant data for this site, and a relationship between adult spawners and coho smolt production based on 14 brood years. The average size of female coho spawners has also been determined throughout this period, allowing for annual estimates of egg deposition that have been used to estimate freshwater survival from egg to smolt for each brood (Suring et al. 2012).

In addition to the core data collection that occurs at all LCM sites, Mill Creek has been the subject of additional research and monitoring that provide further background for basin-level research on coho salmon. To complement overall freshwater survival estimates at this site, coho overwinter survival estimates were made by tagging juvenile coho salmon in the fall and then examining smolts captured the following spring for three years starting in 2010. At all LCM sites, a weekly sub-sample of coho smolts and other out-migrants is measured for length to determine the smolt size distribution (Suring et al. 2012). At Mill Creek, smolt weight information has also been collected weekly each season since 2007, providing seven years of coho smolt body condition data to complement the long-term smolt length information for this site. Finally, there is extensive information on the coho salmon spawning distribution

in Mill Creek from fall spawning surveys used to make adult coho mark-recapture population estimates. Since 2010, survey effort has been expanded to include 95-100% of the spawning habitat in Mill Creek as part of a spawning survey calibration study.

Although Mill Creek is a productive watershed for coho salmon and other salmonids, the basin has a history of intensive land management that has resulted in relatively low large wood abundance in most of the stream network. Large wood is a key factor in the creation of stream habitats utilized by rearing salmonids (Fausch and Northcote 1992), particularly during winter (Bustard and Narver 1975; McMahon and Hartman 1989), and Mill Creek is representative of many Oregon coastal streams where declines in large wood have reduced stream complexity (State of Oregon 2005). The placement of additional large wood in Mill Creek would be expected to have a variety of ecosystem benefits, including the creation of more complex rearing habitat for coho salmon and other salmonids. Due to the long-term monitoring framework already in place, Mill Creek also presents an exceptional opportunity to evaluate the effects of large wood placement on salmonid production and the underlying factors influencing fish populations.

Relationships between large wood placement, stream habitat, and fish populations have been investigated in a variety of studies in the Pacific Northwest. Studies that measured local abundance of rearing salmonids at large wood placement sites (e.g. Cederholm et al. 1997; Roni and Quinn 2001) have found significantly higher juvenile coho densities compared to controls, particularly during winter. Steelhead (*Oncorhynchus mykiss*) and cutthroat trout (*O. clarki*) densities were also higher at large wood placement sites during the winter (Roni and Quinn 2001). Questions remain, however, about how local abundance relates to smolt production at the watershed scale, and whether immigration to large wood sites might explain observed increases (Riley and Fausch 1995). Since increased smolt production is often the ultimate goal of restoration work, monitoring salmonid smolt out-migrants from treated streams provides a more direct measure of project effectiveness (Roni et al. 2003). Studies that have estimated the number of salmonid out-migrants from basins before and after large wood additions have shown inconsistent results for coho salmon and other salmonid species. Some studies have found that coho smolt production increased in treated basins following restoration in which large wood addition was an important component (e.g. Cederholm et al. 1997; Solazzi et al. 2000). In other cases (e.g. Reeves et al. 1997; Johnson et al. 2005), no significant change in coho smolt production has been observed following extensive large wood additions. Results for other salmonid species also vary among studies.

Given the mixed results from previous studies and the difficulty of documenting responses to restoration, there is a strong need for well-designed, basin-scale research on the response of salmonid populations to large wood placement projects (Liermann and Roni 2008; Roni et al. 2010). Mill Creek, and the other LCM sites that can serve as controls, offer an outstanding opportunity to pursue this type of research. In this document, we present a watershed restoration plan centered on extensive large wood placement in Mill Creek and its tributaries. We then describe an integrated research and monitoring plan designed to investigate relationships between the restoration treatment, physical stream habitat characteristics, benthic communities, and salmonid populations in Mill Creek.

## Project Restoration Goals

The goals for the restoration work proposed in the "Mill Creek Watershed Restoration and Effectiveness Monitoring Project" are three-fold:

1) Enhance instream ecological function and condition.
The specific instream ecological functions that this project addresses are stream complexity, floodplain connectivity and food web interactions, in particular, prey resources or aquatic macroinvertbrates.

2) Improve habitat for native fish.
Habitat improvements include deep complex pools, off-channel/winter refugia habitats, protective cover, and captured and sorted spawning gravel.

3) Increase coho salmon production in the Mill Creek Watershed.
Increased fish production in the watershed primarily targets the freshwater survival of coho salmon smolts. Winter steelhead and coastal cutthroat trout are also present in this system and are also likely to benefit from the habitat improvements.

## Watershed Condition Summary

Mill Creek flows into the mainstem Siletz River at approximately Siletz river mile 49 just upstream of Logsden. The Mill Creek Watershed covers ~8,000 acres most of which are owned and managed by Plum Creek Timber (PCT). The Confederated Tribes of the Siletz Indians (CTSI) also own and manage timber lands in the watershed. This basin is currently under intense forest management with harvest cycles of ~30 years. It is assumed that the current forest management practices will continue throughout the timeline of this project and beyond. There are a few small rural residential and agricultural holdings in the lower watershed. The watershed is comprised of the mainstem Mill Creek and its major tributaries: Cerine Creek, South Fork of Mill Creek (SF Mill), North Fork of Mill Creek (NF Mill), and Gunn Creek. There are also two minor unnamed tributaries: Tributary A and Tributary B (*see* Figure 1 below).

Mill Creek is representative of many small basins on the central Oregon coast with a long history of industrial timber ownership. Historic land management practices have removed the majority of the large-class conifers in the riparian area, limiting the abundance of natural recruitment of instream wood on the landscape. In addition, splash damming, log drives and stream cleaning were also common practices across coast range that reduced stream complexity and beneficial habitats for native fish and other aquatic organisms. There are no known records of splash damming and log drives in Mill Creek specifically (Miller 2010). However, in the 1930s the Oregon Game Commission began to require loggers to prevent woody debris from entering streams, so stream cleaning is assumed to have occurred in Mill Creek. The current watershed conditions of Mill Creek still exhibit its legacy land management. Recent stream surveys have documented very little in-stream wood, reaches of incised stream channels, stream bed scour to bedrock in some locations, and a riparian area that is limited in mature conifers. At a larger spatial scale, the Siletz River coho population failed a viability analysis in the 2005 Oregon Coastal Coho Assessment conducted by the state of Oregon, with stream complexity identified as the primary limiting factor. Nevertheless, nearly all of the Siletz River basin received the highest score for relative Salmonid Ecosystem Value in the recent ODFW Coastal Multi-Species Conservation and Management Plan, reflecting its potential to support diverse salmonid populations and highlighting the importance of restoration in this watershed.

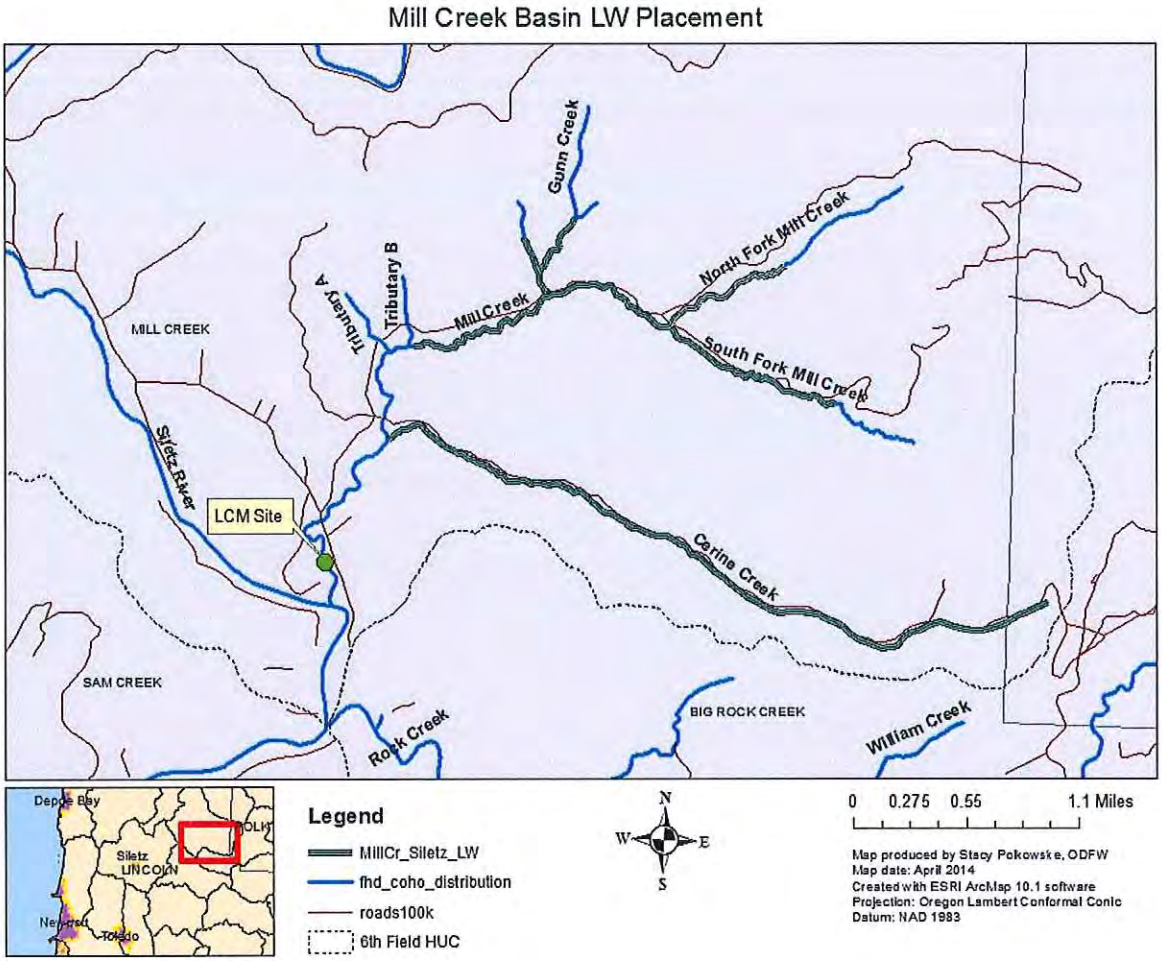



Figure1. Map of the Mill Creek Watershed with LW treated reaches.

The primary limiting factor affecting coho smolt production in the Mill Creek Watershed is stream complexity, specifically winter rearing habitat. ODFW conducted full-basin Aquatic Habitat Inventory (AQI) surveys in the Mill Creek Watershed in the summer of 1993 and the winter of 1998. Using these data, seasonal (summer and winter) carrying capacity of each habitat unit (pool, alcove, riffle, etc.) was estimated with the Habitat Limiting Factors Model (HLFM; Nickelson et al. 1992; Nickelson 1998; Anlauf et al. 2009). The model results identified winter rearing habitat as the limiting factor. A more in-depth discussion will follow on the HLFM and how it will be used in this study (*see* EM Objective 3 below). In addition to the 1993 and 1998 AQI surveys, a full basin wood survey was conducted in 2006 by ODFW. In all three of these surveys, the number of key pieces of wood (wood pieces $\geq$ 12 m in length and $\geq$ 60 cm in diameter) and overall wood volume fell below the ODFW desirable benchmarks (Moore et al. 2007). See Figures 2, 3, and 4 below. The persistent lack of large wood throughout the system has likely played a key role in the reduced stream complexity and the limited availability of quality rearing habitat.

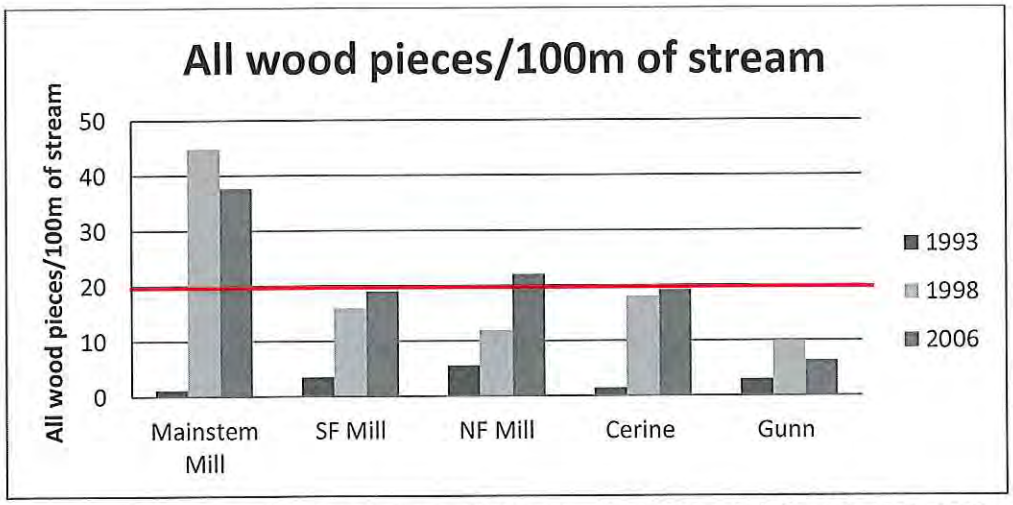



Figure 2. The number of pieces of all wood/100 meters in Mill Creek (Siletz) in 1993, 1998 and 2006. ODFW's desirable benchmark is >20 pieces/100m of stream.

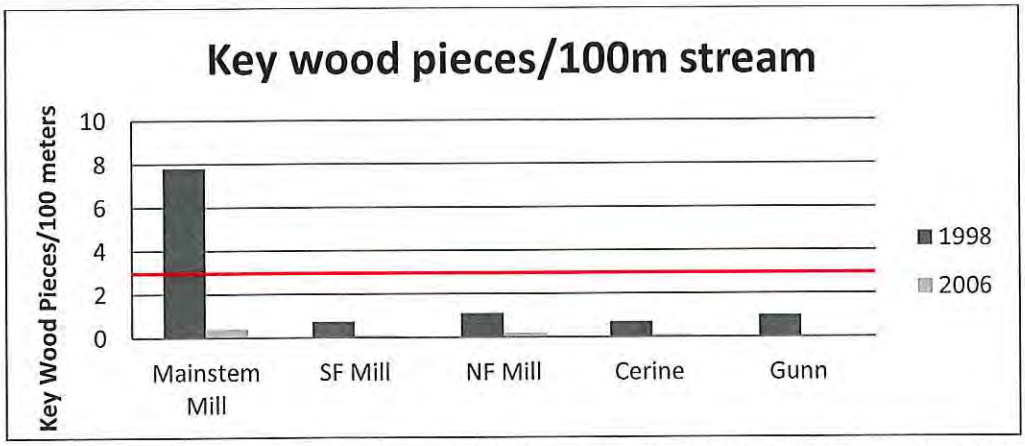



Figure 3. The number of pieces of key wood/100 meters in Mill Creek (Siletz) in 1998 and 2006. ODFW's desirable benchmark is >3 key pieces/100m of stream.

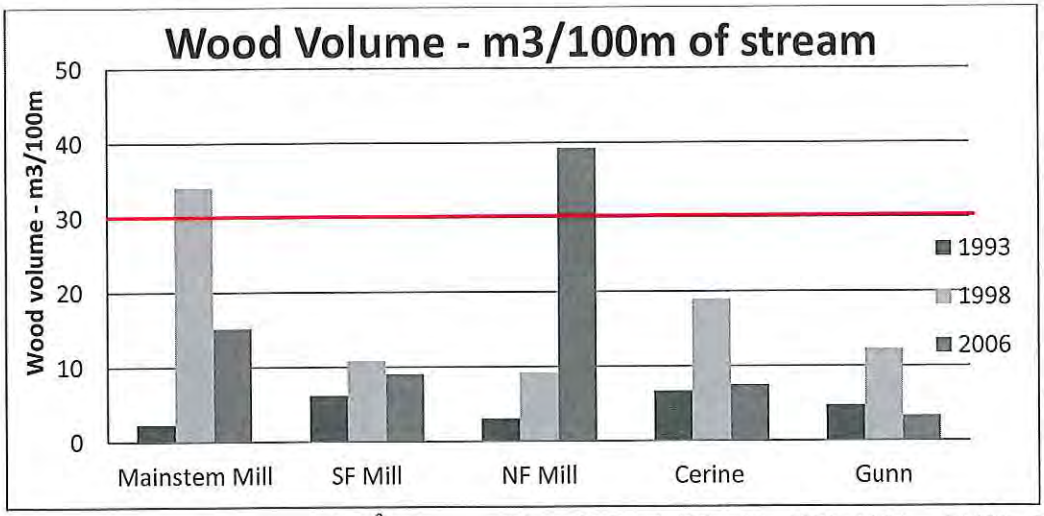



Figure 4. The volume of wood ($m^3$/100 meters) in Mill Creek (Siletz) in 1993, 1998 and 2006. The ODFW desirable benchmark is more than 30 $m^3$/100 meters.

There have been some previous large wood (LW) placement projects in the Mill Creek Watershed. A small LW placement was done in upper Gunn Creek in 1995 that included two sites (four logs total) over 0.1 miles. Logs were placed during a timber harvest. Short (5.5-7.5m; <2X BFW) and wide (0.6-1.0m DBH) wood pieces were used and are providing marginal benefit to the stream. A 1996 LW placement in mainstem Mill Creek was done by Georgia Pacific (previous owner before PCT) staff and included several sites over ~2.5 miles. The logs were cabled to riparian vegetation. The majority of these LW sites are currently decayed, busted up and/or dysfunctional. Finally, a 2009 LW placement was done in collaboration with ODFW and PCT in the lower reach of the NF Mill Creek. This project included 6 sites over the lower 0.75 miles. These LW sites are in good working condition capturing and sorting bed load.

A secondary limiting factor in the Mill Creek Watershed is water temperature. Cerine Creek is on the 303(d) list for exceeding the core cold water habitat criterion (7-day average of daily maximum greater than 16°C) in the summer (ODEQ 2010). The mainstem of Mill Creek is on the 303(d) list for exceeding the core cold water habitat criterion and the spawning criterion (7-day average of daily maximum greater than 12.8°C) from October 1-June15 in the lower reach (RM 0-1.7). ODFW has monitored stream temperature continuously at the LCM trap since 2001 and in the major tributaries since 2011.

Another potential limiting factor this study will investigate is the availability of prey resources or macroinvertebrates for foraging fish. The role of food in fish production has not been studied as much compared to that of physical habitat. However, evidence supports the concept that food can be a limiting factor on fish production and is particularly compelling for stream salmonids (Wipfli and Baxter 2010).

### Proposed Watershed Restoration

**Restoration Reaches:** There are approximately 15 miles of stream accessible to anadromous fish in the Mill Creek Watershed which includes a wide range of stream sizes and gradients. Large wood (LW) habitat structures will be placed in reaches of Cerine Creek, SF Mill Creek, NF Mill Creek, Gunn Creek, and mainstem Mill Creek that are within 0-4% stream gradient. For example, NF Mill Creek has a total of ~1.5 miles accessible to coho salmon from its confluence upstream to a natural falls barrier. At approximately 1 mile from its confluence, the average gradient of the North Fork climbs to 16.1% and cascades and steps dominate the stream channel. This upper reach of the North Fork would not be conducive to a successful LW placement given the stream size and slope (DSL et al. 2010). Additionally, annual spawning surveys have documented that fish use in this upper reach is relatively low compared to lower reaches in the watershed. Ground access for LW placement was also considered in selecting the restoration reaches.

The specific restoration or treatment reaches are as follows (*see* Figure 1):

- Cerine Creek – Place large wood habitat structures in a total of 3.6 miles from the confluence with the mainstem to the end of AQI survey reach 3. Upstream from reach 3 the stream width gets small (~6ft wide) and gradient climbs to 9.5%
- SF Mill – Place large wood habitat structures in a total of 1.0 mile from its confluence with the North Fork to the end of AQI survey reach 2. Upstream from reach 2 the road peels away from the stream which limits ground access. The cost of a helicopter (~$50K) was determined unfeasible to treat only 0.55 miles of habitat.

- NF Mill – Place large wood habitat structures in a total of 0.7 mile from its confluence with the South Fork to near the end of AQI survey reach 1. From here, the stream climbs to 16.1% gradient until it reaches a natural barrier falls 0.3 miles upstream.
- Gunn Creek – Place large wood habitat structures in a total of 0.7 miles from its confluence with the mainstem to the end of AQI survey reach 1. Upstream from reach 1 the stream gets smaller and climbs to 5.4% - 12.2% gradient.
- Mainstem Mill Creek – Place large wood habitat structures in a total of 1.5 miles from its confluence with Tributary B upstream to the junction of the North Fork and the South Fork. No instream treatment below Tributary B is proposed as a measure of safety to the private property downstream.
- Tributary A – Remove car body from stream to restore fish passage to ~0.3 miles of suitable spawning habitat. The car body is easily accessible from an existing logging road.

Restoration treatments total 7.5 miles of large wood placement and restoring fish passage to ~0.3 miles of suitable spawning habitat.

**Restoration Treatment:** Complex habitat structures made of large wood (LW) pieces will be placed with ground equipment throughout the designated reaches. Ground equipment will include either a log loader or excavator with a 360-degree rotating clam shell bucket and a skidder. Ground equipment will access the large wood sites from the existing road network through the riparian vegetation. Precaution will be taken to navigate around riparian trees and large shrubs to reduce the riparian damage from the equipment.

**Large Wood Sites and Design:** Unique to this project, the specific LW placement sites will be identified using the information from the pre-treatment full-basin AQI survey scheduled to occur during winter 2014/2015. The AQI survey will detail the location, size (area), and type of existing winter habitat units (pools, riffles, glide, beaver ponds, side channels, etc.) to be considered in the LW site selection. LW will be placed in existing pools, tributary junctions, side channels and backwaters, old beaver dam sites, and other locations that will likely increase the area of winter habitat. Prior to placement, the project manager will conduct a summer stream survey to add any additional sites that may have been underestimated at high flows such as deep summer pools. The methodology of site selection will be well documented to provide a clear, reproducible process important for the research aspect of this project and for future considerations in other LW placement projects.

To elaborate further, the potential log placement sites will be determined by examining the landscape with the following criteria:

- Anchor capability – priority given to areas with presence of existing riparian trees, existing LW or streambanks appropriate to push tops into.
- Channel width, gradient and connectivity – priority given to locations where the floodplain connectivity is reoccurring or could be improved with bedload accumulation. Stream gradients ranging between 0-4% are preferred as well as wider openings in the valley width.
- Channel substrate – priority given to sites with appropriate sized spawning gravels or substantial gravel input areas like tributary junctions.
- Channel forming processes – priority given to sites that could promote the formation of backwaters, side channels and other winter rearing habitat.

- Natural accumulation potential – priority given to sites where natural LW has accumulated or would likely accumulate if present in the system (pinch points in the valley, meanders, split flows, debris torrents, marsh periphery, etc.).
- Habitat benefit – priority given to sites where LW would provide winter rearing habitat benefit, create scour pools, provide protective cover, and sort and retain spawning gravel.

Key pieces will meet the ODFW benchmark guidelines of >23.6 inches DBH and >32.8 feet in length. Minimum log lengths and diameters for all pieces will follow the guidelines from the "Guide to placement of wood, boulders and gravel for habitat restoration" (DSL et al. 2010), and will be at least 1.5 times the bankfull width (BFW) if a rootwad is still attached and two times the length of BFW if no rootwad.

All LW structures will be full spanning, multiple log complexes. Each log piece will be placed into a predetermined location with ground-based equipment as directed by ODFW project manager. Log structures will be placed to minimize shifting and migration by using existing riparian vegetation, existing LW in the stream, or by driving the top of the logs into the bank (aka anchor capability). The number of key pieces used in a stream section considered any existing LW structures and the needed amount to achieve the NOAA benchmark of 80 pieces/mile and the ODFW desired habitat benchmark of >3 key pieces/100m of stream (or >48 key pieces/mile).

LW site design will also consider methods to encourage beaver dam building (Suzuki and McComb 1998; MacCracken and Lebovitz 2005). These methods consider present beaver activity, past beaver dam locations, channel and valley width, proximity to other LW sites and stream gradient.

Project managers will use the pre-treatment full-basin AQI survey data with the Habitat Limiting Factors Model (HLFM) to alter the current wood volume ratings in particular geomorphic habitat units in order to assess potential changes in complexity that could translate to increased salmon capacity. This will estimate how much wood would be needed to get moderate or high parr/km in each habitat unit. The HLFM model is typically used to estimate the juvenile salmonid carrying capacity of various habitat units (scour pools, alcoves, beaver ponds, etc.). It has never been used as a predictive tool to estimate how much wood would be needed to increase juvenile salmonid carrying capacity and smolt production. Project managers will use this guidance in designing the LW project.

## Effectiveness Monitoring Goals and Objectives

The goals of the effectiveness monitoring (EM) are:

1) To determine the degree to which the project's restoration treatments meet its overall purpose including 1) enhance in-stream ecological function and condition, 2) address the winter rearing limiting habitat factor for fish production, and 3) increase fish production in the Mill Creek Watershed.
2) To understand the relationship between channel geomorphology, aquatic habitat, benthic macroinvertebrate assemblages, and fish production following large wood placement in an actively managed watershed.
3) To evaluate the temporal and spatial recovery of watershed functions after instream restoration.
4) To determine the applicability of the Habitat Limiting Factors Model (HLFM) as a restoration planning and assessment tool.
5) To provide scientifically-sound data to help guide other similar projects and advance the understanding of watershed restoration and fish production; and to disseminate that information to other practitioners, resource managers, decision-makers, and scientists.

To achieve these goals, effectiveness monitoring will focus on five major monitoring objectives:

**Objective 1: Describe short-term geomorphic responses to large wood placement for 1 and 3 years after treatment.**

**Objective 2: Quantify changes in winter rearing habitat following large wood placement 1 and 6 years after treatment.**

**Objective 3: Assess benthic macroinvertebrate biomass and taxonomic composition in years 1, 3 and 6 after treatment. To determine the effects of large wood treatment, sampling sites will be located in Mill Creek and in an untreated control watershed.**

**Objective 4: Investigate how large wood placement affects juvenile coho salmon overwinter survival for 6 years after treatment.**

**Objective 5: Determine if large wood placement affects the annual abundance of coho salmon smolts and other salmonid out-migrants for 6 years after treatment.**

The EM objectives encompass a range of physical changes (stream geomorphology and winter rearing habitat) and the biological responses (benthic macroinvertebrates, overwinter survival and coho smolt production) from the watershed-scale large wood placement. The simple conceptual diagram in Figure 5 below illustrates the relationships between the five monitoring objectives and measured parameters (in bold), and the role they play within the general ecosystem framework. The stream geomorphology, sediment transport, hydrologic processes, and riparian condition are largely influenced by landscape and land use factors. They are key drivers in creating suitable habitats for fish and other organisms. The condition of the aquatic habitat determines the quantity and quality of suitable habitats for rearing juvenile salmonids. It also influences the stream's productivity of food resources to support the aquatic food web, specifically benthic macroinvertebrates for foraging juvenile salmonids.

We are proposing a rigorous and diverse effectiveness monitoring plan that will evaluate the effects of a watershed-scale large wood project on multiple levels. The geomorphic response monitoring will look at

the change in stream geomorphology, sediment transport and hydrologic processes. The response in aquatic habitat and riparian condition will be documented through the AQI surveys and analyzed with the Habitat Limiting Factors Model (HLFM). The potential change in available food resources for rearing salmonids will be determined by monitoring benthic macroinvertebrate biomass and taxonomic composition. ODFW's proposed PIT-tagging efforts will estimate the change in overwinter survival of juvenile coho. And finally, the on-going LCM activities at the Mill Creek site will capture the change in coho smolt production, as well as marine survival and adult spawner returns. Each EM objective is discussed in detail in the following sections.

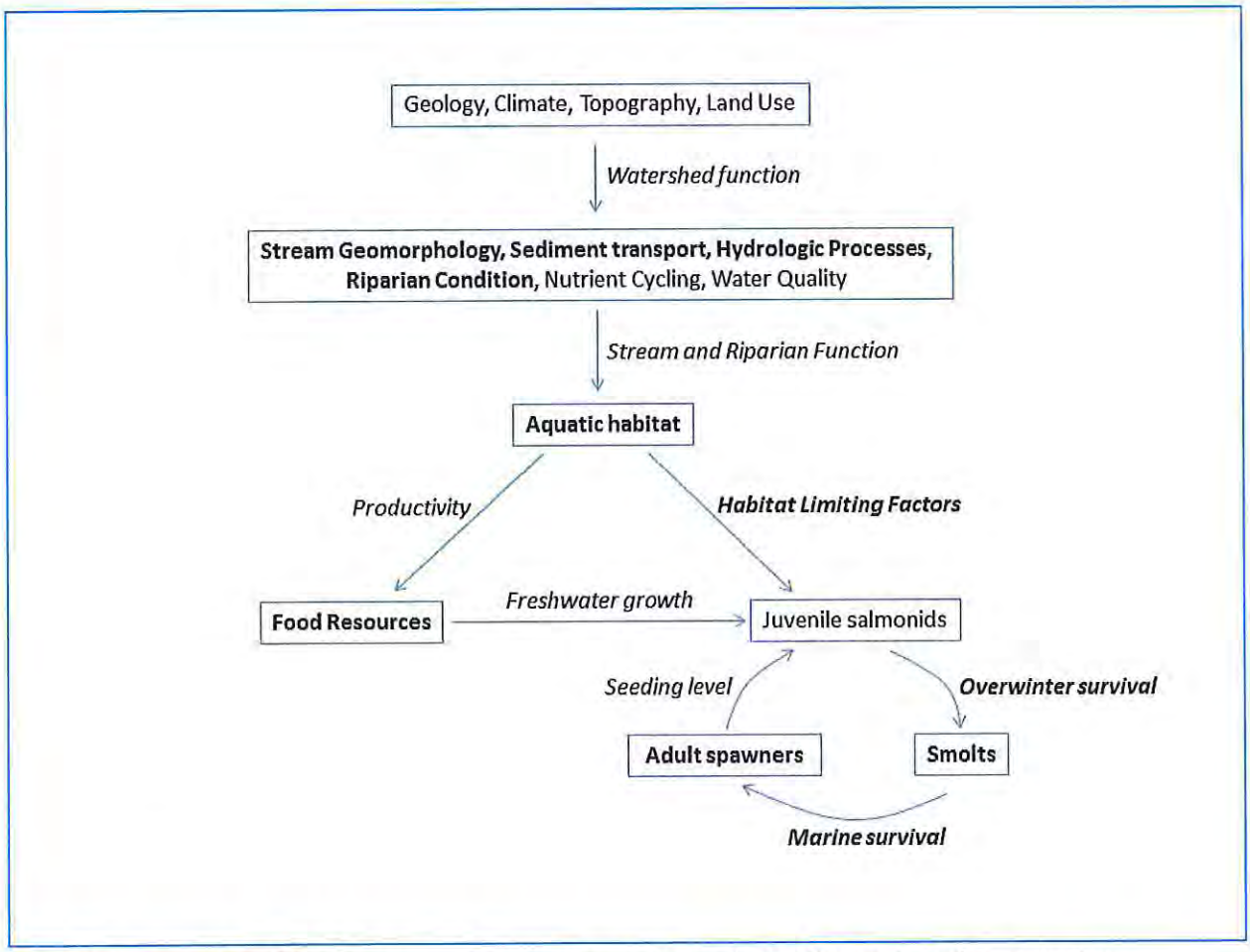



Figure 5. Conceptual model of the proposed monitoring parameters (in bold) in context of the ecosystem framework.

## EM Objective 1: Geomorphic response

Describe short-term geomorphic responses to large wood placement for 1 and 3 years after treatment.

*Background*

We propose to model geomorphic response to the introduction of large wood (LW). Even though LW additions are often part of fish habitat restoration efforts, the relative success of these efforts is rarely reported in terms of ecological significance. The geomorphic character of river systems in northwestern coastal watersheds is heavily controlled by the interaction of the stream channel with the floodplain (Bilby and Bisson 1998). Under natural conditions and adequate sediment supply this interaction allows river systems to recruit wood and develop forced-pool-riffle (FPR) morphologies in reaches that otherwise would exhibit plane-bed (PB) characteristics (Montgomery and Buffington 1997). The level of complexity of these reaches is high and they are often associated with the best habitat for anadromous fish (Beechie and Sibley 1997; Flitcroft et al. 2014). The extensive biological dataset available from the ODFW LCM site along with the anticipated habitat surveys will allow us to link the geomorphic response to the changes in fish habitat and populations. This information would enhance our ability to define concrete and effective restoration targets allowing forest management while maintaining and/or recovering habitat for coho salmon.

*Hypotheses*

The watershed-scale large wood placement will result in more complex geomorphology.

a. Higher spatial variability in shear stress and velocity.
b. Changes in the spatial distributions of flow velocity and shear stress will be related to changes in available winter and summer habitat for coho salmon.
c. Spatial variability of surface grain size distributions will increase after LW placement.
d. Total model bed load will decrease (i.e. increases storage behind structures) but the spatial variability will increase.
e. Spatial patters in erosion and deposition recorded in scour chains will indicate an increase aggradation and a decrease in erosion after the LW introduction.

*Parameters*

Channel types, shear stress, flow velocity, flow depth, sediment transport intensity, erosion and deposition recorded from scour chains, observations of grain size distributions in the surface and subsurface before and after LW additions.

*Sampling Design and Protocols*

We will leverage an ongoing project lead by Catalina Segura to model geomorphic response to large wood introduction in three plane bed reaches of Mill Creek. Specifically, we will use the results of that study on:

Geomorphic classification: This project is currently conducting a basin wide geomorphic classification campaign into channel types (Montgomery and Buffington 1997). An initial approximation of channel types is completed based on available LiDAR information followed by a large scale geomorphic survey.

Geomorphic observations: We will continue to collect detailed information in channel geometry in the three plane bed reaches. The length of each reach is approximately 20 times its bankfull width. We will

survey at least 10 cross-sections per reach and collect detailed information on grain size distributions (i.e. pebble counts) in several locations throughout the channel bed. The cross-sections will be revisited after the LW placement to document changes in channel geometry. Likewise, additional pebble counts will be conducted in approximately the same locations as previous counts.

Flow modeling: We will use the results from the 2d flow modeling, to be completed as part of the mentioned funded project, to describe variations in shear stress, mean vertical velocity, and depth within the three reaches before and after pilot LW additions in the summer of 2015. This modeling system (MD-SWMS McDonald et al. 2006) computes downstream and cross-stream components of velocity and boundary shear stress, using a finite difference solution to the Reynolds averaged momentum equations. The model has been successfully applied to analyze variations in shear stress and bed mobility in single-thread channels (Lisle et al. 2000; Clayton and Pitlick 2007; May et al. 2009; Nelson et al. 2010), the influence of flow variations on in-channel habitats used by freshwater fish (McDonald et al. 2010; Cienciala and Hassan 2013), migratory birds (Kinzel et al. 2009), and benthic organisms (Segura et al. 2011); and the effectiveness of environmental flow releases and river restoration efforts (Pasternack et al. 2004; May et al. 2009; Shafroth et al. 2010; Logan et al. 2011). The input data for the model include detailed topographic measurements, discharge, water surface elevation (WSE) at reach margins, and bed roughness expressed as roughness length or drag coefficient. The reaches have been instrumented with pressure transducers to collected depth information, which together with discharge measurements will be used to build a rating curve (stage-discharge relation). The model assumes steady and incompressible flow, linear variation of pressure with depth, and negligible viscous stresses compared to turbulent stresses. The grid over which the values of shear stress, velocity and depth will be computed within each study reach will have a resolution of ~ 1 $m^2$. The model will be calibrated by comparing observed and modeled WSE and velocity. Modeling results will be verified based on erosion and deposition monitoring that will be conducted in 2015 using scour chains in the three study reaches as part of the ongoing project. The grids will have at least 15 chains per site.

The funding requested with the proposal would allow extending the geomorphic study one more year, in which time we will collect topographic and grain size information to document changes in channel form. We will also be able to incorporate a wider range of flows into rating curves currently being developed in the three sites, which will reduce uncertainty in future flow estimates derived from the stage-discharge relation.

*Data analysis*

We will use the flow modeling results to investigate variability in the spatial distributions of shear stress, velocity, and depth before and after LW placement. The data will be analyzed together with fish population information to determine the flow features that related best to fish population dynamics.

*Expected Outcomes*

We expect to have a clear understanding on how the spatial distributions of depth, velocity, and shear stress change before and after the placement of LW. We will also identify the flow field characteristics that best predict fish habitat by linking flow modeling results to fish metrics collected by the ODFW. We will attempt a basin wide model that will provide insight into the overall effects of LW introduction from the geomorphic perspective.

## EM Objective 2: Winter rearing habitat

Quantify changes in winter rearing habitat following large wood placement 1 and 6 years after treatment.

*Background*

There is seasonal variability in juvenile coho salmon habitat use. In the summer, coho salmon are more abundant in pool habitats and less abundant in fast water habits (e.g. riffles and glides; Nickelson et al. 1992). In the winter, coho are more abundant in alcoves, beaver ponds, and off channel habitats that provide refuge from high winter flows (Nickelson et al. 1992). These habitats are increasingly rare on the Oregon Coast. Winter habitat surveys conducted by ODFW throughout the coast range from 2000-2013 found high quality winter habitats and instream complexity to be limiting and in low proportions relative to total available habitat (Anlauf-Dunn and Jones 2012). Therefore, the production of coho salmon smolts in most streams is thought to be limited by the availability of suitable winter habitats for parr.

*Hypothesis*

The watershed-scale large wood placement will increase the quantity and quality of winter rearing habitat available to coho salmon and other salmonids.

*Parameters*

Wood pieces and volume, habitat types, units and areas as defined in ODFW's Aquatic Habitat Inventory (AQI) protocol (Moore et al. 2007), habitat carrying capacity and potential smolt production estimates from the Habitat Limiting Factors Model (HLFM; Nickelson et al. 1992; Nickelson 1998; Anlauf et al. 2009)

*Sampling Design and Protocols*

To evaluate the effects of large wood placement on stream habitat, full-basin habitat surveys will be conducted in Mill Creek using the ODFW AQI project protocols (Moore et al. 2007) before and after the large wood placement. All surveys will be conducted during the winter because winter habitat availability is thought to be the limiting factor for coho smolt production in Mill Creek. A single pre-treatment habitat survey will be conducted the winter before the large wood addition to characterize current habitat conditions and large wood abundance. Although ODFW has previously conducted full-basin surveys of stream habitat (summer 1993 and winter 1998) in Mill Creek, significant changes in habitat have occurred since these surveys were conducted. The planned pre-treatment survey will serve as the benchmark for all comparisons. Two post-treatment full-basin surveys will be conducted in Mill Creek (subject to landowner permission). The first post-treatment survey will occur one year following the wood addition to characterize immediate changes in stream habitat. A second post-treatment survey will be conducted six years after the wood placement to characterize the longer-term effects (e.g. adjusting to multiple high flow events, etc.) of the large wood treatment on winter rearing habitat. Full-basin habitat surveys will start at the smolt trapping site in lower Mill Creek and survey all stream habitat upstream within the distribution of anadromous fish (approximately 15 miles).

Full-basin habitat surveys will be augmented with surveys focused on the location and extent of beaver-dammed pool habitats in Mill Creek and its tributaries. Pools associated with beaver dams can support high densities of juvenile coho salmon during the winter (Nickelson et al. 1992), and the presence of these habitats can have a large effect on models of potential juvenile coho rearing capacity. Beaver-dammed pools will be recorded during full-basin habitat surveys, but dam building activity and dam persistence

during winter can vary significantly from year to year. Therefore, the ODFW LCM crew plans to survey Mill Creek each year in the fall, when beaver dams are typically at their highest abundance, and again in late winter to quantify the amount of beaver-dammed pool habitat present in the basin. Information collected at each dam will include dam height, pool surface area, location, and whether the dam is anchored by naturally recruited or recently placed large wood.

*Data analysis*

The pre-treatment winter habitat survey will be compared to the post-treatment winter habitat survey to characterize the effects of the wood placement on winter rearing habitat in Mill Creek. Results will be compared to trends in particular habitat metrics at randomly selected AQI surveys (the "control" sites) in similar mid-coast streams (geology, size, slope, etc.) that did not undergo any habitat restoration during the Mill Creek project timeframe. It estimated that there will be approximately 20 suitable control sites. Paired t-tests will be used to assess the change in pools, channel complexity, substrate, and habitat capacity at restoration treatment sites compared to the control sites. Three sets of comparisons will conducted for each habitat metric: (1) pre-treatment to 1 year post-treatment, (2) pre-treatment to 6 years post-treatment, and (3) 1 year post-treatment to 6 years post-treatment.

The Habitat Limiting Factors Model (HLFM) as described by Nickelson et al. (1992), Nickelson (1998), and Anlauf et al. (2009) will be used to estimate current carrying capacity for juvenile coho salmon based on pre-treatment winter habitat surveys. The model estimates summer and winter rearing capacities (parr/km) by applying a specific density estimate to each geomorphic habitat unit within the reach, multiplying that value by the surface area of the habitat unit. The density estimates vary by geomorphic habitat unit type (e.g. scour pool, beaver pond, alcove) and wood loading (qualitative; low, medium, high). The average winter or summer parr capacities and 95% confidence intervals (CI) can be calculated at multiple scales (e.g. reach, stream). The model will also be used to estimate the expected change in carrying capacity following large wood placement. An HLFM carrying capacity estimate will be made using post-treatment winter habitat survey data, and comparisons between empirical smolt abundance and potential smolt capacity will provide a quantitative link between observed habitat changes and coho production.

*Expected Outcomes*

We expect the large wood placement to address the current habitat limiting factor by increasing the surface area of winter habitat units and the number of complex pools. A clear, detailed understanding of how the large wood affects instream conditions will allow us to build upon the geomorphic study results and connect the biological monitoring responses to the restoration treatment.

### EM Objective 3: Benthic macroinvertebrate response

Assess benthic macroinvertebrate biomass and taxonomic composition before large wood placement and in years 1, 3 and 6 after treatment. To detect effects of treatment, sampling sites will be located in Mill Creek and in an untreated control watershed

*Background*

The major focus of watershed restoration has been on restoring physical habitat with less attention to the role that available prey resources (or fish food) have on fish production (Matthews 1998; Diana 2005).

Large wood placed in Mill Creek may increase habitat for both fish and their invertebrate prey. Physical changes in inorganic sediments, hydraulics, and organic matter retention will likely change habitat diversity and food availability for invertebrates, potentially increasing their diversity and abundance. By measuring instream macroinvertebrate biomass we can estimate potential instream energy available to fish and determine if that change is due to large wood addition. Additionally, benthic invertebrate taxa are useful indicators of habitat conditions. Invertebrate metrics are used by the Oregon Department of Environmental Quality for regulatory purposes to determine which streams may have habitat or water quality impairment. Little information is available on how watershed-scale wood additions might affect invertebrate communities and this study provides a rare opportunity to evaluate such effects.

*Hypotheses*

1) Benthic macroinvertebrate abundance and composition, measured as density, biomass, and diversity will respond to the large wood enhancement.
2) Invertebrate taxonomic composition and metrics will change to reflect changes in hydraulic complexity and substrate composition after wood placement.

*Parameters*

Benthic macroinvertebrate density, biomass and taxonomic composition.

*Sampling Design and Protocols*

We propose collecting benthic macroinvertebrate samples in July during the summer sampling period when macroinvertebrate samples used for habitat/water quality monitoring are typically collected. A benthic macroinvertebrate collection site will be established in each of the 5 Mill Creek restoration reaches. Sites will be randomly selected in the downstream half of the 0.7 to 3.6 mile stream reaches in which large wood will be added, and will consist of a section of stream 40 times the wetted channel width. By placing these collection sites in the lower portions of each restoration reach, we will be assessing the cumulative effects of the multiple wood placements in each of these tributaries. Our study design includes control replicates equal in number to sites where macroinvertebrates will be collected in Mill Creek. The 5 control sites will reflect the stream size, slope, aspect and substrate of the treatment sites and be located in proximity to Mill Creek (i.e. in an adjacent 6$^{th}$ Field Watershed). Paired watershed studies at Hinkle, Alsea and Upper Trask watersheds have identified the critical importance of multi-year assessments that establish control (i.e., untreated) sites to provide a context for annual variations inherent in streams. By incorporating the physical measures of stream conditions from the AQI surveys into our analyses, we will be able to look at the relationships between physical and biological changes due to large wood addition.

Because most of the wood placement in Mill Creek will be additions to existing pools to increase complexity, we propose having our main sampling locations in sections where this type of wood placement is being employed. However, because so much additional physical information will be collected at the 3 initially plane-bed geomorphic study reaches where wood will be added, we would like to collect some biological data at these sites as well. As a result, we will look at relationships between the physical data collected at these geomorphic study sites and macroinvertebrate biomass. We will also test whether the macroinvertebrate biomass responds in the same way to wood additions in the geomorphic study reaches as in the main Mill Creek sampling sites.

At all sites, benthic macroinvertebrates will be collected from riffle habitat using Surber samplers. Although macroinvertebrate community changes will undoubtedly occur in pools where most of the wood is being placed, we are confining our sampling to riffles because of the logistical difficulties of collecting good, quantitative macroinvertebrate samples in deep, complex pool habitat. Furthermore we anticipate changes in substrate grain sizes, hydraulics, and organic matter retention in riffles, reflecting changes in the restoration reaches overall and leading to changes in macroinvertebrate communities. As an additional benefit, riffle sampling is used most often in monitoring by Oregon DEQ and watershed councils, so our data will be directly comparable to most other monitoring data and will be well-suited for use in Oregon DEQ water and habitat quality assessment models.

Benthic sampling field methods: At each site, eight 1-$ft^2$ benthic macroinvertebrate sub-samples will be collected and composited from riffles in study reaches that are 40 times the wetted channel width. ODEQ will provide two staff to lead the field work for benthic sampling. We propose to team with ODFW LCM and local district crews to collect the samples for each site. One ODEQ staff with extensive benthic monitoring experience will be paired with one ODFW staff without extensive benthic monitoring experience. This will give us two teams of two each to collect samples at each site. Initially, each crew will work together for each Surber sample. At the discretion of the ODEQ crew leader, crews may split up to collect sub-samples separately following completion of at least two full samples, to improve collection efficiency. However, because sampler variability could have a potential for introducing undesired variability, each crew member will provide the same number of subsamples to each composite sample. The ultimate goal is for ODEQ to pass on its knowledge and experience in benthic macroinvertebrate sampling to ODFW staff. This will allow ODFW staff to develop internal capabilities to perform similar sampling for other projects and increase collaborative monitoring efforts among ODFW, ODEQ, and other entities (USFS, Watershed Councils, etc.).

Additional field data collection: Continuous temperature monitors will be strategically placed throughout the LW treatment reaches, including the macroinvertebrate sampling locations. Pebble counts will also be done at the benthic sampling locations. This is to provide further information on the watershed condition (we are not proposing a temperature effectiveness monitoring component in this study). Data on fish species composition and numbers will be collected by using single-pass electrofishing through each study site when coho diet samples are collected.

Benthic lab work: OSU's Stream Lab and ODEQ staff will analyze the benthic samples. Based on protocols developed at Alsea, Trask and Hinkle Creek watershed studies, each composite sample will be frozen in dry ice in the field then defrosted in the lab after which:

- ½ the composite will be picked (i.e. non-invertebrate bits removed), dried in drying oven, weighed for biomass
- ½ the composite will placed in alcohol preservative; invertebrates will be identified for desired metrics, taxonomic ordination, and models (biological condition + habitat)

Samples collected from the geomorphic study reaches will be processed in the same way, but because only biomass will be determined from these samples, the half of the sample normally reserved for identification will be preserved and held, so that additional funding can be sought if there is a compelling reason to analyze these samples further.

*Data analysis*
The change in benthic assemblage will be assessed with ordination techniques and various metrics – change in diversity, biomass, density, etc.

Ordination techniques will be used to illustrate changes in macroinvertebrate assemblage composition. Taxa will also be assigned to various habits, functional feeding groups, and tolerances. Shifts in these metrics may be observed as overlays in ordination space, or as summaries of each metric across treatments and controls.

The potential shift in sediment tolerance in macroinvertebrate assemblages will be assessed with ODEQ's Fine Sediment Stressor ID model (http://www.deq.state.or.us/lab/techrpts/docs/10-LAB-005.pdf) and the Fine Sediment Biotic Index (Relyea et al 2012). Both of these models attempt associate tolerances to fine sediment conditions in streams throughout Oregon or the Pacific Northwest, then use the abundances of taxa observed within each sample to estimate an overall assemblage-level preference for (or tolerance of) fine sediments.

Benthic biomass will be compared before and after treatment, as well as between treated and control sites using repeated measures Analysis of Variance (ANOVA). This conservative approach will take into account the necessity of resampling the same locations over repeated years. Repeated measures ANOVA can also be used to compare invertebrate metrics such as the proportion of relevant functional groups (e.g. shredders), or proportion of particular taxonomic groups (e.g. chironmid midges) the years following large wood placement.

*Expected Outcomes*
This monitoring component provides a critical link between the physical and biological responses to the large wood placement. While physical measurements will identify how large wood will improve habitat availability, these macroinvertebrate assessments will help us understand benthic community responses that indicate changes in stream habitat and may be an important link to increased fish production.

## EM Objective 4: Overwinter survival of juvenile coho

Investigate how large wood placement affects juvenile coho salmon overwinter survival for 6 years after treatment.

*Background*
Overwinter survival of juvenile coho salmon has been the focus of many studies due to the high mortality that can occur during this period of challenging environmental conditions, and the strong influence overwinter survival has on smolt production (e.g. Quinn and Peterson 1996; Ebersole et al. 2006; Brakensiek and Hankin 2007). In Oregon coastal streams, where the availability of appropriate overwintering habitat is often a limiting factor for coho smolt production (Nickelson et al. 1992), large wood additions have been shown to significantly increase the overwinter survival rate of juvenile coho salmon (Solazzi et al. 2000; Johnson et al. 2005). By increasing the quantity and complexity of winter rearing habitat in the Mill Creek basin, we expect to increase the percentage of juvenile coho salmon that survive through the winter and out-migrate as smolts in the spring. Overwinter survival data will provide more resolution to overall freshwater survival estimates (from egg to smolt), effectively breaking these

estimates down into early (egg to parr) and late (parr to smolt) components. Existing data from Mill Creek suggests that both can vary significantly over time, and the proposed monitoring will provide insight into restoration effects early and late in the freshwater rearing period.

*Hypothesis*
The watershed-scale large wood placement will increase overwinter survival rates for juvenile coho salmon.

*Parameters*
Overwinter survival rate (parr to smolt)

*Sampling Design and Protocols*
Coho salmon overwinter survival in the Mill Creek basin will be determined by tagging a representative group of juvenile coho salmon in late summer and early fall and then estimating the number of fish that survive to the spring out-migration period. Fish to be tagged will be collected in randomly selected reaches throughout the basin selected using a Generalized Random Tessellation Stratified design (GRTS, Stevens 2002). This method will be used to create a spatially balanced, random point distribution within a sampling frame that encompasses the entire rearing distribution of coho salmon in the Mill Creek drainage.

Field crews will navigate to each random point, and use it as a starting location for a sampling reach that is 20 times the active channel width. All habitat units in that reach will be sampled using a combination of beach seining and electrofishing with the goal of collecting as many juvenile coho salmon (parr) as possible. All coho parr captured will be anesthetized and measured for fork length (FL) to the nearest mm and weight to the nearest 0.1 gram. Coho parr $\geq$ 65 mm FL will be implanted with a 12.5-mm passive integrated transponder (PIT) tag in the body cavity following guidelines from the PIT Tag Steering Committee (1999). Coho parr < 65 mm FL will be marked by injecting a small amount of red visible implant elastomer (VIE) material (Northwest Marine Technology, Inc., Shaw Island, Washington) into the dorsal fin. To evaluate potential overwinter loss of VIE tags, a sub-sample of fish receiving PIT tags will also receive a VIE tag.

All coho smolts captured during the spring smolt trapping season will be scanned for PIT tags and examined to determine if a VIE tag is present. The total number of tagged smolt out-migrants will be estimated based on the number of tag recoveries, smolt trap efficiency, and estimated tag loss rates. Starting in spring 2015, a PIT tag antenna array will be in place near the smolt trap to further refine estimates of PIT-tagged coho smolt out-migrants. The PIT tag antenna array was installed in fall 2014, and will also provide information on tagged coho that migrate out of Mill Creek during the winter when the smolt trap is not operating. Overwinter survival estimates have been made at Mill Creek using similar methods for three years pre-treatment. Two additional years of pre-treatment data will be collected in addition to six years of post-treatment data. The freshwater rearing period of fish tagged in fall 2016 will include periods before and after the wood placement, but these fish will be included in the post-treatment group because we expect the wood placement to have immediate benefits for overwintering juvenile coho salmon.

*Data analysis*
A Before-After, Control-Impact (BACI) sampling design (Stewart-Oaten et al. 1986) will be used to test for changes in overwinter survival following the addition of large wood. Overwinter survival is not routinely measured at other LCM sites, but long-term data is available at the Lobster Creek monitoring sites (Alsea basin). These sites in upper Lobster Creek were originally part of a paired watershed study examining effects of habitat modification on salmonid populations and overwinter survival (Solazzi et al. 2000). ODFW has continued to estimate overwinter survival at the paired sites since that study concluded in 1994. Due to the close proximity of the two Lobster Creek sites, a single aggregate value from the two sites for years corresponding to data collection at Mill Creek will be used in the BACI analysis.

*Expected Outcomes*
Overwinter survival estimates will provide key information about the survival processes underlying the coho population response to large wood placement. Information collected from PIT-tagged fish will also be used to evaluate how parr size and summer rearing location affect subsequent overwinter survival, and how these relationships might change following restoration work.

### EM Objective 5: Coho smolts and other salmonid out-migrants

Determine if large wood placement affects the annual abundance of coho salmon smolts and other salmonid out-migrants for 6 years after treatment.

*Background*
Increasing fish abundance is often a primary goal of watershed restoration, and many studies have been undertaken to evaluate the effects of large wood placement on salmonid populations. Studies focused on local reach-scale abundance have often observed a significant increase following the addition of wood or other in-stream structures (Roni and Quinn 2001; Whiteway et al. 2010). Studies focused on smolt out-migrants from treated watersheds have had mixed results, however (e.g. Cederholm et al. 1997; Reeves et al. 1997; Solazzi et al. 2000; Johnson et al. 2005). This may be due in part to the high variability in salmonid populations, which can make it difficult to document significant responses to restoration (Liermann and Roni 2008). Depending on the effect size of restoration treatments, many years of monitoring may be required (Roni et al. 2003). ). With 17 years of data already collected at Mill Creek and 10-17 years of data at the other LCM sites that can be used as controls, a framework is in place to make a rigorous evaluation of restoration effects.

*Hypothesis*
The watershed-scale large wood placement will result in an increase in the abundance of coho smolts, steelhead smolts, and cutthroat trout out-migrants.

*Parameters*
Life Cycle Monitoring data from smolt trap operations including number of coho smolts and other salmonid out-migrants (steelhead and cutthroat trout), coho smolt length and weight

*Sampling Design and Protocols*
Monitoring of coho smolts and other salmonid out-migrants will be conducted at Mill Creek and five control sites using standard LCM project methods (Suring et al. 2012). The control sites are other ODFW

smolt monitoring sites at the East Fork Trask River, Mill Creek (Yaquina basin), Lobster Creek (Alsea basin), Cascade Creek (Alsea basin), and Tenmile Creek (direct ocean tributary). These sites vary in habitat conditions, land-use patterns, and geological setting, but all experience similar temporal trends in precipitation, temperature, and adult coho salmon abundance as the Mill Creek (Siletz) site where the wood addition will take place. There are also no major recent or planned modifications in stream habitat at these sites, as have occurred at the West Fork Smith River LCM site in the Umpqua basin.

At each of the monitoring sites, salmonid out-migrants will be caught using a five foot rotary screw trap or motorized inclined plane trap (Figure 6). Smolt traps are operated continuously from the beginning of March until the end of the coho smolt outmigration period, typically in mid to late June. By this time, the number of juvenile steelhead and cutthroat trout out-migrants showing external signs of smoltification also declines to a very low level. Trapping locations at the control sites are described in Solazzi et al. (2000), Johnson et al. (2005), and Suring et al. (2012). Population estimates for coho salmon smolts and other salmonid out-migrants are based on mark and recapture information for each species, and are made using a Bayesian statistical model (Bonner and Schwarz 2012) implemented in program R (R Core Team 2013). For steelhead and cutthroat trout, estimates are made for several different length classes due to differences in trap efficiency for fish of different sizes (Suring et al. 2012). For each species and size class, fork length measurements are made on up to 25 fish per week, allowing characterization of the size structure of the out-migrant population.

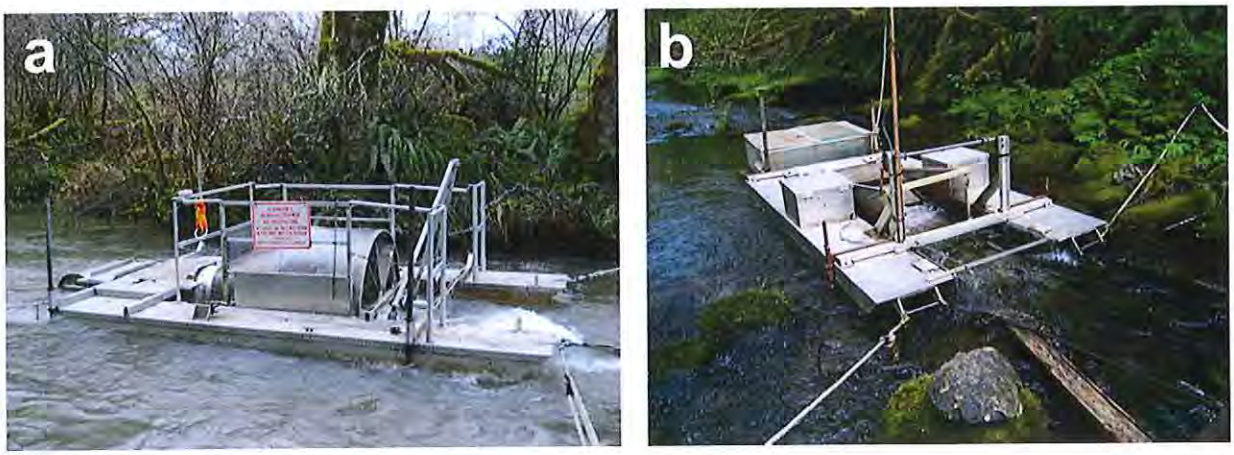



Figure 6. Rotary screw traps (a) and inclined plane traps (b) will be used to monitor salmonid out-migrants at Mill Creek and the five control sites.

Coho parr are known to out-migrate from Mill Creek in the late fall and winter, outside the spring monitoring period when our smolt trap is operated. It is extremely difficult to operate rotary screw traps during this time due to high flow conditions and heavy debris loads, but the smolt trap at Mill Creek (Siletz) was fished sporadically when conditions allowed from October 2006-January 2007. Results indicated that the number of migrants was very low during this time (ODFW, unpublished data). To further investigate the prevalence of the earlier migrants and their potential contribution to adult returns, we have installed a PIT tag antennae array near the smolt trapping site at Mill Creek. Coho parr will be PIT-tagged in the fall (see EM Objective 4), and the number of fall and winter out-migrants will be estimated based on detections at the array and antennae efficiency. We plan to collect these data for one year pre-treatment and for at least two years post-treatment. These data will not be subject to the data

analysis methods described below due to lack of a time series, but will provide important information on the prevalence of alternative life history strategies in the study stream and their contribution to overall coho salmon production.

*Data analysis*

A Before-After, Control-Impact (BACI) sampling design (Stewart-Oaten et al. 1986) will be used to test for changes in smolt production following the addition of large wood. The availability of long-term smolt production data for several LCM sites on the Oregon coast will allow the use of an asymmetrical design with multiple control sites (Underwood 1994). Data collection began in different years at the different sites, but smolt estimates are available from 1998 to present for the treatment stream and four of the five control sites. Smolt estimates from the paired watersheds in Lobster Creek will be pooled due to the close proximity of the two sites. Data collection did not commence at the East Fork Trask River until 2005, but the pre-treatment period will cover 12 years from 2005 to 2016. The post-treatment period will initially include the 6 years from 2017 to 2022, but we also plan to test for changes on a longer time scale as data collection continues at these sites.

ANOVA will be used to test for interactions among locations and treatment periods, indicating whether there was a significant change in smolt production in Mill Creek relative to controls following the large wood addition. Environmental covariates, including flow and temperature conditions during the rearing period, will be explored and may increase the statistical power of the BACI design. Parental spawner estimates are available for the treatment stream and a subset of the control sites, and could be a very important covariate depending on trends in adult abundance. Data analysis will primarily focus on coho salmon smolts, but tests will also be conducted for steelhead smolts (defined as migrants $\geq$ 120 mm fork length, Suring et al. 2012) and the most abundant size classes of cutthroat trout. Changes in stream habitat are primarily expected to result in changes in smolt abundance, but comparisons of coho smolt size and weight before and after the treatment will also be made to evaluate potential effects on individual fish growth and condition.

*Expected Outcomes*

By 2022, there will be sufficient data to make an initial evaluation of the effect of large wood addition on the abundance of coho salmon smolts and other salmonid out-migrants from Mill Creek, as well as potential changes in the coho spawner-smolt recruit relationship at this site. Ongoing data collection at Mill Creek and other LCM sites will also provide excellent opportunities to evaluate long-term restoration effects on salmonid populations.

## Monitoring Synthesis

One of the key aspects of this monitoring plan is the strong connection between the five major research topics that will be investigated. Our goal is to connect the dots between fine-scale geomorphic responses to wood addition and reach-scale habitat conditions, and then link these changes to fish survival and production at the basin scale. Quantifying potential invertebrate food resources available to rearing salmonids will provide another important piece in this puzzle. The integrated approach to effectiveness monitoring we propose will provide a deeper understanding of how large wood additions affect juvenile salmonid populations and the magnitude of the response that can be expected in different geomorphic settings. This information is critical to understanding how current restoration efforts are influencing

salmon populations, how future projects should be prioritized, and the scope of restoration needed to achieve salmon recovery goals.

Intensive monitoring of geomorphic changes at a subset of the treated sites will provide detailed information on local effects of wood placement on channel form and function. Extensive habitat surveys that encompass the entire rearing distribution for anadromous salmonids in the study basin will be used to determine how these local changes scale up to reach level habitat conditions. They will also be used to determine how post-treatment changes in stream habitat in the treated reaches compare with non-treated reaches within the Mill Creek basin and in control sites outside Mill Creek. A subset of the benthic macroinvertebrate monitoring sites will be located in the reaches targeted for intensive geomorphic monitoring. Local changes in substrate and current velocity can then be linked to macroinvertebrate abundance and community composition. Extensive habitat surveys will encompass all of the macroinvertebrate monitoring sites in Mill Creek, and will provide information on channel unit size, slope and substrate composition that can also be linked to the macroinvertebrate data.

As discussed above, the Habitat Limiting Factors Model (HLFM) will play a key role in connecting changes in stream habitat to basin-scale fish production. The HLFM will be used as a predictive model prior to the large wood placement and to estimate pre- and post-treatment carrying capacity for juvenile coho salmon based on full basin habitat surveys. Comparisons with actual smolt abundance before and after the restoration work will provide a quantitative link between observed habitat changes and coho production. When HLFM carrying capacity estimates have been calculated using winter habitat data collected at other LCM sites, model results have been very similar to the maximum observed smolt production from the basin (ODFW, unpublished data). By linking habitat and fish production data using the HLFM, we plan to go beyond statistical significance tests to a more process-orientated understanding of habitat and fish population responses to the large wood placement. Benthic macroinvertebrate sampling will provide an important additional dimension to these analyses. Habitat conditions and food resource availability interact to influence fish growth and survival (Wipfli and Baxter 2010), and changes in benthic production may help explain discrepancies between HLFM predictions and observed smolt production.

## Reporting and Deliverables to OWEB

A total of three OWEB reports are proposed throughout the study's timeframe (*see* Table 2 below).

Report 1: An effectiveness monitoring progress report will be submitted to OWEB in the winter of 2016/2017. A comprehensive document will discuss monitoring methods, preliminary results, data analysis and discussion on all monitoring parameters conducted pre-treatment through year-1 post-treatment including:

- Winter 2014/2015 and 2015/2016 AQI survey results and HLFM analysis
- PIT-tagging efforts, results and over-winter survival analysis for winter 2014/2015 and winter 2015/2016
- Life Cycle Monitoring data review for 1997 through spring 2016 including estimates for parental females, juvenile production and survival, returning wild coho, and female marine survival
- Geomorphic response results
- Aquatic macroinvertebrate sampling results for spring and summer 2015 and 2016.
- Monitoring synthesis discussion

Report 2: A second effectiveness monitoring progress report will be submitted to OWEB in the winter of 2018/2019. These results will be discussed in conjunction with the other ongoing monitoring efforts:

- PIT-tagging efforts, results and over-winter survival analysis for winters 2014/2015 through 2017/2018 (will not include the winter 2018/2019 numbers)
- Life Cycle Monitoring data review for 1997 through spring 2018 including estimates for parental females, juvenile production and survival, returning wild coho, and female marine survival
- Aquatic macroinvertebrate study results and discussion for monitoring efforts from spring 2015 through summer 2018.
- Monitoring synthesis discussion

Report 3 (final): An effectiveness monitoring final report will be submitted to OWEB in the winter of 2021/2022 after all effectiveness monitoring and analysis is completed. A comprehensive review of monitoring methods, results, data analysis and discussion will cover:

- Winter 2020/2021 AQI survey results and HLFM analysis
- Pit-tagging efforts, results and over-winter survival analysis from winter 2014/2015 through winter 2020/2021.
- Life Cycle Monitoring data review for 1997 through 2020 including estimates for parental females, juvenile production and survival, returning wild coho, and female marine survival
- Aquatic macroinvertebrate density and taxonomic composition results from spring 2015 through summer 2021 sample years.
- Monitoring synthesis discussion

In addition, OWEB will receive a copy of any white paper, scientific manuscript or other publication resulting from this study

## Dissemination of Results

A variety of methods will be used to communicate effectiveness monitoring results to the research community, restoration practitioners, and the general public. We expect to produce several manuscripts for publication in scientific journals, including papers focused on geomorphic modeling results, benthic macroinvertebrate community response to restoration, and restoration effects on juvenile salmonid survival and production. We also plan to develop a synthesis paper that ties together the five main research topics described in this effectiveness monitoring plan. Final results from some study components will not be available for a number of years, and so OWEB reports and presentations at scientific meetings will be used to track monitoring progress and present preliminary results. As monitoring progresses, preliminary findings will also be communicated to agency partners and local watershed councils through meetings and presentations. Watershed council meetings are open to the public and provide an excellent venue for presenting results to community members. At the end of the proposed monitoring period, when all objectives are complete, we plan to summarize the effectiveness monitoring results on a website with contact information for all the study partners.

## Partners and Roles

The Oregon Department of Fish and Wildlife (ODFW) plays a key role in this project. The following ODFW programs have coordinated together to leverage resources, expertise and data:

- Life-cycle Monitoring Project – Chris Lorion, Erik Suring
    - LCM operations – adult and smolt trap activities, annual summaries

  - PIT-tagging efforts
  - Beaver dam surveys
  - Macroinvertebrate sampling assistance
  - Coordinated spawning surveys
  - Project design, coordination and management
- Western Oregon Stream Restoration Program – Stacy Polkowske
  - Restoration implementation (large wood placement)
  - Macroinvertebrate sampling assistance
  - Project design, coordination and management, OWEB grant proposal
- Aquatic Inventories Project – Kim Jones, Kara Anlauf-Dunn
  - Mill Cr AQI surveys – Mill Cr Basin
  - Reference AQI surveys
  - Habitat Limiting Factors Model analysis
- Habitat Restoration Monitoring – Lora Tennant
  - AQI survey assistance
- Restoration & Enhancement (R&E) grant program
  - Funding for materials to increase PIT-tagging efforts

Plum Creek Timber is the cooperative landowner and will be providing input on project design, overall project support, and in-kind match for implementation and effectiveness monitoring. Jeff Light, fish biologist and hydrologist, is the primary PCT contact.

Oregon State University's College of Forestry has funded the geomorphic modeling study through their Fish and Wildlife Habitat in Managed Forests research program. Assistant professor, Catalina Segura will be principle investigator and coordinate this effort with ODFW project managers.

Oregon State University's Stream Lab ran by Judith Li (retired professor) and Bill Gerth (senior research associate) in the Department of Fisheries and Wildlife will collaborate with Shannon Hubler of ODEQ to conduct the aquatic macroinvertebrate sampling and lab analysis. Bob Danehy from National Council for Air and Stream Improvement (NCASI) has provided guidance and support on the aquatic macroinvertebrate study design.

MidCoast Watersheds Council (MCWC) and Siletz Watersheds Council (SWC) will provide project support and outreach to the local public. MCWC will administer the OWEB grant and hold the service contracts.

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Table 2. Timeline of EM activities

| Activity | Spring 2014 | Summer 2014 | Fall 2014 | Winter 2014/15 | Spring 2015 | Summer 2015 | Fall 2015 | Winter 2015/16 | Spring 2016 | Summer 2016 | Fall 2016 | Winter 2016/17 | Spring 2017 | Summer 2017 | Fall 2017 | Winter 2017/18 | Spring 2018 | Summer 2018 | Fall 2018 | Winter 2018/19 | Spring 2019 | Summer 2019 | Fall 2019 | Winter 2019/20 | Spring 2020 | Summer 2020 | Fall 2020 | Winter 2020/21 | Spring 2021 | Summer 2021 | Fall 2021 | Winter 2021/22 | Spring 2022 | Summer 2022 | Fall 2022 | Winter 2022/23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OWEB funding secured for Restoration Grant #215-1004 | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Permiting | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wood acquisition | | | | X | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contracting | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Implementation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Finalize LW sites & design | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| LW placement | | | | | | X (partial) | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OWEB Implementation Report | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | |
| **EM Monitoring** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OWEB Funding secured for Monitoring | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Finalize monitoring plan | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Life Cycle Monitoring Activities** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pit-tagging parr | | | X | | | | X | | | | X | | | | X | | | | X | | | X | | | | X | | | X | | | | | | |
| Beaver dam surveys | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | X | X | | | X | X | | X | X | | | | | |
| Adult spawner tagging | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | X | X | | | X | X | | X | X | | | | | |
| Spawning surveys | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | X | X | | | X | X | | X | X | | | | | |
| Juvenile out-migrants | | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | X | X | | | |
| LCM tri-annual report | | | X | | | | | | | | | | | | X | | | | | | | | | | | | X | | | | | | | | | |
| **Aquatic Habitat Inventory** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AQI 2015 Placement reaches | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AQI Survey - Full-basin | | | | | | | | Pre | | | | Post-1 | | | | | | | | | | | | | | | | | | | Post-6 | | | | | |
| HLFM Analysis of AQI results | | | | | | | | X | X | | | X | X | | | | | | | | | | | | | | | | | | X | X | | | | |
| **Temperature** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HOBO loggers deployed | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| HOBO logger data retrieved & analysed | | | | X | | | | X | | | | X | | | | X | | | | X | | | | X | | | | X | | | X | | | | | X |
| **Geomorphic Study** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Study site selection | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sediment entrainment study | | | | X | X | | | X | X | | | | | | | | | | | | | | | X | X | | | | | | | | | | | |
| Channel classification of alluvial network | | | | | X | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Geomorphic observations in selected reaches | | X | | | | X | | | | X | | | | | | | | | | | | X | | | | | | | | | | | | | | |
| WSE and Q measurements | | X | | | | | X | X | | | | | | | | | | | | | | | X | X | | | | | | | | | | | | |
| Geomorphic data analysis | | | | | | | X | X | X | | | | | | | | | | | | | | X | X | X | | | | | | | | | | | |
| Geomorphic results disseminated | | | | | | | | | | X | | | | | | | | | | | | | | | | X | | | | | | | | | | |
| Journal publication expected | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | X | | | | | | | |
| **Aquatic Macroinvertebrates** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Benthic sampling | | | | | | | | | | Pre | | | | Post-1 | | | | | | | | Post-3 | | | | | | | | | | | Post-6 | | | |
| Lab work, data analysis and reporting | | | | | | | | | | X | X | X | | X | X | X | | | | | | X | X | X | | | | | | | | | X | X | X | |
| OWEB EM Reports | | | | | | | | | | | | | | | | X | | | | | | | | X | | | | | | | | | | | | X |