

# Mill Creek (Siletz) LWD Effectiveness Monitoring Workshop

**Workshop Materials Packet**

**June 27th, 2023**

**Logsden Community Center and Mill Creek**

**Logsden, OR**

DEQ · Oregon State University · Oregon Fish & Wildlife · Oregon Watershed Enhancement Board OWEB · Weyerhaeuser · Midcoast Watersheds Council

# Mill Creek (Siletz) LWD Effectiveness Monitoring Workshop Handout
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**Mill Creek (Siletz) LWD Workshop Agenda**
**Thursday, June 27th, 2023, 9:00-4:00**
**Logsden Community Club and Mill Creek (Field Site), Logsden, OR**

**9:00-9:15-** Meet at Logsden Community Club, light refreshments provided

**9:15-9:30-** Greetings, Introductions, and workshop agenda review

**9:30-12:00 Classroom Session-** Presentations from project partners

9:30 Mill Creek Introduction (Chris Lorion, ODFW)
10:20 Relevance of Mill Creek study to understanding Life History Diversity in Coho (Evan Hayduk, MCWC)
10:30 EM1- Geomorphic Response- (Evan Hayduk, MCWC)
10:50 EM2- Winter Rearing Habitat- (Chris Lorion, ODFW, Tom McCambridge, MCWC)
11:00 EM3- Benthic Macroinvertabrate Response- (Bill Gerth, OSU)
11:20 EM 4- Overwinter Survival (Wes Shum, ODFW)
11:30 EM5- Coho Smolt Production (Wes Shum, ODFW)
11:45 Review of workshop handout- preparation for field site activities (Evan Hayduk, MCWC)

**12:00-12:45-** Lunch

**12:45-1:00-** Load up in passenger vans, travel to field sites

**1:00-3:45 Mill Creek Field Sites-** Three sites within short distance will be visited

**Field Site 1: LWD Site #21-**

Review of placement strategies, access, equipment, utilizing shorter length logs to create a complex jam (*Derek Wilson, ODFW*)

**Field Site 2: Mainstem Geo Site- Geomorphic change research site**

Geomorphological change field methods and results

Discussion of Lessons Learned: This site was installed in 2015 to aid georphology monitoring, but the hihg water velocity in the straight channel are not ideal from an ecological perspective

**Field Site 3: Site 25b-** This site provides easy access to the creek, including a past placement just downstream and an example of logs shifting during high winter flows

Macroinvertebrate sampling strategy and demonstration

**3:45-4:00 Travel back to Logsden Community Club, Workshop over at 4 PM**

*Mill Creek (Siletz) Watershed Restoration Final Completion Summary*

The MidCoast Watersheds Council, working in partnership with ODFW, placed 679 logs in 57 large wood structures in 6.8 stream miles throughout the coho distribution in the sub-basin. The goal of this project was to address limiting factors in the basin of habitat complexity, primarily winter rearing habitat. This project was followed up by an extensive Effectiveness Monitoring project (OWEB grant #215- 1039). Partners in the project with the MidCoast Council and ODFW include Plum Creek Timber (now Weyerhaeuser), Oregon DEQ, and OSU College of Forestry.

*Background*

The Mill Creek Watershed consists of Cerine Cr, South Fork Mill Cr, North Fork Mill Cr, Gunn Cr, Tributary A, Tributary B, and the mainsteam Mill Cr. 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 the unconstrained, multiple terrace channels dominating in the lower gradients.

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 the spawning and rearing occurs lower in the watershed where stream gradients are <4% (totaling 9.8 miles).

The primary limiting factor affecting coho smolt production in the Mill Creek watershed is stream complexity, specifically winter rearing habitat. Previous ODFW aquatic habitat inventories (AQI) and recent stream surveys noted a low abundance of wood throughout the watershed, lack of off-channel habitats and the majority of pools have no to little structure or protective cover. Modeling with the Habitat Limiting Factors Model (HLFM) showed that winter rearing habitat is the primary seasonal habitat type limiting coho production in the watershed. 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 in the summer. Finally, another potential limiting factor is the abundance and availability of aquatic macroinvertebrates for foraging fish.

*Work Done*

A total of 679 logs were placed in 57 habitat structures on reaches of Cerine Cr, SF Mill Cr, Gunn Cr and the mainstem Mill Creek that were within the 0-4% stream gradient, totaling 6.8 stream miles. Log placement took place over two years, with 37 logs placed in three "Geo" research sites in 2015 and 642 logs placed in 54 structures in 2016. Roughly 2/3 of the logs (455 logs) met criteria to be considered key wood pieces (exceeding 23.6" DBH and 32.8 feet in length. These totals do not include additional course wood from riparian area trees and shrubs placed on some structures where access to the creek required removal during implementation.

In Cerine Creek, 243 logs were placed in 21 habitat structures. In mainstem Mill Cr, 222 logs were placed in 18 habitat structures. In the SF Mill Cr, 166 logs were placed in 13 habitat structures. In Gunn Creek, 48 logs were placed in 5 habitat structures.

Also, an old car body spanning the channel of Tributary A and creating a fish passage barrier was removed with log placement equipment via an existing logging road. The car body was hauled to the nearest recycling/transfer station. The stream banks at the sites were shaped and sloped to match the natural steam channel morphology.

*Changes from Proposed*

A few minor adjustments were made in site selection because of access issues (i.e. to wet, soft, steep or thick reprod) and in the number of wood pieces and/or size for a particular stream reach. The original application called for placement of logs in N. Fork Mill Creek but placement did not occur here. This did not affect the total number of logs (more were placed than planned) but did affect the total stream miles affected (now 6.8 miles).

*Public Awareness or Education*

As a part of the accompanying Effectiveness Monitoring portion of this grant there will be a series of workshops run by the MCWC in 2018 and 2022.

Chris Lorion, Assistant Project Leader for the ODFW Salmonid Life Cycle Monitoring Project presented an overview of this project to the Siletz Watersheds Council in December 2015. Evan Hayduk, Restoration Specialist with the MidCoast Watersheds Council, also provided updates on the placement of logs for the project at Siletz Watershed Council meetings in July and September 2016.

*Lessons Learned*

For a project of this magnitude, it is very important to have multiple people involved from pre project planning to final implementation.  This allows for easy transition for staff changes, consistent points of contact, project partner coordination, work distribution, and overall planning and implementation.

Make sure to keep close track of the exact number of logs coming into this project. With so many logs needed (over 600) and staffing changes, it was difficult to keep track of the exact number of logs as they were being stockpiled at the project site from various sources (purchased via mills by weight, donated by Plum Creek Timber and ODFW, and log salvage fund) and at various times (over a 1.5 year time period). Much of the specific site selection and log needs were being planned as logs were coming into the stock pile and/or being sourced. Ideally, all site selection and numbers of logs wanted/needed would be complete prior to log sourcing. This would also allow for individual logs to be marked and measured for total volume in a more efficient manner.

Utilizing the ODFW HLFM model was helpful and/or validated wood placement sites selection. We found that the sites project biologist selected for wood placement correlated very well with the locations/reaches the model said would provide the most benefit of wood placement. This model may be helpful for future wood placement projects being planned by less experienced people or groups and/or provide additional validation to sites selected in river basins/reaches planned to be treated with LWD.

*Recommendations*

It is difficult to think of all the small logistical and implementation components of a project of this size. You must remain adaptive, expect challenges and obstacles, and stay focused on the end result and timeframe.

It is very important to have open lines of communication with the various other research components and partners to ensure all project aspects are being met and not impacted by other research / monitoring needs. For example, additional wood was going to be placed within the GEO study site on the mainstem Mill Creek. Communication prior to this happening prevented a potential impact to the GEO study and a new placement site was subsequently selected.

When selecting placement sites, it is a good idea to have multiple routes of entry if possible. Soft ground in the riparian zones is very common, especially when using large shovel log loaders and very large logs. The overall weight can be an issue. Working with an experienced contractor in such areas is highly recommended.

Consider Fire Danger / Fire Season when planning out projects. Typically the later in the season the drier / low flows and better for wood placement. However, this is typically when fire season and potential constraints come into play. Such as no work at all during high fire danger or limited times of day when operations are allowed.

*Aquatic Habitat*

See compliance letter from Michele Long, ODFW Habitat Biologist

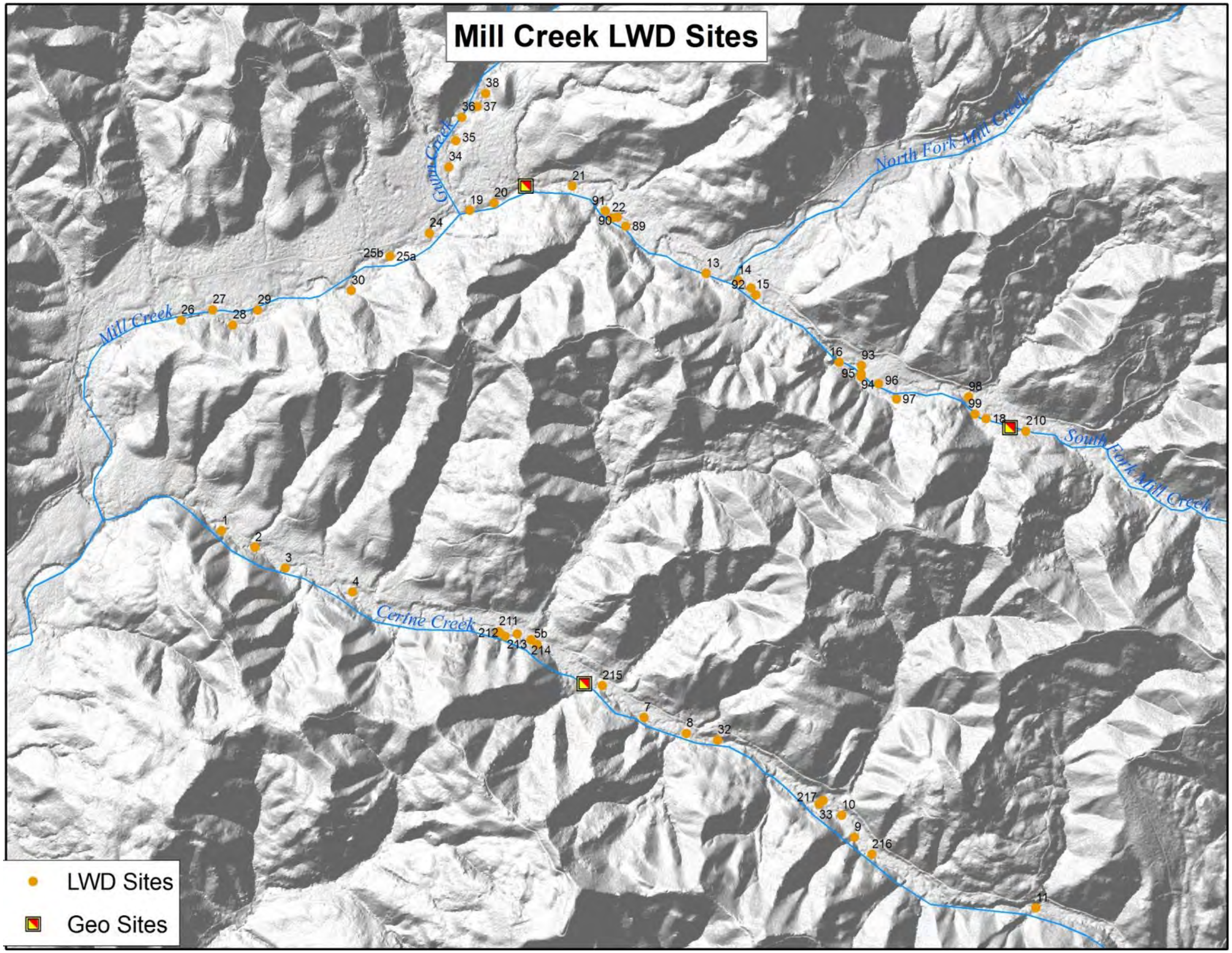
## Project Implementation Budget

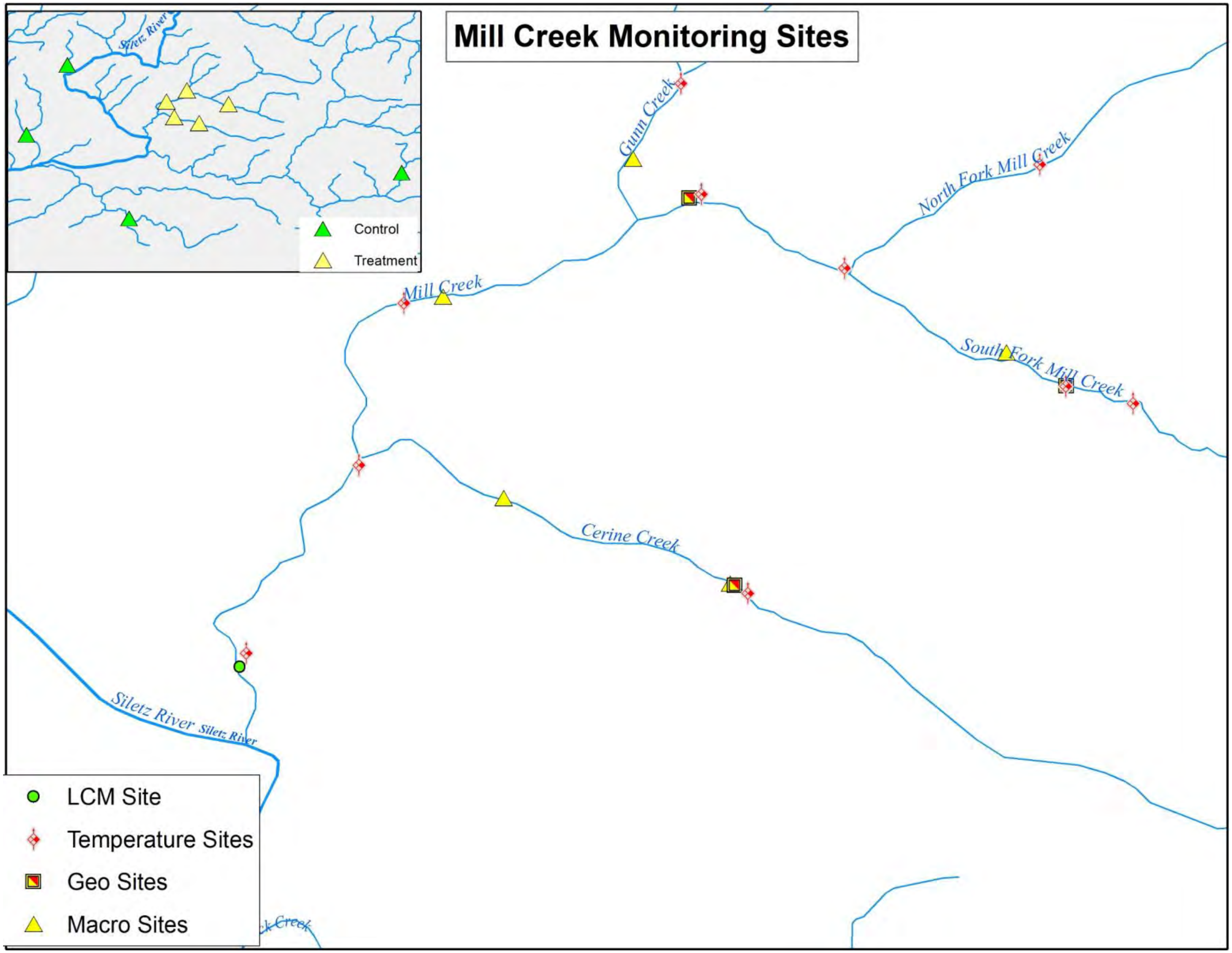
| *Funding Sources* | | | | | |
|---|---|---|---|---|---|
| Source | Identifier | Cash | Inkind Type | Inkind | |
| ODFW | | $0.00 | Volunteers | $6,000 | |
| ODFW | | $0.00 | Materials | $5,000 | |
| OWEB | 215-1004-11304 | $84,440.71 | | $0.00 | |
| Plum Creek Timber | | $0.00 | Volunteers | $2,400 | |
| Plum Creek Timber | | $0.00 | Materials | $11,000 | |
| Plum Creek Timber | | $0.00 | Volunteers | $10,000 | |
| | | | | | |
| *Totals* | | | | | |
| OWEB | Non OWEB Cash | Inkind | Non OWEB Amount | OWEB Match | Total Project Cost |
| $84,440.71 | $0.00 | $34,400 | $34,400 | 41.00% | $118,840.71 |

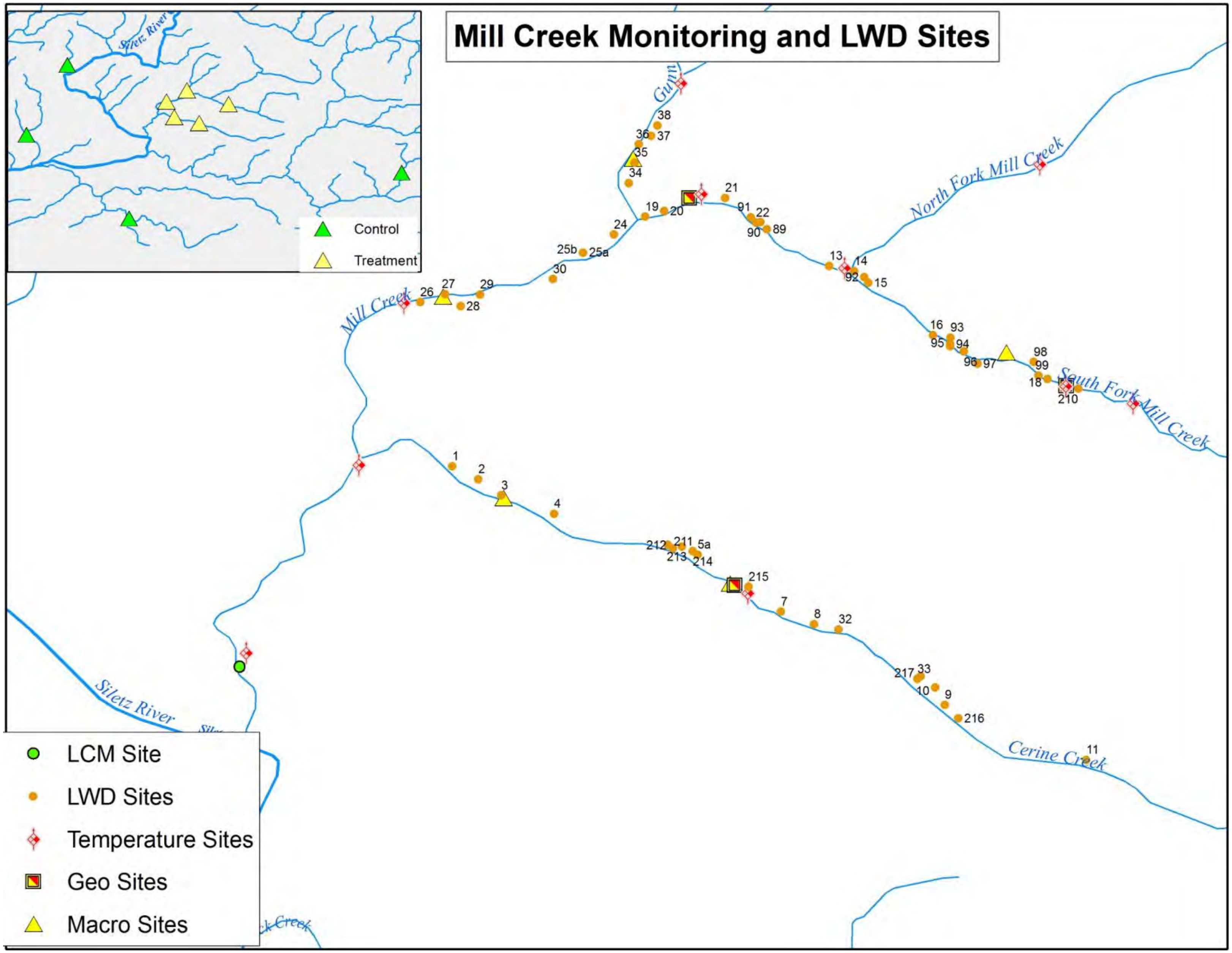
## Effectiveness Montioring Budget

| *Monitoring (215-1031-11635) OWEB Grant* | | | |
|---|---|---|---|
| Source | OWEB Funds | Inkind | Total |
| Salaries, Wages and Benefits | $30,816 | | $30,816 |
| Contracted Services | | $67,400 | $67,400 |
| ODFW-LCM Program | | $2,590,000 | $2,590,000 |
| ODFW-Corvallis Research AQI Program | | $104,332 | $104,332 |
| Aquatic Macroinvertebrate Monitoring | $49,060 | $33,233 | $33,233 |
| Geomorphic Response Monitoring | $17,830 | $8,000 | $25,830 |
| Travel | $2,688 | | $2,688 |
| Materials/Supplies | $7,150 | $18,350 | $25,500 |
| Equipment/Software | | $5,000 | $5,000 |
| Other | $2,200 | | $2,200 |
| Grant Admin | $16,087 | | $16,087 |
| **Grand Total** | **$125,831** | **$2,826,315** | **$2,952,146** |

This total includes life cycle monitoring across 7 sites over 7 years, not only at the Mill Creek site


Mill Creek LWD Sites
Gunn Creek
North Fork Mill Creek
Mill Creek
South Fork Mill Creek
Cerine Creek
38
36
37
35
34
21
19
20
91
22
90
89
24
25b
25a
13
14
92
15
30
26
27
28
29
16
93
95
94
96
97
98
99
18
210
1
2
3
4
211
212
5b
213
214
215
7
8
32
217
33
10
9
216
11
LWD Sites
Geo Sites


Mill Creek Monitoring Sites
Siletz River
Control
Treatment
Gunn Creek
North Fork Mill Creek
Mill Creek
South Fork Mill Creek
Cerine Creek
Siletz River
Siletz River
LCM Site
Temperature Sites
Geo Sites
Macro Sites


Mill Creek Monitoring and LWD Sites
Control
Treatment
Siletz River
Mill Creek
North Fork Mill Creek
South Fork Mill Creek
Cerine Creek
LCM Site
LWD Sites
Temperature Sites
Geo Sites
Macro Sites

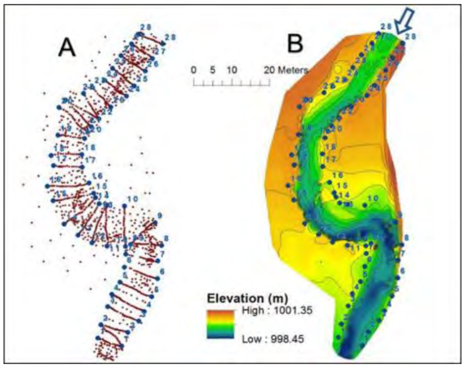
# EM1 –Geomorphic Response

### Background

The geomorphic character of river systems in northwestern coastal watersheds is heavily controlled by the interaction of the stream channel with the floodplain. Under natural conditions and adequate sediment supply this interaction allows river systems to recruit wood and develop forced-pool-riffle morphologies in reaches that otherwise would exhibit plane-bed characteristics. The level of complexity of these reaches is high and they are often associated with the best habitat for anadromous fish. Historic land-use practices have reduced wood supplies and simplified channels, reducing habitat complexity and contributing to declines in fish populations. Although wood additions are commonly used to restore fish habitat, the effects of these projects on channel morphology and the flow field (e.g. depth, velocity, and shear stress) are rarely documented at a high spatial and temporal resolution.

### Methods

Geomorphic observations and flow modeling in three study reaches located in Cerine Creek, South Fork Mill Creek and mainstem Mill Creek began in 2014. Surveys were conducted at 20-28 cross-sections per reach and detailed information on grain size distributions (i.e. pebble counts) were collected before and after wood placement occurred at these sites in 2015. The reaches were also instrumented with pressure transducers to collect depth information, which together with discharge measurements were used to build a rating curve (stage-discharge relation). Starting in 2016, seven additional geomorphology research sites were added to document changes in channel morphology following the main wood addition in 2016. These sites were sampled immediately after wood placement in summer 2016 and then again in summer 2017. Flow modeling at the original three geomorphology research sites was accomplished with the Nays2DH model based on detailed topographic measurements, discharge, water surface elevation at reach margins, and bed roughness. Changes in velocity and shear stress triggered by the addition of LW in the three study reaches during a bank full flow event were evaluated with emphasis on the peak discharge. Then we quantified the differences in the spatial extent of suitable habitat for juvenile Coho Salmon based on published critical and burst swimming velocities. At the additional seven sites added in 2016, detailed topographic surveys allowed for precise estimates of erosion and deposition upstream and downstream from the placed wood, along with adjacent floodplains.




### Preliminary Results

Flow modeling results from geomorphic research sites showed that the wood placement significantly increased habitat area at bankfull flow while creating more slow water habitat and increasing stream bed stability. Ongoing research will help scale up these results to better understand watershed level effects.

**Geomorphic Change- Amelia Yeager and Catalina Segura- Oregon State University Water Resources Engineering Program and Forest Engineering, Resources & Management Department**

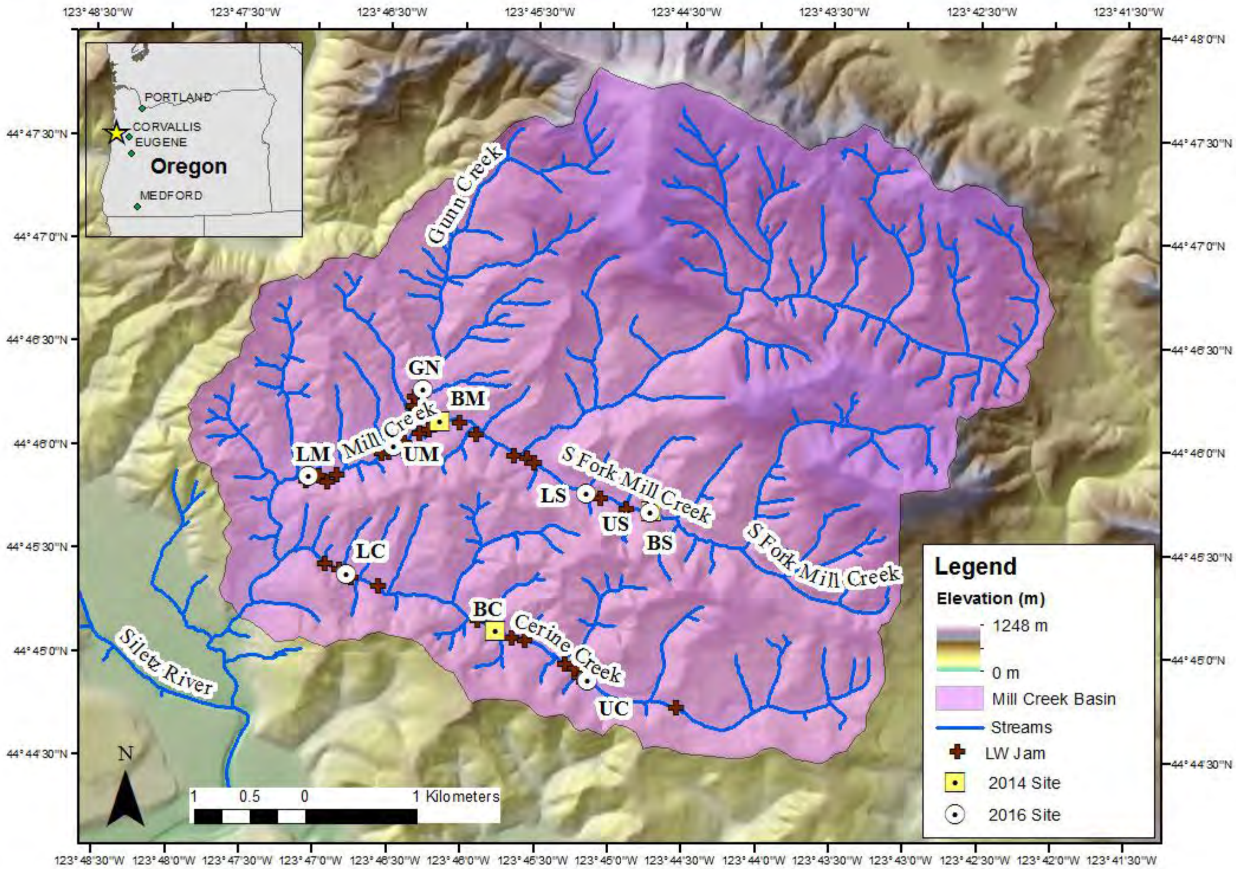



*Figure A1. Overview of Mill Creek basin.*
*Map includes LW addition locations, study sites (denoted in the legend as "2016 sites"), and Bair (2016) sites (denoted in the legend as "2014 sites"). Site codes are as follows: LM = Lower Mainstem, UM = Upper Mainstem, BM = Bair Mainstem, GN = Gunn Creek, LS = Lower South Fork, US = Upper South Fork, BS = Bair South Fork, LC = Lower Cerine, BC = Bair Cerine, UC = Upper Cerine. BS and US are located immediately adjacent to one another so they are represented by a single symbol on the map.*

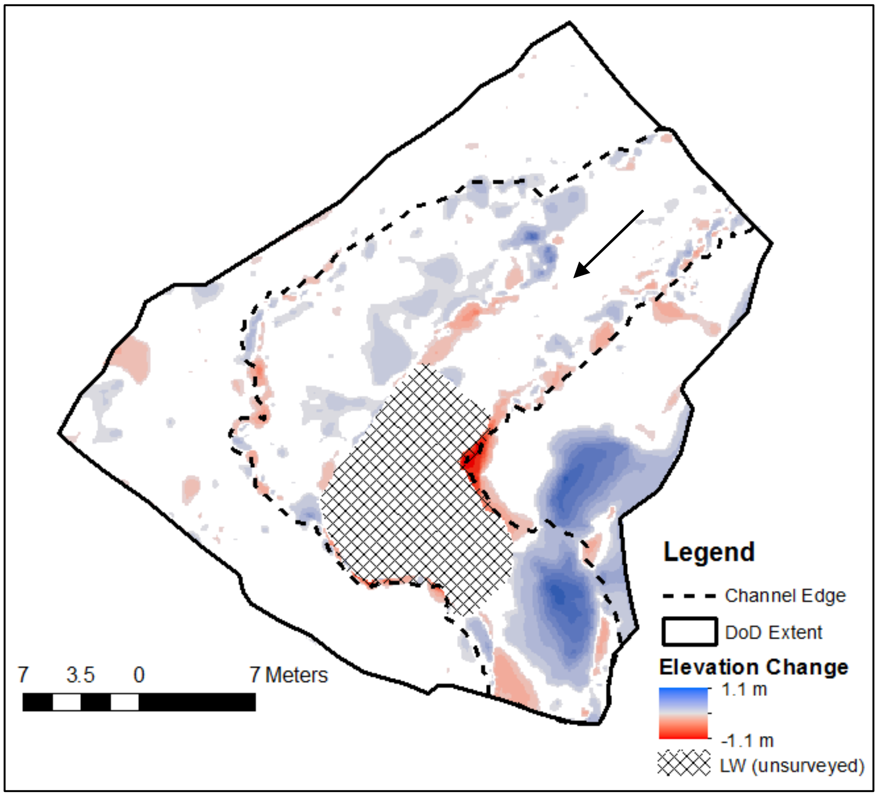



*Figure A2. Lower Cerine (LC)*

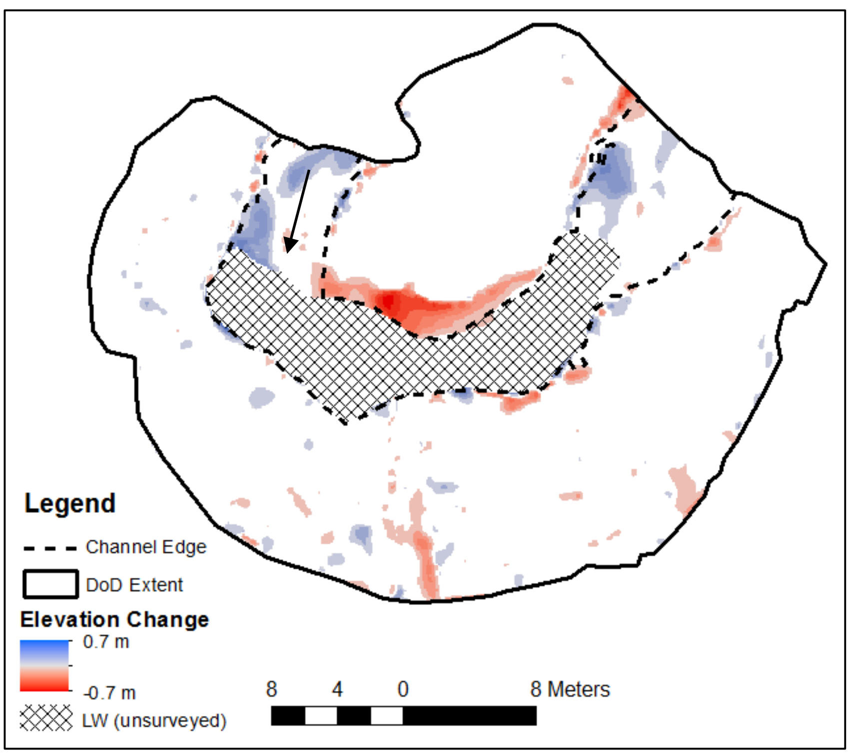



*Figure A3. Upper Cerine (UC)*

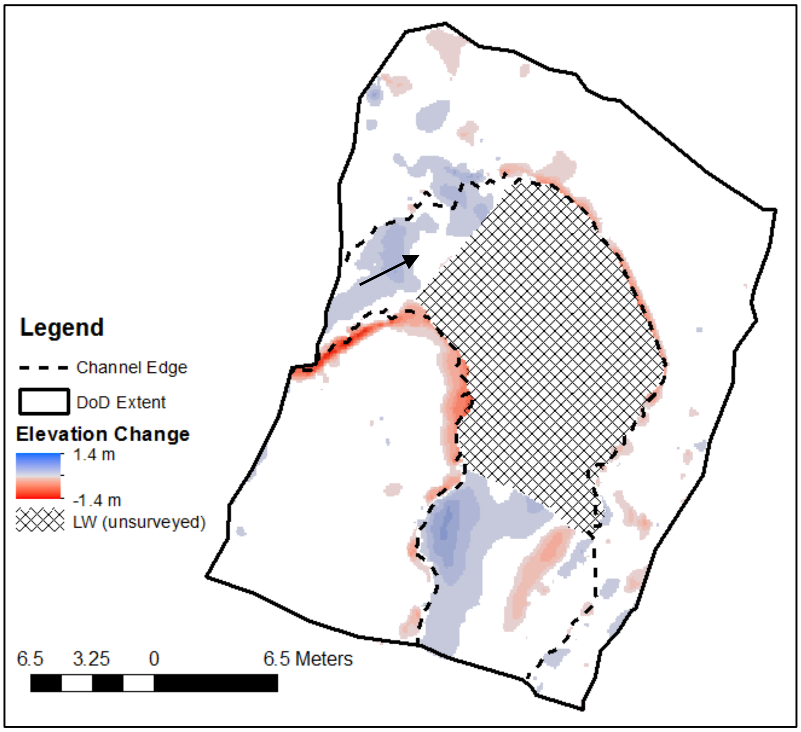



*Figure A4. Lower South Fork (LS)*

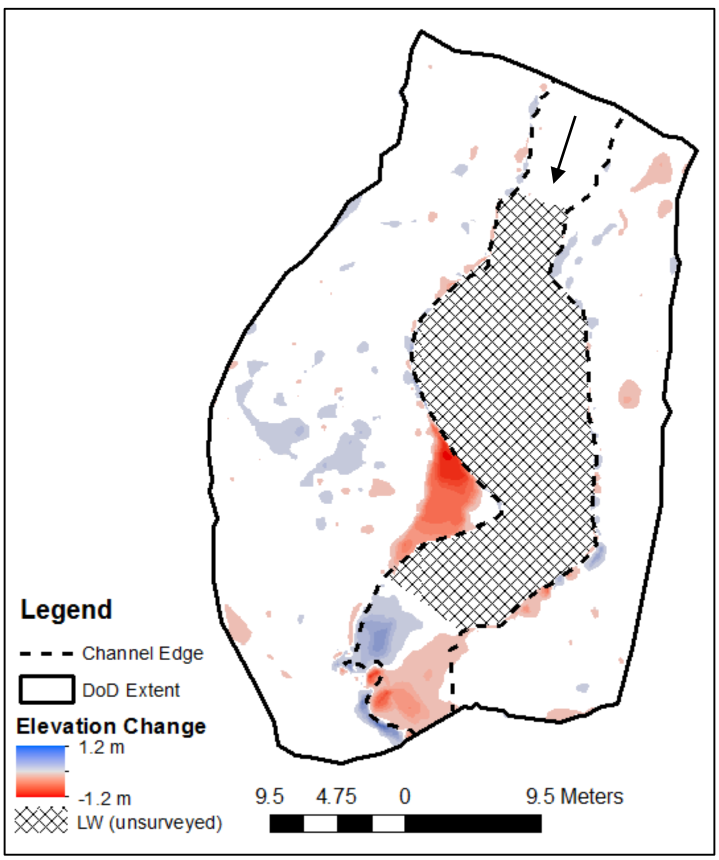



*Figure A5. Upper South Fork (US)*

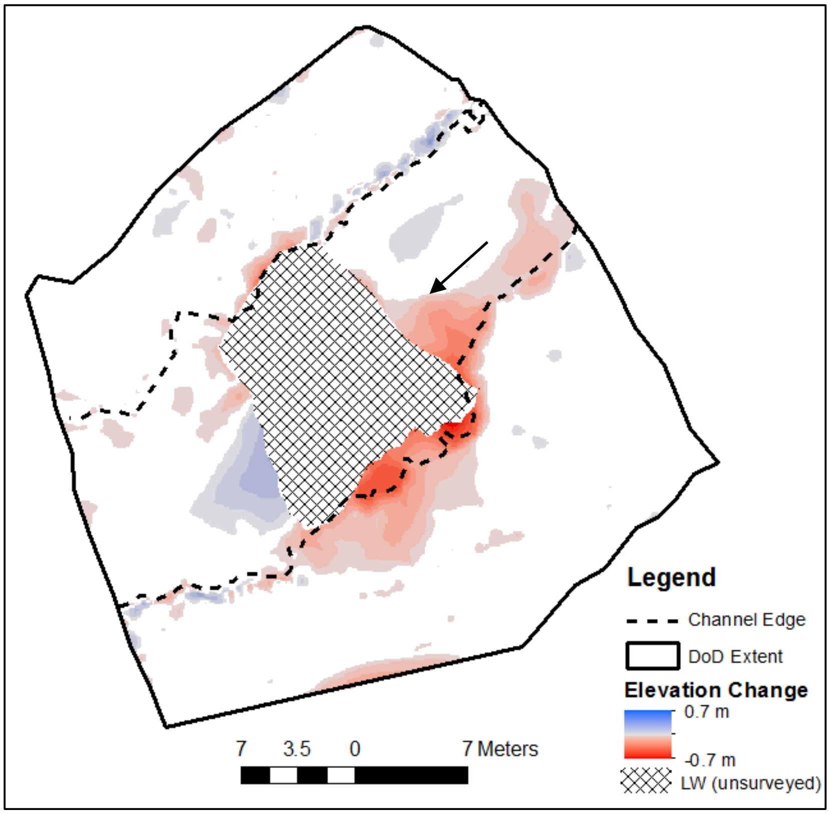



*Figure A6. Upper Mainstem (UM)*

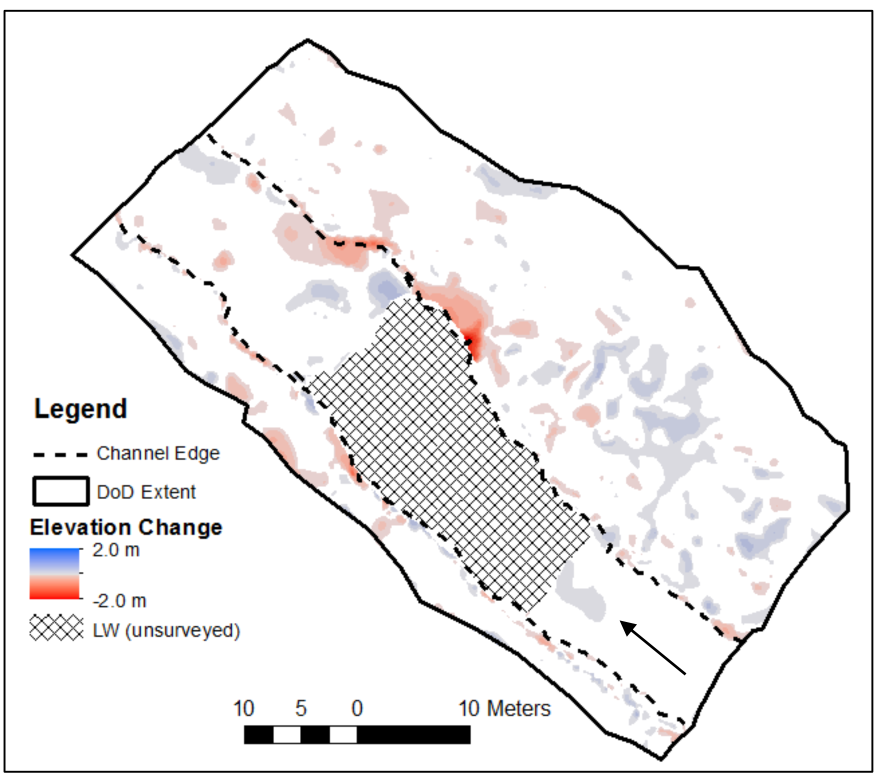



*Figure A7. Lower Mainstem (LM)*

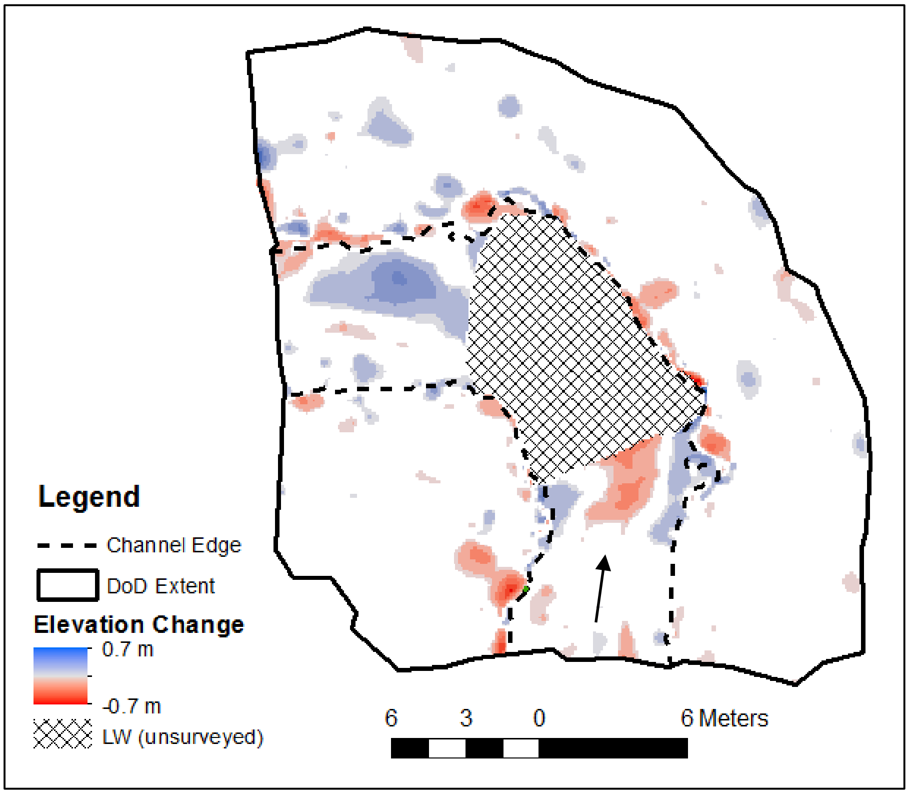
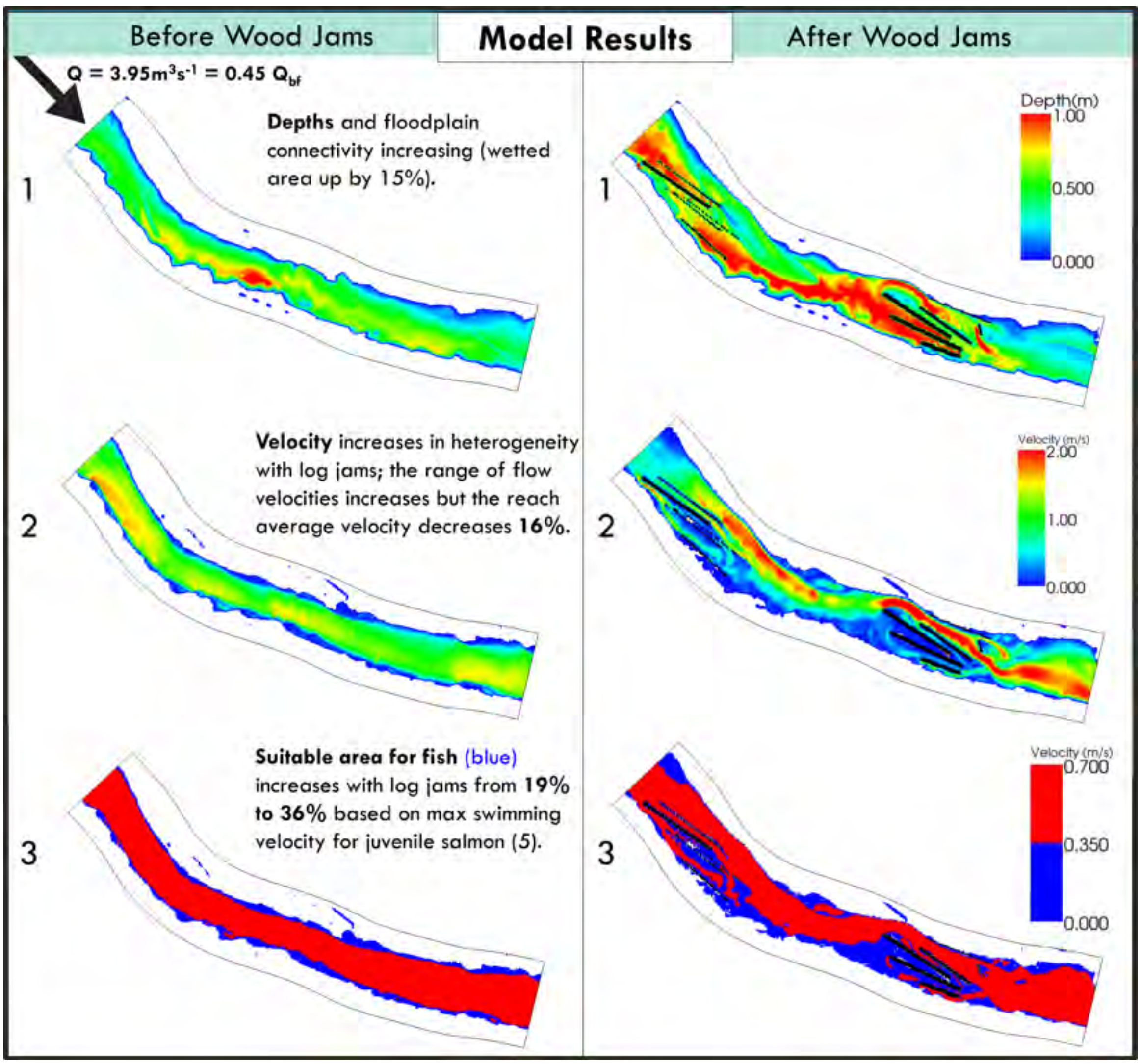


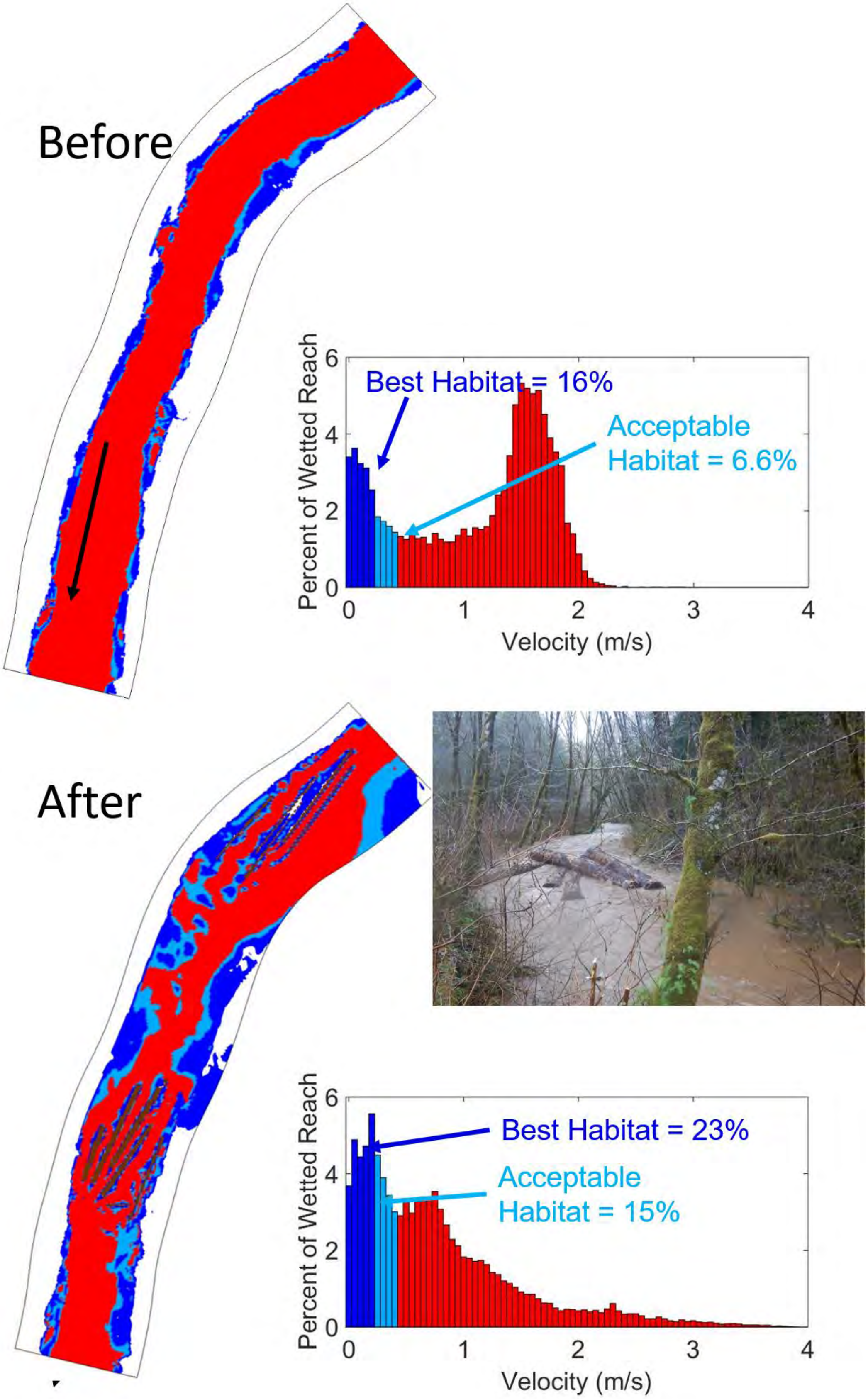

*Figure A8. Gunn Creek (GN)*

**Modeling the Effect of Geomorphic Change Triggered by Large Wood Addition on Salmon Habitat in a Forested Coastal Watershed**

Russell Bair; Catalina Segura- *OSU Water Resources Graduate Program and OSU Forest Engineering, Resources, & Management Department* and Christopher Lorion- *Oregon Department of Fish & Wildlife*

This project aims to quantify the effect that large wood jam introductions have on habitat availability for coho salmon. Flow modeling is used to generate high-resolution data that is otherwise unfeasible from field observations. We worked at the reach scale (100m-120m), which we believe is the smallest possible to consider habitat distribution changes transferable to the basin scale. Large wood addition to streams improves fish habitat at different scales: it alters geomorphic character of reaches over time leading to beneficial changes in habitat quantity and quality and adds complexity within reaches creating suitable habitat during high winter flows for juvenile salmon.




Before
Best Habitat = 16%
Acceptable
Habitat = 6.6%
Percent of Wetted Reach
Velocity (m/s)
0
2
4
6
0
1
2
3
4
After
Best Habitat = 23%
Acceptable
Habitat = 15%
Percent of Wetted Reach
Velocity (m/s)
0
2
4
6
0
1
2
3
4

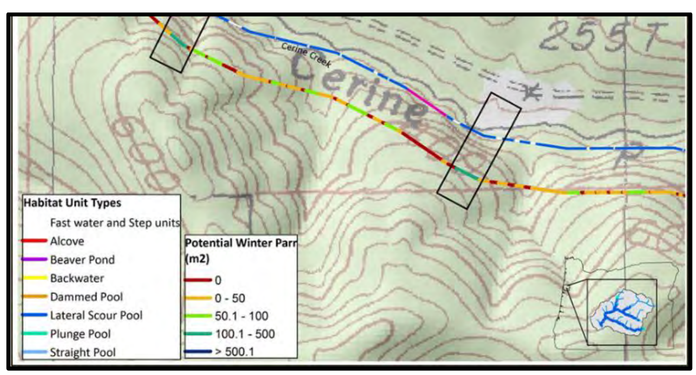
## EM2 – Winter Rearing Habitat

### Background

There is seasonal variability in Coho Salmon habitat use, and in winter juvenile Coho Salmon parr are most abundant in alcoves, beaver ponds, off channel habitats, and complex pools that provide refuge from high winter flows. Habitat surveys conducted by ODFW throughout the coast range have found high quality winter habitats and instream complexity to be limiting and in low proportions relative to total available habitat. Therefore, the production of Coho Salmon smolts in most streams is thought to be limited by the availability of suitable winter habitats for parr. The large wood addition in Mill Creek is expected to significantly increase the quantity and quality of winter rearing habitat available to juvenile Coho Salmon and other salmonids.

### Methods

To evaluate the effects of large wood placement on winter rearing habitat, full-basin winter habitat surveys are being conducted in Mill Creek using ODFW Aquatic Inventories Project protocols before and after the large wood placement. These surveys census all stream habitat in the basin within the distribution of anadromous fish (approximately 15 miles), and are typically conducted between February and April. A single pre-treatment habitat survey was conducted in 2015 before the large wood addition to characterize baseline habitat conditions and large wood abundance. Two post-treatment basin surveys are planned and the first was completed in February-May 2017 following the wood placement in summer 2016. A second post-treatment survey is planned for 2022 to assess stream habitat after the wood interacts with the channel for a longer period and experiences multiple high flow events. To evaluate the effects of the wood addition on winter rearing habitat in Mill Creek, habitat metrics from pre- and post-treatment habitat surveys will be compared to trends at randomly selected AQI surveys in similar mid-coast streams that did not undergo any habitat restoration during the project timeframe. Paired t-tests will be used to assess the change in pools, channel complexity, and substrate at Mill Creek compared to the control sites. In addition, ODFW's Habitat Limiting Factors Model (HLFM) will be used to estimate carrying capacity for juvenile Coho Salmon based on pre- and post-treatment winter habitat surveys. Comparisons between potential smolt capacity and empirical smolt abundance (see EM5 – Coho Smolt Production) will provide a quantitative link between observed habitat changes and Coho Salmon production.




### Preliminary Results

The 2015 basin survey provided valuable baseline data and was useful for the selection of wood placement sites. Completion of the 2022 survey will be key to evaluating project effects on habitat at the basin scale and comparing post-treatment HLFM results to observed Coho Salmon smolt abundance.

## EM3 – Benthic Macroinvertebrate Response

### Background

Watershed restoration is often focused on restoring physical habitat, with less attention placed on how these changes affect benthic macroinvertebrate communities that support fish production and other important ecosystem processes. Physical changes in inorganic sediments, hydraulics, and organic matter retention as a result of the wood placement will likely change habitat diversity and food availability for invertebrates, potentially increasing their diversity and abundance. This could in turn affect the potential instream energy available to fish. Additionally, benthic invertebrate taxa are useful indicators of habitat conditions and invertebrate metrics are used by the Oregon Department of Environmental Quality (ODEQ) 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.

### Methods

Benthic macroinvertebrate sampling is conducted in early summer at four randomly selected sites in the Mill Creek watershed, four paired control sites in nearby streams within the Siletz watershed, and one of the Mill Creek geomorphic research sites discussed in EM1. The random Mill Creek sampling sites are located in the downstream half of the reaches where large wood was placed in Gunn Creek, South Fork Mill Creek, Cerine Creek and mainstem Mill Creek. At all sites, benthic macroinvertebrates are collected from riffle habitats in a reach 40 times the wetted channel width. Eight paired Surber samples are collected at each site and composited, with one set of samples used for determination of invertebrate biomass and the other preserved for macroinvertebrate identification. Field sampling is coordinated by ODEQ staff with some assistance from ODFW, while laboratory work is conducted at Oregon State University's Stream Lab. Macroinvertebrate sampling will occur at treatment sites and paired controls on a total of four occasions, including once in 2015 before the wood is added and three times during the post-treatment period in 2017, 2019, and 2022. Potential changes in benthic macroinvertebrate assemblages following the wood placement will be assessed with ordination techniques and various metrics including diversity, biomass, and density. ODEQ's Fine Sediment Stressor ID model can also be used to evaluate potential shifts in sediment tolerance in macroinvertebrate assemblages.


### Preliminary Results

Pre-treatment sampling in 2015 indicated no significant difference in benthic macroinvertebrate biomass or taxa richness between treatment and control sites, although density was significantly higher in the Mill Creek sites compared to controls. Post-treatment sampling in 2017 indicated no immediate effect of the wood placement on benthic macroinvertebrates, but sampling planned for 2019 and 2022 will give more insight into the macroinvertebrate response as the wood has more time to interact with the stream.

## EM4 - Overwinter Survival

### Background

Survival of juvenile Coho Salmon during the winter they spend in freshwater has long been of interest due to the high mortality that can occur during this period and the strong influence of overwinter survival on smolt production. In Oregon coastal streams, where the availability of appropriate overwintering habitat is often a limiting factor for Coho Salmon smolt production, large wood additions have been shown to significantly increase the overwinter survival rate of juvenile Coho Salmon. By increasing the quantity and complexity of winter rearing habitat in Mill Creek, we expect to increase the percentage of juvenile Coho Salmon that survive through the winter and out-migrate as smolts in the spring.

### Methods

Overwinter survival in the Mill Creek basin is 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 are collected in randomly selected reaches throughout the basin using seines and backpack electrofishing equipment. All juvenile Coho Salmon captured are measured, weighed and then either implanted with a 12.5-mm passive integrated transponder (PIT) tag or marked with a visible implant elastomer (VIE) tag in the dorsal fin, depending on their size. Subsequently, all Coho Salmon smolts captured during the spring trapping season are scanned for PIT tags and examined to determine if a VIE tag is present. The total number of tagged smolt out-migrants is estimated based on the number of tag recoveries and smolt trap efficiency, and then divided by the number of fish tagged in the fall to calculate overwinter survival. Overwinter survival estimates were made at Mill Creek for five years before the wood addition, and will be made for another six years after the wood addition. These estimates will be compared with a control site in the Alsea River basin in a Before-After-Control-Impact (BACI) design.

### Preliminary Results

In the five years of monitoring before the wood addition, the average overwinter survival rate for juvenile Coho Salmon was 28% at both Mill Creek and the control site. In both years since the wood addition, overwinter survival has increased to around 41% at Mill Creek, while estimates at the control site have ranged from 25-37%. Additional monitoring over the next four years will help us evaluate the significance of the short-term increase in survival we’ve observed.

## EM5 - Coho Salmon Smolt Abundance

### 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 projects on juvenile salmonid populations. Studies based on local, reach-scale abundance have often observed a significant increase following the addition of wood or other in-stream structures, but studies focused on smolt out-migrants from treated watersheds have had mixed results. High variability in salmonid populations can make it difficult to document significant responses to restoration, and many years of monitoring may be required depending on the effect size of the restoration work. At Mill Creek, 20 years of pre-treatment data had been collected by the time the wood addition occurred, providing a strong baseline for a rigorous evaluation of restoration effects.

### Methods

Monitoring of Coho Salmon smolts and other salmonid out-migrants is conducted at Mill Creek and four control sites using standard ODFW Salmonid Life Cycle Monitoring Project methods. The control sites are Mill Creek (Yaquina basin), Lobster Creek (Alsea basin), Cascade Creek (Alsea basin), and Tenmile Creek (direct ocean tributary near Yachats). Habitat conditions vary considerably among these sites, but all experience similar trends in precipitation, temperature, and adult coho salmon abundance as the Mill Creek (Siletz) site where the wood addition occurred. At each of the monitoring sites, salmonid out-migrants are captured using either a five foot rotary screw trap or a 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 early to mid-June. Population estimates for Coho Salmon smolts and other salmonid out-migrants are made by marking up to 25 smolts per day and releasing them upstream from the trap. Weekly recapture totals are summed to estimate trap efficiency and total migrant abundance. A Before-After-Control-Impact (BACI) design will be used to test for changes in Coho Salmon smolt production in Mill Creek following the addition of large wood.

### Preliminary Results

In the 10 years prior to the wood addition, Mill Creek produced an average of 14,200 Coho Salmon smolts per year. In 2017, the first year after the wood placement, the Coho Salmon smolt estimate was 18,229 fish, the third highest estimate observed since monitoring began in 1997. The 2018 monitoring season just ended with a preliminary estimate of 18,779 smolts at Mill Creek. Additional data collection over the next four years and comparisons with the control sites will help us evaluate the effects of the wood addition on Coho Salmon smolt production in Mill Creek.

## Unmanned Aerial Vehicle (UAV) Images of LWD Placement Sites Summary

This project followed standard Oregon Watershed Enhancement Board (OWEB) protocols using on the ground photo points to monitor project elements before and after implementation. Before and after photos were taken at each of the LWD placement sites, and six sites were selected for long term photo monitoring. In addition to these on the ground photos, this project utilized Unmanned Aerial Vehicles (UAVs), also known as drones, to collect photos of each LWD placement site. This set of aerial photos provides a superior overview of the placement sites compared to on the ground photos, and will allow the research team to closely monitor how large wood is shifting at each site, as well as document changes in stream morphology visually.

Most placement sites were flown in winter 2016 prior to implementation in summer 2016. Flights were completed in winter because the sites are more visible from the air when deciduous trees do not have leaves. Due to poor weather in winter 2017, photos from only a few sites were collected. Most sites were visited again in winter 2018 to collect photos. This portion of the work is led by Erik Suring, from ODFW's Salmonid Life Cycle Monitoring program. UAV flights to monitor the LWD sites will continue annually as funding and staff time permit.

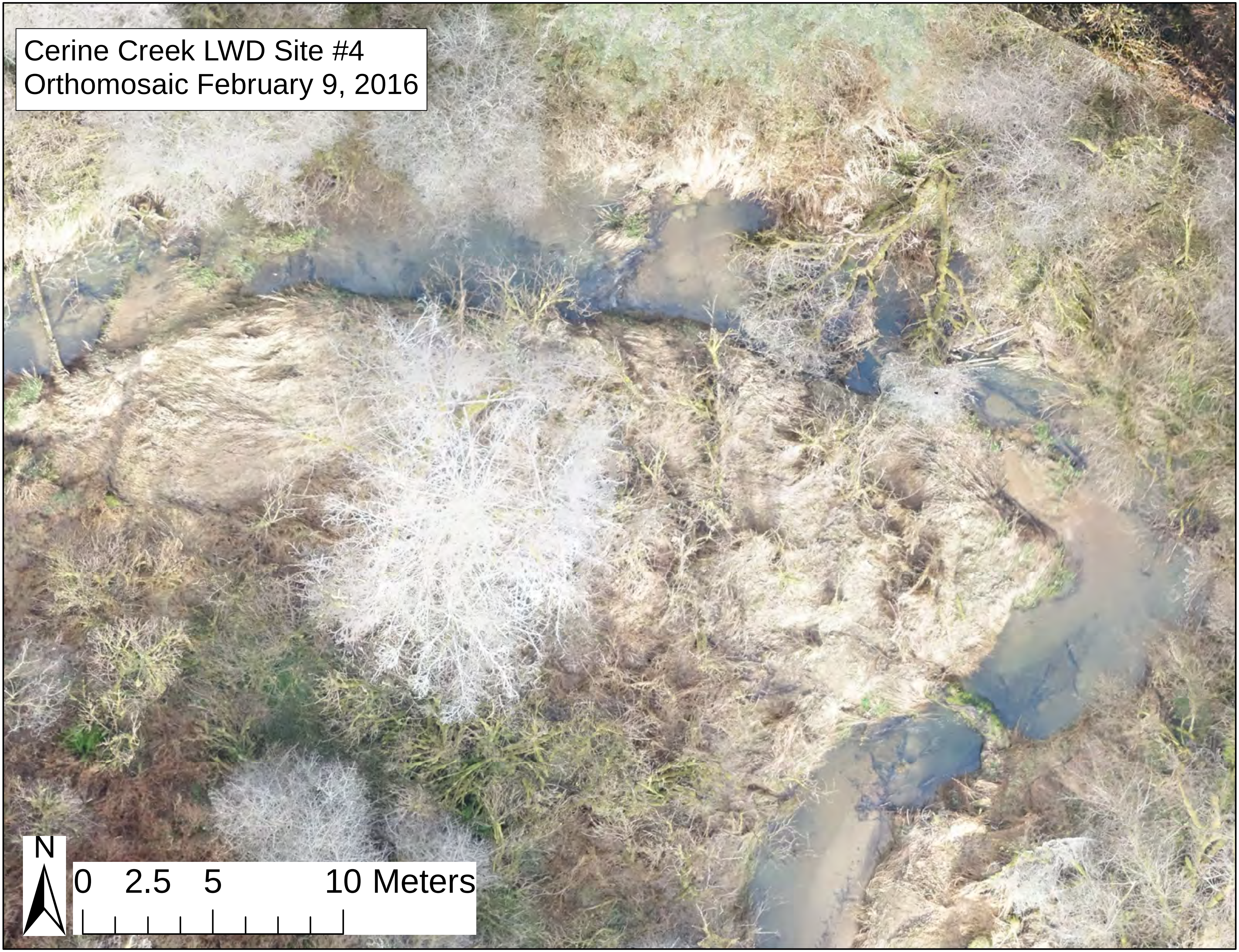
Due to road construction, we will not be able to visit any sites on Cerine Creek or the South Fork of Mill Creek. However, the following set of aerial photos provide a great overview of a few of these sites. The following pages show orthorectified aerial photos for these LWD sites:

- Cerine Creek LWD Site #3 (2016)
- Cerine Creek LWD Site #3 (2018)
- Cerine Creek LWD Site #3 (2022)
- Cerine Creek LWD Site #4 (2016)
- Cerine Creek LWD Site #4 (2018)
- Cerine Creek LWD Site #4 (2022)
- Cerine Creek LWD Site #11 (2016)
- Cerine Creek LWD Site #11 (2018)
- Cerine Creek LWD Site #11 (2022)
- Mainstem Mill Creek LWD Site #29 (2018)
- Mainstem Mill Creek LWD Site #29 (2022)
- South Fork Mill Creek LWD Site #16 (2016)
- South Fork Mill Creek LWD Site #16 (2017)
- South Fork Mill Creek LWD Site #16 (2018)
- South Fork Mill Creek LWD Site #16 (2022)
- South Fork Mill Creek LWD Site #18 (2016)
- South Fork Mill Creek LWD Site #18 (2017)
- South Fork Mill Creek LWD Site #18 (2018)
- South Fork Mill Creek LWD Site #18 (2022)

Cerine Creek LWD Site #3
Orthomosaic February 9, 2016
0 2.5 5 10 Meters
N


Cerine Creek LWD Site #3
Orthomosaic March 20, 2018
0 2.5 5 10 Meters
N


Cerine LWD Site #03
Orthomosaic January 21, 2022
N
0 2.5 5 10 Meters



Cerine Creek LWD Site #4
Orthomosaic February 9, 2016
N
0 2.5 5 10 Meters

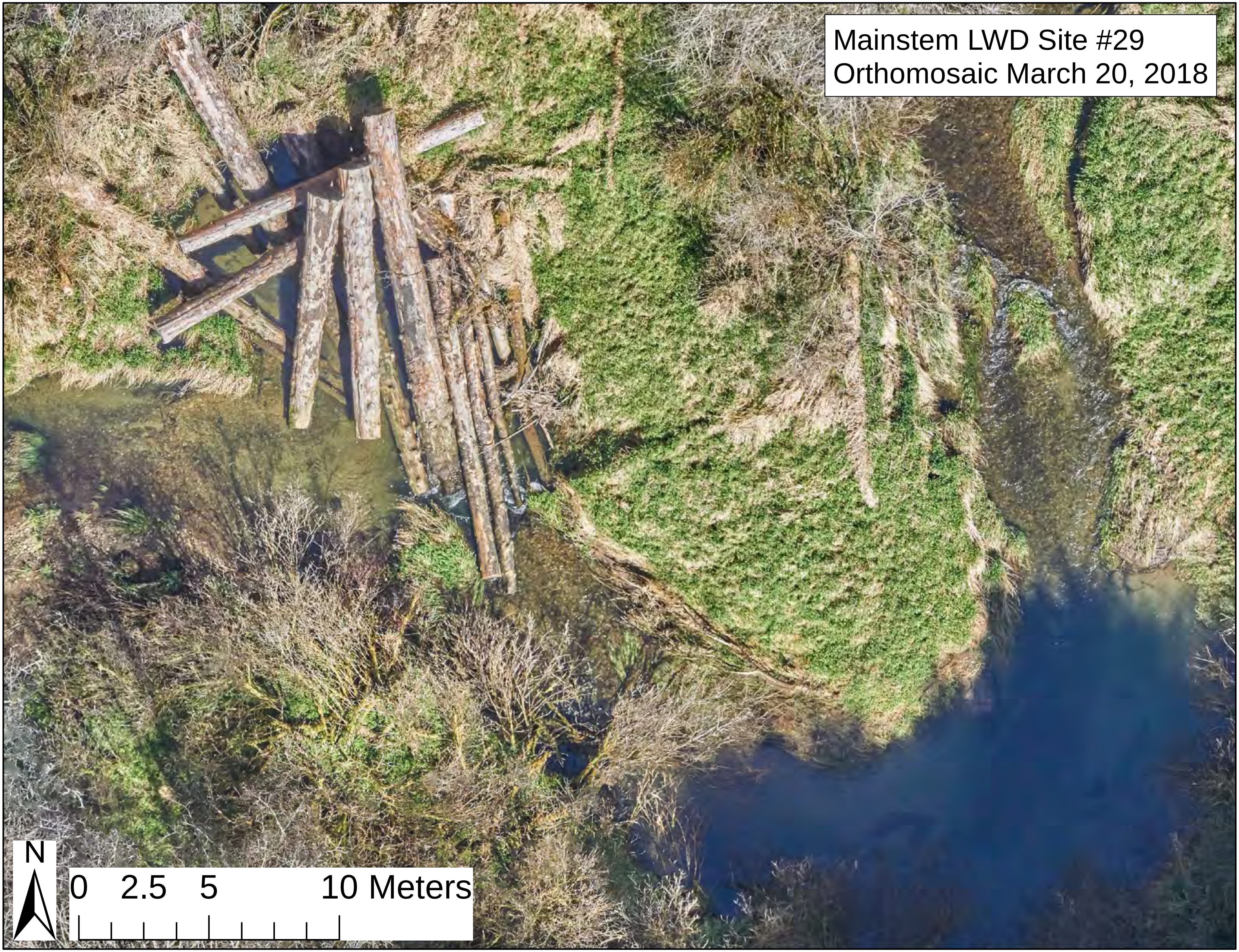
Cerine Creek LWD Site #4
Orthomosaic February 13, 2018
N
0 2.5 5 10 Meters

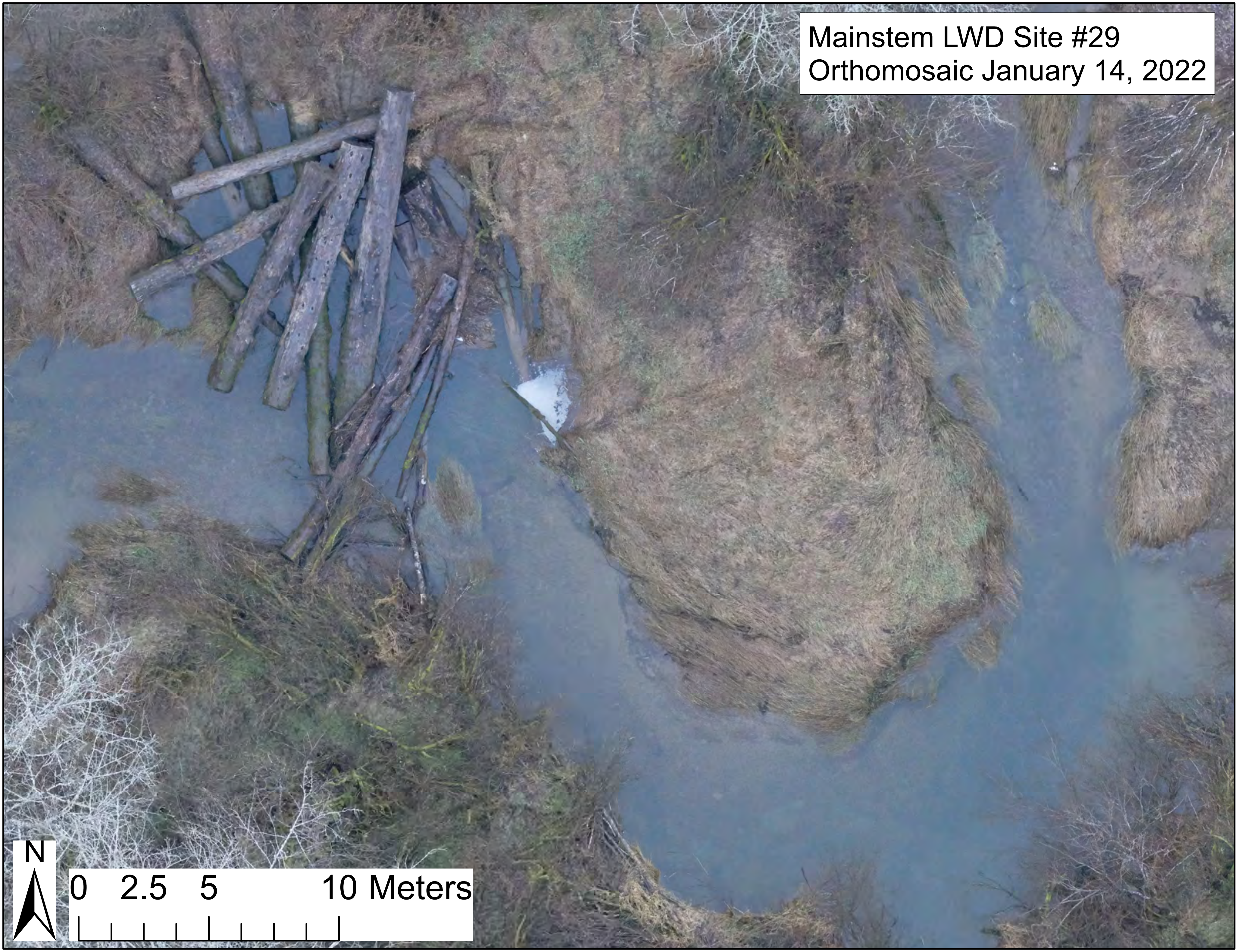

Cerine LWD Site #04
Orthomosaic January 21, 2022
N
0 2.5 5 10 Meters

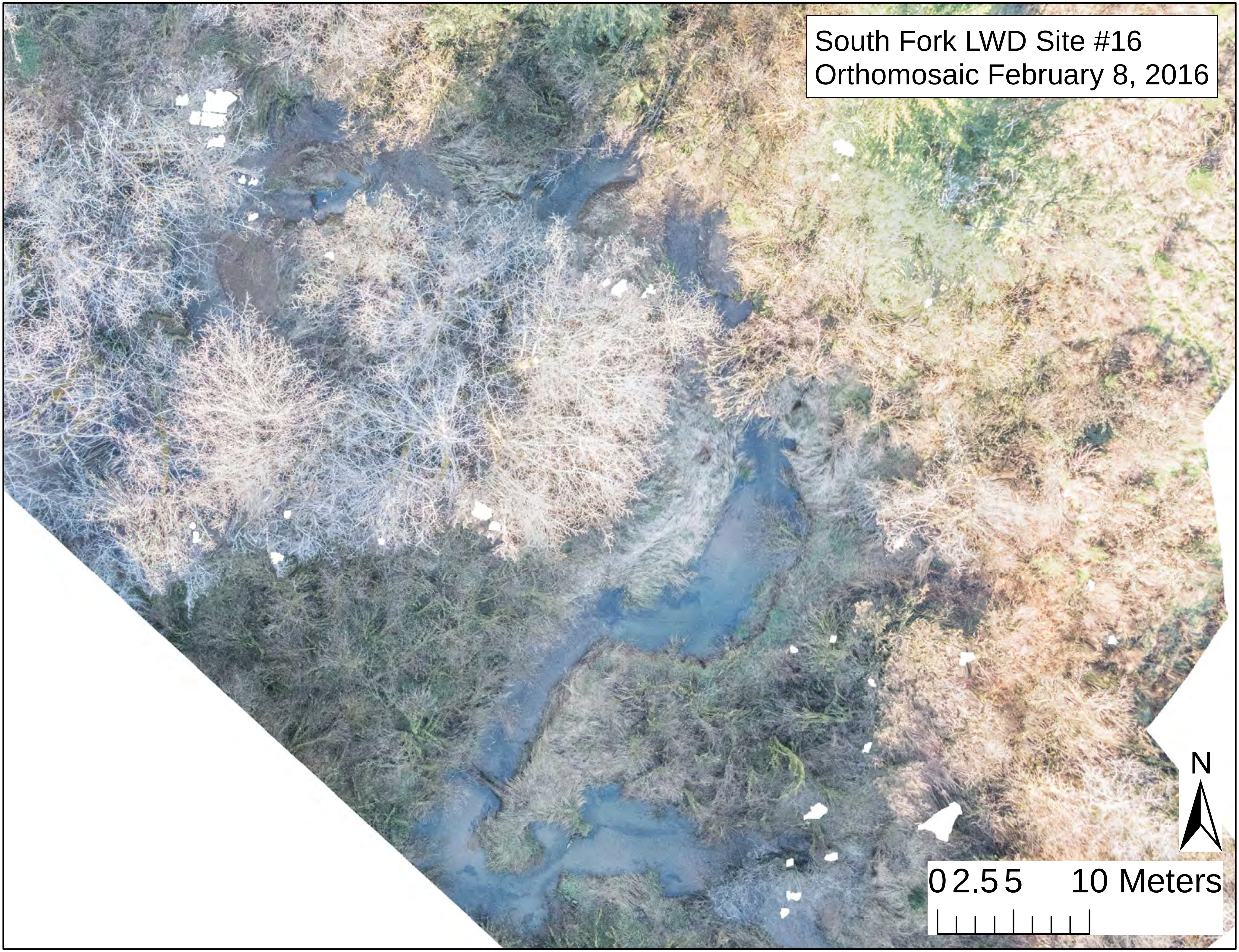

Cerine LWD Site #11
Orthomosaic February 9, 2016
N
0 2.5 5 10 Meters


Cerine LWD Site #11
Orthomosaic February 13, 2018
N
0 2.5 5 10 Meters

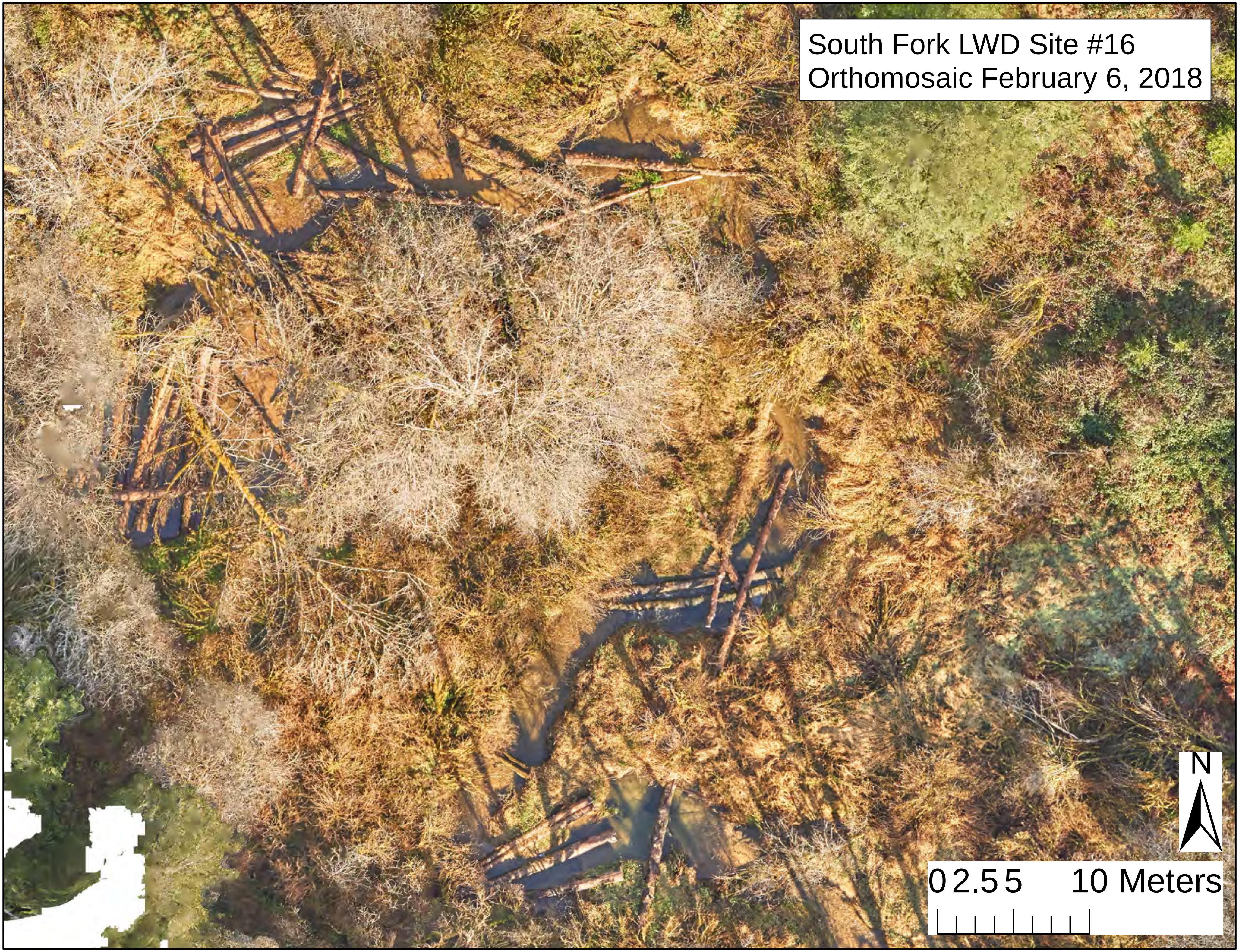

Cerine LWD Site #11
Orthomosaic January 21, 2022
N
0 2.5 5 10 Meters


Mainstem LWD Site #29
Orthomosaic March 20, 2018
N
0 2.5 5 10 Meters

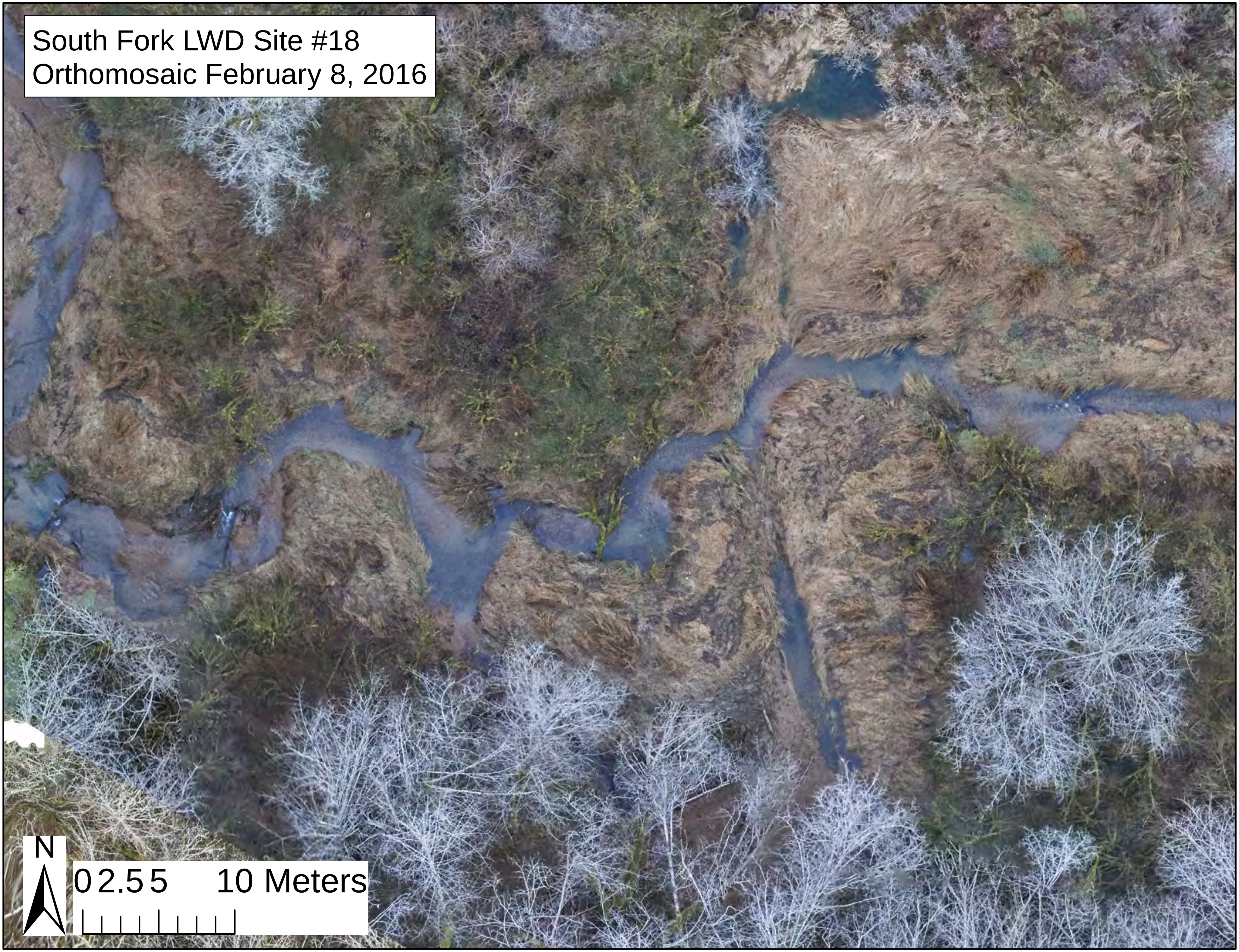

Mainstem LWD Site #29
Orthomosaic January 14, 2022
N
0 2.5 5 10 Meters


South Fork LWD Site #16
Orthomosaic February 8, 2016
N
0 2.5 5 10 Meters

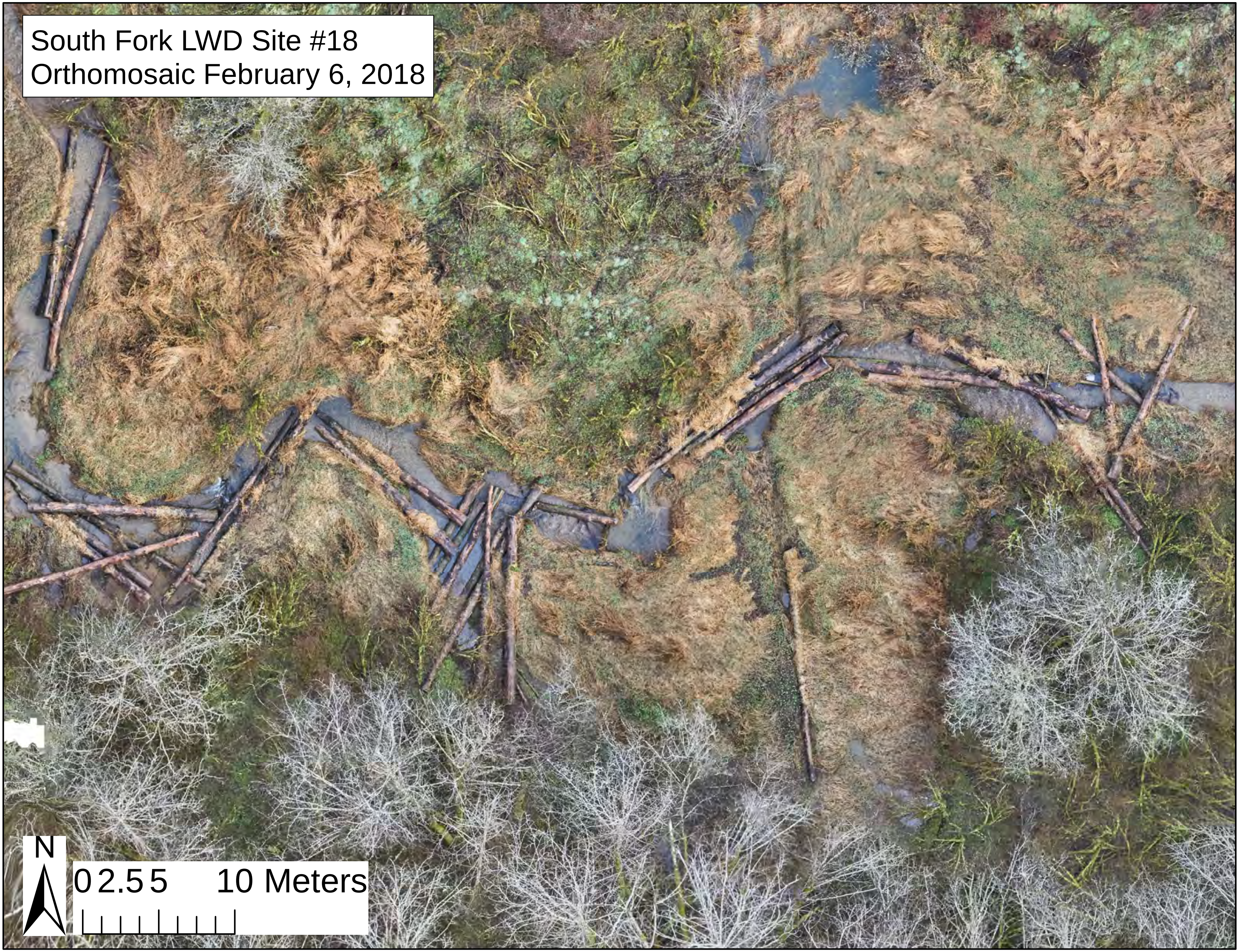

South Fork LWD Site #16
Orthomosaic January 24, 2017
N
0 2.5 5 10 Meters


South Fork LWD Site #16
Orthomosaic February 6, 2018
N
0 2.5 5 10 Meters


South Fork LWD Site #16
Orthomosaic January 14, 2022
N
0 2.5 5 10 Meters


South Fork LWD Site #18
Orthomosaic February 8, 2016
N
0 2.5 5 10 Meters


South Fork LWD Site #18
Orthomosaic January 24, 2017
N
0 2.5 5 10 Meters


South Fork LWD Site #18
Orthomosaic February 6, 2018
N
0 2.5 5 10 Meters


South Fork LWD Site #18
Orthomosaic January 14, 2022
N
0 2.5 5 10 Meters