PROJECT INFORMATION			
Project name:	Clackamas Wetland Habitat Restoration Phase 1		
Project start and end dates (Month/Year):	March 2020 - October 2021		
Primary point of contact & contact info:	Michael Krochta, 503-331-0374, michael@bark-out.org		
DWPP grant award ($):	$28,398	**Total project cost ($):**	$40,675
PROJECT PARTNERS			
Lead organization:	Bark		
Drinking water system(s):	Clackamas River Basin, PWS ID #4100580		
Other project partners:	Institute for Natural Resources (INR) at Portland State University, U.S. Forest Service, Clackamas River Water Providers		
PROJECT LOCATION			
State:	Oregon	**County:**	Clackamas
U.S. congressional district:	OR 5	**State congressional district:**	District 9
River or waterbody:	Oak Grove Fork Clackamas River (HUC 1709001103), Middle Fork Clackamas River (HUC 1709001104)	**Lat/long:**	Approx. 45.080259, -122.043719
PROJECT METRICS			
# of acres improved:	N/A	**# of stream miles improved:**	N/A
Aquatic species benefitted:	Upper Willamette River Chinook, Lower Columbia River Coho, LCR Steelhead	**Names of other species benefitted:**	American beaver, Rough-skinned newt, Red-legged frog, Northwestern salamander, Willow Flycatcher, Yellow Warbler, Olive-sided Flycatcher, Sandhill Crane, Common Yellow-throat
Other ecological benefit(s), please name:	Future benefits of this project include erosion mitigation, trapping of sediment, floodplain re-connectivity, and improved stream temperature.		
# of volunteers engaged:	95	**Other social or community benefit, please identify:**	Public education, improved resources/data for public agencies including USFS, ODFW
Jobs: if contractors were hired, did the firms come from within the same county? Yes or No	YES	**Jobs: if contractors were hired, did the firms come from within the same state? Yes or No**	YES

1. What problem did this project target and what were the results?

As detailed in our 2020 Drinking Water Providers Partnership (DWPP) application and 2020 interim report, the impacts of climate change on drinking water and fish habitat are prominent due to changes in higher elevation areas of the Clackamas River Basin where flows are currently influenced by winter snow accumulation. Specifically, anadromous fish in the Clackamas River basin will experience climate-induced habitat loss primarily as a result of late season low flows and high stream temperatures. Functioning wetlands and other beaver-maintained habitats are critical to the watershed's ability to mitigate these effects. However, there are less beavers than historically present in Mt. Hood National Forest (MTHNF), as evidenced by the low ratio of presently occupied habitat sites to previously occupied ones. Before this project, there was a lack of accurate wetland inventory data (e.g. presence, boundary/extent and type/classification), a lack of trained volunteers to help collect it, and an absence of data on wetland water storage for small palustrine wetlands in forested landscapes.

The Clackamas Wetlands Habitat Restoration Phase I project, in partnership with the Institute for Natural Resources at Portland State University, aimed to evaluate the capacity of wetlands to influence water quantity in the Clackamas River basin, and to use this information along with Bark's ongoing beaver habitat data collection efforts to design and implement high-impact aquatic restoration activities. The results of our 2021 efforts are summarized here:

- Photopoints established at 13 sites (for a total of 43 sites between 2020-2021);
- Beaver surveys completed at 10 new and previously surveyed sites (for a total of 23 sites between 2020-2021);
- Wetland verification surveys completed at 10 sites (for a total of 23 sites between 2020-2021);
- Twenty-one water table wells constructed (for a total of 27 between 2020-2021);
- Hydrological monitoring points/infrastructure (including wells, posts and/or manual measurement points) set up at 6 sites (for a total of 12 sites between 2020-2021, 5 sites of which were ultimately located within the perimeter of the Riverside Fire);
- Nineteen monitoring wells with data loggers, 2 measuring posts, and 17 manual measurement points (for repeat water level measurements) set up across 6 sites (for totals of 25 wells with data loggers, 7 monitoring posts, and 20 manual monitoring points established between 2020-2021);
- 117 water level measurements collected across all monitoring points in 2021;
- Approximately 400 willow cuttings transplanted by volunteers at the Sam Creek meadow site;
- 7 remote cameras installed within the Riverside fire burn area;
- Drone imagery taken at 7 sites;
- Approximately 65 volunteers trained in 2021, including 2 virtual trainings (recording available here) and 5 in-person field trainings;
- 35 field days completed, including 7 overnights by Bark and INR staff and volunteers;
- 20 hours of wetland mapping completed to date;
- Verification and update of geospatial beaver suitability analysis begun; and
- Outreach and education through Bark's email newsletters, social media, website, and events carried out.

In the course of completing the above activities, we noted more beaver activity (current and historic) at palustrine wetland sites rather than in riparian areas along stream or river channels. Often in the media, educational materials, or scientific investigations, beaver activity (including the presence of dams) is associated with flowing water bodies; however, these may not be the primary habitats used by beavers in

all landscapes (e.g. the forested slopes of Mt. Hood). In total, we documented historic beaver activity (i.e. old lodges or dams) at 58 sites; however only 14 of those had signs of active beaver use at the time of sampling, lending evidence to the notion that the current beaver population in MTHNF is smaller than historically. The data we collected on beaver activity were recently added to ODFW's Oregon Connectivity Assessment and Mapping Project (OCAMP).

This year, 2021, was largely dedicated to a) increasing volunteer capacity to contribute to our wetland mapping and classification efforts as well as our wetland monitoring activities, and b) establishing wetland hydrology and water quality monitoring infrastructure (e.g., water table monitoring wells and posts, upstream/downstream water quality monitoring points, etc). Regarding the latter, we launched data collection efforts at key sites summarized in Table 1 below. Following initial wetland verification surveys, sites were chosen based on their attributes, accessibility, and potential to be "paired" with another site in the watershed based on qualities including wetland type, size, elevation and hydrological influences (e.g., beaver dam presence, presence and size of channel(s), etc.). These intensively-studied wetlands will provide opportunities for cross-site comparisons of daily, seasonal and annual fluctuations in hydrology, and aid subsequent efforts to model wetland water storage capacity within the watershed. As several of these sites either remain inaccessible or have only been accessible relatively recently due to past and current wildfire-related closures, results will accumulate with time. Data retrieved from these sites will be analyzed and later summarized in a format useful to local and regional land managers and academic researchers.

Table 1. Summary of wetland sites selected for hydrological monitoring.

Site	HUC10	Within Riverside Fire	Acres	Elev. (ft)	Historic beaver score / Active beaver	Major wetland patch types[1]	Monitoring wells	Days of water level data to date[2]
LCL NW Dam1	Oak Grove Fork Clackamas R.	No	13.8	3300	10 / Yes	Aquatic bed, freshwater marsh, wet meadow, shrub swamp	3: groundwater, pond, outlet	73
LCL NW Dam2	Oak Grove Fork Clackamas R.	No	27.0	3300	10 / Yes	Aquatic bed, freshwater marsh, shrub swamp	3: groundwater, pond, outlet	19 - 74
Anvil Creek	Oak Grove Fork Clackamas R.	No	33.0	3500	10 / Yes	Aquatic bed, freshwater marsh, shrub swamp	3: groundwater, pond, outlet	102 - 115
Hideaway Lake North	Oak Grove Fork Clackamas R.	No	15.2	4000	5 / No	Aquatic bed, freshwater marsh, fen	2: groundwater, pond	88
Sam Creek	Oak Grove Fork Clackamas R.	No	5.6	2500	7 / No	Shrub swamp	3: groundwater, channel, outlet	19 - 87
Butte Creek	Oak Grove Fork Clackamas R.	No	7.1	2200	10 / No	Freshwater marsh, wet meadow, shrub swamp	2: groundwater, outlet	62
Pint Creek	Middle Fork Clackamas R.	Yes	19.1	2000	10 / No	Aquatic bed, freshwater marsh, shrub swamp	3: groundwater, pond, outlet	486
48_RD4621150	Middle Fork Clackamas R.	Yes	3.2	1560	10 / No	Aquatic bed, freshwater marsh	2: groundwater, pond	460
49_RD4621018	Middle Fork Clackamas R.	Yes	0.7	1560	10 / Yes	Aquatic bed, freshwater marsh	1: pond	458
51_RD4621000	Middle Fork Clackamas R.	Yes	4.7	1680	10 / No	Freshwater marsh, wet meadow	1: groundwater well	458
97_RD4621018_S2c	Middle Fork Clackamas R.	Yes	2.5	1560	NA / No	Freshwater marsh	1: groundwater well	458

[1]Christy (2017). Major wetland and riparian types. Note: these are coarse classifications that do not reflect finer-scale differences in vegetation structure and water regime that occur across sites, which are still being gathered and which reflect different ecological functions.
[2]Data loggers are recording water levels at hour intervals (i.e., 24 measurements per day). Wells/loggers were sometimes installed on different dates within a site.

We note that the 2020 Riverside Fire perimeter overlaps with much of our study area, which continues to present challenges, but also provides novel opportunities for future field observations and monitoring. In October 2021, we were granted access to one of our wetland study sites within the burn, where we

retrieved our water table monitoring data loggers which were installed before the fire and which thankfully remained functional even though their PVC wells were mildly to severely damaged. We installed new water table monitoring wells and posts, established vegetation photopoints, and collected data on soil burn depth. Additionally, we installed a total of 7 remote cameras at the site, which include both motion detection (for beaver and other wildlife activity) and time-lapse functions (for documenting changes in vegetation and water levels/cover). The data collected at this burned site and others (pending another successful access request) will inform researchers' and practitioners' discussions and decision making related to post-wildfire wetland restoration, as well as the role and/or limitations of beaver-maintained wetlands as fire refugia or 'natural infrastructure' for reducing wildfire impacts on wildlife habitat and water resources.

In early November 2021, we were able to plan and implement a wetland vegetation restoration event at Sam Creek meadow in the Oak Grove Fork of the Clackamas drainage. This wetland site contains an old, relatively small abandoned beaver dam that was positioned to back up water into the meadow. The dam has breached in recent years, and with no resident beaver to repair it, is holding back less water than it has in the past. We sampled soils at the site and found there to be clear alternating layers of silt buildup with organic material, indicating that the area was flooded at various times. Local long-term anecdotal knowledge also supports this impression. While there is plentiful alder growing near the old dam, most of the willow remained far across the meadow from the deepest water and relatively inaccessible to beaver dam building and maintenance. By transplanting over 400 willow stems across the site, we aimed to promote habitat that is conducive to a long-term beaver colony. Approximately 15 volunteers and students assisted with this activity. We plan to make subsequent trips to this site across various seasons to assess the success of this activity.

2. What lessons did you learn from this project?

Our project implementation included several unforeseen challenges since it began in 2020. The first of these was the COVID-19 pandemic, which prevented access to our focal watersheds (due to the temporary closure of MTHNF) at the start of the field season and had a significant adverse impact on student and volunteer capacity and contribution throughout the project to date. Later in 2020, the Riverside Fire burned much of our study area, including all of the sites in which we had installed water level probes and other tools for repeat hydrological monitoring, and its aftermath (including ongoing road closures) continues to severely restrict our access to established or potential new field sites.

In response to these events, we quickly developed and implemented COVID-19 field work safety protocols in 2020, and, when accessing MTHNF was not possible, we re-focussed our time and effort on the remote aspects of the project, including public education and outreach. Because field access was so often restricted, we spent additional months in the 2021 calendar year to finish activities that we initially anticipated completing by mid-2021 (and will likely continue into 2022 as data become available).

Although the COVID-19 pandemic continued to present challenges for planning meaningful volunteer training events in 2021, we were able to successfully implement a 'hybrid' approach to training large numbers of volunteers. At the beginning of the field season, we held a public Zoom event which included the first half of our wetland mapping training, which was then followed up on with several in-person field trainings. This was done by recording the initial Zoom event, and requiring all registrants of the smaller field trainings and/or field work days to view it as a prerequisite. This ended up saving us time and effort in scheduling subsequent trainings, and made up for the fact that we needed to hold additional field

trainings of smaller sizes due to Covid-19 restrictions in early to midsummer 2021. Because of this model's success, we plan to pursue a similar approach in 2022 for Bark's field work training program.

Additional equipment purchases, such as soil augers purchased in 2021, were helpful for verification of wetland mapping, since they offer clues as to the water regimes of wet sites. Bark's use of a drone improved access for wetland mapping verification and also the collection of high-resolution spatial data that could yield additional information about inundation extent and timing and the presence/location of beaver activity.

As in 2020, we were encouraged by the fact that many people are excited about the restoration of beaver habitat and populations in Oregon, as well as working in wetland environments. The attendance at Bark's volunteer trainings and related events is evidence of this, as well as direct feedback from participants, which often included an affirmed understanding of the relevance of this project and its positive impact on both local ecology and human communities.

3. **Do you have any anecdotes or testimonials from this project that illustrate the importance of the work, lessons learned, or outcomes?**

As highlighted above, the attendance of the remote and in-person trainings that were created for volunteer project participants indicated to us the importance of this project in connecting people to forests and wetlands in the upper Clackamas River Basin, and increasing public awareness and understanding of the ecological benefits of the project. The beaver presence and wetland mapping data that were or will be submitted to OCAMP, USFWS (via the National Wetland Inventory) and the USFS will begin to fill a void of accurately mapped wetlands and beaver population data within our project area, and it will be part of a larger dataset utilized in future beaver management decisions. While we did not anticipate that this project's outcomes could be used in post-fire monitoring and restoration planning, the fact that we collected pre-fire data (e.g. photos, beaver activity/presence, and/or hydrological measurements) at 5 sites which have since burned will allow us to contribute to future research and planning conducted by academic researchers and resource managers within the Riverside Fire area.

Some examples of testimonials by volunteer participants are below:
"I've been a regular monthly donor to Bark since 2009, but I hadn't participated in their volunteer activities until the pandemic hit. Like many people, I found myself with some spare time and wanted to spend it outside so I started attending Bark's beaver habitat surveys, then their wetland delineation workshops, and field trips. What I love and appreciate most about Bark is directly linked to their radical foundation: to preserve, defend, and restore Mt. Hood. It's continuing education without the school institution and tuition fees. There's no monetary exchange. You don't need to be employed in the natural resources field to enjoy field work. It's a radical activist stance that you don't need to exchange money to get a good education and to gain new skills in a supportive environment. You don't have to be employed with the Army Corps of Engineers to gather valuable wetland data. Bark facilitates a major democratization of community-generated science and I enjoy being a part of it."

"Participating in Bark's beaver and wetland surveys this year was the highlight of my summer. After a year spent mostly indoors, working and worrying about keeping my family safe from Covid, I found it incredibly rejuvenating to be out in the forest doing good work with like-minded people. Additionally, I have been recovering from an injury and subsequent chronic pain experience that would have made this type of activity feel impossible just a few years ago. Watching myself complete field days and longer hikes has been so affirming in my recovery journey, and has given me more confidence to continue volunteering and exploring off the beaten path in the MHNF."

4. **<u>Did the project garner any earned media or was there additional outreach conducted? Please provide links to or copies of articles, posts, or mentions</u>.**

Over the course of 2020 and 2021, Bark engaged in numerous efforts to raise public awareness of wetland and beaver ecology through social media, email-based newsletters, our website, and public events. Some examples of the outreach and education undertaken as part of this project are included below.

- In April 2021, Michael Krochta presented at the Clackamas River Providers general meeting to a coalition of city and county municipalities about Bark's DWPP project. The slides to that presentation are available here.

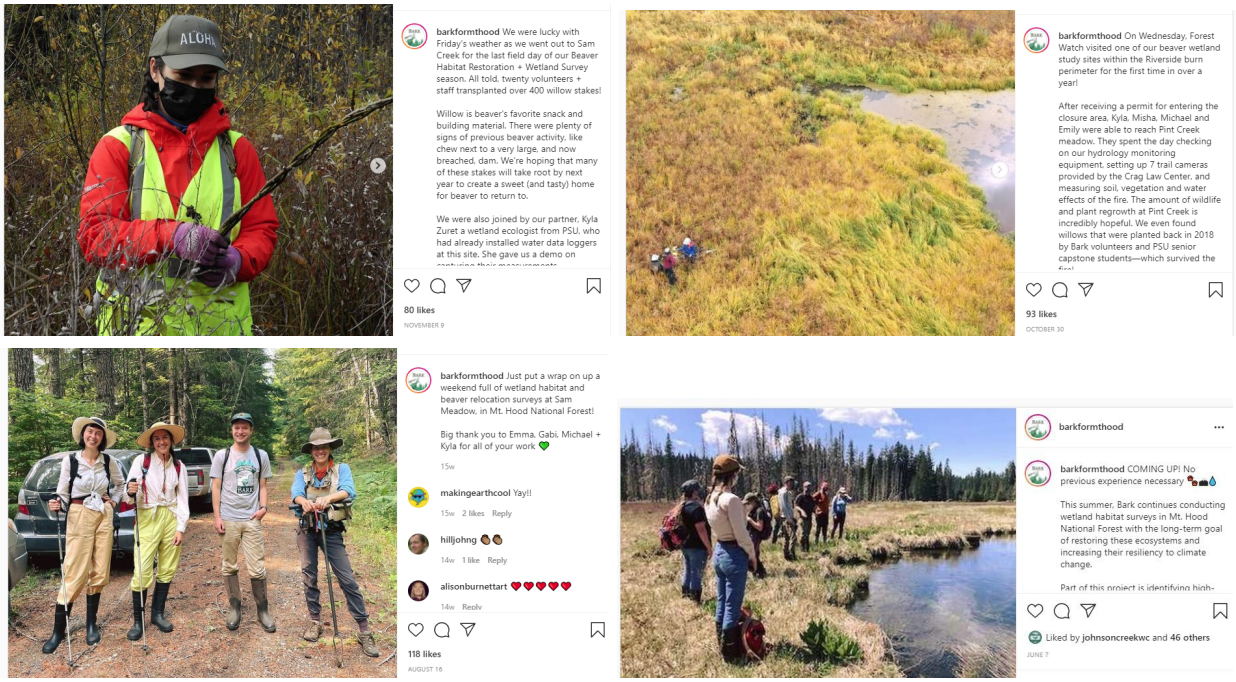
- Our DWPP project prompted multiple conversations with Oregon Public Broadcasting reporter Aaron Scott, which eventually led to the article and Oregon Field Guide Episode, "Could 'Smokey Beaver' help fight wildfires?". Although our project was ultimately not mentioned in the piece (the reporter's interest in visiting our sites was not met by granted access into the burn by the U.S. Forest Service at the time), these conversations did provide OPB with background information, contacts, and ideas that were included in the final story.

- Bark's beaver habitat restoration web page

- Virtual wetland verification and beaver survey training videos

- "Community-generated Science in Mt. Hood's Wetlands" email newsletter article

- Examples of social media posts:

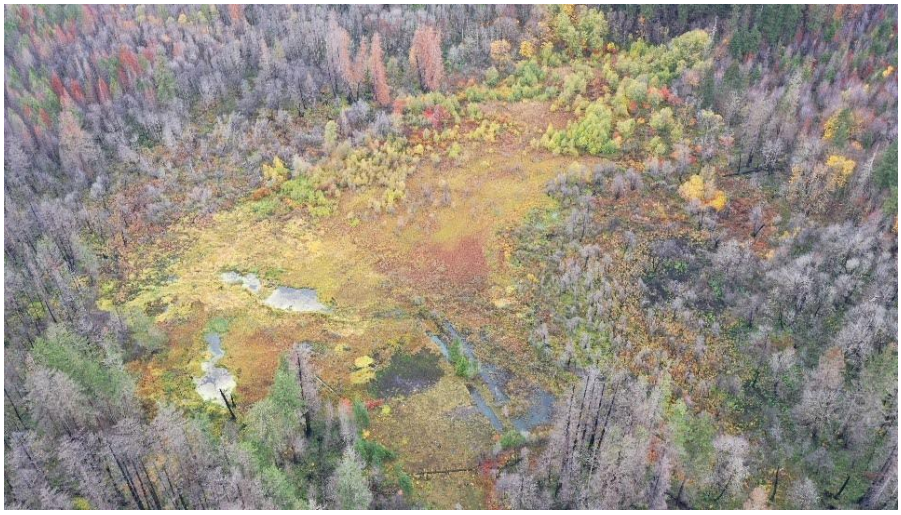


Supporting images

Wetland-spanning beaver dam impounding a large pool of water within the Little Crater Lake wetland complex site where water table monitoring wells were installed. Photo credit: Michael Krochta

Kyla Zaret (INR) demonstrating measurement of bankfull wetted width at a water table monitoring well at Sam Creek. (L); Kyla Zaret (INR) demonstrating sampling of soil horizons using an auger. Photo credits: Michael Krochta (R)

Volunteers at Sam Creek wetland site willow transplanting day. Photo credit: Michael Krochta



Pint Creek wetland site conditions one year post-Riverside fire. Photo credit: Michael Krochta

Michael Krochta (Bark) installing a remote camera at Pint Creek site, post-Riverside fire. Photo credit: USFS (L); Water table monitoring well at Pint Creek, replaced after the 2020 Riverside fire. Although the heat of the fire melted the PVC top of the well, the data logger placed within the lower half of the well remained intact. Photo credit: Michael Krochta (R)