CHEHALIS BASIN STRATEGY

BEAVER DAM ANALOG PROJECT EFFECTIVENESS

Study Goals and Objectives

Beaver Dam Analogs (BDAs) are a habitat restoration technique designed to mimic the form and function of natural beaver dams. Substantial declines in beaver activity in the basin has reduced the occurrence of slow water habitats important for native fish, amphibians, and waterfowl. Installation of BDAs is intended to increase the occurrence of these important habitats, to the benefit of native fishes and other aquatic species. Construction of BDA structures is planned at four sites in August 2023 and, as such, all results to-date are on pre-implementation conditions and not the effects of BDAs. This report documents progress on pre-implementation monitoring to address the following research questions:

- Do BDA structures reduce downstream temperatures and increase thermal habitat diversity?
- Do BDA structures increase fluvial habitat complexity at project locations?
- Do BDA structures increase hydrological connectivity with the floodplain?
- Do BDA structures facilitate beaver use and dam building?

As part of addressing these questions we also anticipate informing:

- What is the expected timeline of benefits from BDA installations?

Methods / Study Design

Site selection was supported by an ASRP Project Development Grant and used an iterative process that included GIS screening, landowner outreach, and field assessment. Our GIS screening tool is published as a Web App (available here). The tool uses a beaver intrinsic potential habitat model (BIP; Dittbrenner et al. 2018). We conducted field evaluations to assess suitability. Suitable sites had the presence of some limited beaver activity but not existing dams, incised channels, and fish presence, among other criteria. We identified four sites for monitoring, all of which are in the Lower Chehalis (**Figure 1; Table 1**). All sites are on private industrial forestlands managed primarily for timber harvest.

Our monitoring design allows for multiple project effectiveness parameters to be evaluated at varying spatial and temporal scales during the pre- and post-treatment periods. We started implementing pre-treatment monitoring summer 2021 and will continue until summer 2023 up until BDA installations. To accommodate a Before-After Control-Impact (BACI) sampling design, each study site is comprised of three contiguous reaches: an upstream control reach, a treatment reach, and a downstream reach (**Figure 2**).

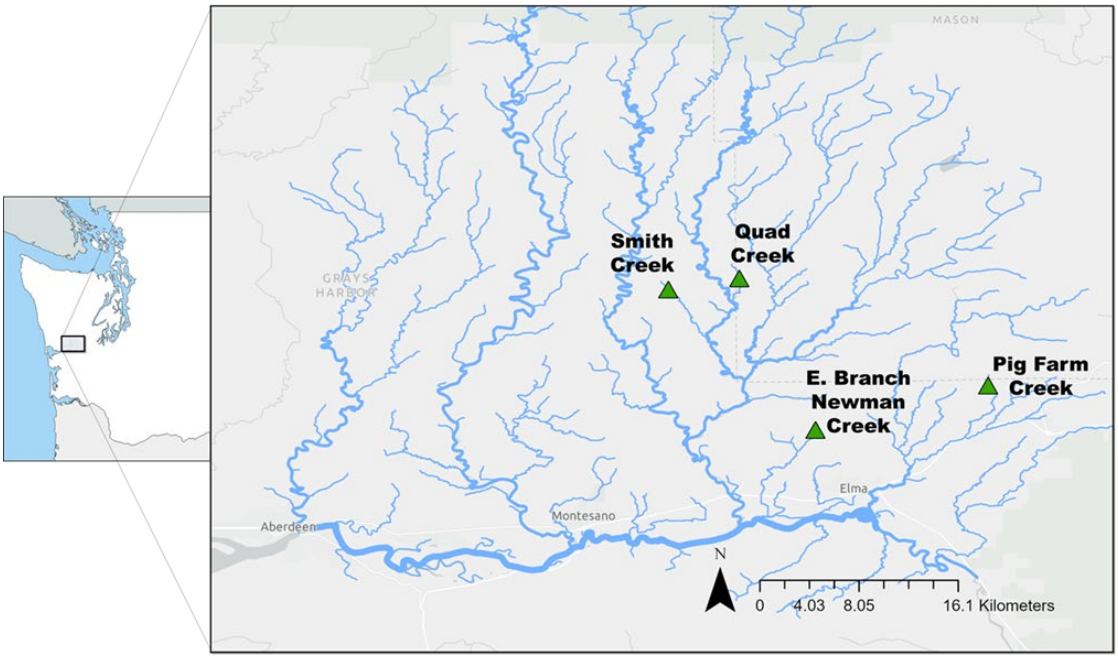

Figure 1. Map of four study site locations included in the Beaver Dam Analog Study.

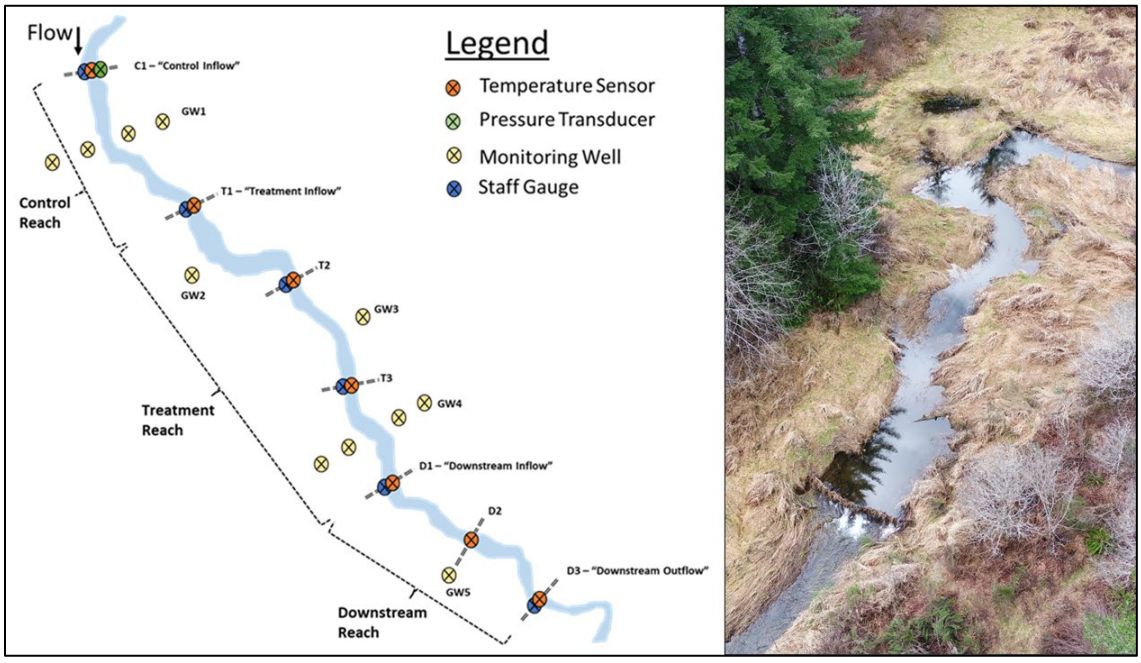

Figure 2. Left: Conceptual site map illustrating the sampling locations and study site layout. BDA structures will be installed in the Treatment Reach during summer of 2023. Treatment reaches range from approximately 330 to 660 meters in length. Right: BDA installation at ASRP pilot site in 2022.

Table 1. Summary of select site characteristics.

	EB Newman	Pig Farm	Quad	Smith
Drainage Area (sq. km)	2.92	4.35	3.93	4.37
Planned # of BDA structures	7	5	8	6
Length of Treatment Reach (m)	330	330	620	470

Field Data Collection

Water Temperature*:* We deployed temperature sensors (Hobo Onset UTBI-001 and U22-001) along the control, treatment, and downstream reaches to evaluate changes in water temperature. Sensors were placed in PVC perforated solar shields within or near the relatively well-mixed area of the stream thalweg at monitoring stations beginning at the inflow of the control reach and concluding at the outflow of the downstream response reach. Automated stream temperature sensors were inspected and downloaded regularly across the hydrologic year. Temperature is recorded at 30-minute intervals. To evaluate the presence of discrete cold-water patches more than 1°C cooler than the adjacent ambient water temperature, we surveyed each study reach during periods of low flow using a handheld digital thermometer with a 1m probe (Model 35200K ±0.1 °C, response rate < 1 s; Cooper-Atkins Corp.).

Stream Habitat Complexity*:* Cross-sectional topographic and water elevation surveys were conducted during the 2022 summer low flow period. Cross-sections were based on the proposed BDA structure location and spaced at 5-meter intervals with two below the BDA, one at the BDA, and four upstream of the BDA. Surveys were conducted using an auto-level, stadia rod, and measuring tape. Elevation and distance data were collected for top of bank, bankfull, wetted edge, and along the wetted channel including at the thalweg. Complete site habitat unit surveys were conducted during spring 2023 using a modified Timber, Fish, and Wildlife habitat unit survey protocol. Habitat survey measurements included unit type, length, average BFW, average wetted width, and residual pool depths.

Floodplain Connectivity: We installed monitoring wells to evaluate changes in riparian water table elevations. Manual measurements of groundwater level were taken approximately every two weeks during the low flow period at monitoring well locations using a Solinst 101 P7 water level meter. Van Essen Micro-Diver pressure transducers were installed in a subset of wells to provide continuous time-series of water level. Year-round stream stage data were collected at 30-minute intervals using Onset HOBO U20L pressure transducers at the control reach inflow to characterize seasonal flow conditions and to provide surface water control data for evaluating change among treatment instream water level measurements. A barometric pressure transducer was also deployed at each site to correct water level pressure values. Additional staff plates were installed within the stream channel along the treatment reach. During each site visit, stream stage was

recorded using visual staff plate readings located along monitoring stations. Discharge measurements were collected from April to October using the area-velocity method with a Hach velocity meter and top setting wading rod.

Beaver Activity: We conducted full-site beaver activity surveys to evaluate the presence and activity of beaver in our study reaches. We incidentally noted beaver dam building activity during other site visits. Three camera traps were deployed at each site to supplement surveys. Surveys consisted of walking the length of each site and to document (GPS and photograph) and characterize beaver sign along each bank, including chews and foraging, tracks, scent mounds, lodge building, burrow excavation and dam building.

Summary of Results

This report covers the preliminary observations from the first of two seasons of pre-implementation monitoring (**Table 2**). BDA construction is planned for summer of 2023.

Table 2. Preliminary summary of select field data characterizing pre-construction site conditions.

Metric	EB Newman	Pig Farm	Quad	Smith
Mean daily maximum July/August (C)	17.6	15.6	18.2	15.0
Mean Wetted Width (m)	2.1	2.9	2.8	3.4
Mean Bankfull Width (m)	2.6	4.1	3.9	4.5
Mean Depth (cm)	21	14	17	25
Min. / Max. Discharge (cfs)	0.82 / 4.02 (n=7)	0.43 / 7.12 (n= 10)	0.01 / 4.17 (n=7)	0.05 / 10.89 (n=8)

Water Temperature: We deployed 31 water temperature loggers across our sites. Using a handheld probe, we conducted cold-water patch surveys at three of our four sites.

Stream Habitat Complexity: We conducted 268 channel cross-sections across 25 BDA structure locations and 16 reference locations. We also performed a systematic instream habitat survey at each of the four sites during spring 2023 to characterize habitat unit type by wetted surface area, and residual pool depth by reach.

Floodplain Connectivity: We deployed 38 riparian monitoring wells, 14 staff plates, and four stream gauges across our study sites to monitor changes in floodplain connectivity. Flow measurements were taken throughout the recession and low-flow period to improve understanding of the timing and flow conditions that mediate connectivity between the stream and shallow riparian aquifer water levels.

Beaver Activity: We observed beaver activity at all four study sites throughout the study period. Recent sign indicates beavers have been at least transitorily present at all four sites since monitoring began. Some ephemeral damming activity was noted at two sites, but the dams are currently not being maintained.

Discussion

Monitoring is on track to inform study objectives related to water temperature, stream habitat complexity, floodplain connectivity, and beaver activity. Our study sites have a range of stream habitat and hydrology conditions representative of many small to medium tributaries in the Chehalis Basin, so we anticipate our findings will be widely applicable to other Chehalis project reaches. We anticipate that early post-implementation results will be available by summer 2024.

We noted beaver presence at all our sites. This is consistent with our expectations because we selected sites with sign of recent beaver activity. Our camera trapping revealed the presence of beaver predators including cougar, bear, and coyote. Water depth and associated cover from predators may be a limiting factor for establishing beaver populations at our study sites. Some transitory damming activity was noted in the control reaches which could impact our BACI design.

We are enthusiastic about incorporating ASRP-supported biological monitoring into our study to inform how fish and amphibians are responding to BDAs. During the pre-treatment period we secured limited WDFW Habitat Program funding to support data collection of fish and amphibian use. We anticipate building upon this baseline and beginning to evaluate salmonid prey with ASRP Hypothesis Testing support in the coming biennium.

Separate from Project Effectiveness monitoring sites, our project team constructed BDAs at two sites in the summer of 2022. All BDA structures are still intact after winter flows. This spring we observed increased water surface elevations upstream from the BDAs that indicates they are enhancing slow-water pool habitats (**Figure 2**). We have also secured additional funding to replicate this BDA experiment at more sites in the Chehalis Basin through Department of Ecology's streamflow restoration grant program.

Adaptive Management

Our data collection to date represents pre-implementation monitoring. We do not have results that inform adaptive management currently, although the test BDAs installed in 2022 provide preliminary support for the effectiveness of this tool in creating slow-water pools. We anticipate providing information about the effectiveness of BDAs in the Chehalis Basin, their site characteristics, and construction considerations beginning in 2024. Most BDA implementation and monitoring has occurred in more arid environments, so we are excited about this opportunity to inform BDA implementation and monitoring in the western Washington context. We anticipate providing a Final Report for Adaptive Management consideration in 2026 that will inform project funding decisions and BDA implementation siting and design.