Quality Assurance Project Plan (QAPP) for

Evaluating the use of beaver relocation as an ecosystem tool in headwater streams of the Snohomish River Basin

Prepared by:
The Tulalip Tribes
Natural Resources
June 2014
Quality Assurance Project Plan

for

Evaluating the use of beaver relocation as an ecosystem tool in headwater streams of the Snohomish River Basin

Approved by:

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Jason Schilling, Technical Project Lead, Tulalip Tribes

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Puget Sound Partnership Team Region 10

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Gina Grepo-Grove, Regional Quality Assurance Manager, EPA

Date

7/10/14

Date

7/10/15

Date

4/17/15
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Hobo ProV2 continuous water and air temperature logger

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Appendix A – Field Forms

Release Site Score Card -- Snohomish Basin Beaver Project

Stream Site Score Card

Stream Gradient of the defined habitat unit

Woody Food

Herbaceous Food

Dominant Stream Substrate

Historic Beaver use

Lodge and dam building materials

Pool – Riffle Complex

Total Score

Beaver Relocation Temperature Logger Field Form

Flow measurement data sheet

Appendix B – Protocols

Intake Processing Procedure

Beaver Handling Precautions

Appendix C: Maps & Figures
A3 - Distribution List

The following individuals will receive copies of the approved Quality Assurance Project Plan (QAPP) and subsequent revisions:

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
<th>E-mail</th>
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<th>QAPP</th>
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<tbody>
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<tr>
<td>Lisa Chang</td>
<td>R10 Project Officer</td>
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<td>Regional QAM</td>
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<td>206-553-1632</td>
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A4 – Project & Task Organization

The following individuals comprised the project team with responsibilities for the design and implementation of this project.

Josh Kubo, Administrative Project Lead; Tulalip Tribes
Mr. Kubo will be responsible for coordinating administrative project activities; his specific responsibilities will include:
1. Oversee development of the QAPP.
2. Review reports and ensure plans are implemented according to schedule
3. Report to the NWIFC QA & EPA QAM regarding the project

Jason Schilling, Technical Project Lead, Tulalip Tribes
Mr. Schilling will be the primary decision-maker for the project and coordinator of technical aspects of the project. His duties will include:
1. Coordinate field and office activities.
2. Conduct project activities in accordance with the QAPP and work order.
3. Validate the field data.
4. Overall responsibility for the investigation
5. Review and approve the QAPP and subsequent revisions in terms of program-specific requirements
6. Make final project decisions with the authority to commit the necessary resources to conduct the project

Abby Hook, consultant, Hook Knauer LLP
Ms. Hook will assist in facilitating professional meetings and coordinating inter-agency discussions to ensure that the project is moving efficiently; she will perform the following duties:
1. Facilitate or oversee facilitation of Beaver Working Group meetings,
2. Provide expertise in inter-agency coordination.

Benjamin Dittbrenner, consultant, Dittbrenner Environmental & University of Washington
Mr. Dittbrenner will act as the field team leader and will perform the following duties:
1. Provide field methodology expertise
2. Select the field sampling team.
3. Conduct the field activities per the approved QAPP and supervise the field sampling team.
4. Distribute the approved QAPP and subsequent revisions to the members of the field sampling team.
5. Provide data analysis oversight
6. Report problems in the field to the Project Leader.

Tiffany Waters, NWIFC, Quality Assurance Manager
The NWIFC Puget Sound Recovery Project Coordinator is Tiffany Waters. NWIFC shall administer the EPA-sponsored grant sub-award and shall be responsible for the oversight of the contract, ensuring that the goals and objectives of the project are achieved. They will ensure that project deliverables are complete and of necessary quality, and that the project completion dates are met. She will interface with USEPA regarding the status of the approved project.

Lisa Chang, EPA, Project Officer
NWIFC’s EPA Project Officer is Lisa Chang; she is responsible for interfacing with NWIFC to oversee that the overall grant conditions are met in accordance with the NWIFC EPA contract.

Ginna Grepo-Grive, EPA, USEPA RQAM
The USEPA Regional Quality Assurance Manager is Gina Grepo-Grove. She or her designee will review and approve the QAPP and subsequent addendums or amendments to the QAPP submitted to the USEPA.

Field Team Technicians, Tulalip Tribes – These individuals will assist in the field work per the QAPP and at the direction of the field team leader. The field team may consist of 2-3 people and will be named at a later date by the field team leader.

A5 - Problem Definition & Background

The Snohomish Watershed has been identified as a priority basin for recovery efforts of salmon, steelhead, and bull trout. The Snohomish River is the largest coho producing watershed in the Puget Sound and the second largest Chinook producer. The Skykomish, which flows into the Snohomish, is used by Chinook (T), steelhead (T), bull trout (T), Coho (sp. of concern), chum, and pink salmon. Declines are attributed to impacts to hydrologic and sediment processes, loss of high-quality habitat, and loss of floodplain and off-channel connectivity. Additionally, climate models predict that hydrology will change substantially within the Skykomish (Dalton et al. 2013). Summer precipitation will decrease (Littell et al. 2009), winter precipitation and storm intensity will increase (Goudie 2006, Hamlet et al. 2008), and the Sky will transition from a mixed/snow to rain-dominated basin by 2080.
Although once an integral component of the riparian area and responsible for providing many of the ecological benefits above (Anderson 2014), beavers are currently absent from much of the upper Skykomish. Beavers and the habitat they create are necessary if we are to restore and preserve our fish populations (Bird et al. 2011). Beavers (*Castor canadensis*) historically numbered in the millions and ranged across most landscapes in North America. The widespread exploitation of the species as part of the Euro-American fur trade resulted in the species being largely depleted by the time settler communities developed. Beaver populations are now on the rebound in lowland areas, and largely in locations where their activities are in conflict with human infrastructure and land use. Current policies dealing with beaver are largely outdated and piecemeal, leaving no central vision for how the species can provide valuable ecosystem services in watersheds while still protecting and maintaining critical infrastructure and reducing damage to private and public lands.

Beavers and their dams change the structure and function of landscapes in ways that can improve the provisioning of ecosystem goods and services for humans. The presence of beaver dams has been shown to positively affect water availability, water quality, in-stream flows, groundwater recharge, and salmon habitat (Collen & Gibson 2001, Woo 2012). There is also recent literature that suggests beaver offer a low-cost technique for climate change adaptation by slowing snowmelt runoff and creating storage in the form of ponds and wetlands (Bird et al. 2011). Furthermore, in degraded systems, beavers are an ideal restoration tool, since they modify and stabilize the underlying ecosystem processes that maintain habitat. While humans are moderately successful at restoring aquatic environments at the reach level, we are not often able to restore the processes that drive these systems. This is particularly troubling, since climate change and human impacts will be most detrimental to these processes. In areas where they have recovered, beavers have demonstrated that they have the ability to restore habitats at much larger scales and ecosystem processes that drive them (Cramer 2012). As keystone species, beavers were once responsible for driving the structural and functional attributes in many riparian areas. Beaver reintroductions have the ability to re-establish critical processes and increase ecosystem resilience to human and climate impacts.

The Snohomish River Salmon Conservation Plan identifies the restoration and preservation of hydrologic and sediment flow processes as the highest priority for all sub-basins in the watershed, yet very few, if any, restoration projects address these large-scale process-based goals. A preceding Tulalip project was completed to characterize beaver populations within the Snohomish Basin uplands. This project seeks to relocate ‘nuisance’ beavers from the Puget Sound lowlands into areas of the Snohomish headwaters that the previous project deemed suitable for beavers, but currently unoccupied. The goal of these relocations are to improve instream habitat for fish and address large scale hydrologic process, greatly increasing progress toward recovery goals that are not being met. The Skykomish basin suffers from altered hydrology and high sediment levels. Tier one priorities for this basin include:

- Preserve/restore hydrologic and sediment flow processes
• Increase floodplain connectivity
• Increase channel complexity

Utilization of beavers to restore the Skykomish was proposed after it became evident that restoration efforts at the individual project scale were insufficient to restore and protect large-scale ecosystem processes in the Skykomish. The plan was first proposed at the 2011 Snohomish Senior Leadership Conference, hosted by the Tulalip Tribes, and aimed at addressing major factors contributing to loss of the Tribe’s treaty rights to salmon. There, leaders from agencies, including NOAA Administrator Will Stelle, agreed that:

• Beaver relocation is a worthwhile project with potential to restore ecological benefits (fish habitat) and create human benefits (reduce flood risk, etc)
• Relocation can decrease water velocity and sediment loading in streams, and increase surface storage and groundwater recharge

This project also addresses Near Term Actions in the regional Puget Sound Partnership Action Agenda: support, develop and integrate climate change programs to improve local and regional readiness for anticipated changes.

This project will help in addressing current beaver issues in the Snohomish Basin by (1) relocating ‘nuisance’ beavers from Snohomish lowlands (2) evaluate the ecological benefit that relocated beavers provide to these upland riparian systems, and (3) assist in establishing broad-scale guidance for non-lethal beaver management techniques. This project will help to develop recommendations on incentives for landowners and resource managers to use beaver as an ecosystem services and conservation tool.
A6 - Project/Task Description

Project Tasks, Outputs and Outcomes

Tasks 1-3 are the phases necessary for a successful beaver population characterization and monitoring project. Task 4 is the outreach portion of the project, and Task 5 is project management. These steps were modified from recommendations developed by the US Forest Service in Winthrop, WA. These recommendations follow the monitoring and relocation portions of the beaver relocation effort in the Methow Valley.

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<td>Task 5. Project Man.</td>
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Task 1: Initiate beaver relocation preparation

1.1 Develop a post-relocation Quality Assurance Project Plan for ecological monitoring and beaver relocation

1.2 Establish relocation goals and objectives, and assemble appropriate relocation partners

1.3 Research permits necessary for relocation

1.4 Evaluate and select release sites from a subgroup of suitable sites identified in FY11 beaver monitoring project’s Task: beaver population and habitat characterization

1.5 Compile list of licensed animal trappers and determine feasibility of utilizing a trapping service for beaver capture. Identify beaver source locations for trapping if utilization of trappers is not found to be feasible or does not supply sufficient numbers of beavers

1.6 Develop plan and protocol for establishment and operation of facility for secure, healthy, and short-term animal husbandry

This work is a continuation of research initiated under the FY 2011 Beaver Project, from which funds were used to assemble appropriate partners, develop a beaver habitat suitability map, and assess current beaver site occupancy to compile a list of potential relocation sites (See Figure 1 in Appendix C). A substantial effort has been put forth in the FY11 project to identify and monitor preferred, but vacant beaver habitat in the upper watershed to maximize the ecological benefits of relocation. The FY13 Beaver Project utilizes these baseline data to implement the relocation and monitoring effort. Task 1 identifies logistical steps needed for initiation of the relocation project. A Quality Assurance...
Project Plan (QAPP) will be completed, which will provide in-depth protocols and methodologies for all activities undertaken as part of this project. The QAPP will be largely based on our FY11 Beaver Project QAPP, but it will address additional metrics collected specific to relocation and post relocation impacts. A project kickoff meeting will be held to discuss relocation expectations, success criteria, tasking assignments, and general project planning. While the project team has been already established in the FY11 Beaver Project, this task will identify peripheral project partners that will add value and knowledge required in the relocation process. Regulatory requirements and the necessary process to satisfy those requirements will be identified. This may require meetings and negotiation between higher level administrative staff from relevant regulatory entities to ensure that tribal rights are adequately considered during the permitting process. Release sites will be identified from the previously selected monitoring sites through a randomized selection process, outlined in the statistical analysis discussion in the QAPP. We will identify active trappers in the region and characterize the amount of live trapping occurring annually to determine if trappers could be used as a source of beaver for relocation. Coordination with trappers is preferred, as it will provide greater efficiencies and will utilize active dam-building beavers that would otherwise be euthanized. However, if coordination with trappers is not found to be feasible, we will identify problem beaver source locations for trapping through our project partners. Finally, an animal handling protocol will be developed that will guide the various steps necessary to trap, store, and release beavers in the most humane way possible. This plan will also discuss the construction and operation of the husbandry facility.

**Deliverable:**
- EPA-approved Quality Assurance Project Plan
- Map of optimal beaver relocation sites in the Snohomish Basin
- Animal trapper list if determined that their use is feasible
- Animal holding facility protocol manual

**Task 2: Beaver Relocation**

2.1 Acquire necessary permits for relocation and monitoring
2.2 Construct beaver holding facility
2.3 Coordinate with trappers in acquisition of captured beavers
2.4 Initiate trapping and holding
2.5 Release beaver at select sites

In this task, we will work with appropriate agencies to acquire any permits necessary for relocation or monitoring. An animal husbandry and holding facility will be constructed in unused raceways at the Tulalip Tribe’s hatchery. If found to be feasible in Task 1, we will work with trappers to acquire source beaver for relocation. If not feasible, the project team will work with partners to identify source ‘nuisance’ beaver and begin trapping. We will trap entire colonies when possible from areas within the Snohomish County lowlands through coordination with Snohomish County. The relocation sites will be prioritized for sequencing using the habitat suitability analysis performed in the FY11 Beaver Project. This analysis identified high quality beaver habitat, which was then ground-truthed to identify unoccupied high quality habitat.
Beavers will be released in pairs or colonies to areas currently unoccupied by beaver in headwater basins on Forest Service land within the Snohomish River watershed. Relocation sites will be at a minimum of 1km away from existing beaver colonies to reduce competition and conflict.

**Deliverable:**
- Beaver relocation strategy report summarizing findings from Tasks 1, 2, and 3, environmental baseline conditions, finalized basin-specific relocation protocol, and implementation timeline.

**Task 3: Monitoring of post-release habitat, hydrology, and biotic conditions**

3.1 Monitor success of beaver colonies at release sites
3.2 Completion of annual survey of fish, riverine habitats, riparian vegetation, and physiographic features

In Task 3, Tulalip staff and consultants will monitor the success of beaver relocation to release sites by use of wildlife cameras acquired in the FY11 beaver project and through onsite evaluation of damming activity and other sign. Biotic, abiotic, and hydrologic metrics at relocation and control sites will continue to be monitored to identify changes in provisioning of ecosystem services resulting from establishment of beavers. These changes will be analyzed against the baseline conditions reported in the FY11 Monitoring installation and strategy report. The report will be updated to include the results of beaver relocation and will be made available as the deliverable identified below. The monitoring design will identify beaver impoundments’ contribution to the moderation of stream temperature, buffering of peak flow events, effects on base flow, hyporheic and groundwater recharge, increase in ecosystem structural complexity, rates of beaver emigration and predation, and downstream habitat quality improvements.

**Deliverable:**
- Monitoring installation and strategy report discussing sampling plan, mortality and emigration rates, habitat, water quality and hydrologic conditions, and observations on effect of beaver introduction at sites.

**Task 4: Outreach and coordination**

4.1 Host 3 meetings to inform stakeholder on project status

This task consists of coordination with basin partners to keep them informed on the project status, share appropriate data, and gather information relevant to the project. Three meetings will be convened with the Snohomish Beaver Working Group to achieve these goals.

**Deliverable:**
- Summary of correspondence with project partners
- Presentation to beaver working group of project status
Task 5: Project Management

5.1 Management of contracts, budget, and FEATS reporting

This task will cover the project management associated with the relocation project. Project management tasks will include contracting, permitting, reporting, and making any changes to budgets and schedules.

A7 - Quality Objectives and Criteria

Data Quality Objectives (DQOs) are the quantitative and qualitative terms field personnel and project managers use to describe how good the data needs to be in order to meet the project’s objectives. DQOs for measurement data (referred to here as data quality indicators) are precision, accuracy, representativeness, completeness, comparability, and measurement range. The overall QA objective for analytical data is to ensure that data of known and acceptable quality are provided. To achieve this goal, data must be reviewed for 1) representativeness, 2) comparability, 3) precision, 4) accuracy (or bias), and 5) completeness. Precision, accuracy, completeness, sample representativeness and data comparability are necessary attributes to ensure that analytical data are reliable, scientifically sound, and legally defensible.

Representativeness is the degree to which data from the project accurately represent a particular characteristic of the environmental matrix which is being tested. Our study design helps insure representativeness by randomly selecting relocation sites across the study landscape. Our year-round sampling design ensures we have sufficient temporal coverage. While sites were initially selected based on habitat suitability, hydrologic monitoring is the second primary consideration; sites were also selected to represent the primary stream conditions found within the headwaters of the basin. Habitat survey designs will incorporate sites within, and adjacent to the project and reference sites and represent different habitat types along an elevation gradient.

Comparability is the measurement of the confidence in comparing the results of one sampling event with the results of another achieved by using the same matrix, sample location, sampling techniques and analytical methodologies. Our survey design requires that all sites are repeatedly sampled, at least monthly, to ensure we sample on a similar time series to reduce sources of temporal variation.

Accuracy and Precision: Accuracy is the degree to which samples reflect the true value of the system, and bias can be measured as a difference from the true estimate. Precision is the degree to which separate measurements agree. While it is difficult to evaluate accuracy and precision for some measures because of tradeoffs with representative and completeness, we will use methods that have been cross-validated with similar projects throughout the region (e.g. The USFS Methow Beaver Project) and will operate and maintain technical equipment according to manufacturer’s standards as outlined in the Quality Control section below.
Completeness: Our stratified random survey design which incorporates index sites strives for completeness by sampling throughout the year across several environmental gradients representative of the system.

A8 - Special Training/Certification

Specialized training for field sampling and analyses and off-site analyses and validation has not been identified as necessary during the planning of this project. The field team lead will be responsible for ensuring that all members of the field team have valid and current specialized training required by the OSHA regulations. Specific certifications have not been identified as necessary during the planning of this project. The field team lead and technical project lead have attended two 3-day beaver trapping and husbandry training sessions, offered by colleagues doing similar work. The field team lead and technical project lead will train all field team members on proper trapping and husbandry techniques.

A9 - Documents and Records

The records for this project will include miscellaneous correspondence, animal health & holding logs, field logs and field data worksheets, a field activity report, habitat suitability maps, photopoints, and final reports. All reports will be submitted to the Tulalip Technical and Administrative Project Leads. Animal and field logs will be recorded with no more than one entry per page, in write-in-the-rain notebooks or field data worksheet with pre-numbered pages. Field logs will include observations about weather conditions at the site when samples are collected and field analyses are conducted. Any other pertinent observations or deviations from the procedures in this QAPP, deemed noteworthy by any member of the field team will also be recorded in the field log book. Field data worksheets (Appendix A – Field Forms) will be used to record all field measurements. Each page of the field logs and field data worksheets will be dated and signed by the person making the entries. The habitat suitability maps will be stored electronically as GIS files on Tulalip servers and backed up in Dropbox cloud data storage. Final reports will be submitted to the Tulalip Technical and Administrative Project Leads. Photopoints will be established at each site and photos will be collected during each subsequent visit.

Beaver log and field forms (examples located in appendix A)
- Intake processing procedure
- Animal handling log
- Beaver release & monitoring form

Field Log
- Site, location description, GPS points
- Meteorological conditions (time, temperature, weather conditions)
- Stream temperature at sampling locations and spot measurements
- GPS location of recent activity or beaver sign
Field Worksheets (examples located in appendix A)
- Site Rating form
- Continuous temperature logger deployment form
- Flow discharge form

Final Reports

Task 1 Reports
- QA Project Plan

Task 2 Reports
- Beaver relocation strategy report

Task 2 Reports
- Monitoring installation and strategy report.

A field activity report will be generated by the Field Leader and submitted to the Technical Project Lead within 60 days of completion of the field activities described in this QAPP. This report will include the analytical data report, a signed narrative about field activities, a summary of all field data collected, a written report of the audit of field activities (see section C1), and all the original field log books and field data worksheets for this project. The narrative report will include at least discussions of all field activities, any problems encountered and their solutions, any deviations from procedures described in this QAPP, and a discussion of the quality of all field data.

The EPA Project Manager will disseminate copies of the QAPP to the people listed in the distribution list (see section A3) once it is approved. Any revisions to the QAPP will be numbered sequentially. It will be the responsibility of the Tulalip Administrative Project Leader to see to it that each person on the distribution list receives copies of any revisions.

All Tulalip records and documents from this project and original raw data (both hard copy and electronic) will be preserved for at least six years and the EPA Project Manager will be consulted before they are disposed. Records will be stored and maintained by the Technical Project Lead; he will be responsible for records management, and document retention. Any deviations from these procedures will be approved by the Tulalip Technical Lead before implementation.

B: DATA GENERATION AND ACQUISITION

B1- Sampling Process Design (Experimental Design)

This project will relocate ‘nuisance’ beavers into at least 4 highly suitable, but unoccupied sites within alpine, headwater portions of the Skykomish River Watershed. Relocation and monitoring sites will be identified from a ground-truthed Habitat Suitability Index Model (HSI), created as part of the previous project. Appropriate relocation sites are those that are suitable, but vacant sites. Prior to the start of this project, six sites will be randomly selected from this pool.
These sites will be monitored using techniques described in the QAPP, *Using Beaver as an Ecosystem Service Provider on Forestlands in the Snohomish River Basin* (2014). Release sites will be randomly selected from the pool of 6 sites. Beavers will be trapped, paired, and released into sites as they become available. If beavers emigrate from sites or are lost due to predation, those sites will fall back into the pool of available sites to be used either a subsequent release or control site. However, if beaver are lost after producing noticeable site modifications, those sites will be treated as release sites (non-control) and beaver will be preferentially released into those sites as soon as they are available. Four sites will serve as release sites, and two sites will act as control.

**Schedule**

- Compile list of nuisance animals                    By August
- Begin trapping beavers                             August - Nov
- Pair beavers at holding facility                   August - Nov
- Release beavers                                    August - Nov
- Monitor relocation success                         August - end of project
- Environmental monitoring of release and control sites Continuous
- Habitat survey                                     Late summer

**Equipment**

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<td>Marsh Mc Birney Flow Meter</td>
</tr>
<tr>
<td>1</td>
<td>Top-setting wading road</td>
</tr>
<tr>
<td>50</td>
<td>ground water wells</td>
</tr>
<tr>
<td>1</td>
<td>Water level tape</td>
</tr>
</tbody>
</table>

Equipment list from previous QAPP, which will carry over to this project.
**B1.1 Beaver Trapping**
The project team will coordinate with WDFW-preferred trappers to determine feasibility of acquisition through partnership with those individuals. This would both increase animal acquisition efficiency immensely, and would decrease beaver mortality (trappers are required to euthanize beavers upon collection). If we determine that it is not feasible to coordinate with trappers, we will initiate or supplement animal trapping. Only ‘nuisance’ animals will be targeted. Locations of these animals will be obtained through our project partners, including Snohomish County, King County, regional city governments (e.g. Bellevue, Monroe), NGO & local special interest groups (e.g. Snohomish Conservation District, Sound Salomon Solutions), WDFW, and private entities. Nuisance status will be evaluated prior to trapping to verify that these are truly ‘nuisance animals’. Examples of true ‘nuisance’ animals are beavers that are living in catch basins or drainage systems, and beavers building dams that threaten infrastructure, but cannot be managed non-lethally. If the colony is deemed a ‘nuisance’, we will set traps before dusk and check these traps within 2 hours of dawn each day of trapping. Beavers will be transferred to the Tulalip Hatchery, which will act as our holding facility.

**B1.2 Beaver holding, sexing, pairing**
The holding facility allows for the processing of our trapped beavers, determination of sex of each animal, and pairing of animals prior to release. Pairing has been shown to greatly increase relocation success for beavers.

Transfer to holding facility
The holding facility will be a sanitized raceway within the hatchery. Raceway will be filled 1-2 feet deep to allow beavers to feed and defecate naturally. Two beaver houses will be constructed within each holding area. These shelters will be constructed of cinder blocks, plywood, and a mesh metal floor. They will be elevated above the water, and will be enclosed to mimic a lodge.

Animal Intake Processing
Animal intake is addressed fully in the attached form Intake Processing Procedures. In summary, incoming animals will be assessed for health. They will be weighed, photographed, given an ear tag for identification, and a hair sample will collected. Each animal will be ‘sexed’ to identify sex. Beaver sexing is addressed in the Processing Procedures attachment.

Pairing
Once beavers have been processed and sexed, they will be paired. Family groups will remain together if possible. Singly trapped beavers will be paired in the following preferred order: female-male, female-female, male-male. Initial release of animals into the holding facility will be monitored closely to ensure that animals are not aggressive. Animals will be watched to identify if a pair-bond forms. This process is further addressed in the Processing Procedures attachment.

**B1.3 Release**
Prior to release of beaver pairs, the release site will be prepped to ensure maximum relocation success. Prepping the site consists of constructing a temporary lodge. Materials can be sourced from around the site and will consist of downed logs and debris. The lodge is simply a small hut along the stream edge, into which the beavers can be released. Release into this type of structure
has been shown to increase relocation success by up to 30%. The US Forest Service has determined that minimal non-ground disturbing movement of logs for this purpose does not trigger permits, such as NEPA.

Beavers will be collected from the holding facility and transported in transport cages to the relocation site. There, they will be released into their temporary lodge. The relocation crew will evacuate the site as quickly as possible to decrease animal stress. Wildlife cameras will be positioned at lodges to track activity.

**B1.4 Post-release and control site monitoring**

Sites will be defined as the stream length containing 1) the core area likely to be colonized by beaver, 2) the area upstream of the core area that would experience direct modification by impoundment and herbivory, 3) and the area downstream that may experience indirect modification, 4) the extent of the home range (based on PNW literature), and 5) a safety margin (~0.25 mi on either side of the site). Each site will be given an initial site characterization, continuous temperature probes will be installed, and surface and groundwater flow will be monitored, as discussed below in Sampling Methods. Sites will be re-evaluated monthly throughout the grant period to establish baseline data at each site. Baseline data to be collected include water temperature, characterization of the flow regime, surface water-groundwater interactions, and habitat quality.

**B2 - Sampling Methods**

**B2.1 Monitoring Methodologies**

*Wildlife Cameras*

Bushnell wildlife cameras will be placed at 10 locations within the 6-10 sites to monitor animal activity. This will provide a qualitative summary of the number and type of visits by predators to the site, other animal activity, and any potential beaver use and activity at the site. Cameras will be checked every 2 months, at minimum. Images will be downloaded on a regular basis and a wildlife image program will be used to process data and note presence/absence of beavers, predators, and other wildlife. Hydrologic conditions, if visible, will be noted. This may include high water, snow, frozen water, etc.

*Habitat Surveys*

Streams will be surveyed in the later summer, during base flow conditions to assess aquatic habitat quality within the vicinity of the site. Streams will be evaluated using the EPA Wadeable Streams Assessment (WSA) methodology (Levine 1999).

*Temperature Monitoring*

A combination of Hobo ProV2 and Pendant continuous water and air temperature loggers will be deployed at each site (See Appendix D for instrument technical details). One logger will be placed in a pool in the stream at the upper and lower extent of the site. An air logger will be placed within the core area of the site. Additional loggers will be placed at locations where there is a substantial surface/ground water input or other source of temperature alteration. Temperature
measurements will be collected continuously, every 30 minutes and will be converted to seven-day averages of the daily maximum (7DADMax) for analysis.

Stream Flow Discharge Monitoring
Stream discharge will be collected at the upper and lower extent each site and at any significant surface/groundwater inputs. Discharge will be measured using the USGS Midsection Method (Buchanan et al. 1969). Discharge measurements will be used to estimate surface and groundwater fluxes using the USGS differential flow gauging method (Buss et al. 2009). Flow data will be collected using a Marsh McBirney FLO-MATE Model 2000 flow meter (See Appendix D for instrument technical details).

Groundwater Monitoring
Groundwater will be monitored by well arrays placed at four sites. The sample design will follow that outlined in Roseberry (2008) for monitoring changes in shallow groundwater storage. Piezometer wells will be evaluated monthly for water height and subsurface flow. Data will be used to detect fluctuations in groundwater height during the hydrologic year, track storage trends, and serve as baseline data where beavers are relocated in the future.

B2.2 Sampling oversight
The protocol for corrective action following a sampling or measurement failure is dependent on collection type and severity of failure. In general, precautions will be taken to prevent equipment failure and sampling error. If the field team encounters any problems or unexpected situations while in the field (e.g., access problems, safety issues, inadequate supplies), the field team leader will be contacted and will be responsible for corrective actions. Quality control measures will be employed during data input and analysis to isolate erroneous data and determine preferred solutions. Equipment will be calibrated quarterly to ensure precision. Continuous temperature loggers will be checked quarterly to ensure batteries are charged and that they are collecting properly.

B3 - Sample Handling and Custody
No samples will be collected as part of this project. All data will be derived from field-based measurements or from geoprocessing in GIS.

B4 - Analytical Methods
There will be no analytical methods employed as part of this project.

B5 - Quality Control
Data Collection Quality Control Methods
Data will be collected in field notebooks, field forms, GPS/data loggers, and field tablets. These forms and electronic data will be uploaded/downloaded weakly onto the Tulalip network. Data
will be backed up in Dropbox cloud data storage. Data will be reviewed during the week of collection for any errors in populating field forms, labeling locations, dates, etc.

B6 - Instrument/Equipment Testing, Inspection, and Maintenance

Monitoring equipment testing, inspection, and maintenance has been address in the previous, related QAPP, Quality Assurance Project Plan for Using Beaver as an Ecosystem Service Provider on Forestlands in the Snohomish River Basin.

Periodic Preventative and Corrective Maintenance of Measurement equipment
An inspection checklist and initial calibration check will be completed by the Field Coordinator quarterly. Any preventive or corrective maintenance done will be documented in the equipment log. Any preventive or corrective maintenance done will be documented in the maintenance log.

B7 - Instrument/Equipment Calibration and Frequency

Instrument calibration has been address in the previous, related QAPP, Using Beaver as an Ecosystem Service Provider on Forestlands in the Snohomish River Basin.

B8 - Inspection/Acceptance of Supplies and Consumables

The Field Team Leader will be responsible for inspecting sampling equipment before leaving for the field. This project will not require the use of sampling containers. Electronic data storage media (SD cards) will be inspected for proper labeling, verification that all data has been downloaded and cleared, and that cards are in good working order, prior leaving for the field each time.

The Field Team Leader will be responsible for inspecting equipment and supplies upon receipt. The manufacturer’s specifications for product performance will be used as the acceptance criteria.

B9 - Non-direct Measurements

Selection of monitoring sites will occur through analysis of the Habitat Suitability Model (HSI) and site rating forms. Historical beaver surveys, qualitative indicators of past presence, and other qualitative geomorphological evaluations will be used to characterize sites. GIS data acquired from Federal, Washington state, local, and other sources will be utilized to assist in site characterization, monitoring, and field planning. Baseline hydrological and temperature measurements will be compared to regional atmospheric data collected from NOAA National Weather Service and USGS databases for both QA/QC purposes as well as regional characterization.
B10 - Data Management

Data for this project will be produced in three locations: at field sites, at the holding facility, and in the office. Data collected onsite will be recorded on field data worksheets and into field logbooks. These field data worksheets and logbooks will be submitted by the Field Team Leader to the Tulalip Technical Project Lead with the field activity report when field activities are complete, and will become a part of the project file. Data collected within the holding facility will be generated by a number of individuals. Ultimate responsibility for management will fall to the Tulalip Technical Project Lead. Office data (primarily GIS data) will be submitted by the Field Team Leader as it is created and QA/QC’d to the Technical Project Lead.

The Project Leader will be responsible for ensuring that field reports meet the requirements in section A9 and for forwarding it to the EPA Project Manager. Both the Technical Project Lead, and Field Coordinator will have the necessary computer software required for data handling and data management. These include ArcGIS, HOBO temp logger management software, a spreadsheet program (MS Excel), ArcPad, Trimble navigation software, and cloud storage software (currently Dropbox). As discussed previously in this document, project records will be managed according to Tulalip data management standards. All field records and the analytical report will be submitted to the Tulalip Technical Project Lead. The Field Coordinator will retain hardcopy field notebooks, which is a requirement for submission and publication of scholarly articles for most scientific journals. Adherence to these practices will assure that applicable information resource management requirements are satisfied.

C: ASSESSMENT AND OVERSIGHT

C1 - Assessments and Response Actions

One audit of field activities will be performed half way through the project. The Technical Project Lead will perform verification and validation of all reported data (conducted in accordance with sections D1 and D2).

The audit of field activities will be conducted by the Administrative Project Lead, on-site, at the time that the Wadeable Stream Surveys are performed. The purpose of this audit will be to verify conformance with the procedures discussed and referenced in this QAPP. Findings of this audit will be presented to the Technical Project Lead and Field Coordinator for revision of methodologies if necessary. The Administrative Project Lead will have the authority to stop work on-site if he deems the findings from the audit to justify such actions. The Field Team Leader, in consultation with the Project Lead will be responsible for corrective actions relating to field activities.

C2 - Reports to Management

Two reports will be submitted to the Project Leader as final deliverables and a presentation will be given to the regional Beaver Working Group. These deliverables will consist of the following:
• Beaver relocation strategy report summarizing findings from Tasks 1, 2, and 3, environmental baseline conditions, finalized basin-specific relocation protocol, and implementation timeline.

• Monitoring installation and strategy report discussing sampling plan, mortality and emigration rates, habitat, water quality and hydrologic conditions, and observations on effect of beaver introduction at sites.

• Project status presentation to Beaver Working Group

All deliverables will be generated by the Field Coordinator.

Any significant QA problems encountered in the office or in the field, as deemed by the Administrative Project Lead, will be reported immediately to the Field Coordinator and the Technical Project Lead via meeting or conference call, so that these deficiencies can be corrected.
D: DATA VALIDATION AND USABILITY

D1 - Data Review, Verification, and Validation

Data will be accepted if they meet the following criteria:
1. Field data sheets are complete.
2. Field data and office data were validated
3. Actual sample locations and collection procedures match the proposed sample locations and collection procedures identified in sections B1 and B2, respectively.
4. Data handling procedures documented on the field activity report, and case narrative match the proposed data handling procedures identified in sections B2 and B3.
5. Field QC was conducted as planned and meets the acceptance criteria in section B5.

Any deviations from the QAPP are to be reported in the final Monitoring Installation and Strategy Report described in section A9. The Technical Project Lead will verify the content of these reports.

If the data fails to meet the criteria, they will be flagged by the Tulalip Technical Project Lead as estimated. Any flagged data will be discussed with the Field Coordinator and project team to determine if the data will be rejected and what actions should be taken.

D2 - Verification and Validation Methods

The Field Coordinator will validate office and field data using the QA/QC methods discussed in B5. Any problems identified during this process will be reported to the Technical Project Lead in the field activity report.

The Technical Project Lead will review and verify the field sheets, the field activity report, and the population characterization report. Any problems or deviations identified will be discussed with the project team.

D3 - Reconciliation with User Requirements

Anticipated Outputs and Outcomes

Outputs

The proposed work will reintroduce beavers into high quality, headwater riparian habitat, which has been vacant for a substantial period of time (>10-20 years). Over this period, these areas have seen a decrease in ecological health through sedimentation, erosion, channel encroachment, and similar processes, or lack thereof. Our goal is to increase the number of healthy beaver colonies within these critical areas, which will serve as epicenters for dispersal and recolonization in similar sites. We will monitor the changing conditions of these systems as it relates to hydrology and habitat quality. System-wide monitoring of hydrology will enable us to determine patterns of spatial and temporal...
variation throughout headwaters as beavers reoccupy these systems; this will help to provide context and inform future management decisions.

**Outcomes**

These outputs relate to several important short-term and long-term outcomes. Our baseline data will feed directly into a decision making plan for future beaver relocation efforts and will allow for the development of a comprehensive adaptive management plan for beaver-related restoration project. Relocation success rates will be compared with regional rates, and successful techniques will be shared with partners. Continued hydrologic data collection will supplement existing, but very limited datasets and ensure results from the monitoring component of the proposed work will not only provide context for past and present restoration projects but may also be used to inform future management decisions regarding restoration projects by providing critical data for prioritizing future sites throughout the Skykomish headwaters.

**References**


Tulalip Tribes. 2014. Quality Assurance Project Plan for Using Beaver as an Ecosystem Service Provider on Forestlands in the Snohomish River Basin (2014), Tulalip, WA


http://water.epa.gov/type/rsl/monitoring/streamsurvey/upload/wsa_fulldocument.pdf

Appendix A – Field Forms

Release Site Score Card -- Snohomish Basin Beaver Project

<table>
<thead>
<tr>
<th>Site ID</th>
<th>Date</th>
</tr>
</thead>
</table>

Pneumonic site reminder _______________________________ Observer _______________________________

GPS Coordinates_UTM (NAD 83) __________________________ Subwatershed __________________________

Lat Long ________________ Location Description ________________________________

Elevation ________________ Estimated OHWM ________________________________

<table>
<thead>
<tr>
<th>Beaver Activity (circle)</th>
<th>Absent</th>
<th>Old</th>
<th>Some sign present</th>
<th>Active</th>
</tr>
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<tbody>
<tr>
<td>dams w/in area</td>
<td>Rating site w/in complex</td>
<td>Other</td>
<td></td>
<td></td>
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<tr>
<td>Stream Gradient of the defined habitat unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>________</td>
<td>5. ≤3%</td>
<td>3. 4-6%</td>
<td>1. 7-9%</td>
<td>0. ≥9%</td>
</tr>
</tbody>
</table>

Low Flow (fall)

<table>
<thead>
<tr>
<th>Stream Flow</th>
<th>garden hose</th>
<th>fire hose</th>
<th>30”culvert</th>
<th>un-wadeable</th>
</tr>
</thead>
<tbody>
<tr>
<td>garden hose</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>fire hose</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
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<tr>
<td>30”culvert</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>un-wadeable</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Habitat Unit Size (stream length)

5. Extensive stretch of the stream 3. Large area, primarily linear 1. Small isolated pocket

Woody Food

- a. 3. Aspen, willow 2. Alder 1. Other hardwoods
- Veg (circle) s.berry v. maple r.elderberry currant Indian Plum Spirea Dogwood
  - b. 3. Within 10 meters 2. Within 30 meters 1. Within 100 meters
  - c. 3. Large amount (thousands of stems) 2. Some (hundreds of stems) 1. Little (dozens)

Woody food score = multiply a x b x c

Herbaceous Food

3. Grass/Forbs Present 0. No Grass/Forbs Present

Floodplain Width

5. Wide stream bottom 3. Moderately confined reach 0. Narrow V Channel

Dominant Stream Substrate


Historic Beaver use

10. Old structures present 0. No indication of previous occupancy

Lodge and dam building materials

5. variety of 1-6” diameter woody vegetation avail. -10. no building material present

Pool – Riffle Complex

5. Many deep pools or wetland 3. Some pools present 0. No pools or wetlands present

Bonus Round:

(5 pts each) 1. Easy Access. 2. Existing aquatic escape cover. 3. Channel-spanning logs/ LWD/structure

(-10 pts each): 1. Landowner not enthusiastic, 2. Conflict with human values

Total Score
Beaver Relocation Temperature Logger Field Form

Temp Probe #: Serial #

Placement

Personel: Date: Time:

Site Name Site ID

Sample Location Name

WATER or AIR placement (circle one)

Basin: Stream Name

GPS Information

GPS Unit Used

Easting (DD/MM/SS. #): Northing:

State Plane Coordinate System

Township/Section/Range (E.g., N38W22S18): 

Site Information

BFW: WW:

Site Placement Description

Notes:

Site Sketch or Photo

Retrieval

Date: ___ Time: ______________ Temperature: ______

Condition/Notes: ______________________________
Flow measurement data sheet

<table>
<thead>
<tr>
<th>Date &amp; time</th>
<th>Lat &amp; Lon / UTM</th>
<th>Bank A tape reading</th>
<th>Bank B tape reading</th>
<th>Location</th>
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<tr>
<th>Observers</th>
<th>Channel width</th>
<th>Weather &amp; Temperature</th>
<th>Water temp</th>
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<table>
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<th>Weather &amp; Temperature</th>
<th>Staff gauge reading</th>
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<thead>
<tr>
<th>Cell</th>
<th>Collection Point</th>
<th>Cell width</th>
<th>depth</th>
<th>Velocity (.6 or .2&amp;.8)</th>
<th>Discharge</th>
<th>Notes</th>
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TOTAL DISCHARGE: __________
**Site Monitoring Form**

Date: ______________ Location: ________________________________

GPS Coordinates: ____________________________ Crew: ____________________

Release date and beaver details (#, sex, tag numbers, etc.):

Beavers present and active? Describe evidence thoroughly. Aspen used?

Dam construction? Describe thoroughly and map on reverse using GPS distances.

Doubled stream cross section maintained? Measurements:

Photo/Videos #’s and Descriptions:

Monitoring Notes:
Aspen delivered, fish, birds, vegetation, cows, water, tracks, human activity, etc.
Appendix B – Protocols

Intake Processing Procedure

Snohomish Beaver Project - Intake Processing Procedures
So, you have captured a beaver… congratulations! You are well on the way to watershed restoration! Here is a write-up of how to process this beaver and record data for consistency in our documentation. The Intake Documentation form should be filled out completely, and by following along and filling out all of the fields you should be good to go. If in doubt, take more notes and append them to the form as necessary.

HUMAN SAFETY
When processing beavers, some basic safeguards need to be in place. Beavers can transmit disease to humans, and this hazard needs to be minimized. Wearing gloves is a requirement. Wash your hands following handling beavers and before eating. Don’t rub your eyes while working. Wash your beaver work soiled clothing separate from your other laundry. Handling beavers freely should not be done. Beavers can bite and scratch. Beavers are stressed by handling. Do your work while beavers are in the trap or in the beaver bag. Do not process beavers that are unusually aggressive, appear sick, or injured in such a way that you would be unreasonably exposed to blood or injury. Discuss this with your supervisor. Do not expose other beavers to a sick beaver. We work with sharp syringes around beavers and each other. Some guidelines for working with “sharps”:

- Keep syringes capped until use.
- Say “sharps” aloud when uncapping needles to alert those nearby to use extra precautions around you. Do not turn around suddenly with uncapped needles.
- Reusable needles such as the floy tag gun should be carefully sterilized with alcohol before and after use.
- Recapping syringes should only be done if required and if done should be done one handed—Use the needle to scoop up the cap which is laying on a flat surface, instead of depositing the cap on the needle with your free hand to prevent accidental punctures.
- Deposit needles in a hard sided sharps container with a screw cap. An old juice container will work. Dispose of the container properly with medical waste when full. If you have to shove needles in, it is way too full to use.

ANIMAL SAFETY
Some basic things, like working calmly to insure minimal stress to the animal, are very important. Beavers are stressed out by loud noises and quick movements. The health of our beavers is very important. Keeping beavers properly restrained will help protect them. Properly sterilize your tools and injection sites. Protect beavers from each other as required. Treat our wetland restorers with respect. If an animal appears to be suffering from great stress it is appropriate to postpone the intake until later, but remember that recapturing an animal in the raceway causes stress as well.

BEAVER ID and EAR TAGS
The first step in processing is assigning an ID. Make sure it is not a recapture by carefully scanning the tail with a pit tag reader. This can usually be done while the beaver is still in the trap upon arrival to the hatchery. The Beaver ID is a combination of several items together. Ear tags (also known as Floy tags) are used to quickly and easily identify captive beavers in the hatchery. They are not designed as a permanent record, as they do fall out naturally and get pulled out by beavers. They are color coded to correspond with the Beaver ID capture number. The first digit (tens column) color tag goes in the animals left ear, and the second digit (ones column) color tag goes in the animals right ear. Below are the color codes:

<table>
<thead>
<tr>
<th>Number</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>No Tag</td>
</tr>
<tr>
<td>One</td>
<td>White</td>
</tr>
<tr>
<td>Two</td>
<td>Blue</td>
</tr>
<tr>
<td>Three</td>
<td>Red</td>
</tr>
<tr>
<td>Four</td>
<td>Fluorescent Orange</td>
</tr>
<tr>
<td>Five</td>
<td>Pink</td>
</tr>
<tr>
<td>Six</td>
<td>Fluorescent Green</td>
</tr>
<tr>
<td>Seven</td>
<td>Fluorescent Pink</td>
</tr>
<tr>
<td>Eight</td>
<td>Yellow</td>
</tr>
<tr>
<td>Nine</td>
<td>Dark Green</td>
</tr>
</tbody>
</table>

Examples:
- Beaver number 79: Left Fluorescent Pink, Right Dark Green
- Beaver number 183: Left Yellow, Right Red
- Beaver ID 12TROY201: Left No Tag, Right White

It is possible that in the future we may have recaptures that will conflict with new captures, such as having Beaver 12PEAR79 recaptured at the same time that 14TRFP179 is in captivity. This would create a situation where both beavers would have the same ear tags. Use your discretion to determine how to ID the beavers. Remember the Floy tags are simply there to help you – and the Pit tag is the ultimate identifier that really matters. We do not recommend ear clipping or other inflicted animal mutilation for identification.

Sterilize the floy tag gun with alcohol, and place the row of tags into the gun. You may need to slightly depress the trigger about halfway to allow the tags to seat fully into the gun, and again when removing the tags. Keep only the tags out that you need to reduce mistakes and keep the gun capped until use to reduce accidental stabbings. Pin the beaver into a corner of the trap by stepping or placing pressure on the trap. Try to immobilize the beaver but not stress it out too much. You want to get the ear available thru the mesh of the trap and massage it a bit with your fingers to locate an area free of cartilage, scars, and large veins (this may calm the beaver a bit as well). Rub an alcohol soaked cotton ball over the identified site to sterilize it. Grasping the ear with the beaver immobilized, quickly inject the needle into the ear fully, squeeze the trigger, and remove the needle. Wait as long as is necessary for the beaver to be in the right position, and immobilized, before attempting injection – then when placing the tag act with a decisive motion. You do not want to be timid and give the beaver a chance to wiggle around; this will cause mistakes, waste tags, force multiple injections, and quite possibly harm you and the beaver. Check the tag to make sure it is fully through and that it is
seated correctly. Place triple antibiotic on wounds that appear to need it. Sterilize the gun between injections, and before capping for storage.

WEIGHING BEAVERS
Now that you have the ID figured out get a weight. Keep the beaver in the trap and hang it on the scale at the hatchery. Keep your hands off the trap and weigh it several times, until you are sure of a consistent number. Subtract the trap weight and record the number. Snared beavers will have to be weighed by difference in an appropriate enclosed container, probably the transport cage.

COLLECTING HAIR SAMPLE
We take a hair sample from every beaver captured, usually done at the same time as ear tagging. This was initially done to verify sex using mitochondrial DNA, but now we take the sample because this could be useful for future studies. The hair sample should be taken in such a way to prevent cross contamination with human DNA or any other contaminants, as much as is possible. While the beaver is in the Hancock trap, grasp a lock of hair with pliers and quickly tug it out. You want to get some guard hair AND underfur to insure that you get some hair follicles with the sample. Place the hair sample into a small manila (coin) envelope with the pliers. Do not mash the hair around in with the pliers or stick your fingers into the envelope. Staple the envelope shut and write the Beaver ID and the date on the envelope. Ultimately the hair samples will be stored in a clearly labeled ziplock in the samples freezer at the Tulalip lab.

BEAVER BAG
Now that you have the beaver weighed, ear tagged, and a hair sample taken, everything remaining is done from the posterior of the beaver. This is done by immobilizing the beaver in a “beaver bag”, or if not available (this is written for other projects) wrapped in some sort of cloth. We highly recommend to other projects obtaining or sewing a large bag of a 45°-45°-90° triangle of Cordura cloth open on one end adjacent to the 90° corner with a small breathing hole in the opposite 45° corner. Place the beaver in its trap into a dry raceway to prevent escape during transfer. Prepare all materials you will need to finish processing before transferring beaver to the bag. Open the Hancock trap up and place the beaver bag over the open end of the trap. Lower the trap to its side and lay the bag out so the beaver can crawl into it. Laying the trap folded frame side down is awkward but allows the beaver to “step up” out of the trap and is useful, especially with larger animals. Extend the bag so the beaver can see the breathing hole or “the light at the end of the tunnel”. Rustling the Cordura material of the bag is a frightening sound to many beavers, so minimize it. As the beaver enters the bag, use your hands outside the bag to guide the beaver into the end and prevent it from turning around. The beaver will squeeze down into the end and you can have an assistant hold the beaver still while you work.
Move the bag away from the tail and take a digital photo of the dorsal side of the tail. Record the picture number on the intake sheet. This may be useful data and help in identification in the future.

SEXING
Sexing beavers accurately is very important to our project and we feel it is a keystone part of successful beaver restoration. By accurately sexing beavers, we can:

- Reduce peer-induced conflicts and death in captivity
- Maximize chances of establishing breeding colonies
- Help predict whether beavers remain at a trapping location
- Infer beavers demographics about our watershed

Sexing of lactating or reproductively receptive females can be done by simply checking for enlarged teats, but it is recommended that the sex is confirmed by anal gland secretions as well. Sexing beavers is done while the beavers are restrained in the beaver bag by manipulating the cloacal area and examining anal gland secretions. The 2 anal glands of beavers are located inside the cloaca on the left and right, slightly anterior of the vent. They need to be manually protruded from the vent and “milked” gently to express secretions for examination. This is a
tricky, slippery, and somewhat messy process. Don’t worry, you can do this, and it gets easier with practice.

You and your assistant should wear gloves for this procedure. Have your assistant cradle and restrain the beaver on its back, in the bag. Beavers do not like to be on their back, and will thrash around if you let them. Pinning the beaver forcefully against the flat hard ground on its back can cause spine injury, and should be avoided. Cradling, as is done with an infant, can be a good way to go. You may be able to kneel on the ground, and position the beaver on its back with its tail away from you and its body rested on your thighs. You may also be able to access the cloaca with the beaver right side up, by lifting the tail. It is not recommended that you lift the animal off the ground by pulling the end of the tail in the air, but if necessary lift gently by the base of the tail with a firm grasp. The cradling method is by far the safest for most animals. Now that you have a clear, stable, and unimpeded access to the cloaca, press your fingers GENTLY along the exterior of the vent just anterior and to the side of the vent. You should feel a lump. Pressing too far forward may cause castor oil to be expressed; a thin, brown, strong smelling liquid (if this incidentally occurs you may wish to save it on cotton balls to use as a trapping lure). You may also cause beaver to excrete feces or gas with force applied in the wrong area, too far forward or central. This may be a good time to mention that this procedure should be done with your face a reasonable distance from the cloaca, with your mouth shut, and perhaps safety glasses on. When you feel one of the anal glands (either one is fine) you can direct it to emerge from the vent for manipulation. The gland will look like a swollen bulb with a pointed tip, free of hair and usually quite slippery. Use one hand to maintain the steady, gentle pressure that was required to emerge the gland. Use your other hand to massage the gland to get the secretion from the tip. Steady, firm, and gentle pressure may work. Perhaps a milking motion will work better. You will need to vary your technique to find what works best for you, and some animals will be easier to work with than others. Be patient and gentle, this animal under your care needs to be protected. You may have the anal gland withdraw and be forced to start over multiple times. Once some of the secretion has been emitted, wipe it onto a clean finger on your glove for inspection and compare to the chart below.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor</td>
<td>Smells like petroleum (motor) oil</td>
<td>Smells like funky cheese</td>
</tr>
<tr>
<td>Color</td>
<td>Yellowish-Brown</td>
<td>Whiteish</td>
</tr>
<tr>
<td>Viscosity</td>
<td>Thicker, more slippery</td>
<td>Thinner, less viscous</td>
</tr>
<tr>
<td>Ease of “milking”</td>
<td>Challenging</td>
<td>Easier</td>
</tr>
<tr>
<td>Amount of discharge</td>
<td>Less</td>
<td>More</td>
</tr>
</tbody>
</table>
Use a combination of these indicators to formulate your decision on the sex of the animal. Using just one clue increases the chance of a mistake. Remember these are general guidelines, and that individual animals can differ, although the color and odor are quite distinct and probably the best indicators. This sexing process may need to be repeated for a good sample to be obtained. Have your assistant evaluate the sample as well, and both of you should make independent decisions about the sex of the animal before comparing answers. It is better to admit you cannot tell than it is to make unsure decisions. Try again, later if necessary. This technique, when done correctly, can give you an unmistakable sex ID.

RELEASE INTO RACEWAYS
By now your beaver is probably fairly stressed out and is ready to get loose. Putting the beaver into a raceway is the next step. First though, double check your intake sheet, because now is the time to catch omissions and errors, not after you release. The person already holding the beaver can bring the animal to the water and let it go, or hand it off carefully to someone else. Place the beaver bag into the water and pull it off the animal carefully. If necessary grasp the beaver by the base of the tail to pull them out of the bag. Do not drop the beavers from any height into the water - place them gently.

We build beaver groups in the hatchery for release, and every situation is a bit different. Who to release them with as you build groups is pretty important, as is immediate monitoring following release. Here are some general guidelines to help your beaver matchmaking a success:

- Intact family groups are usually a good way to go, but still should be observed.
- Keep an eye on the beavers for initial meetings, and interactions between them until you are confident that they are friendly.
- Have a plan to physically separate beavers safely and be in position to do so quickly.
- Release into the water, so that victims of aggression can flee quickly.
- Stressed beavers may need time to calm down before true reactions can be observed.
- Kits are especially vulnerable to attack, and should be protected from aggression, even from parents if necessary.
- Remove the aggressor, not the victim.
- Use caution placing unrelated males together.
• Have multiple houses available for the first night or two, so if a beaver is rejected from a lodge it does not need to spend the night swimming.
• Observe if beavers are lodging together upon subsequent arrivals to the hatchery.
• Take good notes on unusual interactions.
• Males may attempt to breed with new, unreceptive females and occasionally other males.
• Make sure you know who is who before releasing.

CONDITION NOTES
Condition notes are a good way to keep track of the health, behavior and location of each beaver under your care. There should be a binder with the condition notes that stays at the hatchery at all times. The condition notes should be used for making notes about when or if the beavers are eating (aspen, pellets and apples). The condition notes are also used for making notes about injuries and behavior. Keeping track of all of the beaver’s health is really important. Beavers tend to behave differently, so it’s important to get to know each of them so you can tell when they aren’t acting normal. The condition notes are really helpful for weekend feedings especially. It will allow you the opportunity to write down any observations and notes you find when you are alone. It is REALLY important to communicate with your crew any concerns you may have with the beaver’s health. Also use this binder to make good notes when you are moving beavers from raceway to raceway. Make sure you are moving the correct beaver. They all look the same so double check the ear tags and pit tag. Make sure you pay close attention when you move beavers into a new raceway. In the conditions binders you can make notes so you can about how they are getting along. For example are they sleeping in the same house? These things are all really important and will help you figure out if the beavers are going to do well together when you release them into their new home.

WHITEBOARD
The whiteboard is used for keeping track of what beavers are in each raceway. It can be really helpful if you keep it up dated. We draw the four raceways and write the beavers ID, sex and ear tag colors on the board.

![Raceway Diagram]

BRED183
L: Yellow, R: Red
Beaver Handling Precautions

**Snohomish Beaver Project Beaver Handling Precautions**

Like most wild animals, beavers do not like to be handled and will bite if threatened. Also beavers can carry a variety of diseases. Caution is warranted when handling beavers to keep human contact as safe as possible. Be aware of the potential to be bitten during all transport and handling. A restraint bag is a good tool to keep beavers and humans safe during handling, tagging, and examinations. If you are bitten while working with beavers on this project, clean the wound carefully and immediately notify your supervisor. Additional wound management may be necessary.

1. Wear exam gloves during all beaver evaluations, ear tagging, and sexing.
2. When tagging, prep skin on tails and ears with alcohol to reduce bacterial infection.
3. Always wear PPE (safety glasses, gloves, waders) in raceways.
4. Limit the exposure of wounds on hands and arms to water in the raceways.
5. Don’t eat, drink, smoke, or touch your eyes, nose, or mouth after handling beavers, their traps, or working in their environment until you have thoroughly washed your hands.
6. If you become ill (fever, aches, swollen glands) during or after this project, report to your supervisor, see your physician, and inform them that you have been working with beavers and that could be the cause.
7. Beavers that appear injured or sick should be placed by themselves in an individual raceway and watched and not tagged or sexed until they seem well.
8. We won’t incorporate sick beavers in the project – and will consider:
   a. Attempting for a few days to support the beavers’ recovery while in an isolated raceway
   b. Euthanasia for humane reasons and protection of the other captive and wild beavers
9. Avoid dissection or necropsy. Necropsies will be conducted by qualified veterinarians at appropriate facilities.
10. Regular disinfection of vehicles, traps, and gear – especially after handing sick beavers - is our policy. A *Virkon™* rinse weekly for traps, boots, tools, and food bowls, are our disinfection best management practices.
11. Dry and expose raceways and houses to sunlight between occupancy.
12. We will work with Dr. Kristin Mansfield in Spokane to identify potential beaver disease issues.

   Kristin Mansfield DVM, MPVM
   State Wildlife Veterinarian
   Washington Department of Fish and Wildlife
   2315 N. Discovery Place
   Spokane Valley, WA 99216
   Office Phone: 509-892-1001 ext. 326
   Mobile Phone: 509-998-2023
   FAX: 509-921-2441
   kristin.mansfield@dfw.wa.gov

This will include shipping recently dead beavers or tissue through her to:

   Washington Animal Disease Diagnostic Laboratory
   P.O. Box 647034
   Pullman, WA 99164-7034

Dr. Mansfield will be the project contact for all beaver health questions. We will work with her to learn together the best ways to handle and manage captive beavers for their individual health, wild beaver population health, and our crew health and safety.
Figure 1: Potential Relocation and Monitoring Sites in the Skykomish Watershed

- Potential Relocation Sites
- Skykomish Watershed
Appendix D: instrument technical specifications

**Hobo ProV2 continuous water and air temperature logger**

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature Sensor</strong></td>
<td></td>
</tr>
<tr>
<td>Operation range</td>
<td>-40°F to 70°F (-40°C to 158°F) in air, maximum sustained temperature of 50°F (122°F) in water</td>
</tr>
<tr>
<td>Accuracy</td>
<td>0.2°C over 0°F to 50°F (0.36°F over 32°F to 122°F), see Plot A</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.02°C at 25°C (0.04°F at 77°F), see Plot A</td>
</tr>
<tr>
<td>Response time (90%)</td>
<td>5 minutes in water, 12 minutes in air moving 2 m/sec (typical)</td>
</tr>
<tr>
<td>Stability (drift)</td>
<td>0.1°C (0.18°F) per year</td>
</tr>
<tr>
<td><strong>Logger</strong></td>
<td></td>
</tr>
<tr>
<td>Real-time clock</td>
<td>± 1 minute per month 0°F to 50°F (32°F to 122°F)</td>
</tr>
<tr>
<td>Battery</td>
<td>2/3 AA, 3.6 Volt Lithium, factory-replaceable ONLY</td>
</tr>
<tr>
<td>Battery life (typical use)</td>
<td>6 years with 1 minute or greater logging interval</td>
</tr>
<tr>
<td>Memory (non-volatile)</td>
<td>64K bytes memory (approx. 42,000 12-bit temperature measurements)</td>
</tr>
<tr>
<td>Weight</td>
<td>42 g (1.5 oz)</td>
</tr>
<tr>
<td>Dimensions</td>
<td>3.0 cm (1.19 in.) maximum diameter, 11.4 cm (4.5 in.) length; mounting hole 6.3 mm (0.25 inches) diameter</td>
</tr>
<tr>
<td>Wetted materials</td>
<td>Polypropylene case, EPDM o-rings, stainless steel retaining ring</td>
</tr>
<tr>
<td>Buoyancy (fresh water)</td>
<td>+13 g (0.5 oz) in fresh water at 25°C (77°F), +17 g (0.6 oz.) with optional boot</td>
</tr>
<tr>
<td>Waterproof</td>
<td>To 120 m (400 ft.)</td>
</tr>
<tr>
<td>Shock/drop</td>
<td>1.5 m (5 ft.) drop at 0°C to 70°C (32°F to 150°F)</td>
</tr>
<tr>
<td>Logging interval</td>
<td>Fixed-rate or multiple logging intervals, with up to 8 user-defined logging intervals and durations, logging intervals from 1 second to 18 hours. Refer to HOBOware software manual.</td>
</tr>
<tr>
<td>Launch modes</td>
<td>Immediate start and delayed start</td>
</tr>
<tr>
<td>Offload modes</td>
<td>Offload while logging: stop and offload</td>
</tr>
<tr>
<td>Battery indication</td>
<td>Battery voltage can be viewed in status screen and optionally logged in datafile. Low battery indication in datafile</td>
</tr>
<tr>
<td>NIST certificate</td>
<td>Available for additional charge</td>
</tr>
<tr>
<td><strong>CE</strong></td>
<td>The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).</td>
</tr>
</tbody>
</table>
**Pendant continuous water and air temperature loggers**

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Measurement range**          | Temperature: -20° to 70°C (-4° to 158°F)  
Light: 0 to 320,000 lux (0 to 30,000 lumens/ft²) |
| **Accuracy**                   | Temperature: ±0.47°C at 25°C (±0.85°F at 77°F), see Plot A  
Light intensity: Designed for measurement of relative light levels, see Plot D for light wavelength response |
| **Resolution**                 | Temperature: ±0.10°C at 25°C (±0.18°F at 77°F), see Plot A |
| **Drift**                      | Less than 0.1°C/year (0.2°F/year) |
| **Response time**              | Airflow of 2 m/s (4.4 mph): 10 minutes, typical to 90%  
Water: 5 minutes, typical to 90% |
| **Time accuracy**              | ±1 minute per month at 25°C (77°F), see Plot B |
| **Operating range**            | In water: -20° to 70°C (-4° to 122°F)  
In air: -20° to 70°C (-4° to 158°F) |
| **Water depth rating**         | 30 m from -20° to 20°C (100 ft from -4° to 68°F), see Plot C |
| **NISS traceable certification** | Available for temperature only at additional charge; temperature range -20° to 70°C (-4° to 158°F) |
| **Battery life**               | 1 year typical use |
| **Memory**                     | UA-003-08: 5K bytes (approximately 3.5K combined temperature and light readings or events)  
UA-002-64: 64K bytes (approximately 28K combined temperature and light readings or events) |
| **Materials**                  | Polypropylene case, stainless steel screws, Buna-N o-ring |
| **Weight**                     | 18 g (0.6 oz) |
| **Dimensions**                 | 58 x 33 x 23 mm (2.3 x 1.3 x 0.9 inches) |

The CE Marking identifies this product as complying with the relevant directives in the European Union (EU).
## Specifications

Specifications are subject to change without notice.

### Sensor specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Velocity measurement</strong></td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>Electromagnetic</td>
</tr>
<tr>
<td>Range</td>
<td>0 to 6.09 m/s (0 to 20 ft/s)</td>
</tr>
<tr>
<td>Minimum water depth</td>
<td>3.18 cm (1.25 in.)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±2% of reading ±0.015 m/s (±0.05 ft/s) 0 to 3.04 m/s (0 to 10 ft/s); ± 4% of reading from 3.04 to 4.87 m/s (10 to 16 ft/s)</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.01 value &lt; 100; 0.1 value &lt; 1000; 1.0 value ≥ 1000</td>
</tr>
<tr>
<td>Zero stability</td>
<td>±0.015 m/s (±0.05 ft/s)</td>
</tr>
<tr>
<td>Material</td>
<td>ABS, glass filled</td>
</tr>
<tr>
<td>Enclosure rating</td>
<td>IP68</td>
</tr>
<tr>
<td>Dimensions (L x W x H)</td>
<td>11.9 x 4.3 x 6.3 cm (4.7 x 1.7 x 2.5 in.)</td>
</tr>
<tr>
<td>Cable material</td>
<td>Polyurethane jacketed</td>
</tr>
<tr>
<td>Cable lengths</td>
<td>1.5, 6.1, 12.2 and 30.5 m (5, 20, 40 and 100 ft)</td>
</tr>
</tbody>
</table>

### Depth measurement

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>Diaphragm type: absolute pressure with single point calibration</td>
</tr>
<tr>
<td>Accuracy (static)</td>
<td>The larger of ± 2% of reading or ± 0.015 m (± 0.504 inches). Steady state temperature and static non-flowing water.</td>
</tr>
<tr>
<td>Range</td>
<td>3.05 m (0-10 ft)</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.01 value &lt; 100; 0.1 value &lt; 1000; 1.0 value ≥ 1000</td>
</tr>
</tbody>
</table>