FY 2013 Noncompetitive Tribal Projects for Restoration and Protection of Puget Sound

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

Project Deliverable:
Beaver Relocation Strategy Report

Tulalip Tribes
March 20, 2015

Summary
In 2012 the Tulalip Tribes implemented a project to investigate the ecological benefits of beaver in the Snohomish River Basin. Beavers can improve the ecological structure of riparian forests, provide greater flood abatement, increase groundwater recharge, provide habitat for fish and wildlife, and improve water quality. The Tulalip project aimed to assess a subset of these ecological effects to identify the benefit of placing and maintaining of beavers in the forested landscape. Project goals included identifying the extent of the current beaver population within the Snohomish Basin, monitoring ecological benefits, and evaluating the feasibility of relocation strategies including identifying potential relocation sites. This report provides a comprehensive overview of the steps and considerations necessary to implement a beaver relocation program. It addresses monitoring over the course of this and the previous grant. The report also identifies some of the initial results of beaver relocation success and site modification that have been observed to date, and provides insights on what we found to be successful (and not successful) strategies for implementing this project.

Introduction

The Sky Beaver Project was initiated in December of 2012 and the field component of the project commenced in June 2013. The first steps in the project were to map potential beaver habitat using a habitat suitability index (HSI) or Intrinsic Potential model, which was developed by NOAA Northwest Fisheries Science Center for this purpose. From the HSI, the project team ground-truthed all high priority areas of the model and explored additional areas outside model predictions for project site selection. Ground truthing allowed for site selection, prioritization of release sites, and initiation of project monitoring. A suite of monitoring metrics have been employed to elucidate the biotic, abiotic, and physiographic aspects of each site. This data is being used to evaluate pre-release ecosystem properties and compare them to post-release trends. The trapping and relocation portion of the project, which was funded as part of this grant, commenced in 2013, with actual relocation occurring in the fall of 2014. This report summarizes both the initial project efforts (funded by EPA's FY11 grant), and also the second portion of the project, which consists of beaver trapping, husbandry, relocation, and post-release monitoring. Together, this report describes the complete process of beaver relocation, from initiation of project planning to the very last step, monitoring of post-release beaver benefits.

Steps in the beaver relocation

The relocation process can be divided into three main project actions: 1) Site selection and relocation preparation, 2) Trapping, holding, and release of beavers, and 3) Post-release monitoring. These categories and the individual steps required within each category are identified in Table 3. Tulalip staff and a broad group of project partners performed worked together to accomplish these goals. The project has currently completed steps 1-6. An initial round of trapping, release, and post-monitoring release has occurred at half of the pre-selected release sites. Future efforts will continue relocation and supplementation of beavers into the Skykomish.

Table 1 12 steps towards a successful beaver relocation program

Site selection and preparation
1. Develop HSI
2. Evaluate site conditions, habitat suitability, occupancy, and accuracy of model
3. Characterize population
4. Identify potential sites & initiate pre-release monitoring
5. Select release sites and prioritize based on constraints
6. Perform site preparation
Trapping and release effort
7. Coordinate with jurisdictions & landowners to find beaver conflict sites
8. Trapping
9. Housing & animal care
10. Relocation
Post release monitoring
11. Revisit sites to identify relocation success
12. Conduct post-release monitoring

Site selection and preparation

Step 1. Developing a beaver intrinsic potential model

A beaver intrinsic potential (BIP) model was developed for the Skykomish Basin with the intent of identifying high quality beaver habitat (Figure 1). The purpose of the beaver intrinsic potential model was to determine where beaver populations are most likely to be present or where high quality beaver habitat is likely to exist. The Intrinsic potential model used a number of environmental variables and site conditions known to be preferable for beaver colonization. These variables included stream slope, floodplain width, stream power, bankfull width, and similar predictors. The model covered the entire Skykomish Basin and predicted habitat suitability within mapped stream reaches. The project focused primarily lands owned by the US Forest Services, which comprises most areas in the North and South Forks of the Skykomish River Basin.

Model results showed that 23% of Skykomish stream reaches are optimal beaver habitat, 10% are moderate beaver habitat, and 8% are adequate beaver habitat. Approximately 60% of streams are not suitable as beaver habitat (Table 2). These streams were most often not suitable due to high stream gradients (>6%). The model was validated for accuracy by comparing model results to field observations at 70 sites. Initial test results indicated that the model accurately identifies beaver habitat correctly 72% of the time (true positive) and disregards non-beaver habitat 58% (true negative) (ANOVA validation: p=.014). These model results were sufficient to allow us to identify many potential beaver relocation sites. In some cases, while it did not identify a specific site, it allowed us to identify an area where further searching was warranted. About a third of the sites that we identified were found in this way.

Table 2 Beaver intrinsic potential model results for stream reaches within the Skykomish River Basin.

Suitability	stream segments	Length (km)	%
High	11768	1,202.48	23.2%
Moderate	4987	497.22	9.6%
Low	5058	398.90	7.7%
Not suitable	26584	3,082.56	59.5%
Total	48397	5,181.17	100.0%

Step 2. Evaluate site conditions, habitat suitability, and occupancy.

Following initial assessment of sites, all sites were rated for suitability as beaver habitat. A site-release scorecard was used to quantitatively rate each site's level of habitat suitability and potential as beaver habitat (see Site Suitability Rating Form in appendix). Wildlife cameras were deployed to assist with assembling site usage data by predators and to verify absence of beaver. This provided 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 were checked every 2 months, at minimum. Images were downloaded on a regular basis and presence/absence of beavers, predators, and other wildlife was noted. Hydrologic conditions, if visible, were noted. This included high water, snow, frozen water, etc. The majority of high suitability habitat was located in the floodplain area of the north and south folk of the Skykomish River. However, there also were larger areas of suitable habitat along the large rivers flowing into the Skykomish, including the Beckler, Foss, Money, Tye, and Miller Rivers. Suitable off-channel wetland habitat was also found in some of these areas.

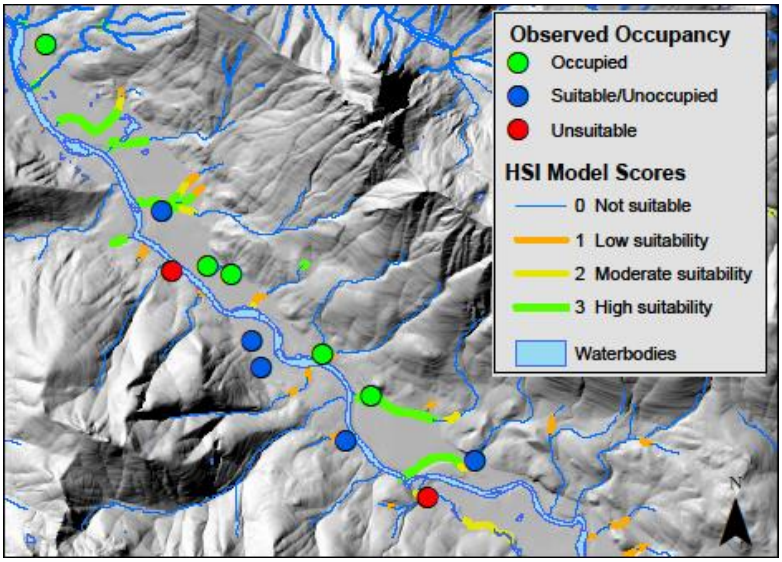

Figure 1 Example of field observations of beaver presence-absence, and BIP model scores on the South Fork Skykomihs River.

Each site was thoroughly evaluated for previous beaver activity. In more than 80% of the sites that the model predicted as being high quality, there was evidence of beaver sign in the form of old chew sticks. It was difficult to determine the age of these sticks, some of which may have been preserved for quite a long time, being submerged. A significant number of sites also showed evidence of beaver structures, either dams, bank dens, or lodges. Some sites had structures present that appeared to be less than 5 years old. In these sites, dam condition was assessed to determine beaver presence. In some cases, the dams were notched to see if a potentially present beaver would rebuild it. In no case were dams rebuilt. Wildlife cameras were also deployed at sites where there was a potential for occupation. No beavers were identified. However, a variety of wildlife was observed, including raccoons, coyotes, bobcat, and bears. Historic beaver structures were evaluated and described as well as possible. If they represented a large area or impounding structure, the total size was noted with GPS points on all edges. If they were small structures, one single point was collected to identify these features.

Within the areas that we focused on, approximately half of the sites with high quality habitat were not occupied by beaver and were suitable for relocation. Further ground truthing is required to determine whether these observations are seen in other areas of the Skykomish.

Based on our experiences and results of the data, we feel that the process of identifying optimal release sites could be formulated to allow others to utilize a similar strategy. An publication is in preparation that identifies the general steps for how to produce a suitability model for any area in the pacific Northwest with similar constraints as the Skykomish. This is a necessary step in site selection, so some degree of technical ability is required. Nevertheless, if individuals desired to implement this process, they could work with local NGOs, tribes, or similar groups to develop a model, which is fairly straight forward. Ground truthing of sites that the model identifies as suitable is straightforward; the use of a site scorecard helps to confirm that sites meet minimum criteria for suitability. Presence of old beaver structures at abandoned sites is usually sufficient to indicate suitability, making these sites priorities for groups wishing to expedite the relocation process. Ensuring that beavers are not currently present at the site is important, and confirmation of absence can be difficult. By thoroughly surveying the upstream and downstream reaches, and watching for new sign over time, it is possible to assume absence with fairly high confidence.

Step 3. Population characterization

The large number of suitable, unoccupied stream reaches in the Skykomish River indicates that a relocation program is both possible and warranted. This is further supported by the large number of sites that contained evidence of historic beaver use. Over the course of two years, we conducted thorough site assessments at approximately 80 sites. This information provides baseline data to suggest that populations within the Skykomish Basin remain below carrying capacity. Information that we gathered there was sufficient to allow us to implement the following steps of the beaver relocation strategy. However, further characterizations in areas outside of our core research area need to be conducted before of basin-wide population estimate can be completed.

Step 4. Identify potential sites & initiate pre-release monitoring

The process of site selection was iterative. The BIP model initially informed and directed the site selection process. However, it eventually became evident that the HSI was limited by the poor spatial resolution of the input data. While some sites were identified using the model, most were found by extensive ground truthing. Hundreds of potential sites were evaluated using orthoimagery and model data, and over 80 sites were ground truthed by walking stream sites. In all, 30 sites were originally selected. A number of these were recently excluded as these sites dried out during an unusually warm and dry summer. Beavers may be able to colonize these areas in the spring or fall when hydrology is present, but these sites prohibit continuous monitoring. At the end of the project, there are at least 23 sites with confirmed perennial streams. Additional sites are currently being explored.

The following metrics were recorded at each site and are also described in Table 3:

- Site sketch: A site sketch was completed at each site at the beginning of monitoring. It included the position of loggers, inputs, flow, and other relevant information.
- Amount of water impounded within the site: Water impoundment was evaluated using quantitative and qualitative metrics. If only normal streamflow was present, it was described qualitatively. If there were factors impounding flow, such as old beaver dams, debris jams, or similar morphological contributors, impounded area were be evaluated using a range finder.
- Bank-full widths (BFW) cross sectional measurements every 100 meters of site. Locations were recorded using a GPS. BFW/OHWM determination were performed using US EPA (2004) bankfull assessment methodologies.
- Description and area of wetlands were arranged by Cowardin type (forested, scrub-shrub, emergent, open water). Any changes in site conditions were recorded as they occurred.
- Location of surface water and groundwater inputs: Inputs were noted by GPS and included on GIS maps and databases.
- Location of historic beaver structures. Historic beaver structures were evaluated and described as well as possible. If they represented a large area or impounding structure, the total size was be noted with GPS points on all edges. If they were small structures, one single point was collected to identify these features.
- Site sketch: site sketches were completed at the beginning of monitoring. They included the position of loggers, inputs, flow, and other relevant information.
- At least one photopoint per site, documenting site conditions over time and overall change to the site if it was a future release site.

Table 3 Monitoring metrics and their purpose

Category	Metric	Purpose
Hydrogeomorphic	Stream gradient	
	Dominant stream substrate	Habitat suitability estimator
	Floodplain width	Habitat suitability estimator
	Stream Ordinary High Water Mark	stream width monitoring
	Stream wetted width	stream width monitoring
	Pool-riffle presence	Habitat suitability estimator
Vegetation community	Plant list	Site characterization, food availability estimate
	Photo-points	Community change
	Plant structure characterization	Habitat suitability estimator
Previous occupation	Active (or recent) site determination	Habitat suitability estimator
	Historic beaver use (structures, sign)	Habitat suitability estimator
	Wildlife cameras	Beaver presence, Wildlife presence
Weather	Observations	Site characterization
Temperature	Stream temp	Site characterization, Temp change above/below dam
Hydrology	Stream discharge	Flow volume, Flow partitioning
	Groundwater height	Characterize GW storage

Step 5. Select release sites and prioritize based on constraints

Determination of release sites was done using a randomized selection methodology to ensure that monitoring data was not biased. The 30 monitoring sites were divided into 15 control sites and 15 release sites. For monitoring purposes, our statistical design dictates that all sites are considered control sites until successful beaver colonization is confirmed. In the fall of 2014, beavers were released at seven of the release sites. While the initial selection of release sites was random, the order in which colonies were released was not. Site-specific considerations, such as elevation, were used to determine where to release at first. Higher elevation sites were targeted first to allow the new colonies sufficient time to accumulate a supply of forage food for the winter. Lower elevation sites, especially those that receive small amounts of snow were selected for later releases. We were not able to evaluate or incorporate ecological interactions such as predation pressure in the prioritization due to the sparse amount of information about predator abundance in the area. Currently, there are only range maps for many predator species known to inhabit the area and rely on beavers.

Step 6. Perform site preparation

Some site preparation was completed at each site to increase the success rates of relocation. This primarily consisted of constructing temporary lodges at each site. The temporary lodges were constructed with downed logs and other dead woody debris found at the site. The purpose of the lodge was to provide initial protection for the beavers during the first few hours of release. Past relocation efforts have shown that by providing a safe place for a newly release beavers, long-term relocation success is increased. The temporary lodges were placed near historic beaver structures such as dams or near open water. While no other preparation was done for this project, it is likely that success could be further increased by increasing ponded area by impounding stream flows with small natural dams. This technique could be employed by future restoration and relocation projects but was not explored as part of this project due to the onerous permitting process that would have been required.

Trapping, holding, and release

Step 7. Coordinate with jurisdictions & landowners to find beaver conflict sites

Over the course of the 2014 trapping season, we coordinated with at least 16 landowners and a large number of regional governments and nonprofits. Coordinating with local governments proved to be more efficient than with landowners, as these entities often had a better idea of the number of beavers present at problem sites and the degree of effort that might be required to trap those beavers. When working with landowners, we made great efforts to ensure that we only trapped animals that could not be managed non-lethally onsite. We coordinated with these individuals closely, and in some cases, spent a large amount of time offering technical advice and assistance.

While we initially considered coordinating with beaver trappers to acquire source beavers, we had a difficult time finding willing participants. Over of the course the project, we contacted around 10 different trapping companies. Some companies were not interested in participating for unspecified reasons. A number of trappers initially indicated that they were interested in coordinating, but this turned out to be logistically unfeasible. At least one trapper was interested in participating but only if they would receive a payment for each beaver. While a nominal payment may have been appropriate, this particular trapper wanted $400 per beaver, which was not realistic.

Step 8. Trapping

Beaver trapping was usually conducted by two trapping crews; one crew focused on areas to the north, primarily in Snohomish county, and the second crew focused on areas to the south in king county. A total of six traps were used, with 3 per crew. Traps were usually deployed at dusk and were checked just after sunrise, if possible. In areas with high levels of beaver activity, such as those experiencing intense beaver conflict, trapping success was generally high. In other cases, while fresh beaver sign and construction was observed each day, beavers were trap-shy and unwilling to investigate the traps. This may have been due to a behavioral cue; some report that beavers become less territorial in the fall and may be less likely to respond to trap scent at these times. We deployed wildlife cameras at each trapping site to observe beaver activity and behavior. While we used a variety of lures, trap placements, and trapping strategies, we failed to detect any trapping trends by location, level of development, or other descriptor. Most beavers were trapped within rural and suburban areas that had intact wetlands or streams with large buffers. Over the course of the 2014 trapping season, we captured 26 beavers at 11 sites. In most cases, we captured only a portion of the family and it’s likely that the remaining beavers will continue to maintain a system where we trapped.

Step 9. Housing & animal care

Captured beavers were held an animal husbandry facility located at the Tulalip fish hatchery. The purpose of animal holding was to increase overall relocation success. Previous relocation projects have documented that families that are relocated together, or individuals that are paired and released together, have a higher likelihood of staying at the release location than individual beavers. An effort was made to hold beavers for no more than 14 days, since longer durations of captivity tend to increase stress level. In some instances, beavers were held for longer if pairing the beaver proved to be difficult. Beavers were held as family units or pairs, with one family or pair per enclosure. Beavers were offered rodent food in pellet form, as has been commonly done in previous relocation projects. However, more often, beavers preferred to eat shrubs that were placed in each enclosure, which most commonly consisted of salmonberry, vine maple, and alder.

Step 10. Relocation

In 2014, 24 beavers were released to 6 sites within the Skykomish. At each release site, beavers were placed into temporary lodges as described in Step six. Wildlife cameras were placed at each site to monitor presence and behavior. Beavers are transferred in an IACUC approved vehicle as family units or as a pairs. In most instances, relocated beavers appeared healthy and reactive during relocation. In one instance, one member of the relocated pair appeared to have fallen into a stress induced malaise. This individual had been previously treated at PAWS Wildlife Center by veterinarians there. The animal had been originally captured at a construction site where it had been trapped in a detention pond with little food available. The original health of this individual was questionable, and it was likely that the stress of trapping, holding, and relocation was too much for it. This individual was later found dead in the temporary lodge. There was also moderately high mortality of the kits that were relocated, which has also been seen in other relocation projects. The cause of mortality of the kits is unknown. It could be due to exposure, stress, lack of care from the stressed adults, a combination of these factors, or reasons completely different. Multiple projects have documented low success for relocation of kits. It might be possible to increase success by holding kits longer, but increased holding time reduces success for adult and juvenile beavers; most have chosen to hold families for as little time as possible.

Post release monitoring

Step 11. Population monitoring

After relocation, beaver site occupancy was verified monthly. Table 4 presents a list of sites along with relocation success at the seven sites where relocation was conducted this past year. Sites were scheduled to be replenished if predation/emigration occurred and beavers were not found within 0.5 km. This was only possible at one site in 2014, since any subsequent relocations would have been too late in a season. Three sites continue to retain beavers, with presence documented both by continued dam building and occasional captures on the wildlife camera. We feel confident that there are no beavers at two sites (i.e. OT01, FS03), since there is no sign or detections by the wildlife camera. Presence at the final site remains questionable. While there's been no physical sign, either by herbivory or dam-building, there has been an occasional capture of a picture of a beaver from the wildlife camera. It is possible that this is one of the beavers released at the site, or is also possible that it could be a roaming member of one of the other room relocated families, which is fairly close (~1 km).

Table 4 Site list including impact by release site status

ID	Stream	Release Suitability	Released	Activity Seen Since Release?
BK01	Beckler tributary	Suitable		
BK02	Beckler tributary	Suitable		
FS01	Burn Creek	Suitable		
FS02	First Site	Suitable		
FS03	Foss trib	Suitable	2014	No
SY01	Klinger	Suitable		
MR01	Miller trib	Suitable		
MR02	Miller trib	Suitable		
MR03	Miller trib	Suitable		
MN01	Money Creek	Suitable		
MN02	Money trib	Suitable	2014	Yes
NF01	N. Fork Sky trib	Suitable		
NF02	N. Fork Sky trib	Suitable		
OT01	Olney tributary	Suitable	2014	No
OT02	Olney tributary	Suitable	2014	Yes
OT03	Olney tributary	Suitable		Yes
OT04	Olney tributary	Suitable		
RR01	Rapid river trip	Suitable		
RR02	Rapid river trip	Suitable		
SF01	S. Fork Sky trib	Suitable		
SF02	S. Fork Sky trib	Suitable	2014	No
SF03	S. Fork Sky trib	Suitable		
SF04	S. Fork Sky trib	Suitable	2014	No
TY01	Tye Tributary	Suitable		

Step 12. Conduct post-release monitoring
Monitoring continues to be done at both release and control sites. Sites are mapped using GPS to record changes in surface water area. Up to 5 temperature loggers were installed at each site to collect hourly stream temperature to calculate 7DADmax for the duration of the project, and will be compared to reference streams and baseline data. Reduced peak flow and scour potential will be assessed by tracking of physical change to the site including increase in sinuosity, roughness, LWD, and elements that encourage sediment precipitation. Flow will be measured using the hydrograph separation method to evaluate maintenance of summer base flow.

Many of the hydrogeomorphic parameters assessed allowed for a characterization of potential current and future beaver habitat. These, along with vegetation data provided details necessary to evaluate site changes. These included the following quantitative and qualitative metrics:

- Amount of water impounded within the site: Water impoundment was evaluated using quantitative and qualitative metrics. If only normal streamflow was present, it was described qualitatively. If there were factors impounding flow, such as old beaver dams, debris jams, new dams or similar morphological contributors, impounded area was evaluated using a laser distance device or orthoimagery.

- Bank-full widths (BFW) cross sectional measurements were recorded at flow collection points. Locations were recorded using a GPS. BFW/OHWM determinations were performed using USEPA (2004) bankfull assessment methodologies.
- Location of surface water and groundwater inputs: Inputs were noted by GPS and were included on GIS maps and databases.

At the time of publication, there was insufficient data to report any significant trend for this report. We are pleased to see that initial beaver activity at our release sites are changing the hydrology of these systems. However, at least a full season of post-release data is needed before data can provide any meaningful conclusions. This is especially true for temperature data, since summer dry season is most important, and we have not yet completed a full year's cycle to include that time period yet.

Defining current and future success

A number of existing and past relocation projects located both in Washington and the Inter-mountain West have used various success criteria when evaluating beaver relocation. For Tulalip's Sky Beaver Project, success will be defined as the following:

- Double the surface area of water in colonized impoundments,
- Increase the complexity of stream morphology (statistically significant),
- Increase habitat heterogeneity (statistically significant),
- Increase potential for ecological resilience, groundwater recharge, and moderation of peak flows; all for climate adaptation,

Success will be achieved through the following measures:

- Monitor and adaptively manage sites and populations,
- Continue collaboration with regional beaver management practitioners,
- Work with public to ensure colonies do not become 'nuisance' sites .

We're encouraged by the fact that we're nearing our success criteria at three of the sites where we have relocated beavers. In particular, at one site, relocated beavers built a dam at the outlet of an alpine lake, raising the water by approximately 3 feet. The approximate surface area of the lake is 275 acres, meaning that this beaver colony has increased water storage by at least 825 acre-feet or 2.69 million gallons. For reference, using Wetzel's (2001) estimates for average discharge, small perennial streams (1^{st}-4^{th} order) might have a total annual discharge of 400,000 to 3 million gallons. The increased storage that these beavers created at this single site is likely sufficient to convert a small stream from seasonal to perennially flowing, and will have substantial benefits during summer low flow periods. These results go well beyond stated success criteria. This demonstrates that our long-term goals are achievable and that the overall purpose of this effort, to develop a conservation and climate adaptation strategy is within reach. Existing funding sources are in place to allow us to continue this work and increase the number of sites where we will be relocating beavers in the future. Currently this project is scheduled to relocate beavers and conduct posts release monitoring efforts until at leased 2017. Each mating pair has the potential to increase to 300 individuals over the course of 10 years, offing many times more restoration power than the original relocated pair. It is our hope that after 10 years, colonies will be well established, increasing long term survival & dissemination.

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Appendix

Monitoring Methodologies, previously described in DOE FY11 Grant

Sites were 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 was be given an initial site characterization, continuous temperature probes were installed, and surface flow and groundwater levels were monitored. Sites were evaluated monthly throughout the grant period to establish baseline monitoring data at each site. Baseline data collected includes water temperature, characterization of the flow regime, surface water-groundwater interactions, and habitat quality.

Data collection was conducted by Tulalip staff, consultants, field technician, and volunteers. Dittbrenner Environmental was sub-contracted to assist with the data collection effort. Data was collected to assess the conditions across headwater riparian areas within the Skykomish River watershed, and long-term monitoring sites were established for assessing and tracking long-term changes in these areas. At selected sites, hydrological conditions were assessed utilizing temperature assessments, flow measurements, and groundwater characterization, biological data and habitat quality were collected in the study stream corridors. Monitoring sub-tasks were as follows:

Vegetation Community

The vegetative community was characterized qualitatively at each site to document conditions at the start of the project, to document ecosystem structure, and to evaluate food availability for beavers. At planned release sites, the community was evaluated much more thoroughly using orthoimagery. This information will be included in a subsequent grant report (FY13). Wetlands were classified using the Cowardin system (Cowardin et al. 1975). The area of wetlands by Cowardin type (forested, scrub-shrub, emergent, open water) and any changes in site conditions were recorded as they occurred. At least one photopoint was designated per site, documenting site conditions over time and overall change to the site.

Weather

Weather observations were collected at each site location when discharge was collected. This information was cross-referenced with nearby NOAA National Weather Service weather stations.

Stream Temperature

A combination of Hobo ProV2 and Tidbit continuous water and air temperature sensors were used. One logger was placed in the stream at the upper and lower extent of the site. Air loggers were placed within the core area of the site in some cases. Additional loggers were placed at locations where there was a substantial surface/ground water input or other source of temperature alteration. Temperature measurements were collected continuously, every 30 minutes and will be converted to seven-day averages of the daily maximum (7DADMax) for analysis.

Hydrology:

Hydrologic monitoring efforts included stream discharge and groundwater height. Hydrology is a key driver of riparian ecosystems and expanding both the spatial and temporal coverage of hydrological monitoring within the study sites will provide several major benefits: (1) improve our understanding of existing physical and biological patterns within the headwater riparian areas of the Skykomish, and (2) provide baseline and response data to evaluate future beaver release efforts

With these benefits in mind, we collected surface water discharge monthly at or near temperature logger locations. Discharge was 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). Piezometer wells were installed at select sites and groundwater height was monitored monthly. Groundwater is not a monitoring metric identified in this grant. It was added in a subsequent grant proposal, but is included here to provide continuity.

Site Release Scorecard

Release Site Score Card -- Snohomish Basin Beaver Project

Site ID________________________ Date_______________________

Pneumonic site reminder ____ Observer____________________

GPS Coordinates_UTM (NAD 83) ____ Subwatershed________________

Lat Long____________________________ Location Description ______________________________________

Elevation ____________________________ Estimated OHWM ____

Beaver Activity (circle): Absent Old Some sign present Active dams w/in area Rating site w/in complex Other__________

Stream Gradient of the defined habitat unit

_______ 5. ≤3% 3. 4-6% 1. 7-9% 0. ≥9%

Stream Flow

____

Low Flow (fall)

Winter High flow	garden hose	fire hose	30"culvert	un-wadeable
garden hose	1			
fire hose	3	4		
30"culvert	4	5	5	
un-wadeable	1	2	1	0

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

_______ 5. Silt/Clay/Mud 2.Sand 1. Gravel 0. Cobble -1. Boulders -3. Bedrock

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**

Sketch on back (include location of rating), Narrative description of site and notes/ Photo ID# /

Last Updated: October 14, 2014

Temperature Logger Deployment Form

☐ Data uploaded?
☐ Form scanned?

Temperature Logger Deployement Form

Last updated: 7/9/14

Temp Probe Number	Serial number
Date	Time
Site Name	Sample Location
UTM_E	UTM_N

		Water Air
Observers	Depth of log placement?	Logger type (circle one)

Site placement Description

Site sketch

Retrieval	Date	Time
Condition/Notes		

Flow Discharge Collection Form

☐ Data uploaded?
☐ Form scanned?

Flow Measurement Data Sheet

Last updated: 10/11/14

Date	Time
Site Name	Sample Location
UTM_E	UTM_N

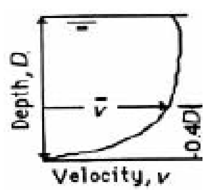
Observers	Air Temp	Weather (days precip,condition)	Other

Wetted stream width, OHWM	Staff guage reading (meters)

cell	X -Collection Point (ft)	Y - depth (tenths ft)	Z –velocity Ft/s (.6 or .2&.8)	Discharge (do not populate)	notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

General Notes:

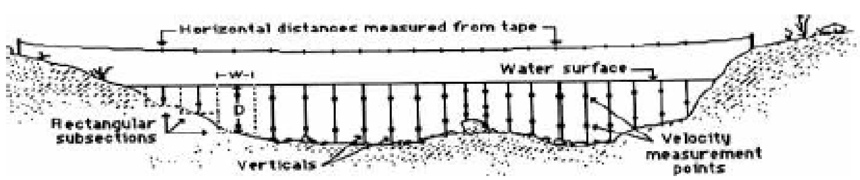
Inches	Tenths foot
1	0.08
2	0.17
3	0.25
4	0.33
5	0.42
6	0.50
7	0.58
8	0.67
9	0.75
10	0.83
11	0.92



Colletion guidance: IF YOU RUN OUT OF BATTERIES DURING COLLECTION, MAKE SURE TO RECORD WETTED WIDTH

The width of the subsections can be variable across the cross-section. Ideally, the stream is divided into sections so that no more than 5-10% of the discharge flows through any subsection.

The mean velocity is assumed to be 0.6d from the water surface. In deeper streams (> 2.5 feet) you should take a velocity reading at 0.2d and 0.8d and then average those to get mean velocity in a section.



Piezometer Level Collection Form

☐ Data uploaded?
☐ Form scanned?

Piezometer Level Data Sheet

Last updated: 9/10/14

Date	Time
Site Name	Sample Location

Observers	Weather (air temp, days precip,condition?)	Staff guage reading (meters)

	Well ID	Well Top Reading	Wetted Reading	Difference	notes
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
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32					
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34					
35					
36					
37					

Collection guidance:

Insert scanned site drawings of each site