THE LANDS COUNCIL

Beaver Re-Introduction in Hangman Creek

An Analysis of Suitable Habitat and Potential Effects of Beaver Re-Introduction in the Hangman (Latah) Creek Watershed

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Abstract: The degradation of the Hangman Creek watershed can be improved from beaver re-introduction. After analysis, we found that 37 stream miles are currently suitable for re-introduction. With at least one colony per stream mile, the watershed can support 185 beaver. At this level, we estimate future beaver activity can store 3,885 acre feet of water, increase late-season flow, reduce phosphorous and nitrogen levels, as well as restore floodplain connectivity. Future dams can store 1.2 to 3.9 million cubic feet of sediment. Potential changes to riparian communities need further study. Following analysis, steps to re-introduction are outlined.

Introduction

Hangman Creek and its tributaries begin in Idaho and flow westward into Washington. The Hangman Creek watershed encompasses approximately 689 square miles (441,000 acres), the majority of which are in the southeastern portion of Spokane County, WA; though the watershed also extends into Whitman County, WA, and Benewah and Kootenai Counties in Idaho. It is also a major tributary of the Spokane River.

The degradation of the watershed has long been documented, and studies have shown that the watershed frequently does not meet Washington State water quality standards for fecal coliform, dissolved oxygen, pH, turbidity, and temperature (SCCD 1994, 1999, 2000, 2009). Agriculture has dominated the Hangman Creek landscape since the early 1900's; and by the 1920's, significant portions of riparian forest had been cut and cleared, stream channels straightened, and wetlands drained to move water quickly off farmable land (SCCD 2009). Since then, many stream meanders have also been lost to road construction. The resulting altered hydrology means flashy flows during winter and spring followed by significant decreases in flow during summer months, making water quantity another issue the watershed faces. The altered hydrology also stresses the stream system with heavy sediment loading and accelerated streambank erosion (SCCD 2009).

The Lands Council (TLC) believes that the re-introduction of beaver into the Hangman Creek (HC) watershed could improve both water quality and quantity issues. Though beaver activity is currently low in this watershed, first-hand accounts from trappers reveal that before the mid-19th century, beaver were abundant in nearly every stream throughout the Northwest (Ott 2003). However, by the 1850s North America's largest rodent was trapped to near extinction for political reasons (Muller-Schwarze and Sun, 2003; Ott 2003). The first objective of this report is to determine current beaver activity and available suitable habitat in the HC watershed. The second is to estimate the potential effects that full-scale beaver re-introduction would have on water quantity and quality parameters. The final objective is to outline a short- and long-term plan for beaver re-introduction that is specific to the HC watershed. The latter will be given following the Methods, Results, and Discussion of the former objectives.

Methods

Current Beaver Activity

To identify current beaver activity in the HC watershed, TLC staff floated Hangman Creek using inflatable kayaks on 16 May 2010 in search of beaver activity from approximately the Rattler Run confluence to the Rock Creek confluence. A Garmin Rino 120 was used to record any beaver or beaver activity sightings. Later in the month, once water levels were too low to float viably, staff members checked for beaver habitat where stream reaches were easily accessible/visible from roads.

Available Suitable Habitat

To identify available suitable habitat for beaver in the HC watershed, Geographic Information System (GIS) software was used. The index utilizes National Elevation Dataset (NED), Transportation Network, and Washington State Watercourse Hydrography to identify slope, elevation, transportation proximity, and stream type. A fifth criteria, vegetation availability, used NAIP Orthorimagery and field checks to determine suitability. These criteria are based on a literature search and are all key to long-term beaver habitat.

Key Habitat Characteristics

- elevation less than 6,000 ft
- low slope grade of 6% or less
- first through fourth order streams (WA Dept. Fish & Wildlife, 2004)
- proximity to major human transportation routes is considered so that habitat near roads is not utilized, decreasing potential flooding or other conflict with the built environment.
- presence of aspen, willow, or other desired riparian vegetation (Allen, 1983; Barnes and Mallik, 1996; Collen and Gibson, 2001; Gurnell, 1998; WA Dept Fish & Wildlife, 2004)

The data for the suitability index was generally available online from state agencies or other repositories of free GIS data. This data was downloaded and pre-processed to ensure a common data projection and coverage over the entire study area.

Data Set Name	Availability
National Elevation Dataset (NED) @ 1 arc second	USGS Seamless Server
Transportation Network	Washington State Department of Transportation
Wahington State Watercourse Hydrography	Washington Deptartment of Natural Resources
Washington Orthoimagery (2009 NAIP)	Washington State Geospatial Data Archive

Table 1. Source of data for the suitability index.

Suitable slope, elevation, stream order, and transportation proximity GIS layers were combined to create one layer of suitable habitat. This layer was used to clip the original stream data layer to eliminate the unsuitable stream reaches and develop a stream data layer that contained only the stream reaches with suitable beaver habitat. For further information on the Habitat Suitability Index methods, see *The Beaver Solution* (2010), available at www.landscouncil.org/documents/Beaver_Project/The_Lands_Council_Beaver_Solution_1mar2010.pdf. To assess available vegetation in the defined suitable beaver habitat in the HC watershed, TLC staff used 2009 NAIP orthoimagery to visually inspect for riparian corridors. A polygon was created to encompass any stream sections with visible riparian corridors, and these polygons were later used to clip the suitable streams layer to an even further defined suitable habitat stream layer. On the 16 May 2010 float down Hangman Creek from Rattler Run to Rock Creek, GPS points were taken with a Garmin Rino 120 whenever suitable vegetation was encountered. When water levels became too low for floating later in the year, TLC staff recorded occular estimates of vegetation availability on Hangman Creek and its tributaries where stream reaches were easily visible from roads. The data recorded during these field visits was compared to the suitable habitat stream layer to verify accuracy of orthoimagery riparian habitat estimates.

Potential Effects of Beaver Re-Introduction

The potential effects of beaver re-introduction can be split into two categories: water quantity and quality.

Water Quantity. Methods and results from TLC's *The Beaver Solution* (2010) were used to estimate the potential effects beaver would have on water quantity in the HC watershed. A literature review yielded the average number of beaver dams per mile in ideal conditions, while field work conducted in 2009 revealed the average surface water and groundwater storage capacity of beaver dams in Eastern Washington. The number of available stream miles, based on the above analysis, was then multiplied by the first two factors to calculate an estimate of water quantity increases from beaver re-introduction. The following equation was used:

$$S \times D \times A = W$$

Where

- *S* is the total available stream miles containing suitable habitat;
- *D* is the average number of beaver dams per mile in ideal conditions, determined by literature review;
- *A* is the average water storage capacity of a beaver dam, determined by 2009 field work;
- then *W* is the total water storage estimate.

To estimate the potential effects on late-season flow, results from *The Beaver Solution* were again applied. In that study, researchers determined the increase in flow over a beaver dam from August to October of 2009. This number was multiplied by the number of dams the HC watershed can support to estimate the watershed-wide effects of beaver re-introduction on late-season flow. Again, for further information on the methods used, see *The Beaver Solution* (2010).

Water Quality. The effects of beaver activity on the surrounding environment have been widely studied. A literature review was therefore conducted to estimate the effects beaver activity would have on water quality in the HC watershed. The following water quality parameters were reviewed: phosphorous levels, nitrogen levels, sediment levels, riparian community structure, and floodplain connectivity. These parameters were chosen because it is believed these are the areas where beaver activity will show the greatest benefit.

Results

Current Beaver Activity

Beaver activity was noted twice during field reconnaissance. On the 16 May 2010 float, a beaver was seen swimming in Hangman Creek, between Rattler Run and Rock Creek confluences. During ocular estimates by vehicle, a newly built beaver dam was noted on California Creek, near its confluence with Hangman Creek. See Figure 1 for more details.

Available Suitable Habitat

After suitable slope, elevation, stream order, and transportation proximity were calculated, nearly the entire watershed met criteria. Suitable habitat in Hangman Creek and its annual tributaries spans approximately 179 stream miles. After vegetation analysis of these, we identified approximately 37 stream miles to be currently suitable for beaver relocation. This is approximately 20% of the watershed. See Figure 1 for more details.

Hangman Creek Suitable Beaver Habitat

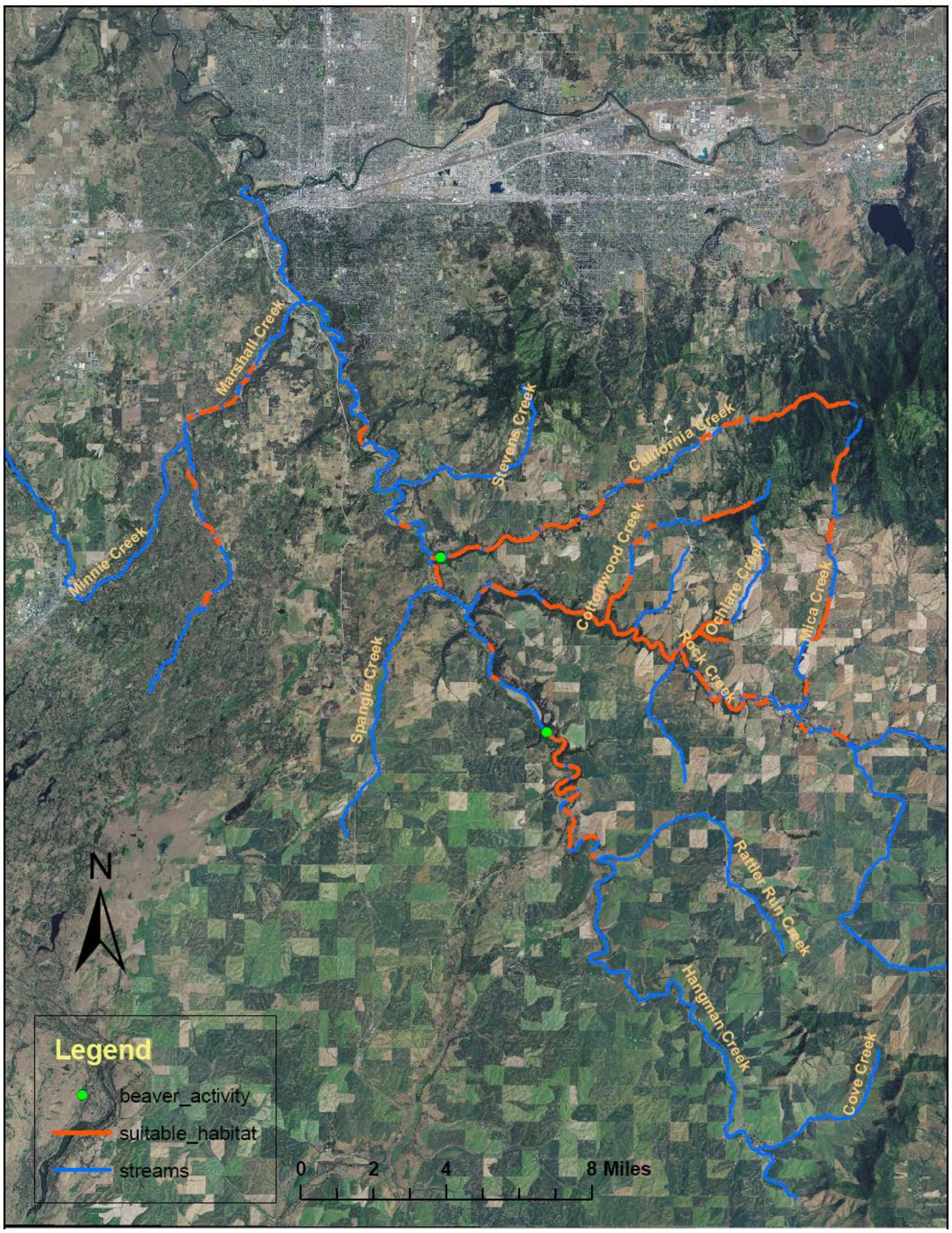

Figure 1: Map of current suitable beaver habitat and current beaver activity in the Hangman Creek watershed.

Potential Effects of Beaver Re-Introduction

Water Quantity. In the equation, S x D x A = W, the following numbers were used:

- Total available stream miles, *S*, is 37, from the available suitable habitat results.
- Literature review revealed two estimates on *D*, beaver dams per mile. Naiman et al. (1988) showed an average of 11 dams per mile in ideal conditions in Minnesota. Howard and Larson (1985) showed in excellent habitat an average of 1.25+ *colonies* per mile in Massachusetts. This was converted to *dams* per mile using TLC's mean dams per colony, 3.73, in the 2009 study of beaver habitat in Eastern Washington. So the second estimate, 1.25 x 3.73, became 4.66. The lower estimate, rounded up to 5 dams per mile, was used in calculations.
- In 2009, TLC determined that in Eastern Washington beaver dams store an average of 21 acre feet of water in surface water and groundwater combined. This was used as *A*, average water storage capacity.

The following calculation gives the final water storage estimation, *W*:

37 x 5 x 21 = 3,885 total acre feet of water storage

The average increase in late-season flow, determined by TLC's 2009 research, was 0.0022 cubic feet per second (cfs). With 37 stream miles and 5 dams per mile, we estimate a 0.41 cfs increase in flows in the HC watershed in the late summer and early fall.

Water Quality.

<u>Phosphorous Levels</u>

Naiman et al. (1994) studied the standing stocks of various chemical elements in a beaver-influenced drainage. Samples were taken from organic soil horizons in beaver ponds, wet meadows, moist meadows, streams, and riparian forests. The results show that total phosphorous (P) increased by 43% from 1927 to 1988, which was caused by beaver activity in the drainage during those years.

<u>Nitrogen Levels</u>

Again from Naiman et al. (1994), total nitrogen (N) in various organic soil horizons increased from 1927 to 1988 by 72%. Nitrate and ammonium (NO3 and NH4), the plant-available forms of nitrogen, increased by 208 and 295% respectively. For both P and N retention, these results are echoed in other research that shows chemical elements increasing in sediment that is retained by beaver ponds (Collen & Gibson, 2001).

<u>Sediment Levels</u>

Naiman et al. (1988) shows that even small dams are able to retain 6,560 to 21,320 cubic feet of sediment. With 37 stream miles at 5 dams per mile, beaver dams could retain 1,213,600 to 3,944,200 cubic feet of sediment.

Riparian Community Structure

Beaver damming raises the water table, which causes significant changes in riparian ecosystems. Foraging by beaver also causes significant changes in riparian communities. Flooding from dams would inundate surrounding vegetation and subsequently kill off any plants that cannot tolerate such prolonged flooding. The edges of ponds create favorable environments for hydric grasses, sedges, and rushes, as well as willow and alder species (Rossell et al. 2005). Foraging is concentrated on hardwood species: preferred species include aspen, willow, and alder. These species may be virtually clear-cut, opening the riparian zone to more sunlight and shifting vegetative dominance to non-browsed trees, shrubs, and root suckers of aspen and willow. This results in an initial reduction in riparian vegetation height and a shift in biomass partitioning (Naiman et al. 1988). TLC is currently undergoing a long-term study of plant community changes in the riparian zone before and after beaver re-introduction to further characterize these effects.

Floodplain Connectivity

Many articles show the positive effects of beaver damming activity and floodplain connectivity, though it is difficult to quantify. For example, Woo and Waddington (1990) found that in areas of low slope, river flow is diverted into sub-channels which can become a permanent part of the landscape. These multi-channel systems restore stream meanders, helping to attenuate floods and storing additional water temporarily (Gurnell 1998). The raising of the water table also serves to enhance floodplain connectivity (Johnston and Naiman 1990, Lowry and Beschta 1993, Collen and Gibson 2001, Fouty 2008).

Discussion

After analysis, it appears that 37 stream miles in 689 square miles of the Hangman Creek watershed are currently suitable for beaver re-introduction. Suitable habitat is concentrated in California Creek and Rock Creek, as well as areas of Hangman Creek, primarily between the Rattler Run and Rock Creek confluences. Tributaries of Rock Creek also contain significant suitable habitat. It is important to prioritize sites to begin re-introduction by locating receptive land managers/owners and by enacting specific vegetation checks at any potential site. A suitable stretch of California Creek is owned by the Department of Natural Resources and would be a good place to start, given that working with private landowners can be more unpredictable.

With each stream mile capable of supporting at least 5 beaver dams, and each beaver colony maintaining and average of almost 4 dams, it is safe to say that each suitable stream mile can support one beaver colony. With a mean colony size of 5.2 $\pm$ 1.4 S.D. (Rosell et al. 2005), this means that Hangman Creek and its tributaries can currently support approximately 185 beaver. During field reconnaissance, a lack of aspen was noted. Care should be taken to plant aspen and willow throughout the watershed to ensure availability of plants that easily regenerate after beaver activity.

Results indicate that beaver re-introduction in the Hangman Creek watershed holds enormous potential in increasing water storage and late summer flows, reducing phosphorus, nitrogen and sediment levels in the water column, altering the riparian zone, and enhancing channel meander and floodplain connectivity. The increase in P and N in the sediments of beaver ponds indicate that these nutrients are no longer as prevalent in the water column and are stored for longer periods in sediment. By reducing these nutrients in the water, the potential effect is a reduction of aquatic plant growth, resulting in less demand for dissolved oxygen. An increase in sedimentation in beaver ponds will also have the effect of reducing turbidity, therefore improving fish habitat. TLC's research and field reconnaissance indicates that, contrary to popular belief, large channel width in numerous reaches of Hangman Creek would not prohibit successful beaver dam establishment and maintenance. Similarly, the leaky nature of beaver dams would allow some water to penetrate during flood events and spring runoff, thereby allowing for overall structural integrity of dams. TLC also believes that beaver ponds will raise water levels and re-connect incised channels to adjacent agricultural lands. This offers huge irrigation benefits to farmers, and is an educational angle that must be pursued.

Results on water quantity and quality effects are estimates and can be better understood with more detailed experimental design and field work. TLC is currently undergoing the beginning of such a project, collecting detailed vegetation and water quality and quantity information at sites in Eastern Washington that will later become beaver re-introduction sites.

Steps to Re-Introduction

While The Beaver Solution currently includes re-introduction efforts throughout Eastern Washington, TLC would like to concentrate relocation activities in the Hangman Creek drainage. Beaver offer much potential in reversing ecological degradation and improving overall riparian function on a watershed scale. Given this and the proximity of Hangman Creek to Spokane, TLC believes that characterizing and quantifying changes in surface and groundwater storage, stream discharge, and water quality as a result of beaver dam activity in the watershed is beneficial.

TLC has devised a short-and long-term beaver re-introduction plan for the Hangman Creek watershed. TLC expects to relocate as many beaver families as possible in the immediate term. Staff is presently in the process of identifying landowners in the Hangman Creek drainage with suitable beaver habitat and a willingness to commit to participating in beaver relocation activities. Other short-term activities of the project consist of developing site-specific monitoring protocols (e.g. groundwater storage, surface water discharge, vegetation, water quality sampling, etc.) in conjunction with the Spokane Community College Water Resources program, purchasing project equipment, arranging contracts with licensed well-drillers in order to facilitate piezometer installation, securing necessary relocation permits and training, and identifying sources of nuisance beaver. Where beaver habitat has been categorized as marginal and where landowner support is strong, TLC will consider targeted restoration efforts. These activities would include tree planting and delivery of small-diameter logs of beaver-preferred food and dam-building species (e.g. aspen, willow, and cottonwood). TLC's partnerships with local timber companies will ensure an adequate and sustainable supply of seeds, seedlings, and logs.

TLC envisions widespread beaver re-introduction activities to continue into the long-term, storing thousands of acre-feet of water and creating hundreds of acres of wetlands. This will require continual landowner outreach as a major component of a public education and awareness campaign. Long-term restoration efforts will serve to increase both quality and quantity of available beaver habitat and help restore overall riparian function. TLC intends to work closely with landowners and relevant agencies on the purchase of conservation easements and other potential funding mechanisms. TLC also plans to establish a pilot beaver dam demonstration plot to assist us in future educational activities. TLC hopes that The Beaver Solution will become a model for watershed restoration anywhere that beaver historically occurred, as it is more effective and less expensive than artificial stream restoration.

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