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Assessing Beaver Occupancy and Dam Building Potential: A Case Study in the Umpqua Watershed of Southwestern Oregon

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ABSTRACT: Interest in beaver-related restoration is growing in the western U.S. but understanding the basic ecology of American beaver and their population dynamics is often overlooked when integrating beaver into stream restoration goals. Our study investigated the spatial-temporal distribution of beaver colonies and their damming activities to better inform stream restoration projects in the West Fork Cow Creek Basin of the Umpqua Watershed in southwestern Oregon. During fall 2017, we conducted beaver activity surveys at 144 randomly selected reaches predicted to be either suitable or unsuitable for damming, but suitable for beaver occupation. We categorized beaver use at each reach using assessments of their activities and time of last use. We recorded dam structure and impoundment characteristics at all identified dams. Evidence of beaver activity was documented at 57% of locations suitable for dam establishment and 48% of unsuitable dam sites. Beaver dams were found only in reaches identified as suitable for damming and were concentrated throughout two tributaries located on private ownership. Our beaver activity observations will be combined with other data collected in the Umpqua Watershed, and used to construct a probability of use model that will identify dam and non-dam habitat associations. This work will provide novel insights into the landscape ecology of beaver, and inform critical decisions involving trade-offs of ecological benefits and human-beaver conflicts in freshwater systems of interest.

KEY WORDS: activity, American beaver, beaver-related restoration, *Castor canadensis*, dams, occupancy, stream restoration, surveys

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INTRODUCTION

The ecological and hydrological benefits American beaver (*Castor canadensis*) damming activities provide are widely perceived as a mechanism that can be used for restoring degraded freshwater systems. Improved understanding of using beaver as a stream management tool is critical for implementing effective restoration, especially when financial resources are scarce. Interest continues to intensify among agencies and organizations in pursuing beaver-related restoration (BRR) through a variety of tactics that have not been well vetted (Pilliod et al. 2018) and may even result in effects counter to management goals. These restoration goals often include plans to relocate beavers, ban recreational beaver trapping, and mimic beavers by installing artificial dams or Beaver Dam Analogs (BDA; National Marine Fisheries Service 2016). Such actions may be ill-advised if they are based on a presumption that beaver populations are limited, when consideration of broader aspects of beaver ecology may suggest a more nuanced explanation for lack of damming activity. Moreover, implementing any of the aforementioned actions could produce negative consequences that lead to increased human-wildlife conflict. A first step in beaver-related stream restoration is understanding the processes that influence the probability of beavers using different portions of stream networks, and their likely behaviors when they do so.

It is well established that beaver occupy stream reaches in a cyclical manner (Baker and Hill 2003), but the rate of beaver colonization and abandonment in the Pacific Northwest remains unknown. Colony densities fluctuate in response to a suite of biotic and abiotic factors such as disease, availability of food and water resources (Johnston and Windels 2015), predation pressure (Mumma et al. 2018), and land use (Landriault et al. 2009). Actions that support increasing beaver numbers without understanding local beaver demographics may cause destabilization of existing colonies or elevate the probability of human-wildlife conflict, requiring unplanned and costly management interventions. Assessing the distribution of extant populations prior to implementing restoration projects would provide the foundation for understanding the patterns of beaver occupation and dam construction, while identifying the factors that may be limiting beaver activity in an area.

Beaver are a territorial species that will likely occupy optimal habitat first, leaving less optimal locations to be colonized by dispersing individuals (Fretwell and Lucas 1969). They occupy a wide range of wetland conditions including lakes, ponds, sloughs, rivers, and streams (Baker and Hill 2003). Beaver dams provide security from predators by the ponded water they create. Therefore, dam building is a behavioral trait that increases survival. However, beaver that have existing escape from predators often forego dam building.

Beaver surveys are often based on presence-absence of beaver dams (McComb et al. 1990, Barnes and Mallik 1997, Suzuki and McComb 1998). Despite its widespread use, the efficacy of this approach is often questioned due to possible sampling error if survey methodologies do not consider non-damming signs of activity or surveyors are unable to accurately identify the cryptic signs of beaver activity. Models that are developed from these data to predict dam building sites may be transferable locally (Petro et al. 2015, 2018), but they ignore the influence non-damming beaver may have on site establishment through meta-population dynamics (Petro et al. 2018). Large scale models developed to predict dam building potential fail to identify non-damming beaver habitat and have not yet been evaluated for transferability across regions and scales (Macfarlane et al. 2017, Dittbrenner et al. 2018).

The objective of our study was to improve understanding of beaver populations and their damming activities to better inform stream restoration projects in western Oregon. In this paper, we discuss new methods for defining beaver use by 1) including a temporal component for characterizing beaver activity, and 2) expanding beaver habitat modeling exercises to include non-damming populations.

METHODS

We surveyed beaver activity in the West Fork Cow Creek (WFCC) basin located within the Umpqua River watershed in southern Oregon. Landownerships in WFCC represented a variety of state and federal agencies, large private industrial timberlands, and tribal land. We used ArcGIS (version 10.4.1; ESRI, Redlands, CA) and a stream network developed from a 10-m digital elevation model (TerrainWorks Inc., Seattle, WA) to identify stream reaches that represented the geomorphic attributes of areas used by beaver in western Oregon. Selected stream reaches (hereafter, sites) represented either suitable dam or unsuitable dam locations, but all sites were considered suitable for beaver occupancy. Sites suitable for dam establishment consisted of a 3-6 m active channel width, valley floor width ≥25 m, and channel gradient ≤5%. Unsuitable dam sites were characterized by an active channel width ≥1 m and channel gradient ≤10%, and excluded locations that met the criteria for suitable dam sites listed above. We generated a random selection of sites to represent each site type. We then selected sites from these lists in a manner that provided spatial balance across the basin, while representing a higher density of suitable dam sites due to management and restoration interests (Figure 1).

Beaver activity surveys were conducted in September and October of 2017, which overlapped the principal dam building season when beaver have the strongest propensity to construct dams and sign is easiest to detect (Olson and Hubert 1994). Survey lengths were 150 m in length, which represented the median length of stream segments identified as suitable for beaver occupancy based on our modeling exercises. We implemented ground-based surveys in an upstream direction and categorized beaver activity at each study site using the following classes: 1) Current Activity, 2) Recent Activity (<1 year), 3) Old Activity (>1 year), or 4) No Activity. Activity status was determined by aging beaver sign observed throughout each site while documenting the most recent activity found. Types of activity surveyed included chew sticks, slides, scent mounds, bank dens, bank lodges, lodges, dams, food rafts, and feeding stations.

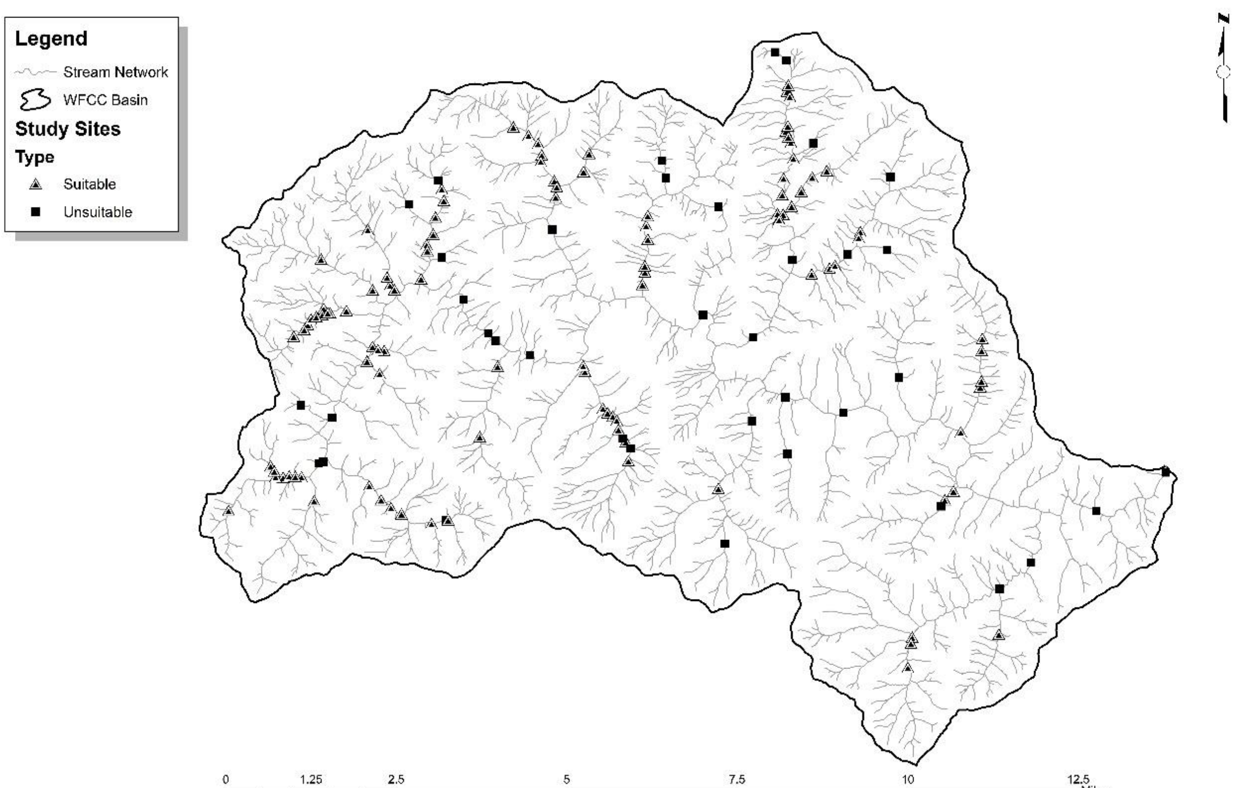

Figure 1. Distribution of study sites throughout WFCC within the Umpqua Basin, Oregon, 2017.

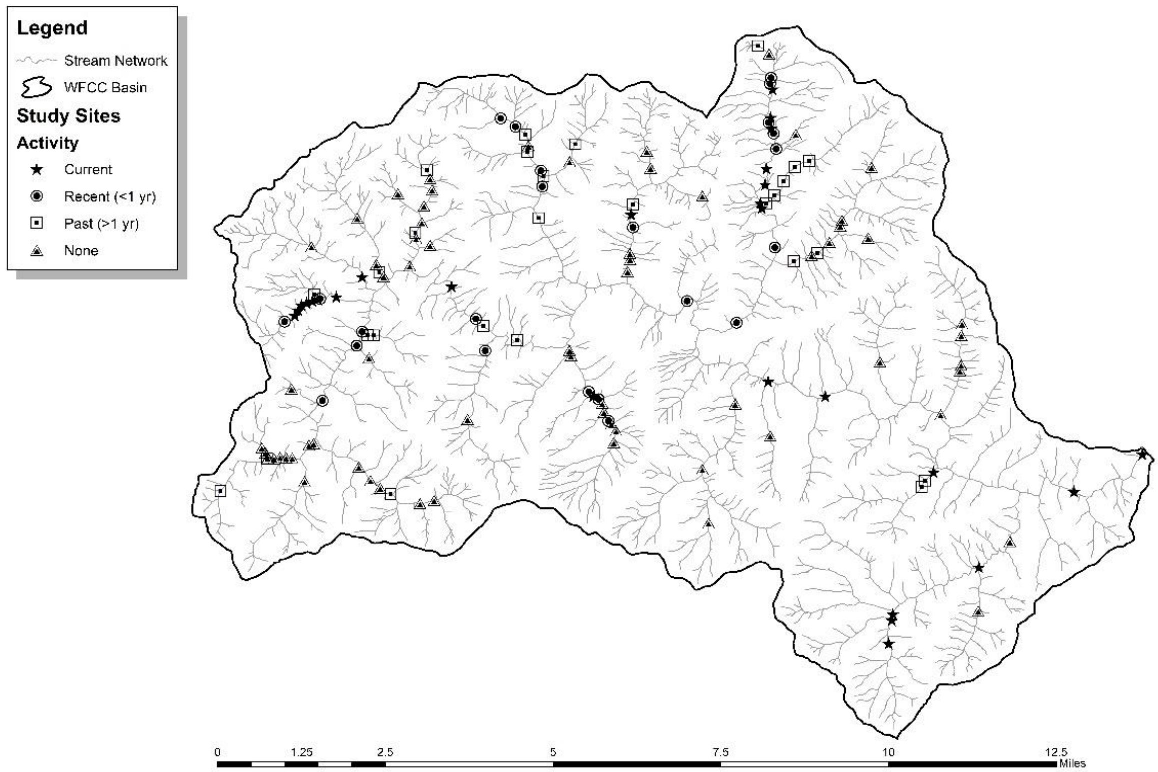

Figure 2. Distribution of beaver colonization history throughout WFCC, Umpqua Basin, Oregon 2017.

All dams were sequentially recorded and measured for structural characteristics. Complexes were noted when present. The façade of each dam was photographed to aid in follow-up visits. We recorded dam status using the following categories: 1) Intact, 2) Nascent, 3) Breached, or 4) Blown-out. Dam height and length were recorded with a meter stick or tape. We identified the major anchoring material the dam was constructed on as either 1) Coarse Woody Debris (>10 cm diameter), 2) Fine Woody Debris (<10 cm diameter), 3) Substrate, 4) Man-Made, or 5) Other. We further identified substrate type as silt, sand, gravel, cobble, or boulder.

We documented pond characteristics if dams were impounding water. Pond length was recorded along the meter tape that followed channel center. Any dams that extended in either direction outside the defined 150 m study site were included in data collection and the additional survey distance (pond length) was noted. We used a meter tape to record multiple pond widths that best represented each pond. Max pond depth was recorded with a meter stick. These measurements were later used to calculate pond volume. We identified impoundment shape (triangular or rectangular) to accurately calculate pond surface area. All descriptive statistics and figures were compiled in Microsoft Excel.

RESULTS

The fall 2017 surveys included 106 sites suitable for damming and 38 unsuitable for damming (144 total). We surveyed a total of 22 stream kilometers, which represented 3% of all available stream habitat and 15% of habitat predicted to be suitable for beaver occupancy. We found evidence of beaver activity at 57% of suitable dam sites and 48% of unsuitable dam sites (Figure 2). The temporal distribution of beaver activity observed throughout WFCC, relative to current and prior use, was similar across both site types (21% and 36% for suitable; 16% and 32% for unsuitable, respectively; Figure 3). Supplemental observations noted 1-5 bank dens at sites were beaver activity was found. No bank lodges or traditional lodges were observed. Beaver caches were documented at only 5% of sites. These observations are representative of beaver ecology in coastal Oregon where stream systems are steeply dissected and forage is available year-round (Maser et al. 1981).

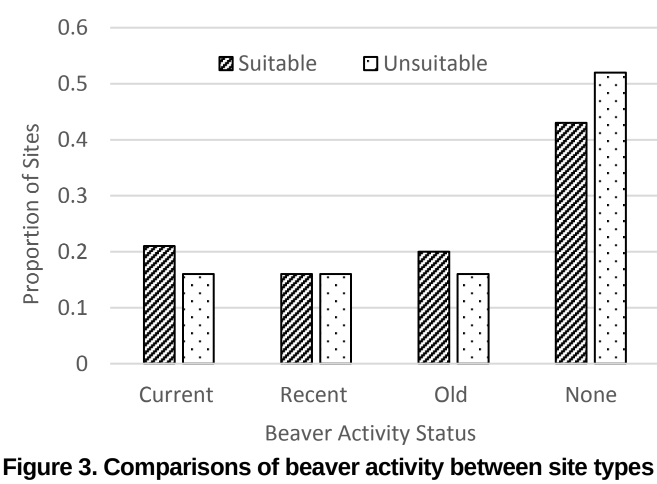

Figure 3. Comparisons of beaver activity between site types based on their suitability for dam building, Umpqua Basin, Oregon, 2017.

Damming activity was documented at 12% of sites considered suitable for dams. No dams were found at unsuitable sites. We identified 48 total dams that were concentrated across 13 sites evenly divided among two tributaries. Dam complexes (eight total) represented 62% of sites where damming was noted. The majority of dams documented during the principal dam building period were intact (79%), few were breached (17%) or blown out (4%; Figure 4). However, the presence of intact dams was greater on WF Elk Valley than Ashur Creek (Figure 4).

Overall median dam length was 6 m (SD ±7 m) and height of 40 cm (SD ±30 cm). The largest individual dam recorded was 42 m long and 1 m tall. Dams on Ashur Creek were larger than those found on West Fork Elk Valley (Table 1). As a result, mean pond volume and surface area were greater in Ashur Creek (523 m^3 and 284 m^2, respectively) than West Fork Elk Valley (34 m^3 and 60 m^2, respectively). Total pond volume was 7,324 m^3 in Ashur Creek and 788 m^3 in West Fork Elk Valley.

We noted 38% of dams were primarily anchored on exposed gravel located on the tail crest of a pool. A combination of coarse and fine woody debris was the second most common (30%), followed by coarse woody debris (17%). Dams with major anchoring material consisting of coarse and fine woody debris accounted for 44% of sites in West Fork Elk Valley Creek and 67% for Ashur Creek. However, 52% of West Fork Elk Valley Creek dam sites were anchored to gravel on a pool-tail crest compared to just 19% for Ashur Creek.

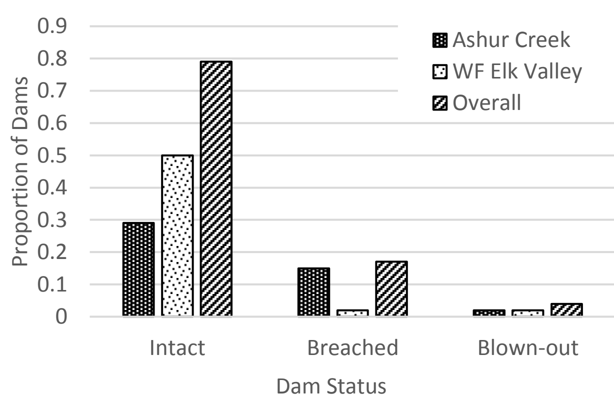

Figure 4. Beaver dam status relative to tributary origin, Umpqua Basin, Oregon, 2017.

Table 1. Beaver dam length (m) and height (cm) characteristics, Umpqua Basin, Oregon, 2017.

	Tributary	
	Ashur Creek	WF Elk Valley
Median Length	7	2
Median Height	55	30
Max Length	42	4
Max Height	120	60

DISCUSSION

Difficulties may arise in any monitoring of wildlife species, especially a semi-aquatic species like beaver. One may assume beaver use could be easily detected by evidence of foraging, but we noted several cases where less than a hand full of clipped stems were observed throughout sites prospected by dispersing beaver. Furthermore, high water events during the previous winter may have removed indications of older beaver sign, such as blown-out dams or feeding stations. Results from our surveys suggest beaver are not uniformly distributed throughout WFCC. This may reflect the cyclic nature of beaver use of stream reaches since beaver will abandon an area once resources have been depleted and later return once they have recovered (Baker and Hill 2003, Perkins and Wilson 2005). The high proportion of formerly active sites observed, whether occupied, used for high water refugium, or prospected by dispersing beaver, may further support this. In addition, absence of evidence is not evidence of absence. Population dynamics, predation pressure, and other factors difficult to measure may be influencing beaver use of areas considered suitable for occupation.

Like all wildlife, beaver are expected to use habitat in a manner that is consistent with improving their individual fitness or lifetime reproductive success, rather than meeting human-defined objectives. Beaver may construct dams only within certain locations in streams, and a host of ecological and biological factors can influence the probability of dam construction and persistence, and ultimately their value in meeting restoration objectives. As a result, restoration activities premised on notions that beaver are below carrying capacity due to absence of dams may fail because there are many other reasons to explain a lack of damming that should be considered in restoration planning and goal setting. The next step in our study is to develop a resource selection model for the Umpqua Basin that considers presence of dam-building beaver in relation to 1) hydro-geomorphic constraints, 2) presence of non-damming beavers, 3) land use, 4) habitat geometry (e.g., size and connectivity of damming habitat), 5) forage availability, and 6) flow permanence. All of these factors have been hypothesized to influence the probability of occurrence of dam-building beaver, but no study has linked them in a comprehensive model of resource selection at a landscape extent. Results of this work will provide novel insights into the landscape ecology of beaver, and inform critical decisions involving trade-offs between ecological benefits and human-beaver conflicts in freshwater systems of interest. If stream restoration strives to support and maintain healthy waterways, a similar position needs to be extended to understanding and supporting healthy beaver populations that occupy these areas.

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