Role of Beaver in Stream Ecosystems: Overview of beaver life history and habitat requirements

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Overview

• Life history niche
• Beaver diet and food preference
• The colony, the lodge, and the cache
• Dams
• Geomorphological feedbacks
• Ecological feedbacks
Life History Niche

- Largest rodent in North America (up to 90 lbs!)
- Ubiquitous within N. hemisphere temperate ecosystems
- Range from boreal to aridlands
- Habitat generalist; highly adaptable
- Common habitat ingredients: water + wood
  - Northern tundra and treeline range boundary: wood limitation
  - Southern range desert boundary: perennial streamflow and/or wood limitation
Worldwide distribution of beaver

- *Castor canadensis* (N. America)
- Historically, 60–400 million pre-European settlement (Seton 1929)
- Currently, 6–12 million (Naiman et al. 1988), but estimates are crude
- Spatial distribution approaches its historical range
- *C. fiber* (Eurasian beaver)
- More limited current distribution, but expanding back to parts of its historical range

300 year history of beaver extirpation in US - economic, not necessarily biological extirpation

Map courtesy of Jim Sedell, USDA Forest Service (2001)
A HABITAT GENERALIST - AND HIGHLY ADAPTABLE

- Lakes
- Rivers and streams
- Abandoned channels on floodplains
- Wetlands
FROM BOREAL FORESTS....

http://www.for.gov.bc.ca/dfn
...TO DESERTS

http://www.rv-boondocking-the-good-life.com/
EVEN SOME UNLIKELY PLACES...

- Estuaries
- Glacier outwash streams

Beaver Dam Creek, Long Island, NY

Mendenhall Glacier, AK (Photo Bob Armstrong)
Beaver Diet:
A choosy generalist

- Spring/Summer: herbaceous plants, including aquatic and riparian forbs, grasses, grains and row crops
- Fall/Winter: tubers, bark and cambium of cached woody plants
- Woody plants comprise 86% of winter diet; 16% of summer diet (Roberts and Arner 1984)
- Number of woody species consumed range from 3 at northern range limit to >30 in southern region (Aleksiuk 1970, Hill 1982, Novak 1987)
The Colony

- Colony unit = 6–8 related individuals
- Avg. litters = 2–5 kits
- Young stay with parents at least 2 years
- Adults (>2 yrs) disperse to establish new lodge, 1 – 25k away from natal site
- 73% females dispersed in spring, 60% males dispersed in fall (Windels 2014)
- Territories marked with scent mounds
- Home ranges tend to follow shorelines in lakes, ~1km in streams
- Colony saturation densities vary with landscape and region
- Max. density ranges 0.5–5 colonies/km² (Hill 1976, Novak 1987, Baker and Hill 2003)
Dispersal Distances

Data complied by Steve Windels, NPS
Aquatic Habitat is Critical to their Success

• Beaver more agile in water than on land; maximize time in the water

• Ponds provide cover from predators and foraging pathways

• Lodge includes underwater entrance, nest area above water
Location, location, location….

- Bank dens vs. aquatic lodges
- Caches are submerged or exposed

Bank den (Colorado Natural Heritage Program)

Bank den (Colorado Natural Heritage Program)

Caches are submerged or exposed

Caches are submerged or exposed

John Stella

Joe Wheaton
Yes, that’s all well and good, but what we’re really here to learn about is...

BEAVER DAMS

- Created to impound water around lodge
- Dam location / repair cued by running water
- Dams constructed of wood and available debris (e.g., plastic, metal)
- Where palatable species are rare, conifers are used more in dams, with hardwoods saved for the food cache (Barnes and Mallik 1996)
World’s largest beaver dam

- Found in Alberta, Canada (2007) using Google Earth
- 850 m; longer than Hoover Dam

Images courtesy of EcoinformaOcs, Inc.
Dam/Pond Complexes

- Multiple dams create safe transportation corridors to connect large ponds
- Dams complexes grow over time, allowing beaver access to more food sources

Photo: G.S. Haulton

Photo by Anna M. Harrison
BEAVER ARE LIKE ROTATIONAL CROP FARMERS

- They will selectively work an area hard for 2-3 years
- Then let it lie fallow and move upstream or downstream

1-3 Years of Regeneration

Joe Wheaton
What are the effects of beaver dam building activity on the landscape?

Pollock et al. 2014
DAMS ARE POROUS... & TRANSIENT
DAMS CHANGE NATURE’S CLOCK

Residence time of:
- Water
- Sediment
- Nutrients

What would time distributions look like when:
- Stream Undammed
- Dam present, Dam breached / failed?
DAMS CREATE A DIVERSITY OF HYDRAULIC HABITATS...
Dams spread water out...

Carol Volk
Dams back water up (and down)...

Watershed Elevation 7 Day Average (Depature from long term Average Daily)

- Control
- Pre-Treatment
- Post-Treatment

Date

2008 2010 2012 2014

7 Day Ave Water Elevation Depar

Matt Nahorniak
Dam building activity drives the ecological feedbacks that beavers are known for:

- Shallower water table
- Increased groundwater moisture
- Forest species composition and size distribution
- Multi-stemmed growth
- Woody species regeneration
Beaver impacts: increase wetland area

• Beaver change landscape from terrestrial to aquatic
• Most landscape change occurs in first 20 years
• Increased landscape diversity (Wright et al. 2002)
• Waterfowl habitat
• Increased amphibian habitat (Karraker and Gibbs 2009)
Beaver impacts: forest structure

• Removal of understory and canopy trees
• Open up canopy to understory/unpalatable species
Multi-stemmed growth habit

Photos: Anna M. Harrison

Not for distribution
(Please contact J. Stella, stella@sf.edu)
Woody Species Regeneration

Harrison & Stella 2010;
Not for distribution
(Contact J. Stella, stella@esf.edu)
Ecological Consequences of Beaver Activity

Alza, C.M. 2014
Another Ecological Consequence of Beaver Activity

Alza, C.M. 2014
But what about the down-sides?
Upstream passage of beaver dams (natural and analogs) by adult steelhead trout

Percentage of wild steelhead above PIA by run year:

- **2009**: PIA-2 (57%), PIA-3 (18%), PIA-4 (17%)
- **2010**: PIA-2 (44%), PIA-3 (14%), PIA-4 (12%)
- **2011**: PIA-2 (63%), PIA-3 (17%), PIA-4 (12%)
- **2013**: PIA-2 (28%), PIA-3 (24%), PIA-4 (12%)
- **2014**: PIA-2 (59%), PIA-3 (37%), PIA-4 (15%)

Restoration implementation noted between 2009 and 2011.
Upstream passage of beaver dams (natural and analogs) by juvenile steelhead trout

Number of Upstream Migrants

Month

2009 2010 2011 2012 2013
Temperature difference between treatment and control reaches
But What Happens When Beaver Dams “Fail”?

**Figure 10:** Progression of reach at upper Owens through a period without a dam (A; 2005), with an active, partially breached dam (B; Nov 2009), to an abandon, partially breached dam (C; April 2010).
The Dynamics of Beaver Dam Complexes Form Landscapes

Hierarchical scale

River network
$10^3$ m
$10^6$ to $10^8$ years

Segment
$10^2$ m
$10^2$ to $10^4$ years

Reach
$10^1$ m
$10^1$ to $10^2$ years

Juxtaposition of functionally different segments modifies network-scale processes, working as bottom-up processes. Segments vary over space and time.

Burchsted et al. 2010