Leave it to Beaver

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A fine balance

risks

• Potential for catastrophic outburst floods when dams fail
• Beaver-landowner conflicts

rewards

• Water storage
• Sediment retention
• Improved ecosystem health
• Resilience to climate changes
To use beaver to promote ecosystem resilience & aid restoration, must consider:

**WHERE?**
Locations where beaver have capacity to influence ecosystem-forming processes

**WHEN?**
Permanency of beaver-mediated changes

**HOW?**
Changes beaver make to ecosystem-forming processes & how these changes enhance ecosystem resilience
Key is understanding the hydrologic functions of beaver dams

- Pond water behind them
- Transfer surface water to groundwater system
- Delay transmission of runoff to downstream areas
Beaver create ponds (i.e. water storage)

Kananaskis region:
• 782 beaver ponds mapped in 166 wetlands in 2012
• 12x more ponds in wetlands with beaver
• How much water is stored?
Beaver pond morphometry is complex

Dam length & pond area correlate strongly with water holding capacity
Beaver dams re-distribute water to the groundwater system

At small scales:

- Stream water infiltrates into the banks above the dam
- Loops around and beneath the dam
- Some returns back to the stream downstream
- Some becomes ‘lost’ to the groundwater system
What is the groundwater footprint of a beaver dam?
Studied groundwater at Sibbald Wetland across range of beaver dam and climate conditions
On average, beaver raise water table by 10 cm

Peatland water storage increased by about 7700 m$^3$
The beaver groundwater footprint (at Sibbald) has a radius of 150 m. Water table is raised 12.8 cm in this footprint, and is 2x more stable varying climate conditions.
Flood protection from... *beaver!*

Can beaver ponds store floodwaters?
Opportunistic Science

Studying the 2013 AB Flood

June 19-22, 2013
72 Hours
19 June 2013 06:00
22 June 2013 06:00

Cities
Rivers
Basins
Lakes

Roads

Distance in Kilometers
0 200 400

Map Scale 1: 5 Million
Source: Government of AB
Sibbald Research Wetland

The 4 largest beaver ponds can store 19,000 m$^3$ of water.

195 mm rain fell here during the flood.

Area 0.63 km$^2$
1480 masl
Soil Water Storage

- Frost at 20-60 cm
- No frost below beaver ponds
- Soils provided little water storage
Beaver Dam outburst flood
(loss of 7900 m$^3$ water in
4.5 hours)

Groundwater level (m - not depth)
Beaver dam

10-m rupture

Pond 53
28 June 2013
Figure 2. Soil core locations. Data source: aerial imagery taken 2008-08-15,18 and ... with the Wentworth scale. Mineral material will be classed using the same size categories as the peat particles.
Water levels in beaver ponds

- Highly dynamic, even when dams are ruptured!

Remember, a 15 cm change in pond level = 2000 m³ of water!
Recession curve shape suggests:
a) some leakage through dam
b) source of recharge to
groundwater system

Groundwater level (m - not depth)

Beaver Pond level (m)

Pond 54
Underlain by 2 m
peat & alluvium

Pond 53

Pond 52
Beaver ponds act as windows to the groundwater system, draining over winter.

Pond 54, mid May 2007

This means timing of floods vs. pond fullness is key, if beaver ponds are to store floodwaters.
Dam failure has a domino effect, right?

Floodwaters flowed right over pond 52 without rupturing the dam.
What happened across the Kananaskis region during the flood?

- 150 sites with 1129 beaver dams
- Ponds held 340 million L of water
- 74 sites assessed after the 2013 flood

**Dam Persistence**
- Breached (24 sites)
- Persisted (31 sites)
- Persisted but Affected (19 sites)
Placing Beaver Pond Storage in Context

<table>
<thead>
<tr>
<th>Location</th>
<th>2017 Volume forecast (dam³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kananaskis River</td>
<td>339,000</td>
</tr>
<tr>
<td>Spray River near Banff</td>
<td>344,000</td>
</tr>
<tr>
<td>Lake Minnewanka inflow</td>
<td>164,000</td>
</tr>
<tr>
<td>Water holding capacity of Kananaskis beaver ponds</td>
<td>340 (at any given time)</td>
</tr>
</tbody>
</table>
Conclusions

• Potential to use beaver as a climate change adaptation tool

• More research needed to uncover where we should and should not be encouraging beaver to build dams in order to best protect and restore aquatic ecosystem functions
  – What unknown ecosystem functions are beaver-mediated?
  – Water storage dynamics of dams in various states of repair
  – Permanency of changes to ecosystem-forming processes
Research is a Team Effort

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