Learning about River Restoration from Invasive Beaver

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Among the biota that affect ecosystems, beavers (*Castor canadensis* and *C. fiber*) are among the best known for creating, destroying and modifying riverine habitats and are considered to be ecosystem engineers.

In the northern hemisphere, dam building results in the alteration of key ecological, hydrologic and geomorphic processes that transform riverine ecosystems from lotic to lentic habitats and terrestrial habitats to wetlands.

Beavers can also occupy lake and large river margins, and mineral soil wetlands, peatlands and groundwater-fed sites that lack channels, although these ecosystems are less studied.

Beaver re-shape key ecological, hydrologic, geomorphic processes that transform riverine ecosystems.
Beaver Meadow Formation Theory

Dam building

Flooding – sediment trapping & plant loss

Woody & herbaceous plant recruitment = beaver meadow

Dam breach exposes nursery grounds
Beaver Meadow Formation Theory

Cyclic pond creation & abandonment
- river valley aggradation
- wetland creation and persistence

Colorado River
Rocky Mountain NP
BMFT has never been tested in a place where beavers have been introduced as exotic animals.
Purposeful introduction of 20 beaver in the southern Andes in 1946.
Riparian *Nothofagus* forests are reported to be the preferred habitat...
Population Explosion

Peak population of 98,000 – 165,000 animals (26,600 colonies) – Whitfield et al. (2015) Ambio
Tierra del Fuego: the beavers must die

“We will move in on the beavers in a rolling front.”
(Some) Big Questions

• Have beaver triggered mineral sediment accretion processes and initiated the formation of beaver meadows?

• What is the range of aquatic and wetland habitat occupied and modified by beaver?

• Is the restoration of *Nothofagus* species the biggest restoration need?
(Initial) Study Design – 3 ‘riparian zones’

- Show our initial study design
- Climate-driven tree species (bioclimatic) region
- Instrument one riparian area in each region
- As all the work so far has said that beaver are in
  - Rivadavia
  - Escondido
  - Cruz
  - Lago Fagnano
  - Canal Beagle
  - Isla Grande (Argentina)
  - Isla Navarino (Chile)
  - Argentina
  - Chile

Map showing various locations and forest types:
- *Nothofagus antarctica* (dry; <300 mm/yr)
- *Nothofagus pumilio* (mesic; 400-600 mm/yr)
- Magellanic mixed forest (wet; 700->2000 mm/yr)
- S. Atlantic Ocean
- Forest cover from G. Martinéz Pastur
Cruz

Martínez Pastur et al. (2006)
Intact soil profile (interbedded peat-mineral layers)

8 soil pits

Fresh sediment

2-40 cm silt to sand

✓ beaver meadow(-ish)
D'oh! Anyone seen my missing stream channel?
Escondido

Sphagnum magellanicum (bog peat)

28 cm

FH horizon (wet)

Invasives (wet)

X beaver meadow

16 soil pits

Colonization by invasive pasture grasses
Rividavia

Flood line
Intact soil profile
Missing O horizon
Soil profile buried by 1-9 cm silt

sediment harvesting & stockpiling!
Rividavia

Excavated sediment
pond 1 = 1805 m$^3$
pond 3 = 242 m$^3$

Stockpiling in dams
pond 1 = 250 m$^3$
pond 3 = 8 m$^3$

X beaver meadow
Regional Survey

n = 51
Mineral System

damming streamflow (6%)
Mineral System

damming groundwater seepage (6%)
Mineral System

stream excavation (31%)
Peatland System

damming bog drains, i.e. fens (57%)
BMFT doesn’t apply in Tierra del Fuego

Dam building

Flooding – sediment trapping & plant loss

No *Nothofagus* recruitment; invasive herb colonization

Dam breach exposes nursery grounds

Novel Ecosystems
Fens – the biggest restoration need

- **STOP** tree planting
- Removal of exotic plants
- Extensive peat rewetting where beaver channels occur
- Native sedge and moss transplants
Lesson #1

Marginal habitat is still habitat
Lesson #2

Beaver have enduring landscape impacts, most of which we are still figuring out.
Stream function pre-beaver? – “novel” ecosystem creation

Restoration plans must consider long-term beaver occupancy desires
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