BEAVER: RESTORATION LIAISON BETWEEN RIPARIAN & UPLAND SYSTEMS?

Joe Wheaton

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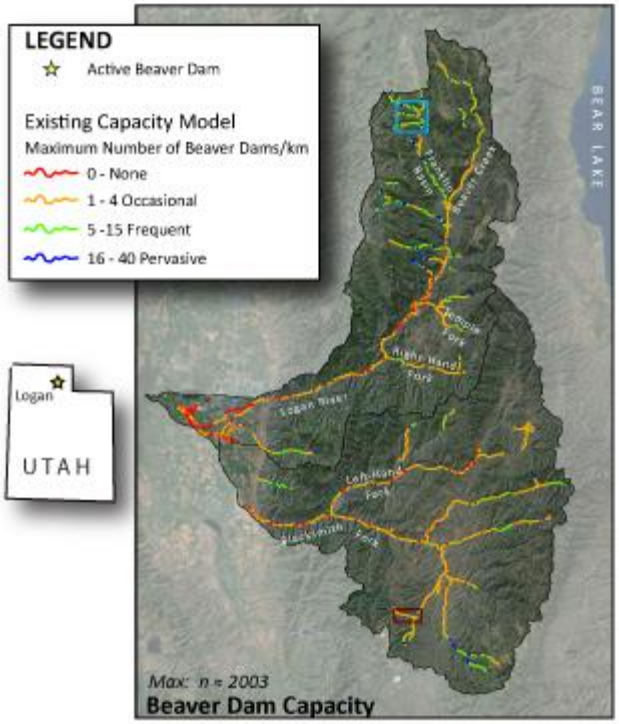
DEPARTMENT OF WATERSHED SCIENCES

Restoring the West
October 17th, 2013



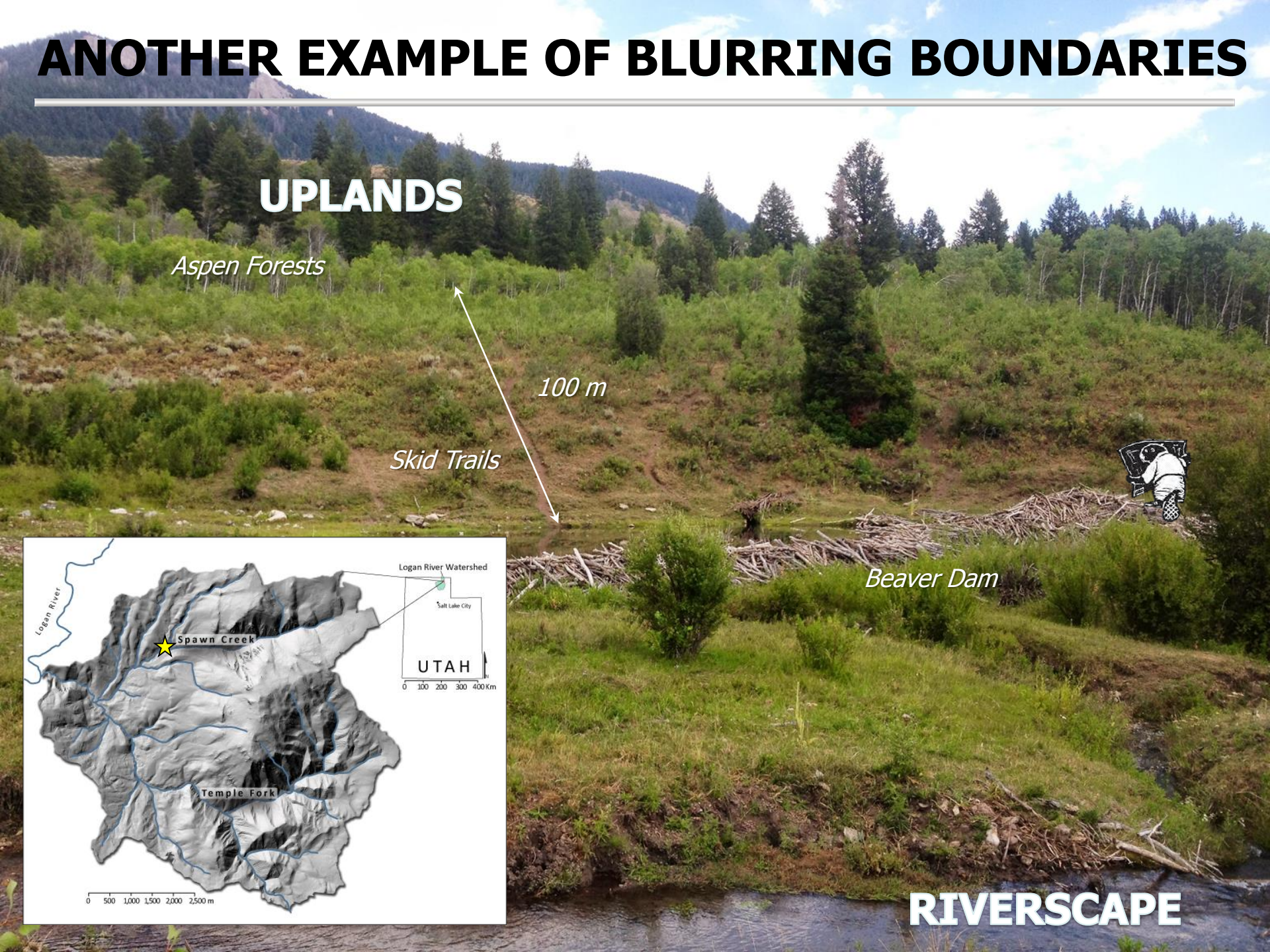
FORGIVE ME… I'M LOST

- I'm really just a fluvial geomorphologist….
- I study rivers… not forests

PURPOSE OF TALK

Share a different angle on **restoring the west**… and highlight the **role a rodent can play** in doing that…

ANOTHER EXAMPLE OF BLURRING BOUNDARIES

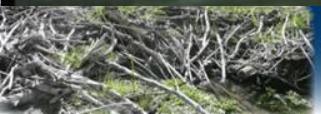


BEAVER: RESTORATION LIAISON? OUTLINE

I. **What Beaver Do**
II. State of our Streams & Adjoining Uplands
III. Restoration by Rodents?
IV. Where? Meet the BRAT
V. Take Aways…

A HABITAT GENERALIST, AND HIGHLY ADAPTABLE

- Lakes
- Rivers and streams
- Abandoned channels on floodplains
- Wetlands



Slide from John Stella

FROM BOREAL FORESTS….

Fred Hirschmann—Science Faction/Getty Images

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

Slide from John Stella

…TO DESERTS

http://www.rv-boondocking-the-good-life.com/

COMMON HABITAT INGREDIENTS: WATER + TREES

- Northern tundra and treeline range boundary: wood limitation
- Southern desert range boundary: perennial streamflow and/or wood limitation

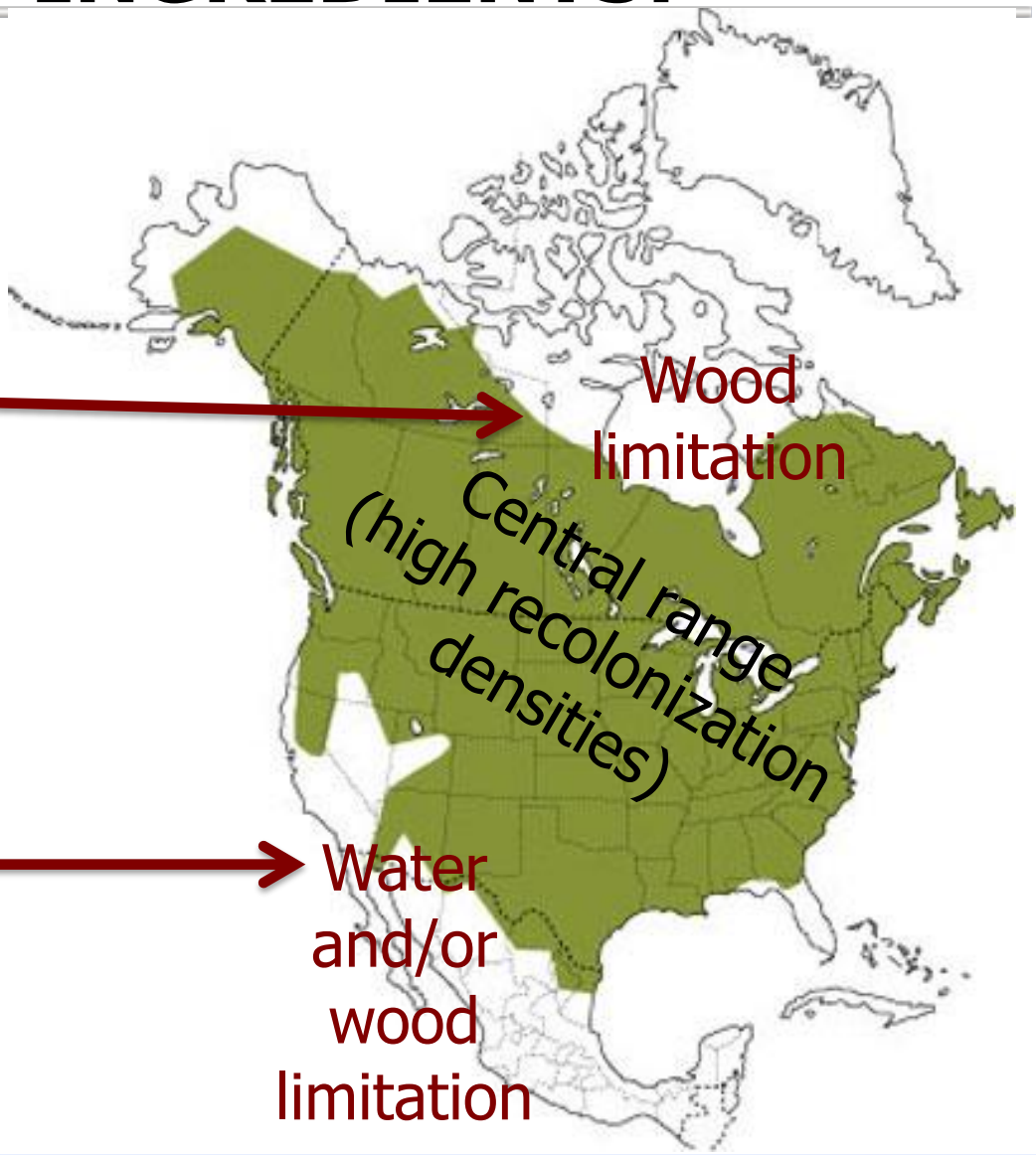


Photo: C. Demers, SUNY-ESF

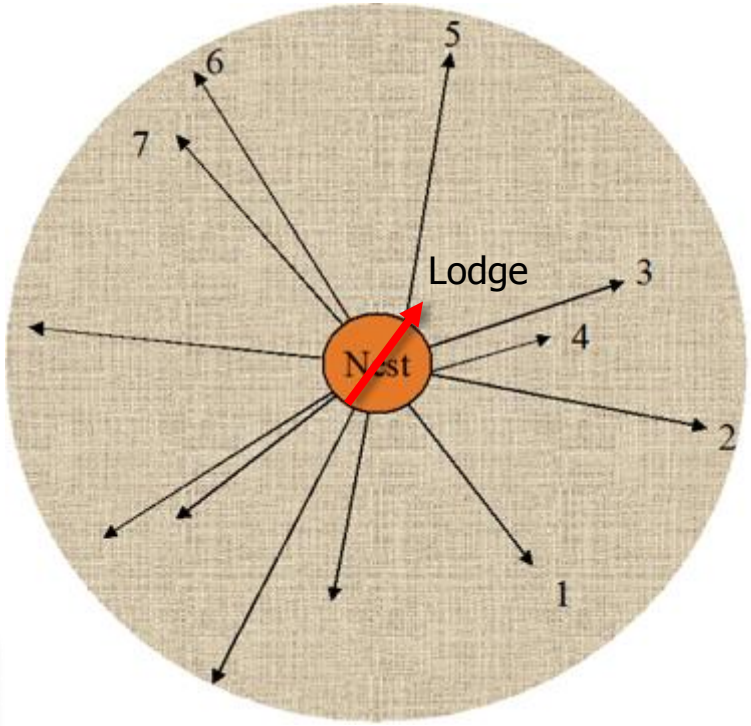
WHAT DO BEAVER EAT?

- Spring/Summer: herbaceous plants, incl. aquatic and riparian forbs, grasses, grains and row crops
- Fall/Winter: tubers, bark and cambium of cached woody plants
- Woody plants comprise ~85% of winter diet; ~15% of summer diet

A CLASSIC 'CENTRAL PLACE' FORAGER

- Animals forage to maximize net energy intake per unit time (Schoener 1979)
- Because provisioning costs increase with distance, animals should forage more selectively farther from their central place (i.e., the lodge).

⑩ ↑ Food quality; ↓ Foraging time



Nicola Plowes, ASU

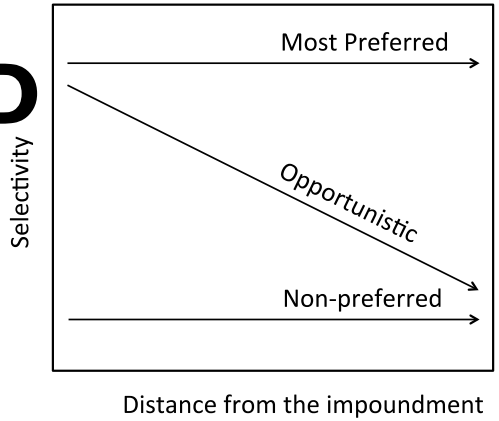
GENERAL FORAGE PREFERENCES

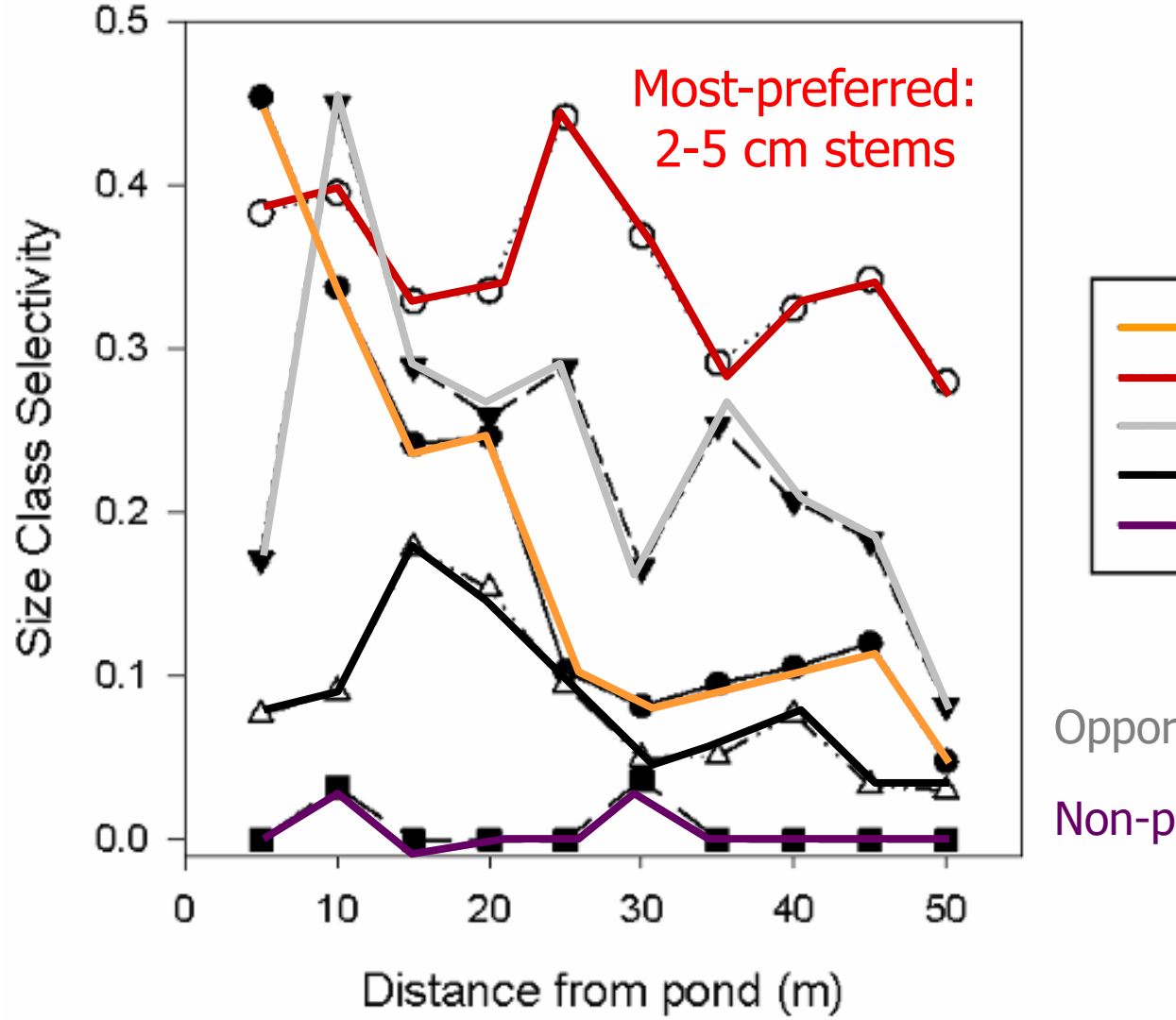
(BUT HIGH SYSTEM SPECIFICITY)

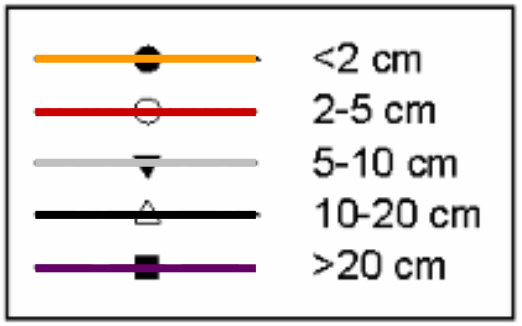
- Forage preferences depend on what is available
  - Aspen, willow, cottonwood, and alder (Denny 1952)
- Preferred sizes: <10 cm diam. allows for multiple uses (Pinkowski 1983, Barnes and Mallik 1997, Haarberg & Rosell 2006, Raffel et al. 2009)
- Increase selectivity with increased distance from pond (Raffel et al 2009)

2-5 CM STEMS MOST PREFERRED

(harvested farthest from the pond)







Opportunistic: <2 and 5-10 cm

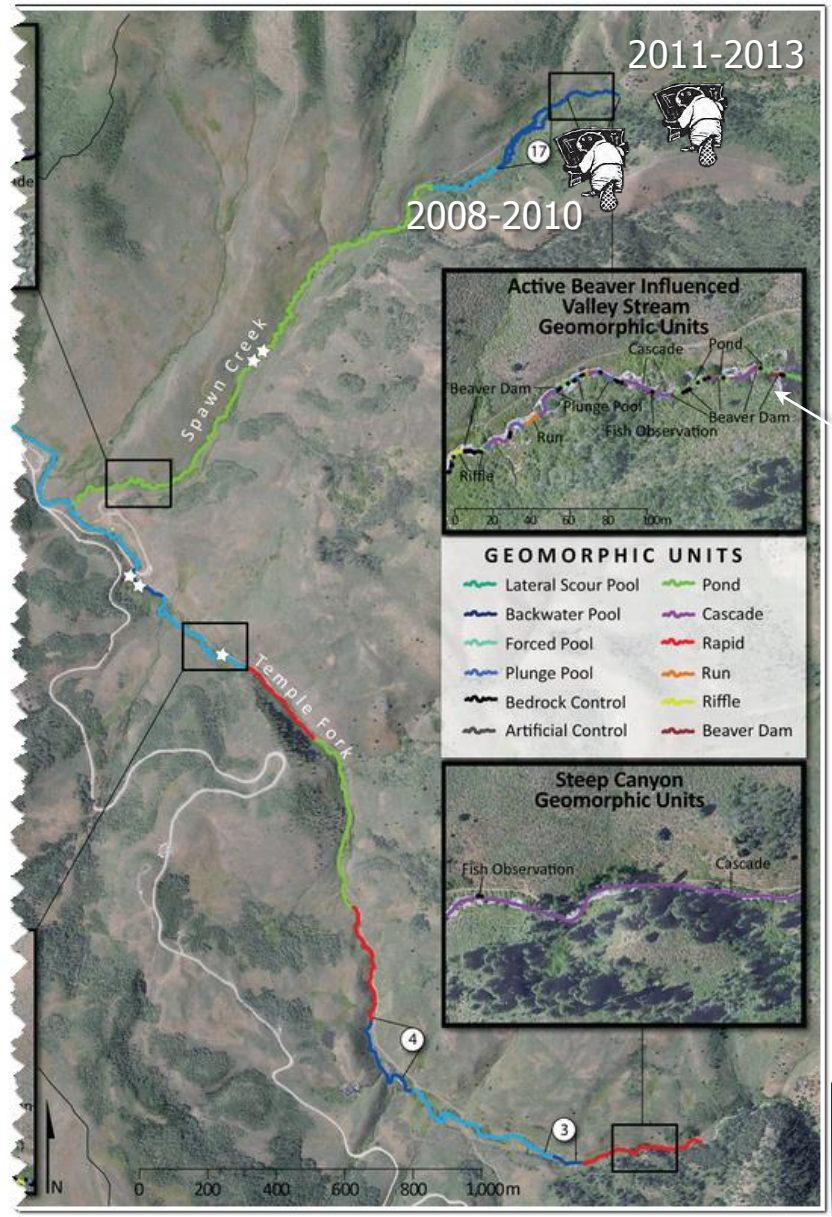
Non-preferred: >10 cm

Harrison & Stella 2010

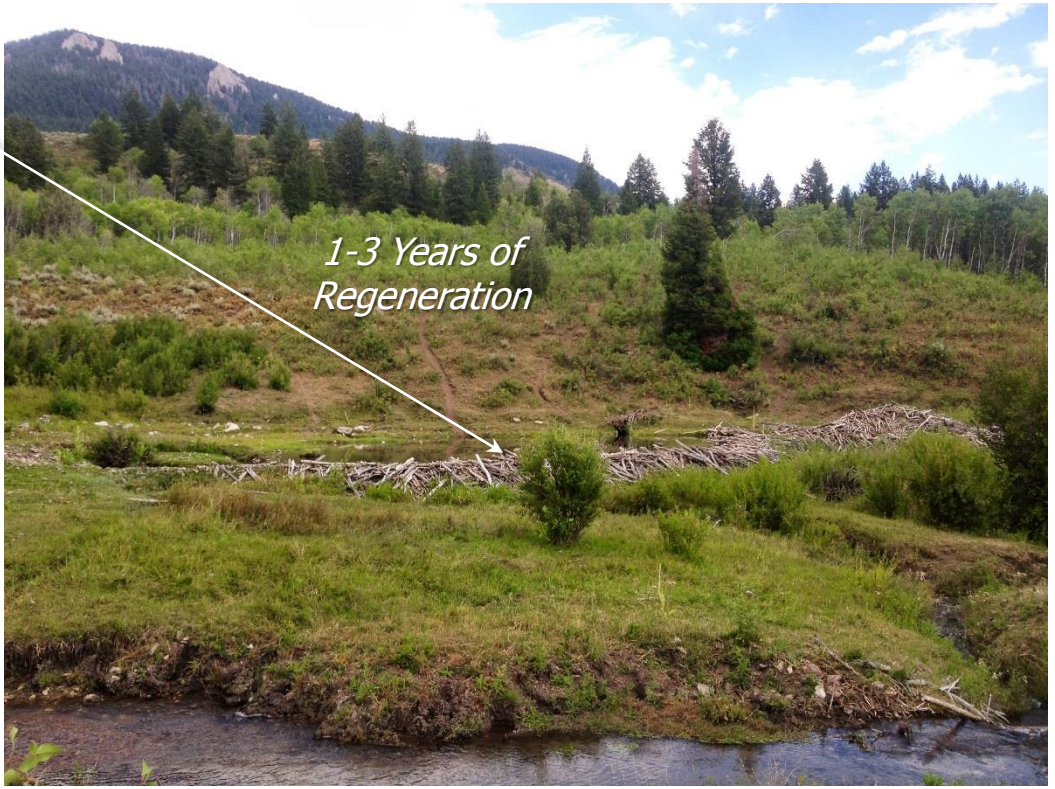
TREE BROWSING PROMOTES SHRUBBY GROWTH HABIT

Photos: Anna M. Harrison

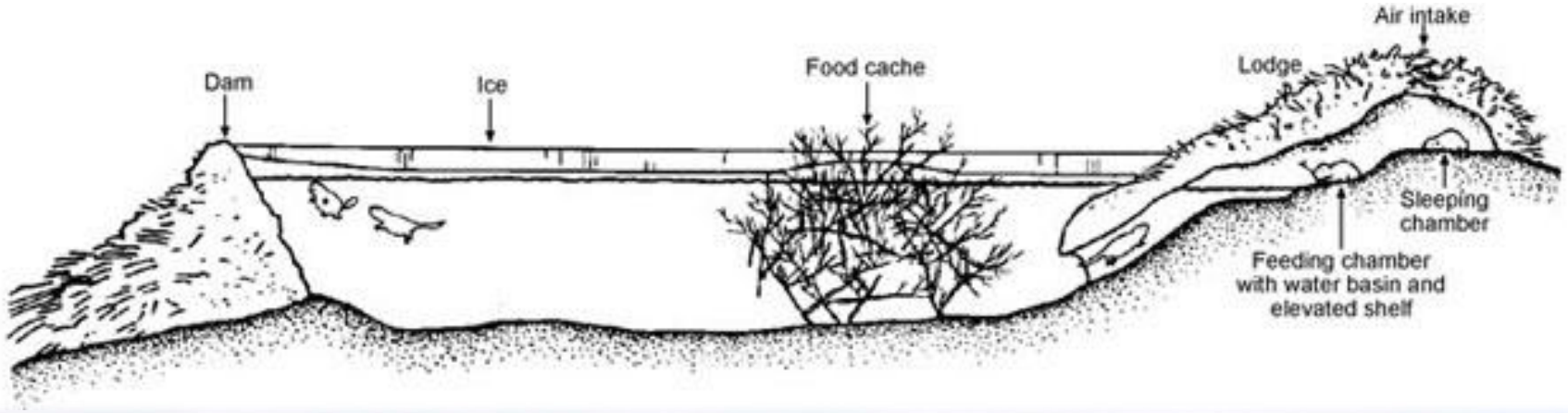
BEAVER ARE LIKE ROTATIONAL CROP FARMERS

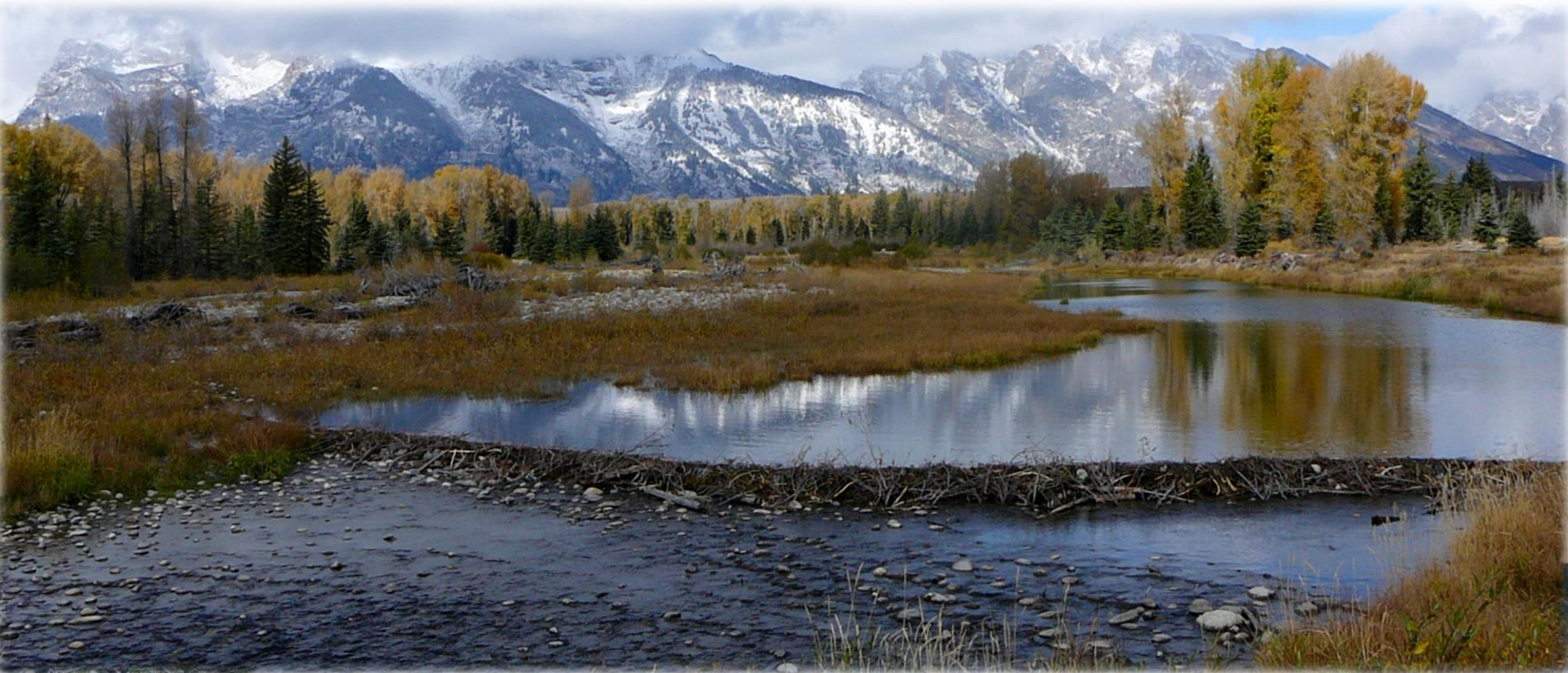


- They will *selectively* work an area hard for 2-3 years
- Then let it lay fallow and move upstream or downstream



SO WHY DO THEY BUILD DAMS?





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

DAMS & BUILDING MATERIALS

- Created to impound water around lodge
- Dam location cued by running water

- Dams constructed of wood and available debris (e.g., plastic, metal)

DAM/POND COMPLEXES

- Multiple dams create safe transportation corridors to connect large ponds
- Dams complexes grow over time, allowing beaver more access to food sources
- Canals constructed to float materials in…

Photo: G.S. Haulton

Photo by Anna M. Harrison

THE HABITAT THEY MAKE IS GOOD FOR OTHERS TOO!

Before & After Wolves

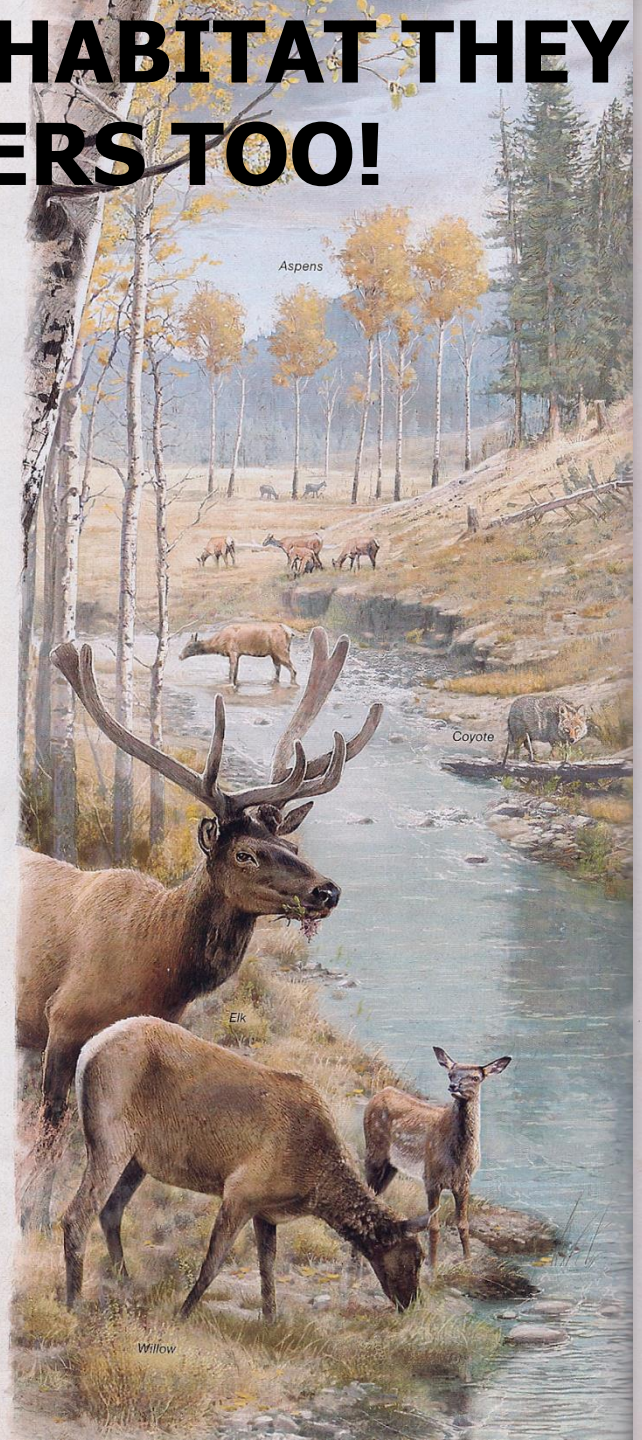
Restoring wolves to Yellowstone after a 70-year absence as a top predator—especially of elk—set off a cascade of changes that is restoring the park's habitat as well.

YELLOWSTONE WITHOUT WOLVES 1926-1995

ELK overbrowsed the streamside willows, cottonwoods, and shrubs that prevent erosion. Birds lost nesting space. Habitat for fish and other aquatic species declined as waters became broader and shallower and, without shade from streamside vegetation, warmer.

ASPEN trees in Yellowstone's northern valleys, where elk winter, were seldom able to reach full height. Elk ate nearly all the new sprouts.

COYOTE numbers climbed. Though they often kill elk calves, they prey mainly on small mammals like ground squirrels and voles, reducing the food available for foxes, badgers, and raptors.



ART BY FERNANDO G. BAPTISTA, NG STAFF; AMANDA HOBBS, NG STAFF
SOURCES: ROBERT L. BESCHTA AND WILLIAM J. RIPPLE, OREGON STATE UNIVERSITY; DOUGLAS W. SMITH, YELLOWSTONE NATIONAL PARK

YELLOWSTONE WITH WOLVES 1995-PRESENT

ELK population has been halved. Severe winters early in the reintroduction and drought contributed to the decline. A healthy fear of wolves also keeps elk from lingering at streamsides, where it can be harder to escape attack.

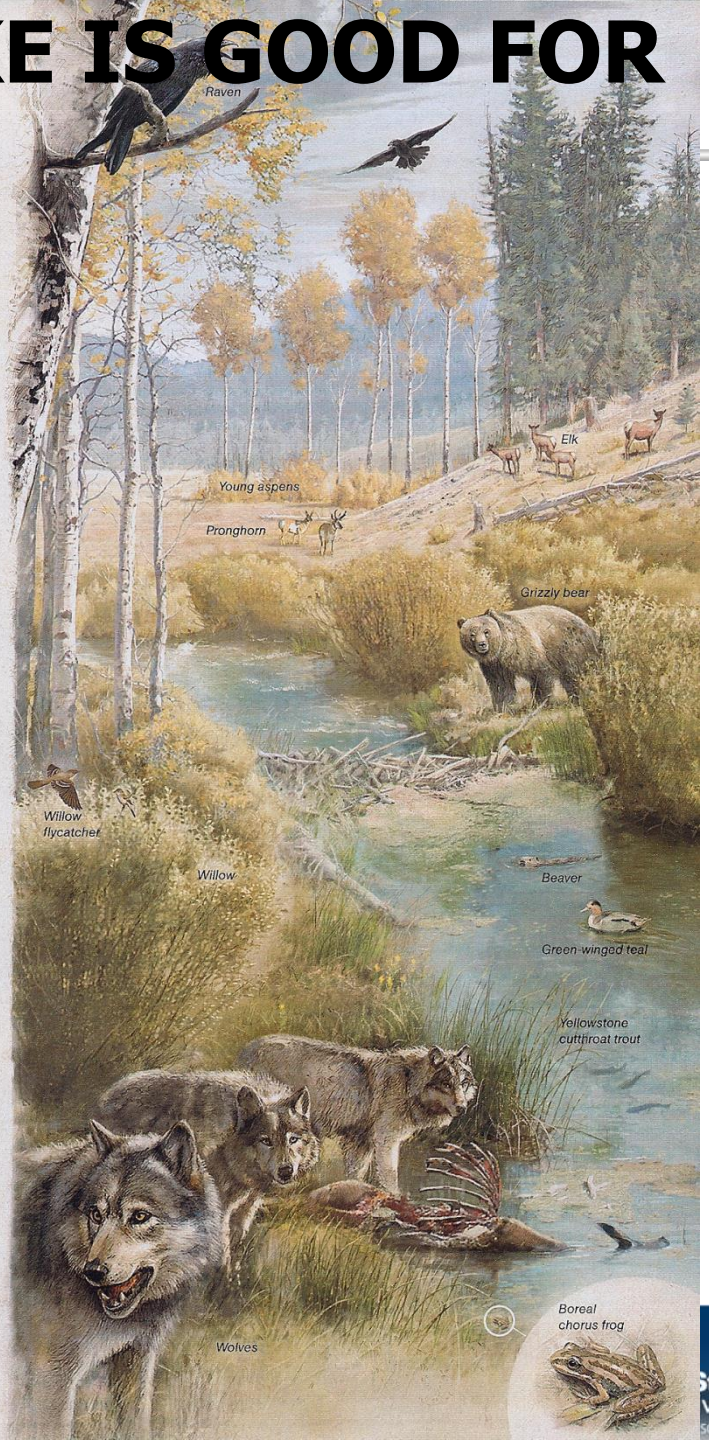
ASPENS The number of new sprouts eaten by elk has dropped dramatically. New groves in some areas now reach 10 to 15 feet tall.

COYOTES Wolf predation has reduced their numbers. Fewer coyote attacks may be a factor in the resurgence of the park's pronghorn.

WILLOWS, cottonwoods, and other riparian vegetation have begun to stabilize stream banks, helping restore natural water flow. Overhanging branches again shade the water and welcome birds.

BEAVER colonies in north Yellowstone have risen from one to 12, now that some stream banks are lush with vegetation, especially willows (a key beaver food). Beaver dams create ponds and marshes, supporting fish, amphibians, birds, small mammals, and a rich insect population to feed them.

CARRION Wolves don't cover their kill, so they've boosted the food supply for scavengers, notably bald and golden eagles, coyotes, ravens, magpies, and bears.



PERCEIVED + IMPACTS OF DAM BUILDING

- Slow snowmelt runoff
- Create ponds, wetlands & critical habitat for fish, amphibians, small mammals, vegetation
- Increased groundwater recharge/ elevated water tables
- Dam complexes increase system roughness & resilience
- Increased LWD
- Change timing, delivery and storage or water, sediment and nutrients

Bird et al. 2011:
http://www.wildearthguardians.org/site/DocServer/Beaver_and_Climate_Change_Final.pdf?docID=3482

IN SOME PLACES… THEY ARE A NUISANCE

- In residential areas they can cause flooding…
- They often block culverts, which can flood roads
- They can chop down our ornamental landscape trees
- They can make a mess of irrigation diversions

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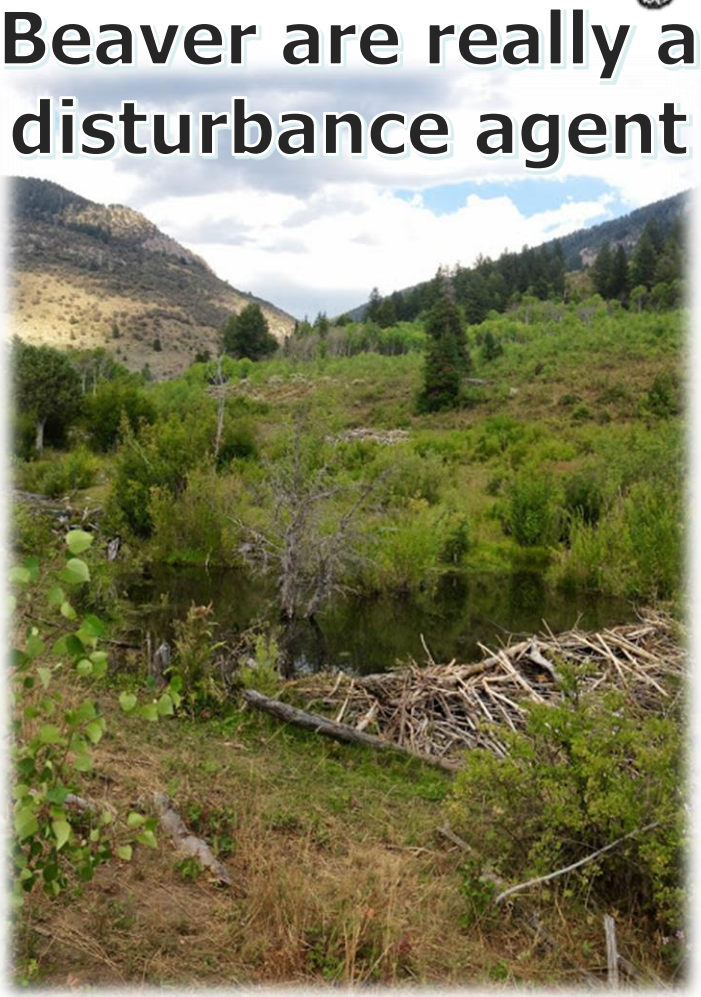


BIOLOGICAL CONDITION OF STREAMS IN WEST

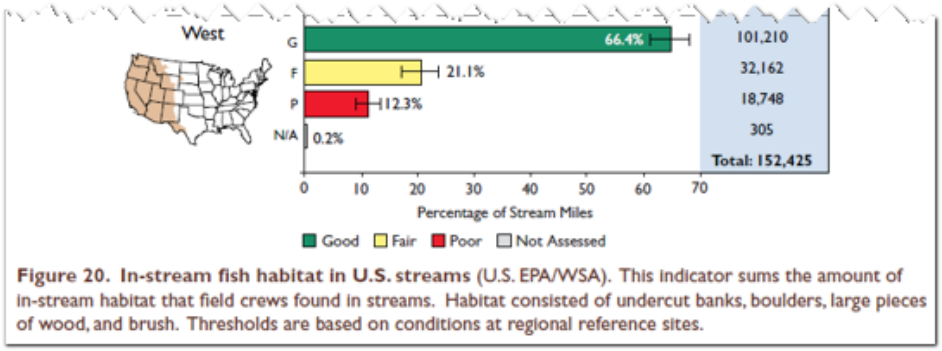


Figure 20. In-stream fish habitat in U.S. streams (U.S. EPA/WSA). This indicator sums the amount of in-stream habitat that field crews found in streams. Habitat consisted of undercut banks, boulders, large pieces of wood, and brush. Thresholds are based on conditions at regional reference sites.

- Over half of streams in west are in fair or poor condition
- 3.5 Million miles of streams and rivers
- 700K miles of wadeable, perennia
- 190K are in poor condition

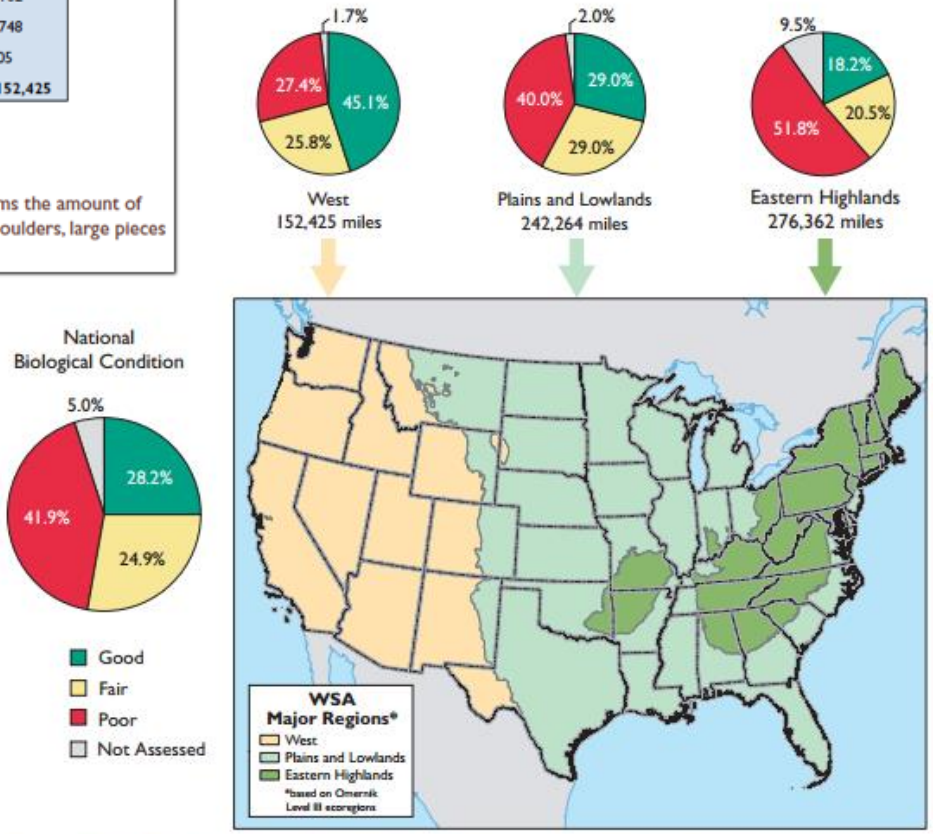
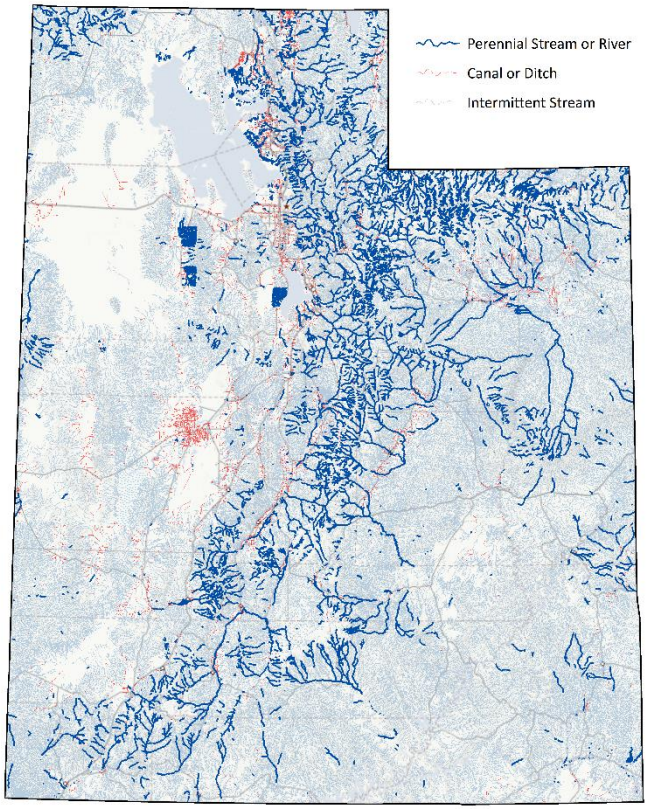


Figure ES-1. Biological condition of wadeable streams (U.S. EPA/WSA).

USEPA, 2006. Wadeable Streams Assessment, Office of Research & Development, Office of Water, United States Environmental Protection agency, Washington D.C., pp. 113.

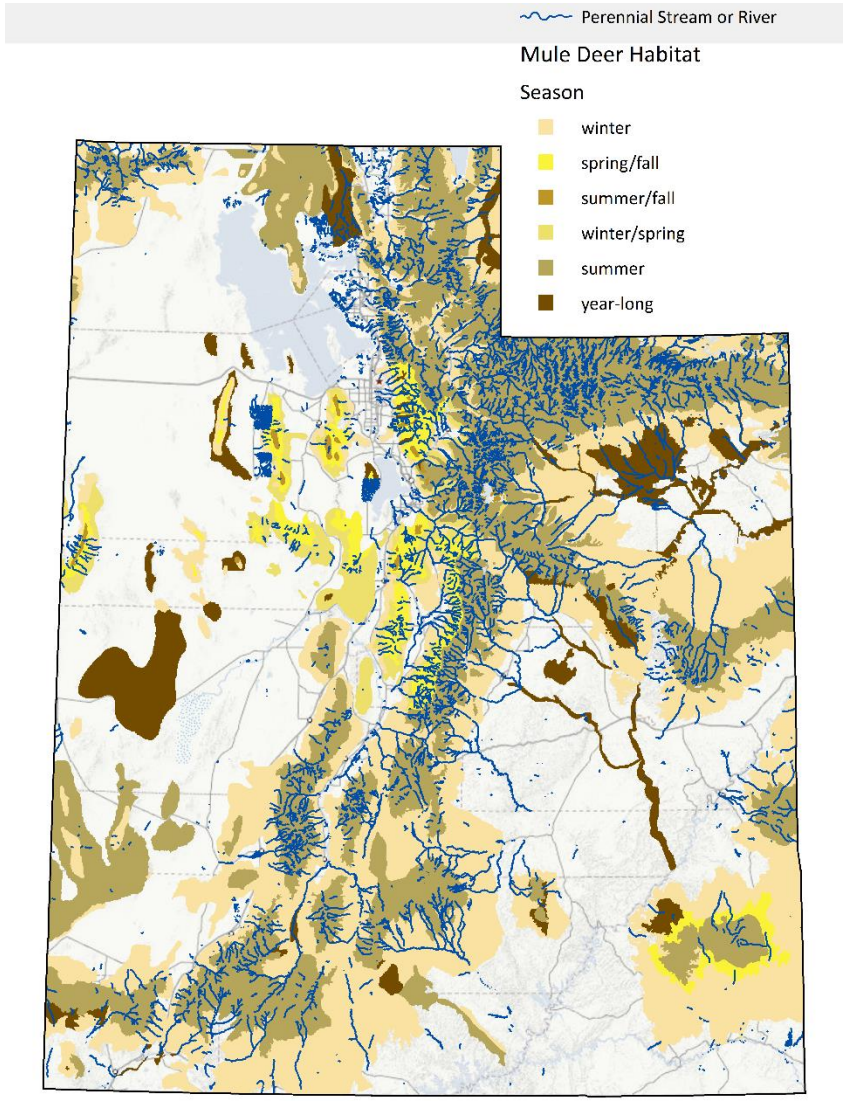
IN UTAH… EVEN THOUGH A DRY STATE

- We have over 85,000 miles of rivers and streams
  - 81% (65,000 miles) are non-perennial and/or ditches
  - 16,000 miles are perennial
  - 1980 estimate that 4,000 miles had suitable beaver habitat
- Historically…
  - Beaver were pervasive throughout this network
  - Much greater proportion perennial



EVEN FOR NON-RIPARIAN SPECIES…

- Riparian areas associated with perennial streams are very important & intersect huge portions of their habitat
- Beaver maintain and expand these riparian areas!
- Many of these streams are degraded



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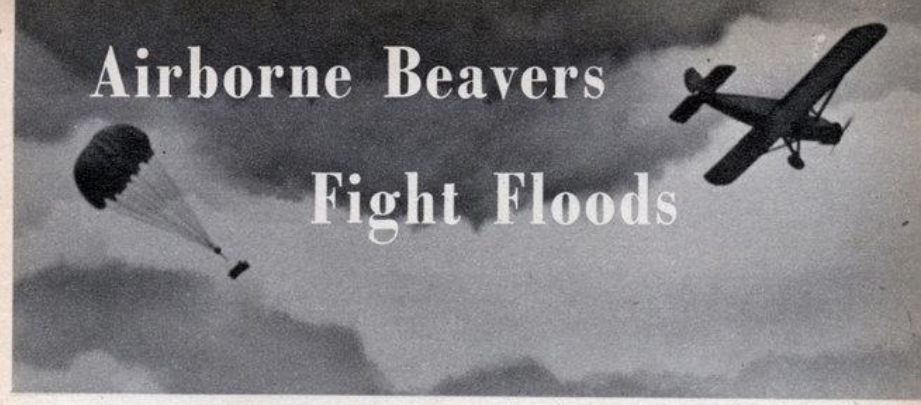
LETTING BEAVER DO RESTORATION NOT NEW!!!

- As early as 1930s, beaver used as conservation tool
- Logic is simple… just take nuisance beaver and relocate them where we want their ecosystem engineering expertise

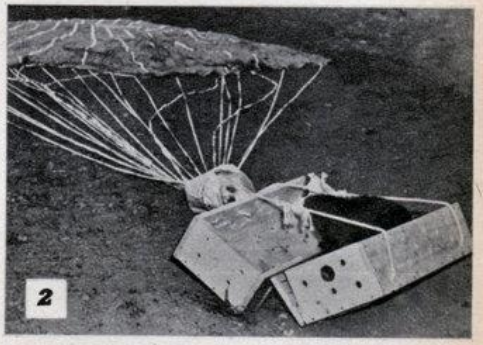


OUT in Idaho, the Department of Fish and Game is teaching eager beavers to yell "Geronimo!" These busy little creatures are being dropped by parachute to terrain where they can do their bit in the conservation battle.

Idaho state caretakers trap unwanted beavers which may be a nuisance in certain areas, round them up at central points and pack them in pairs in specially constructed wooden crates. After they are dropped, the boxes remain closed as long as there's some tension on the parachute shrouds but pull open as soon as the chute collapses on the ground. Then, out crawl Mama and Papa beaver, ready to start work.

After they're settled, the 40-pound, web-footed rodents multiply and become outpost agents of flood control and soil conservation. Fur supervisor John Smith reports that in carefully observed early operations, the beavers headed straight for water and started building a new dam within a couple of days.

However, one problem still remains to be solved—a question of ethics more than conservation. *Are these eager beavers bona fide members of the Caterpillar Club?* •



1. Boxed for travel, this beaver is placed in a crate designed by Scotty Heter, left. 2. Rubber bands pull the box apart when the chute hits the ground, freeing the animals. 3. Heading for water, the airborne beavers start working like beavers on their new dam.

POPULARITY GROWING RAPIDLY RECENTLY

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A-HED

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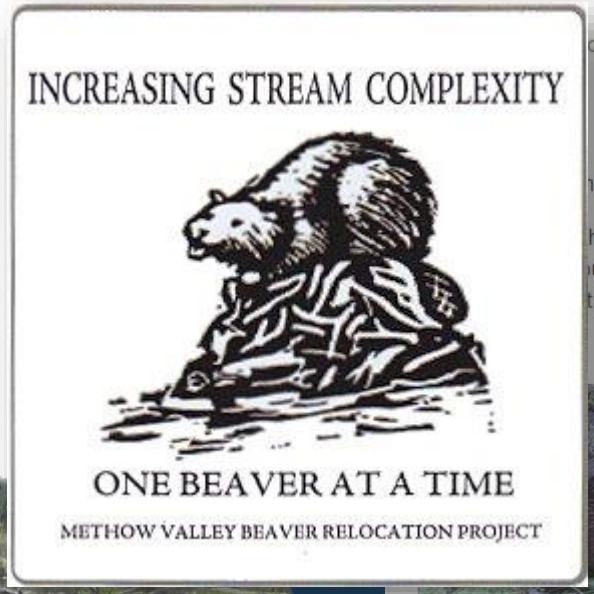


nts his beavers back.

h on Beaver Creek outside Kinnear, Wyo., has been beaver-free for uld sure use their help now. A small beaver colony, he says, would t raise the water table under his pastures, opening up drinking holes for

So the 64-year-old rancher put himself on a waiting list this year hoping state officials would bring him a beaver or two. Wyoming's Game and Fish Commission periodically plucks the rodents from drainage culverts.

It's a bit of a turnabout in these parts, where beavers have long been considered something of a nuisance—blamed for

The Beaver Solution Team live traps beavers on properties where they are causing damage and relocates them to [illegible]

npr

Beavers Offer Solution to Climate Change

by DAVID MALAKOFF

May 03, 2008 4:00 PM

Listen to the Story

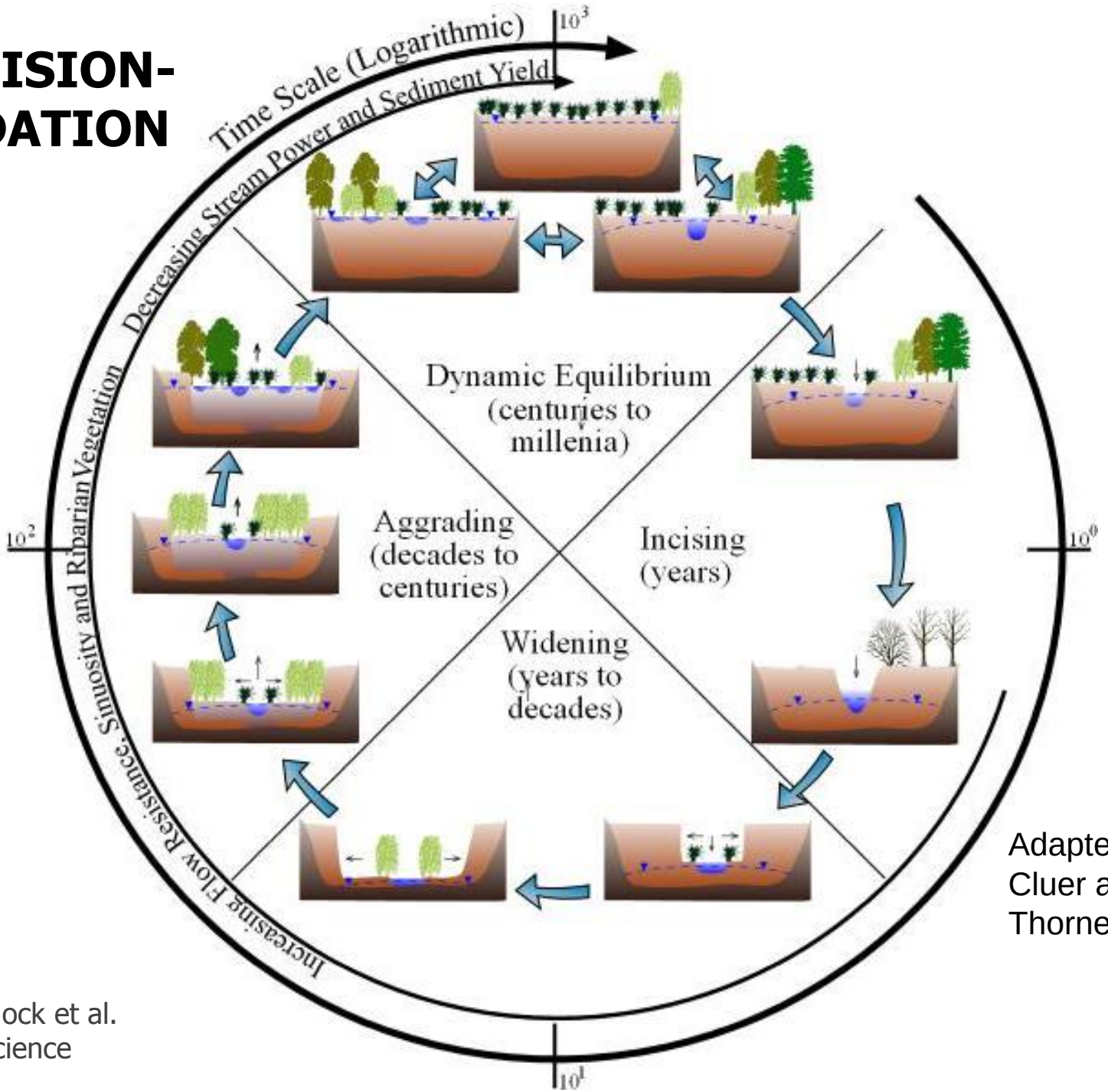
All Things Considered

In the Southwest U.S., biologists are talking about returning beavers to rivers they once inhabited in order to fight droughts — which are expected to get worse as the globe warms. Beaver dams create great sponges that store lots of water.

Transcript

INCISED STREAMS ARE UBIQUITOUS

THE INCISION-AGGRADATION CYCLE



Adapted from Cluer and Thorne 2013

Figure from Pollock et al. (Accepted) Bioscience

THE INCISION-AGGRADATION CYCLE WITH BEAVER DAMS & BEAVER DAM ANALOGUES

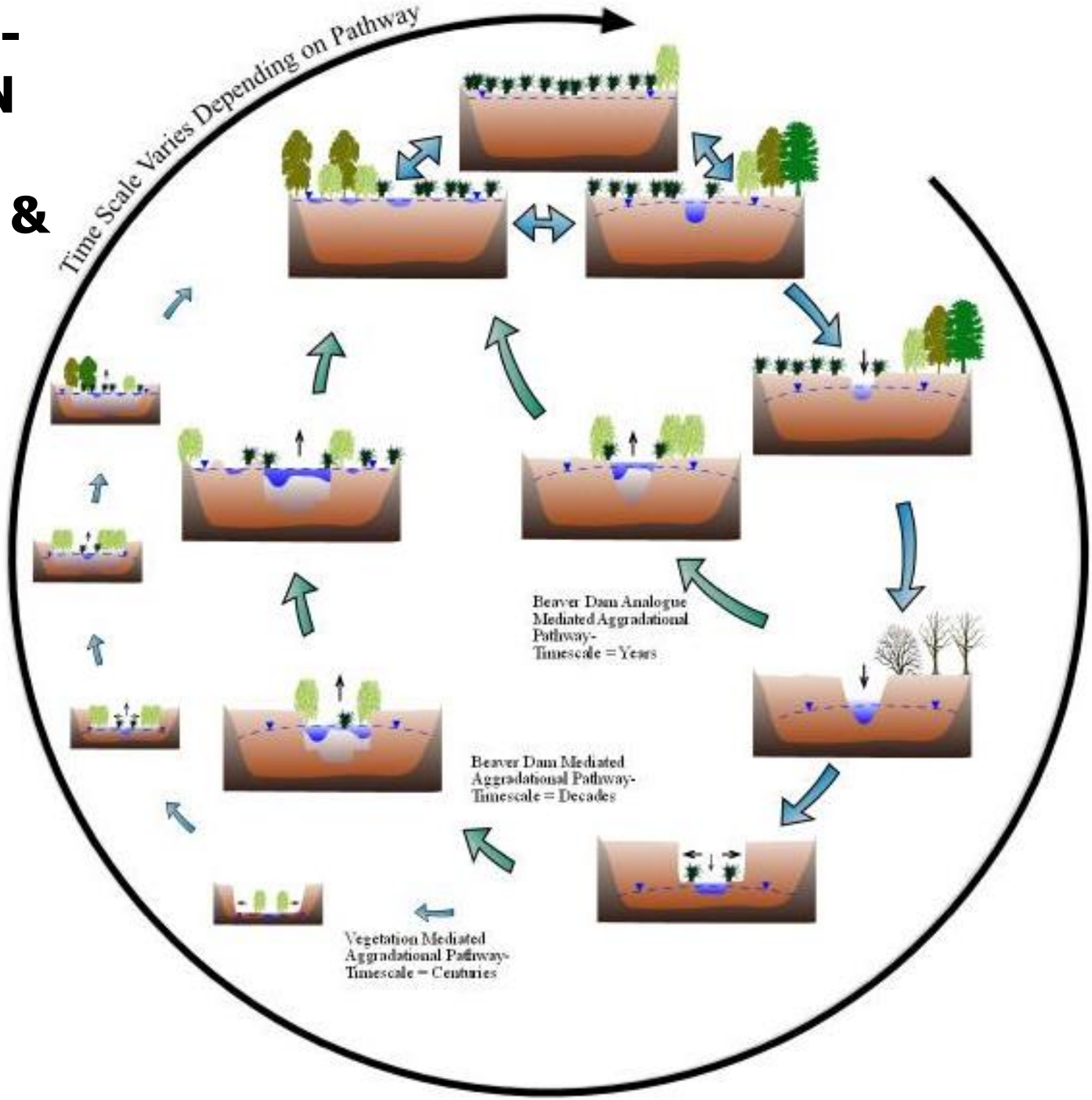


Figure from Pollock et al. (Accepted) Bioscience

USING BEAVER TO RESTORE INCISED STREAMS

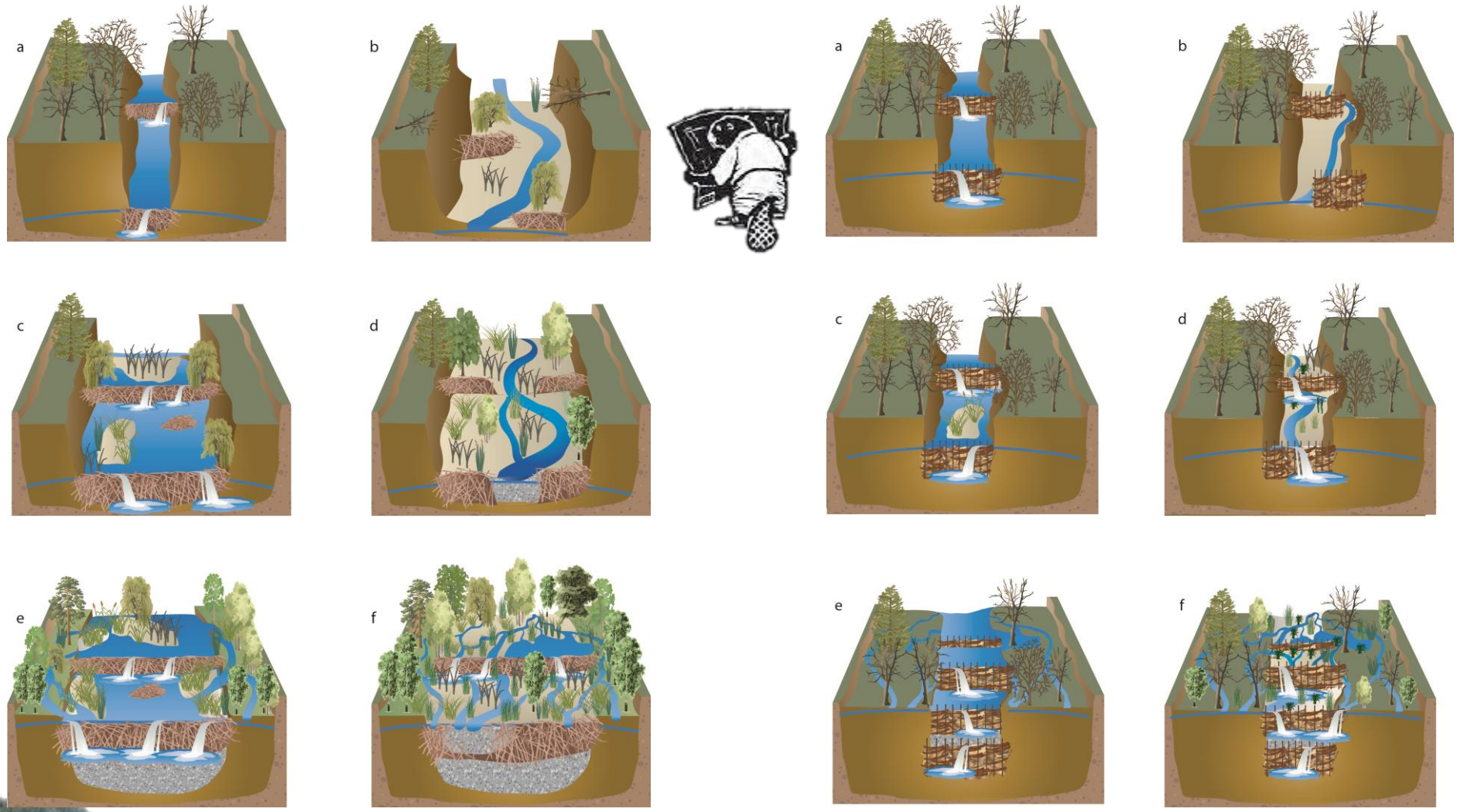


Figure from Pollock et al. (Accepted) Bioscience

SO HELP 'EM OUT... BUY THEM ~~POSTS~~ TIME

FOUR STRUCTURE TYPES

Figure 10. A typical starter dam (SF-17 at Sunflower) with willow branches woven between vertical posts and the back side sealed with rock and clay. Note the dam height is sufficient to divert flow onto the RL terrace, mimicking a stable beaver dam.

Figure 11. A post line with wicker weave is similar to a starter dam, but acts more like a weir in that water is allowed to flow through the willow branches such that low flows are not over topping the structure and the woven branches may not extend to the top of the posts. These may naturally seal up by trapping sediment and organic material moving downstream or they may be utilized by beaver. Note that beaver have started to colonize this PLWW, as evidenced by the chewed stems on the right of the photograph, aligned parallel to the flow.

Figure 12. The purpose of a post line is to provide a site where beaver can build a stable dam. They generally create little or no geomorphic changes unless utilized by beaver.

Figure 13. Any active dams within the treatment areas were strengthened with posts to lengthen their functional life, since most dams along the incised Bridge Creek have been shown to last less than a year (Demmer and Beschta, 2008). This structure was one of four dams built in sequence in Lower Owens to form a new colony. Within one year, all four dams had backfilled with sediment, which improved floodplain connectivity and habitat complexity, but made the site unsuitable for beaver. However, because we had installed additional post lines just downstream the beaver were able to use them to build new dams which allowed the colony to persist.

CAN BEAVER DAMS AGGRADE INCISED STREAMS TO THE POINT OF FLOODPLAIN RECONNECTION AND RECOVERY?

Joe Wheaton

Florie Consolati

Kenny DeMeurichy

Nick Bouwes

Michael Pollock

Chris Jordan

Carol Volk

Nick Webber

Utah State University

Eco Logical Research, Inc.

U.S. Department of the Interior Bureau of Land Management

Bonneville Power Administration

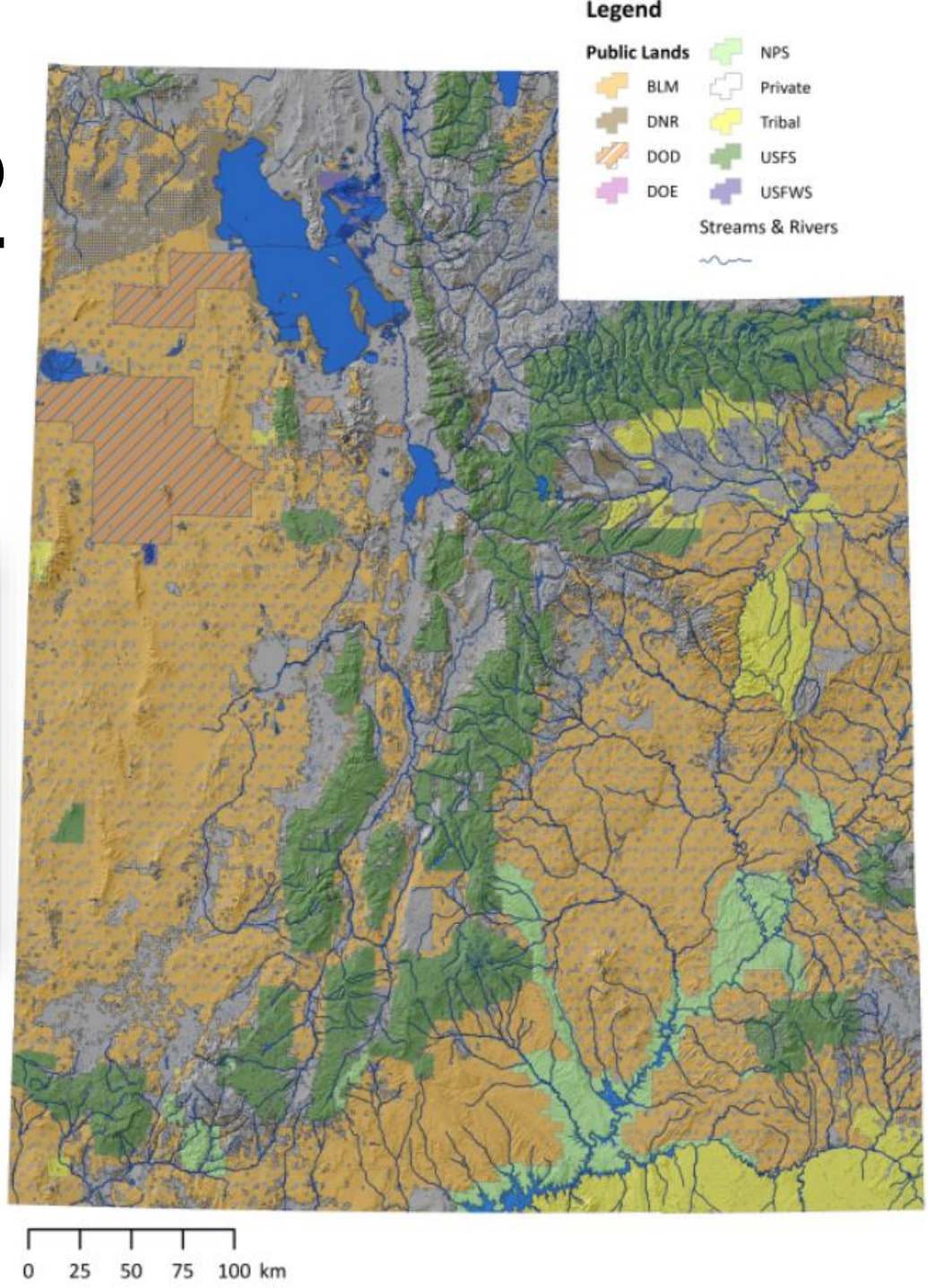
NOAA

Northwest Fisheries Science Center

NOAA Fisheries Service

WE DON'T HAVE A MAP OF INCISED STREAMS IN WEST

- Back to Utah, we have a lot of:



UDWR – BEAVER MANAGEMENT PLAN

- One of most progressive plans in US
- Specifically relies on beaver as a restoration tool

UTAH BEAVER MANAGEMENT PLAN
2010 - 2020

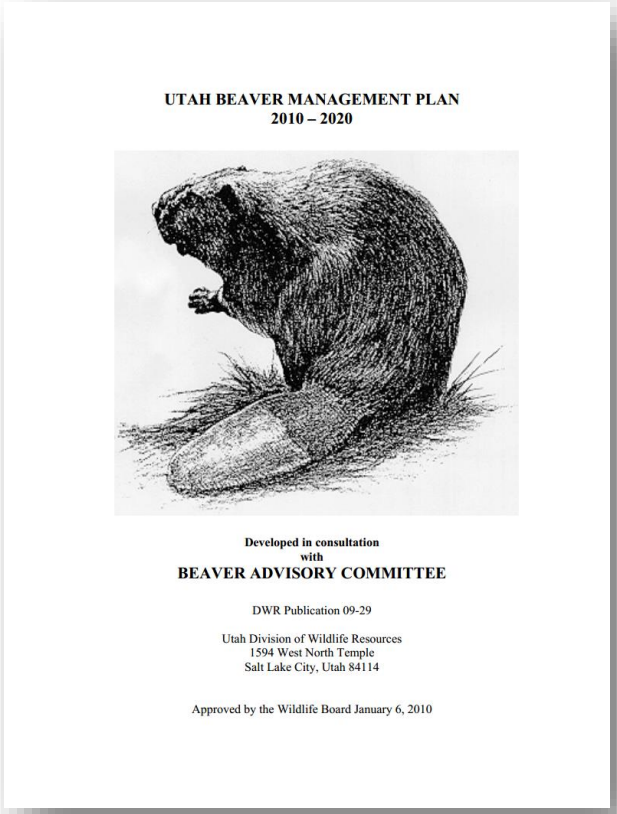
Plan Goal

Maintain healthy, functional beaver populations in ecological balance with available habitat, human needs, and associated species.

INTRODUCTION

The purpose of the Utah Beaver Management Plan is to provide direction for management of American beaver (*Castor canadensis*) in Utah and where appropriate expand the current distribution to historic range. This purpose is in accordance with the mission statement of the Utah Division of Wildlife Resources (UDWR). The mission of UDWR is:

To serve the people of Utah as trustee and guardian of the state's wildlife



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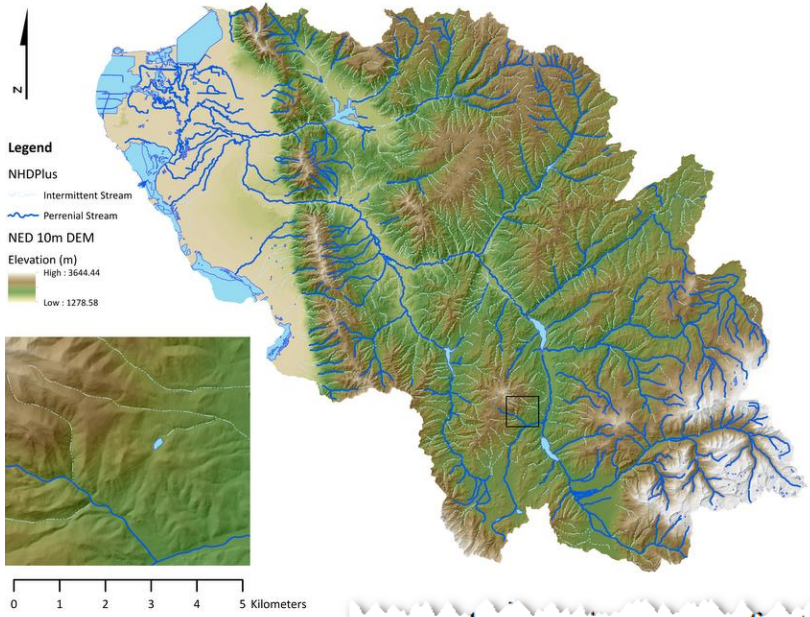
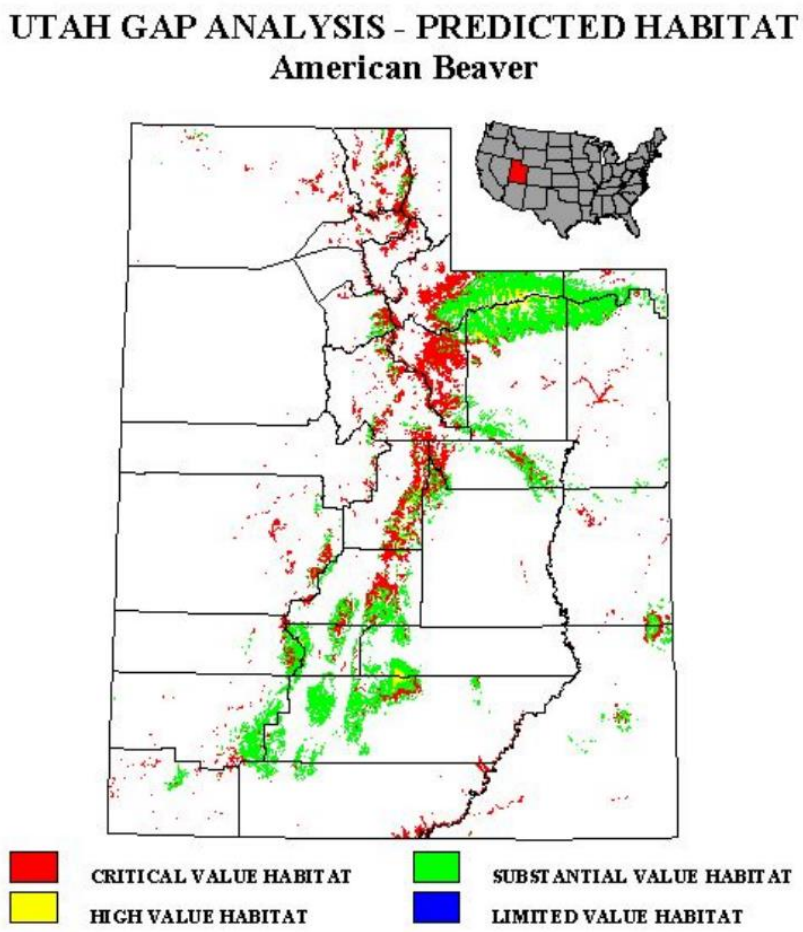
WHERE COULD WE USE BEAVER?

- This is not a very useful map… →
- What about in my watershed, on my stream?

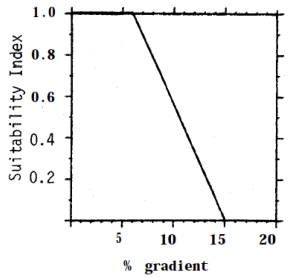


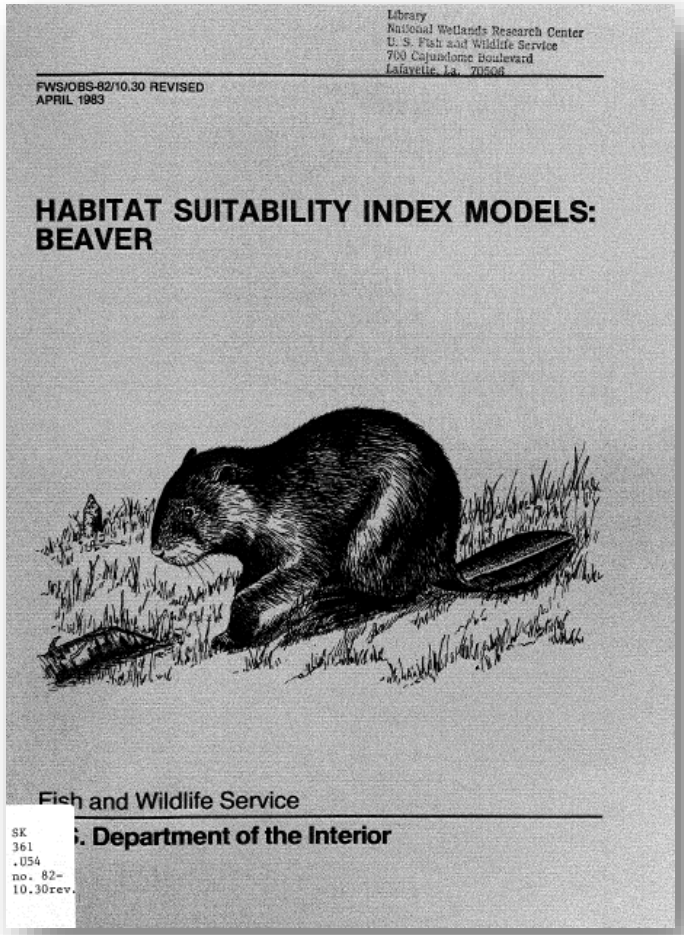


beavers in excess of estimated carrying capacity (Blackwell and Pederson 1993). The predicted beaver habitat in Utah was mapped as part of the 1995 Utah GAP Analysis (Figure 1). Current beaver distribution and abundance is not fully understood, however they are considered common and most of the suitable habitat believed to be occupied.

TRADITIONAL HABITAT SUITABILITY MODELS DON'T WORK FOR BEAVER

- With sufficient water & food, beaver **can survive almost everywhere** - deserts to alpine meadows
  - As such beaver defy traditional habitat suitability models.
  - Correlations between suitability & beaver occurrence tend to be weak or non-existent

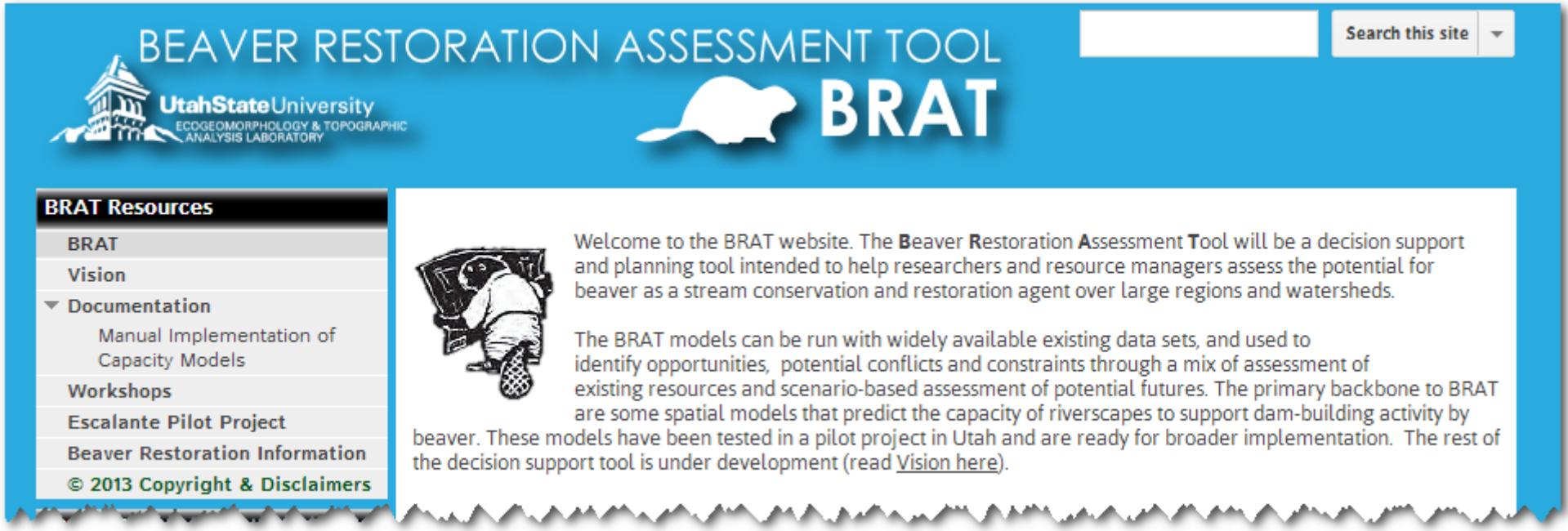




DAM-BUILDING CAPACITY MODELING

- **Beaver dams,** not beaver themselves, provide the positive feedbacks we seek
- While beaver can survive in wide range of conditions, **where they build dams is more limited**
- Dam building activity varies dramatically according to flow regime & availability of dam building materials

BRAT – BEAVER RESTORATION ASSESSMENT TOOL



Grand Canyon Trust
DEDICATED TO THE CONSERVATION OF THE COLORADO PLATEAU

The WALTON FAMILY FOUNDATION

ECOFLIGHT

http://brat.joewheaton.org

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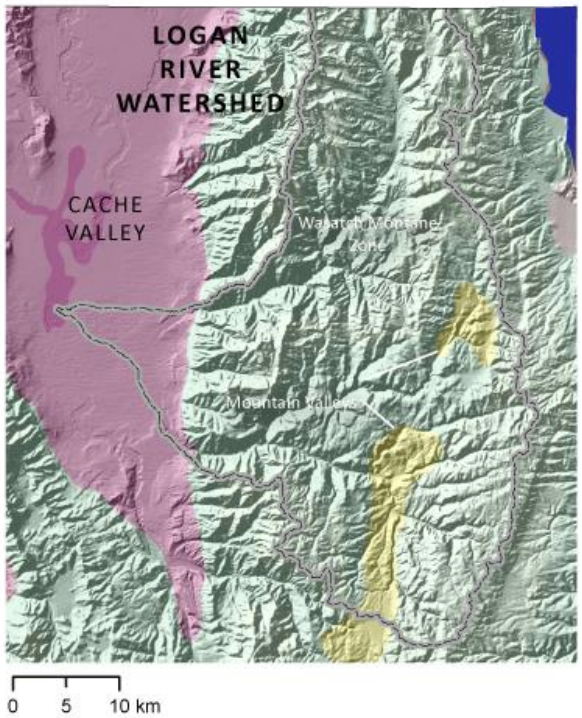
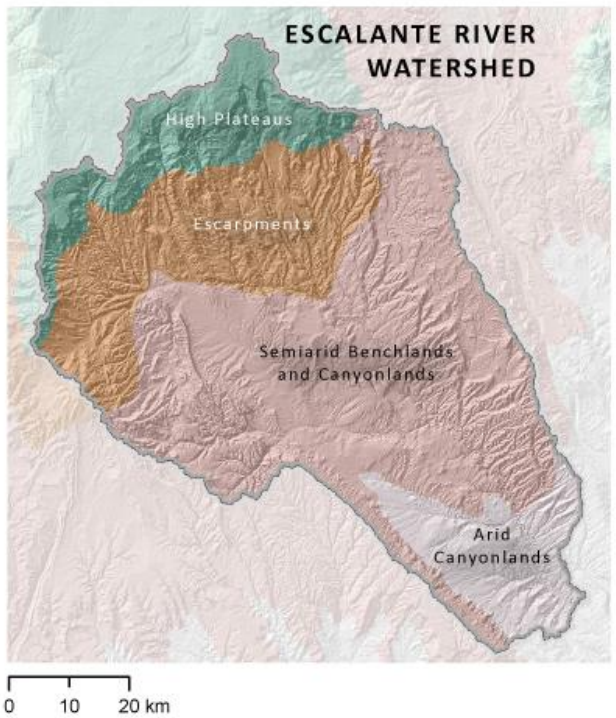
LINES OF EVIDENCE TO ESTIMATE BEAVER DAM DENSITIES AT FULL CAPACITY

- Evidence of a perennial water source
- Evidence of riparian vegetation to support dam building activity
- Evidence of adjacent vegetation (on riparian/upland fringe) that could support expansion and establishment of larger colonies
- Evidence that a beaver dam could physically be built across the channel during low flows
- Evidence that a beaver dam is likely to withstand typical floods

TEST-BEDS

Figure Wheaton & MacFarlane (In Review)





- Escalante Watershed, Utah*
- Logan River Watershed, Utah*
- Greater Yellowstone Ecosystem, Wyoming
- Park City, UT
- Lower John Day Watershed, Oregon
- Deschutes Watershed, Oregon

WORKFLOW

- Get LANDFIRE
- Classify it
- Clip it to streamside and riparian/upland buffers
- Run it through fuzzy inference system
  - Takes inputs and estimates the maximum dam density that can be supported based on this

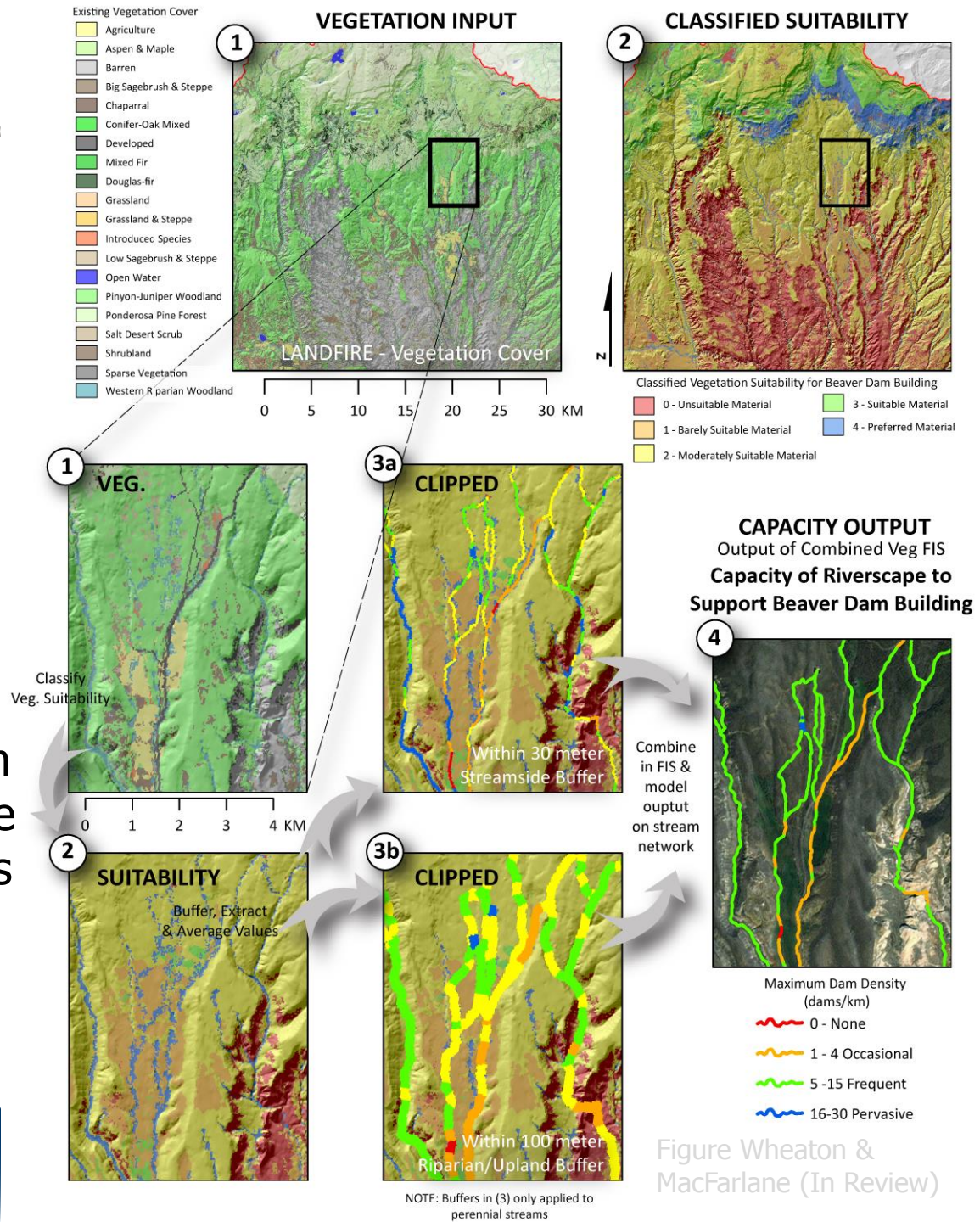


Figure Wheaton & MacFarlane (In Review)

COMBINED

1. Veg FIS
2. Baseflow (can they build a dam?)
3. 2 Year Flood (does dam blow out)

= Resulting Capacity

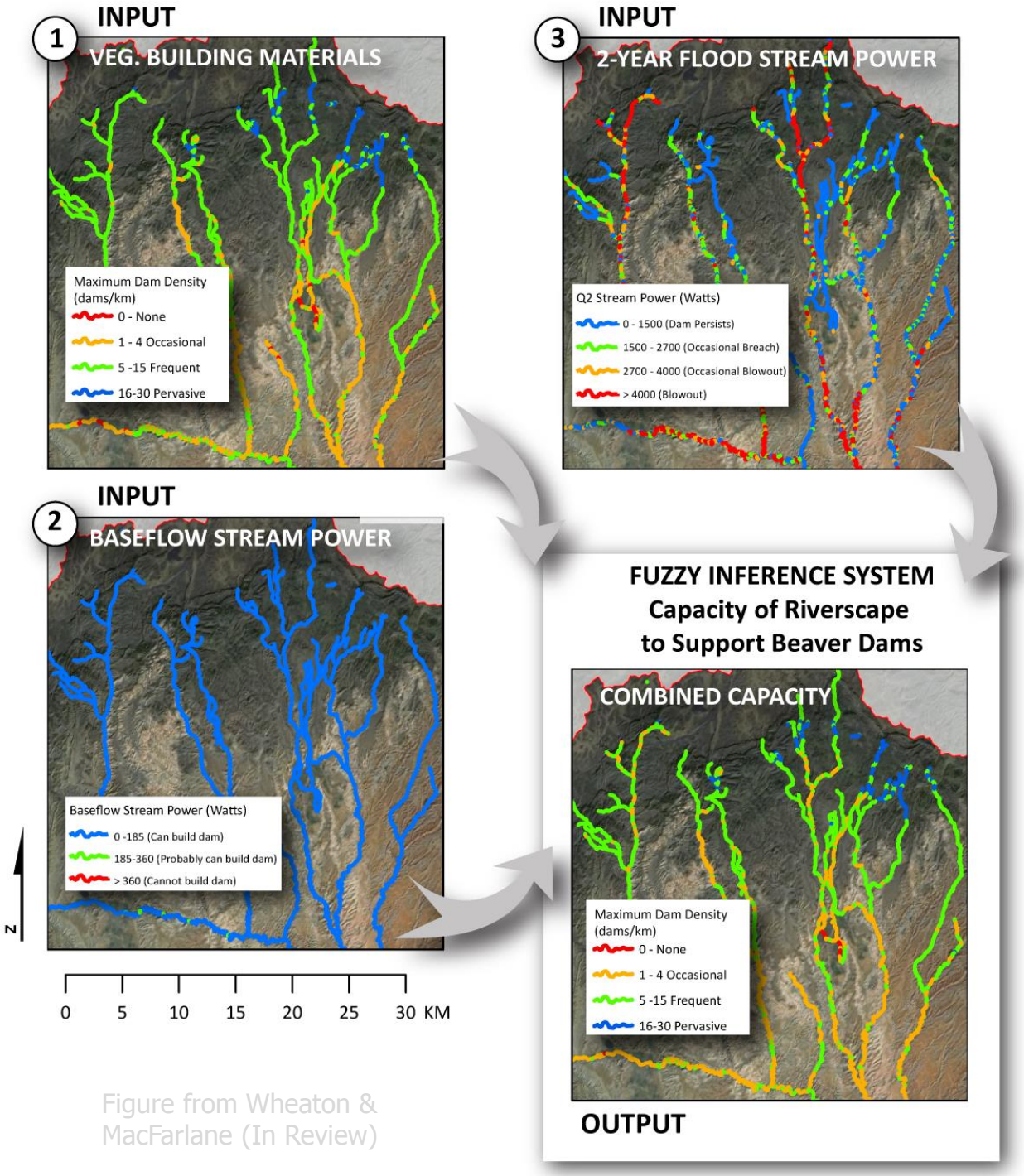
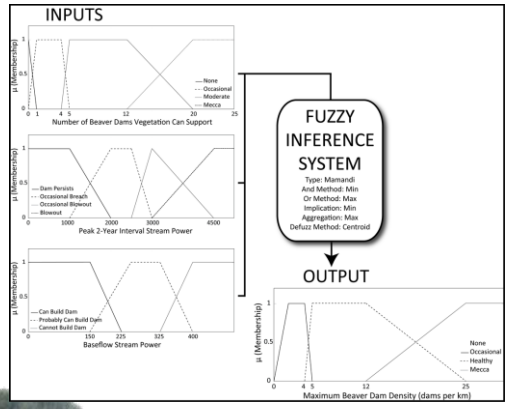


Figure from Wheaton & MacFarlane (In Review)

WE USE FUZZY INFERENCE SYSTEMS

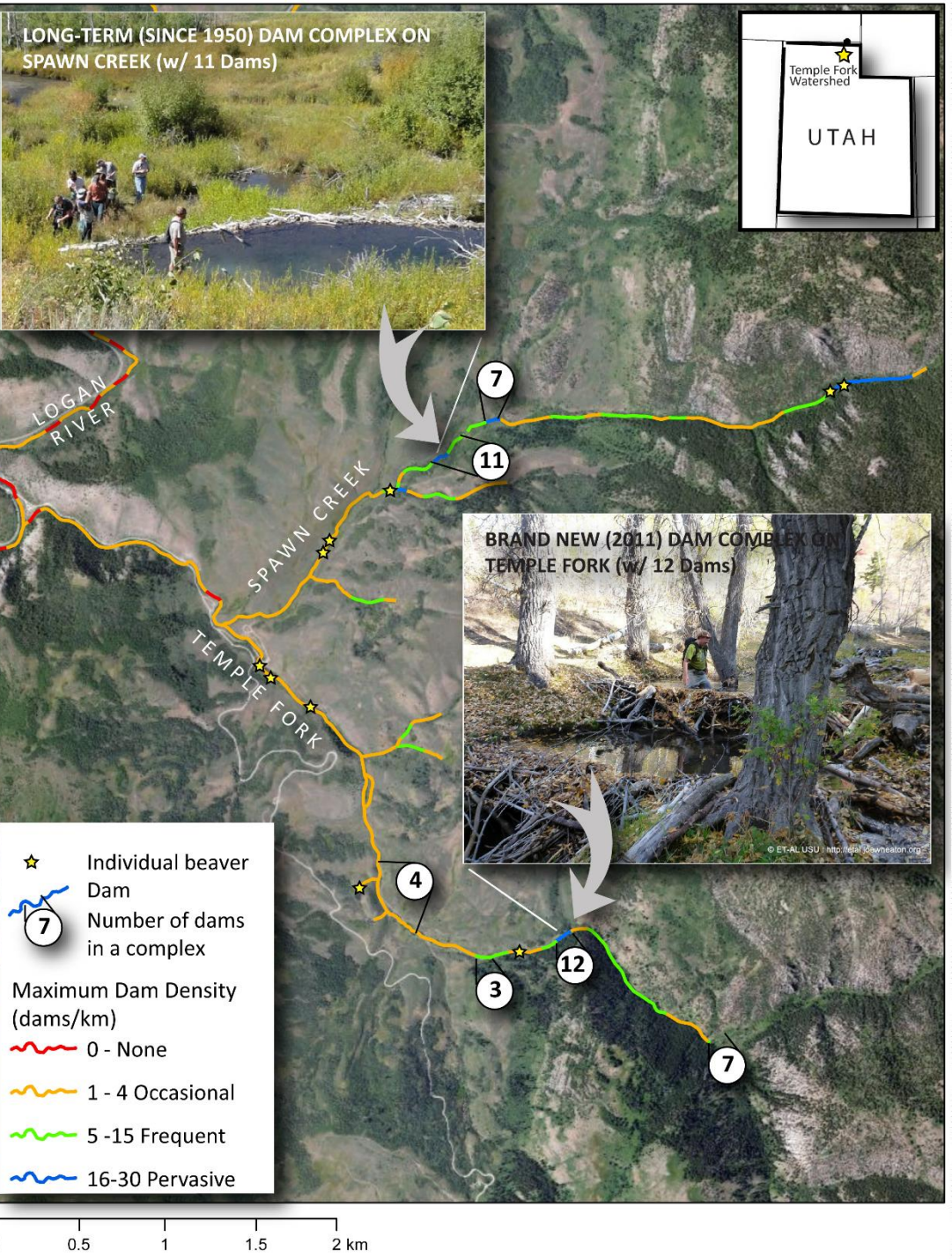
- Allow computing with words…
- Explicitly represent uncertainty due to ambiguity



		INPUTS						OUTPUT
	IF	Vegetative Dam Density Capacity (FIS)		Baseflow Stream Power		2 Year Flood Stream Power		Dam Density Capacity
RULES	1	None	&	-	&	-	, then	None
	2	-	&	Cannot Build Dam	&	-	, then	None
	3	Occasional	&	Can Build Dam	&	Dam Persists	, then	Occasional
	4	Frequent	&	Can Build Dam	&	Dam Persists	, then	Frequent
	5	Pervasive	&	Can Build Dam	&	Dam Persists	, then	Pervasive
	6	Occasional	&	Can Build Dam	&	Occasional Breach	, then	Occasional
	7	Frequent	&	Can Build Dam	&	Occasional Breach	, then	Frequent
	8	Pervasive	&	Can Build Dam	&	Occasional Breach	, then	Frequent
	9	Occasional	&	Can Build Dam	&	Occasional Blowout	, then	Occasional
	10	Frequent	&	Can Build Dam	&	Occasional Blowout	, then	Occasional
	11	Pervasive	&	Can Build Dam	&	Occasional Blowout	, then	Frequent
	12	Occasional	&	Can Build Dam	&	Blowout	, then	Occasional
	13	Frequent	&	Can Build Dam	&	Blowout	, then	Occasional
	14	Pervasive	&	Can Build Dam	&	Blowout	, then	Occasional
	15	Occasional	&	Can Probably Build Dam	&	Occasional Breach	, then	Occasional
	16	Frequent	&	Can Probably Build Dam	&	Occasional Breach	, then	Frequent
	17	Pervasive	&	Can Probably Build Dam	&	Occasional Breach	, then	Frequent
	18	Occasional	&	Can Probably Build Dam	&	Occasional Blowout	, then	Occasional
	19	Frequent	&	Can Probably Build Dam	&	Occasional Blowout	, then	Occasional
	20	Pervasive	&	Can Probably Build Dam	&	Occasional Blowout	, then	Frequent
	21	Occasional	&	Can Probably Build Dam	&	Blowout	, then	Occasional
	22	Frequent	&	Can Probably Build Dam	&	Blowout	, then	Occasional
	23	Pervasive	&	Can Probably Build Dam	&	Blowout	, then	Occasional

Table from Wheaton & MacFarlane (In Review)

VERIFICATION

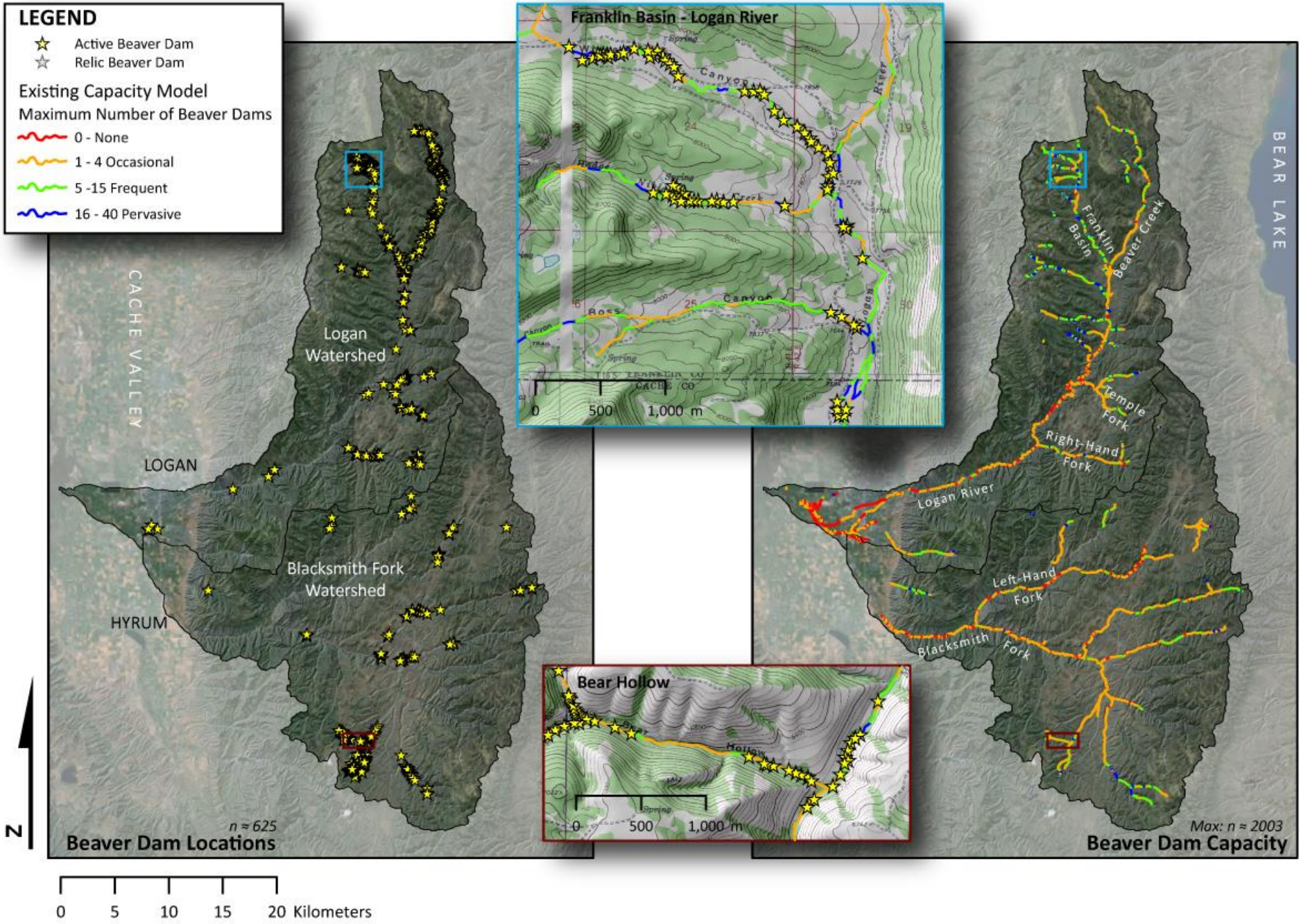


What you look for…

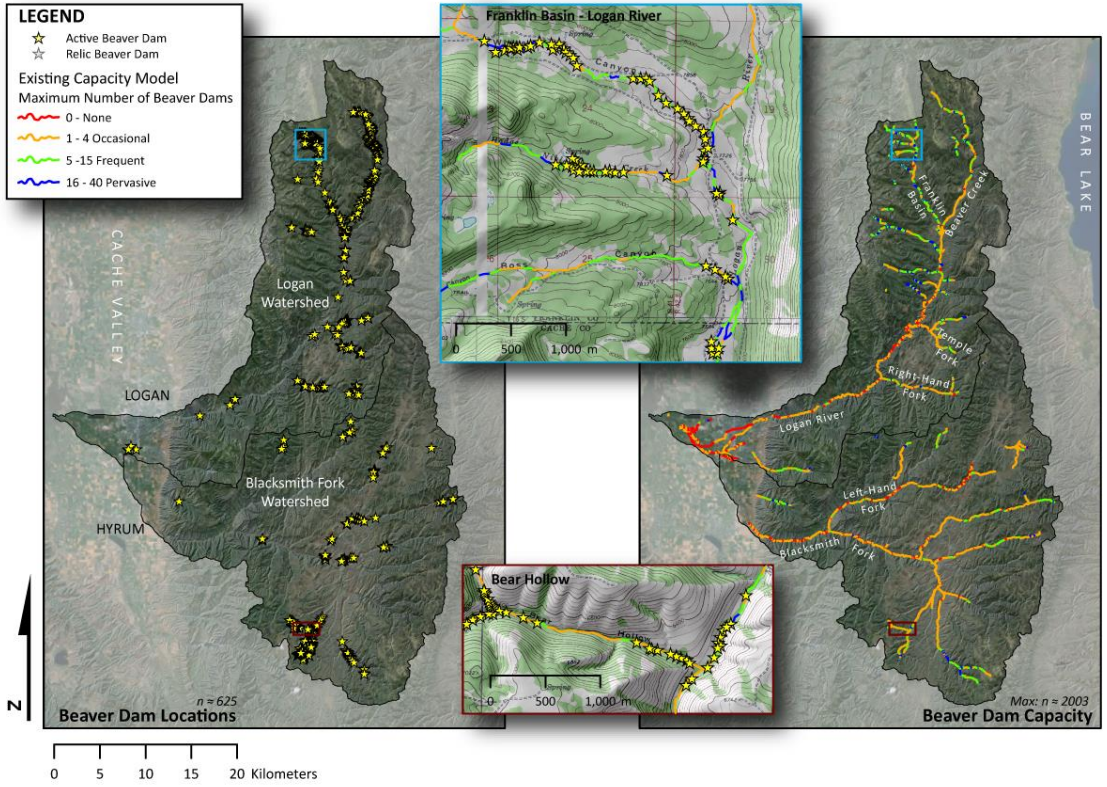
- No beaver dams where None predicted
- Low densities in 'occasional' zones
- Stable long-term dam complexes in 'frequent' or 'pervasive'
- High quality ('frequent'/'pervasive') areas as likely locations of new colonies

Figure from Wheaton & MacFarlane (In Review)

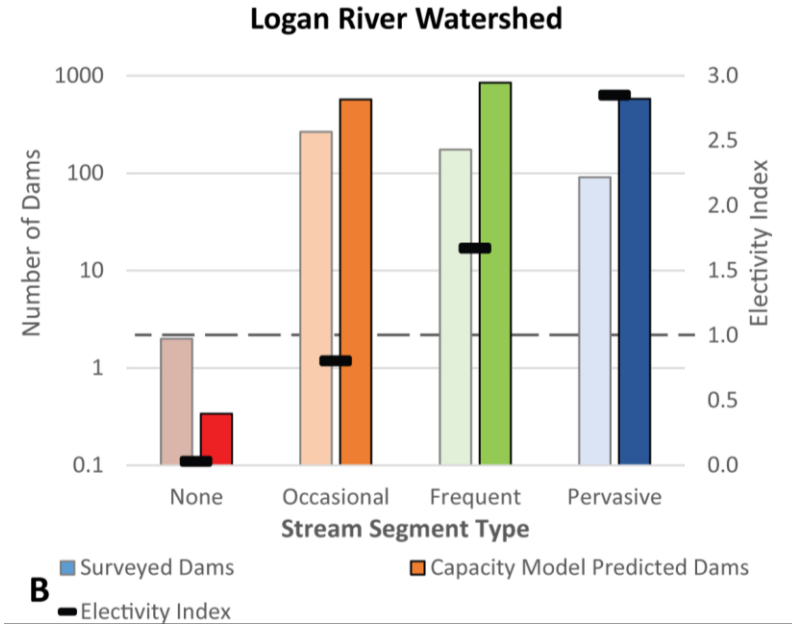
LOGAN-BLACKSMITH VALIDATION



LOGAN-BLACKSMITH VALIDATION



- Actually… 95 more dams….



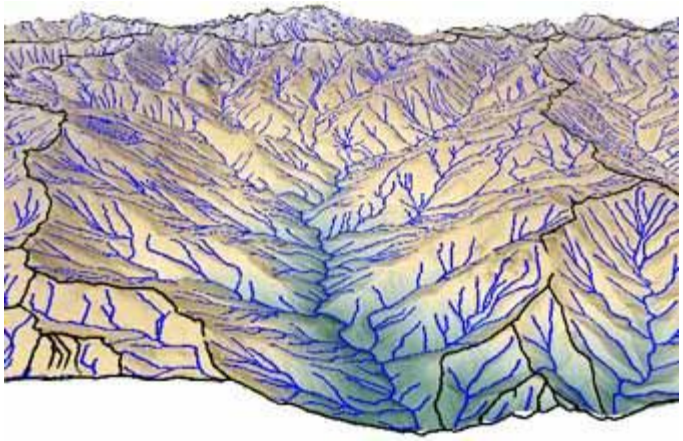
BRAT Segment Type:	Stream Length *(km)*	Percentage of Drainage Network	Surveyed Dams	BRAT Estimated Capacity *(Number of Dams)*	Average Surveyed Dam Density *(dams per km)*	Average BRAT Predicted Capacity *(dams /km)*	Percent of Modeled Capacity	Electivity Index
None	43.4	12%	2	0	0.0	0.0	0.0%	0.0
Occasional	215.8	62%	265	573	1.2	2.7	46.2%	0.8
Frequent	68.1	20%	174	850	2.6	12.5	20.5%	1.7
Pervasive	20.9	6%	91	580	4.4	27.7	15.7%	2.8
Total	**348.2**		**532**	**2003**	**1.5**	**5.8**	**26.6%**	

NEXT STEPS… RESTORATION POTENTIAL

- Classify the drainage network in terms of 'where could they be':
  - Low-hanging fruit streams
  - Quick return streams
  - Long-term possibility streams
  - Unsuitable, Naturally Limited Streams
  - Unsuitable, Anthropogenically Limited Streams

Utah's Watershed RESTORATION INITIATIVE

UTAH DNR WILDLIFE RESOURCES



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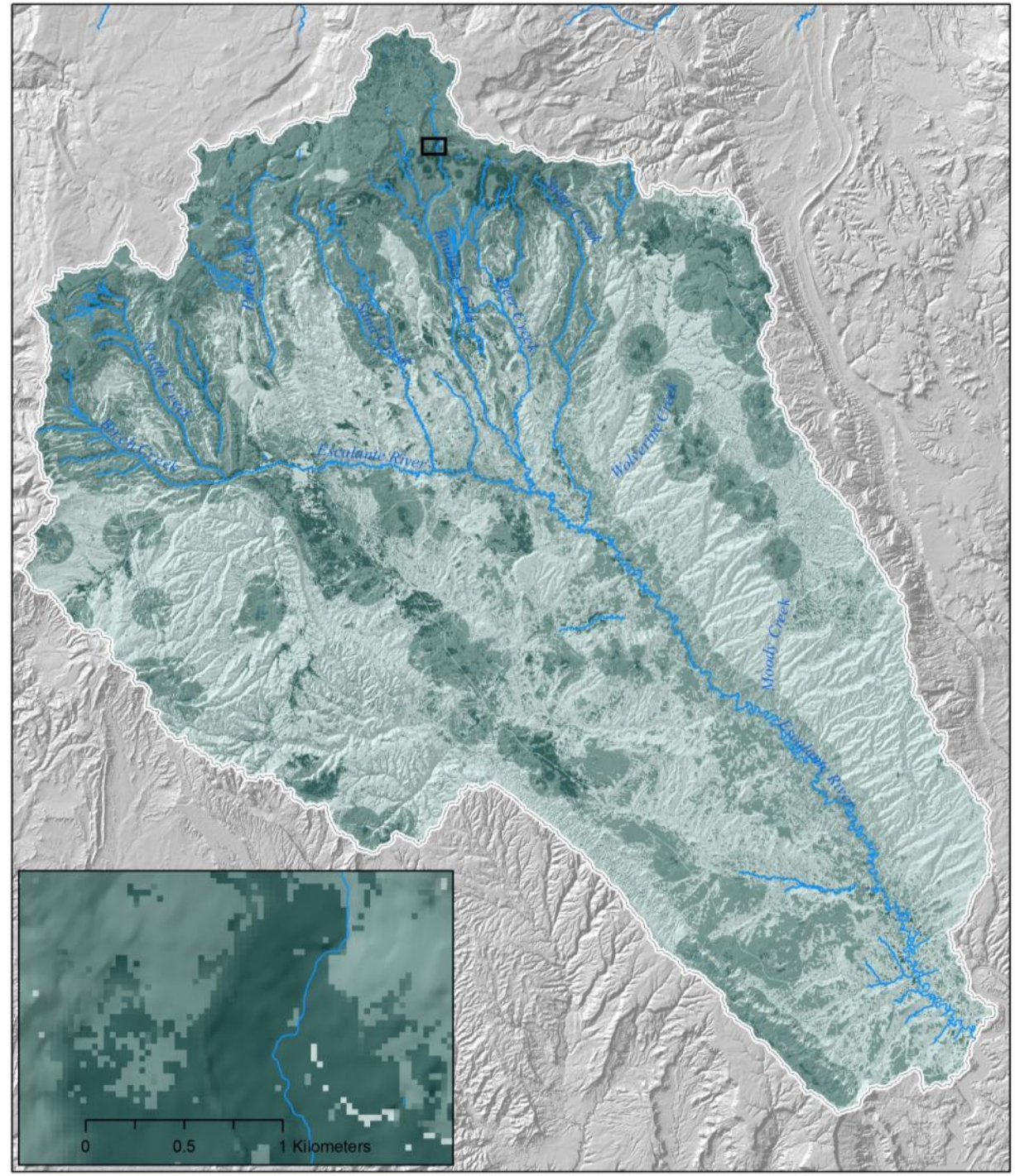
LIMITING FACTORS AFFECTING CAPACITY

- Overgrazing of riparian zone
- Trapping or predation
- Roads/development
- Timber harvesting
- Natural disturbance (flooding, fire)


Probability of Ungulate Utilization
High : 1
Low : 0
Fuzzy Model Based on:
• Slope
• Distance from Water
• Vegetation
Moody Creek
Wolverine Creek
Elkhorn River
0
0.5
1 Kilometers
N
0
5
10
15
20
25 Kilometers
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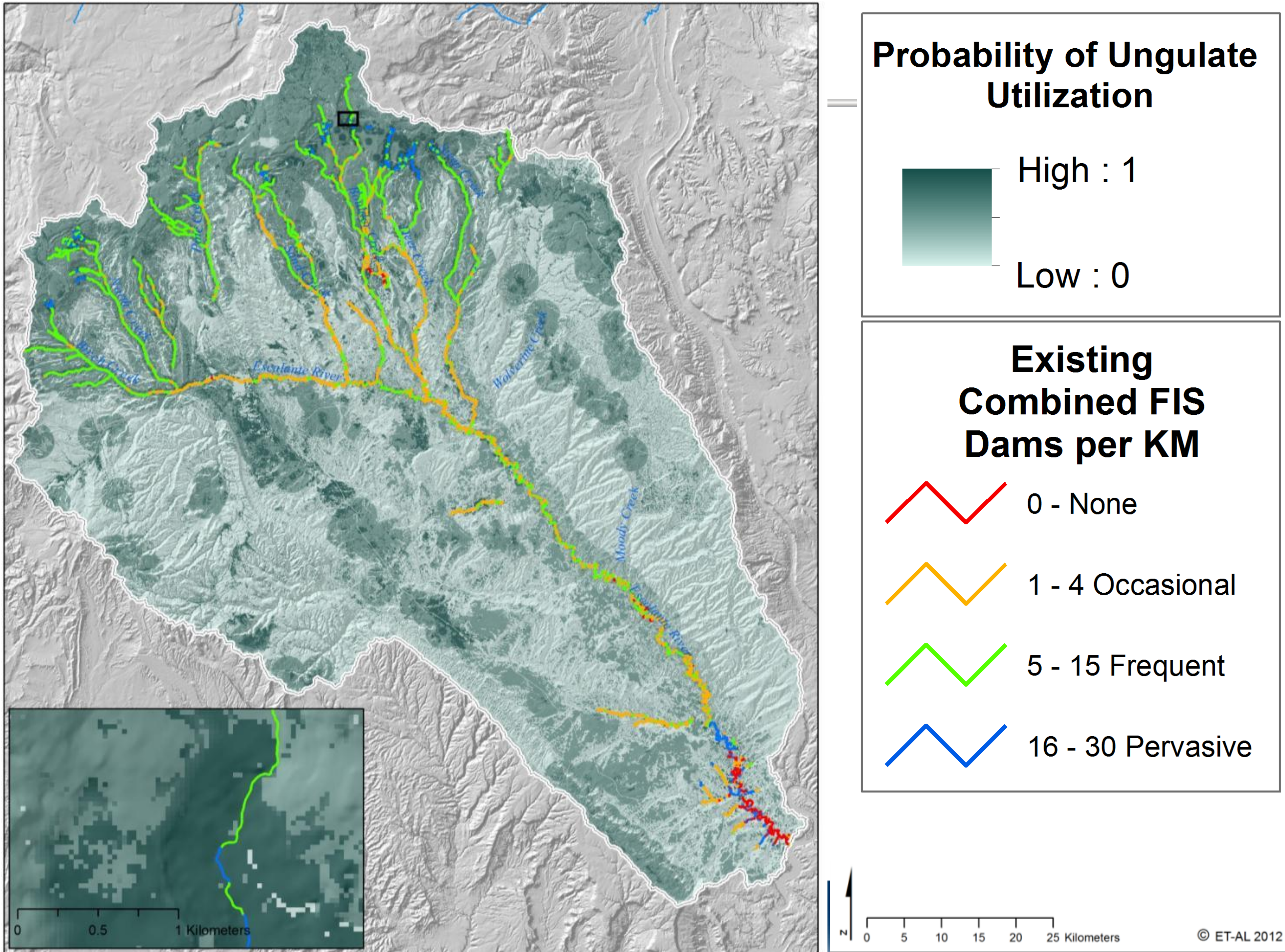

Probability of Ungulate Utilization
High : 1
Low : 0
Existing Combined FIS Dams per KM
0 - None
1 - 4 Occasional
5 - 15 Frequent
16 - 30 Pervasive
Escalante River
Wolverine Creek
Moody Creek
0 0.5 1 Kilometers
N
0 5 10 15 20 25 Kilometers
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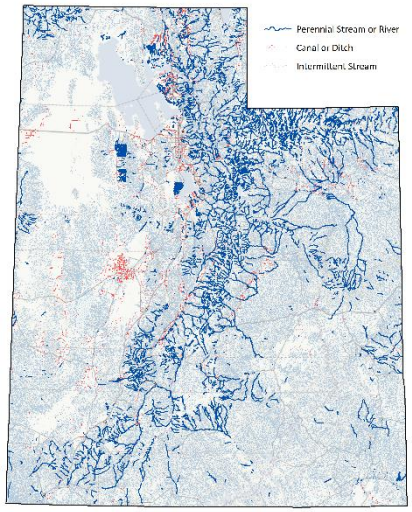
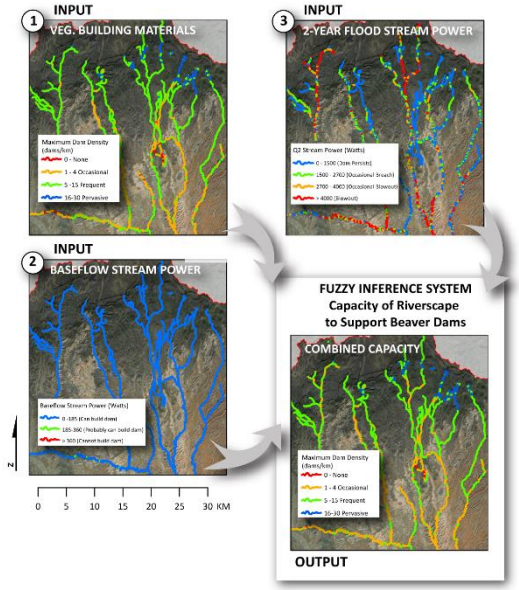
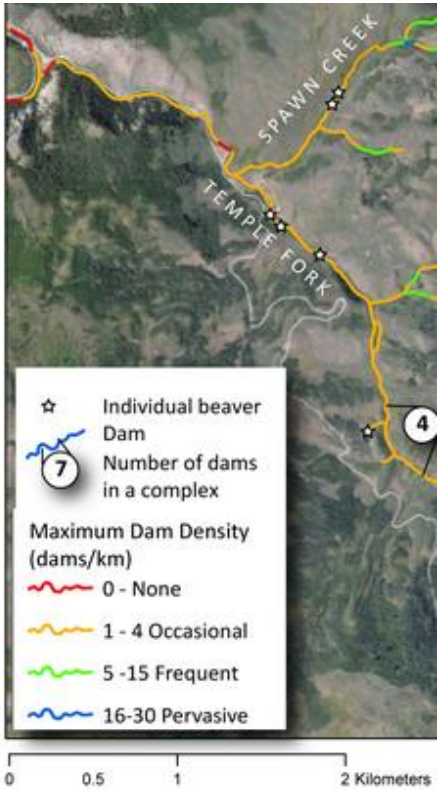
WHAT WE ARE DOING WITH UDWR…

- Finish decision support elements of BRAT in bespoke manner for UDWR
- Take whole state & run BRAT







2. Identify zones on the map to illustrate appropriate beaver management strategies for given geographic areas, i.e. existing populations (including source populations), unoccupied historical range and areas where the potential for conflict is high.

BEAVER: RESTORATION LIAISON? OUTLINE

I. What Beaver Do
II. State of our Streams & Adjoining Uplands
III. Restoration by Rodents?
IV. Where? Meet the BRAT
V. Take Aways…

TAKE AWAYs

- Dam building activity of benefit not just to aquatic and riparian species, but upland species too
- Beaver are a disturbance agent – sometimes disturbance is key ingredient for process-based restoration
- The wadeable streams beaver can impact intersect many of systems you are trying to restore
- BRAT mapping can help building realistic expectations

For more information, visit:
http://beaver.joewheaton.org

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Ryan Lokteff
Martha Jensen

For more information, visit:
http://beaver.joewheaton.org

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ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY