Stream Restoration Symposium 2019

Lessons Learned from Stream Restoration in Other Jurisdictions

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CANADIAN CHAPTER

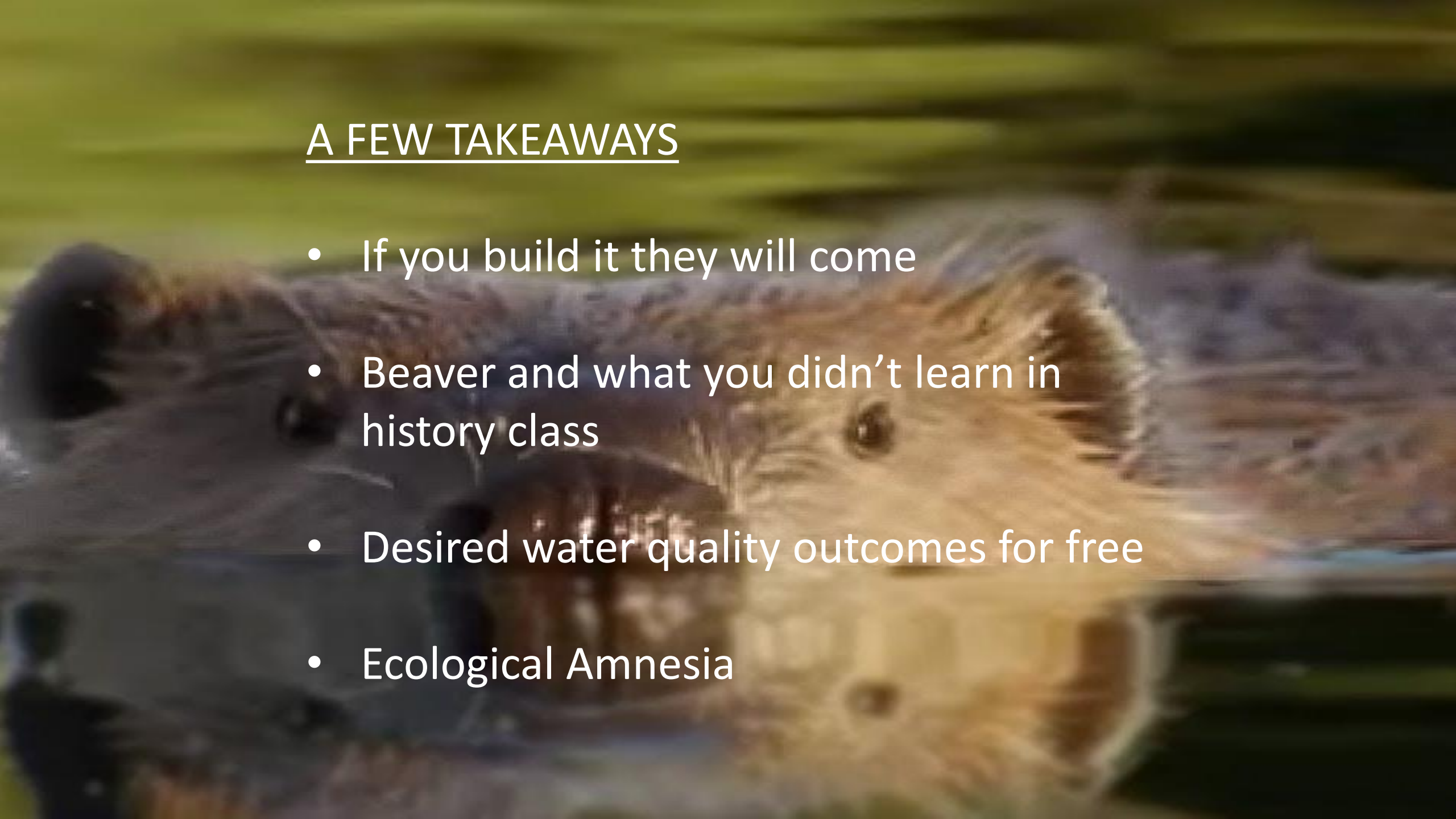
5 | SMOOTH STONES
RESTORATION INC

Toronto and Region Conservation Authority

Using Nature to Restore Nature

Scott McGill
smcgill@ecotoneinc.com

ecotone
ecological restoration



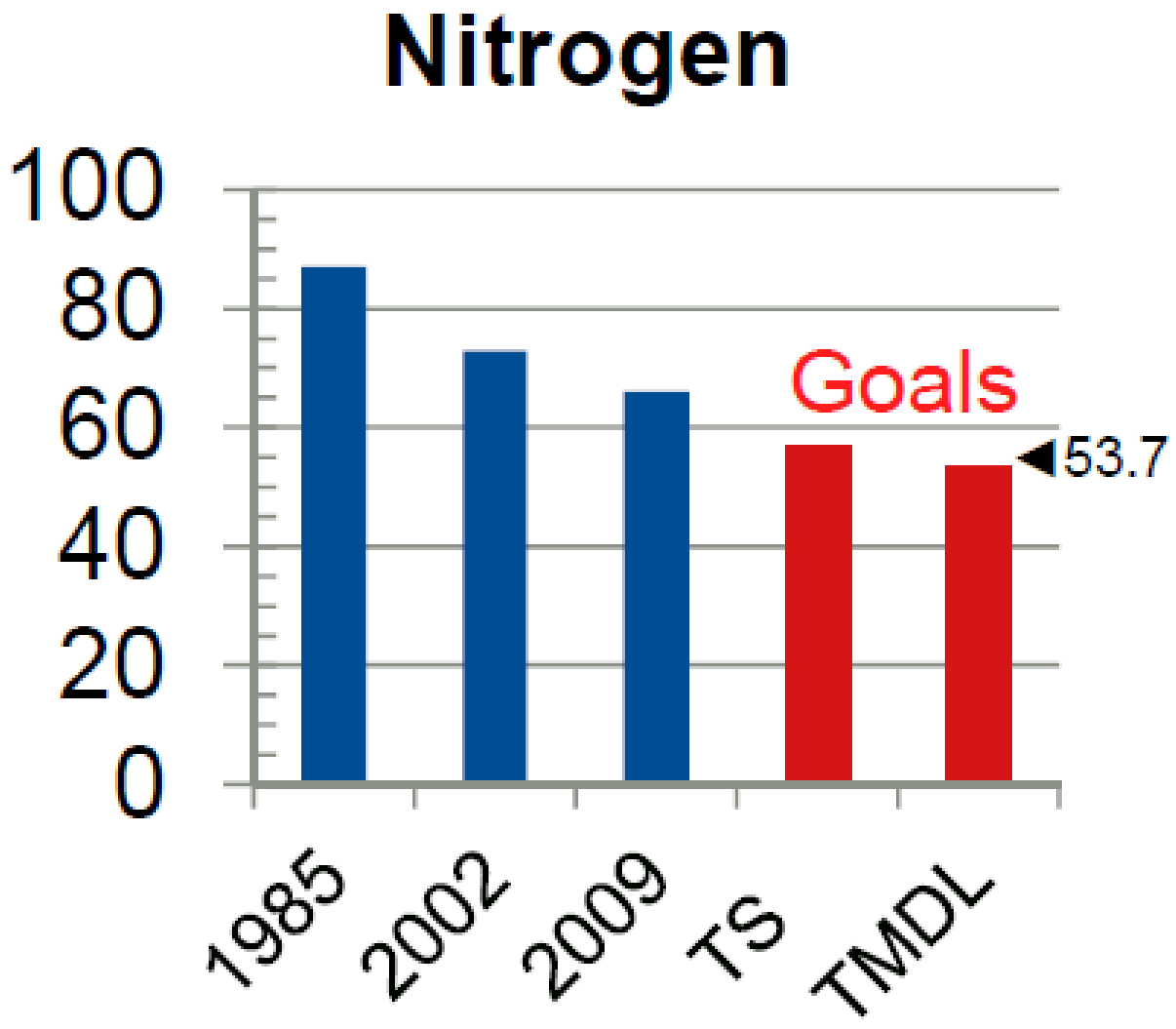
A FEW TAKEAWAYS

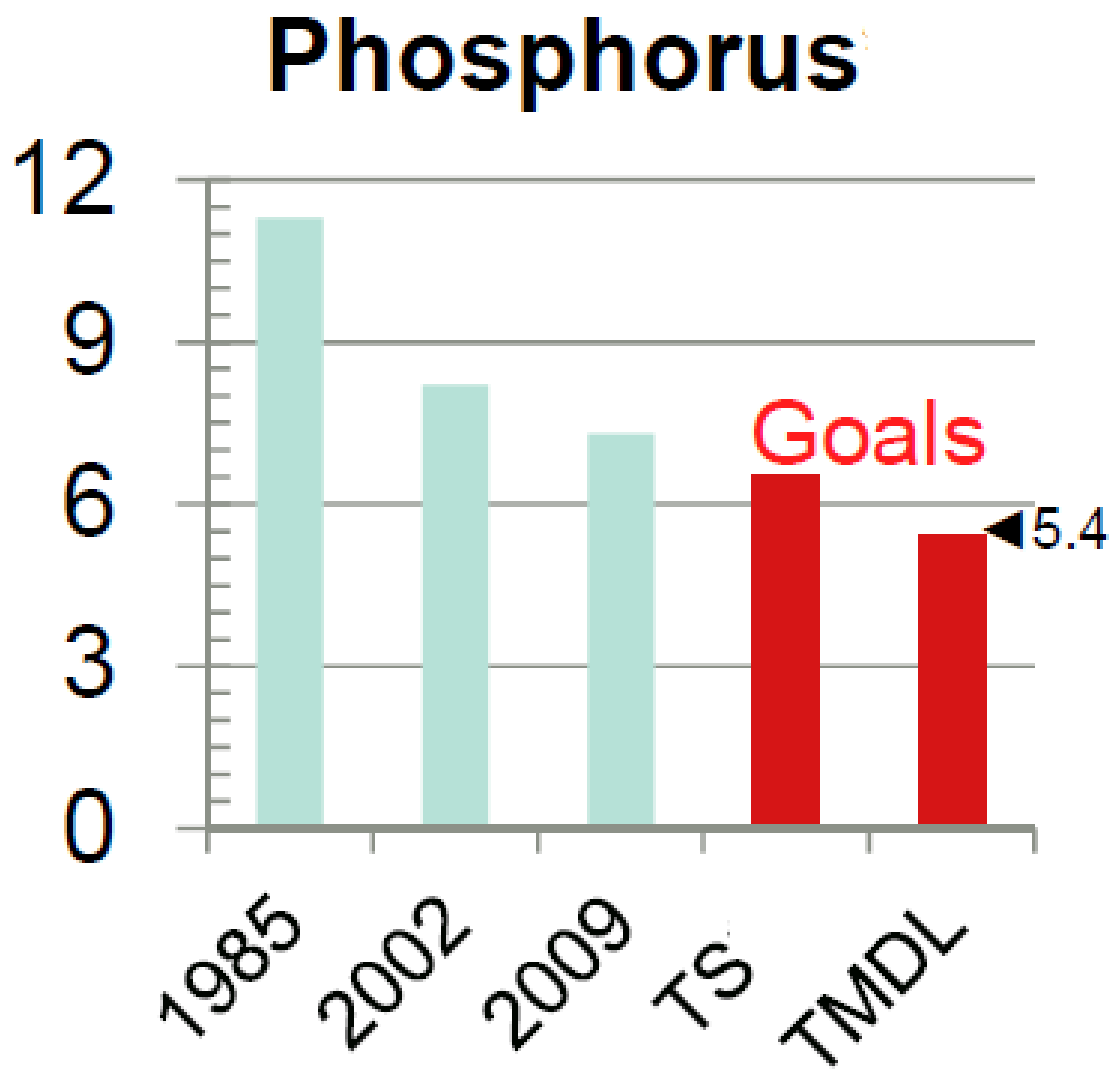
- If you build it they will come
- Beaver and what you didn’t learn in history class
- Desired water quality outcomes for free
- Ecological Amnesia

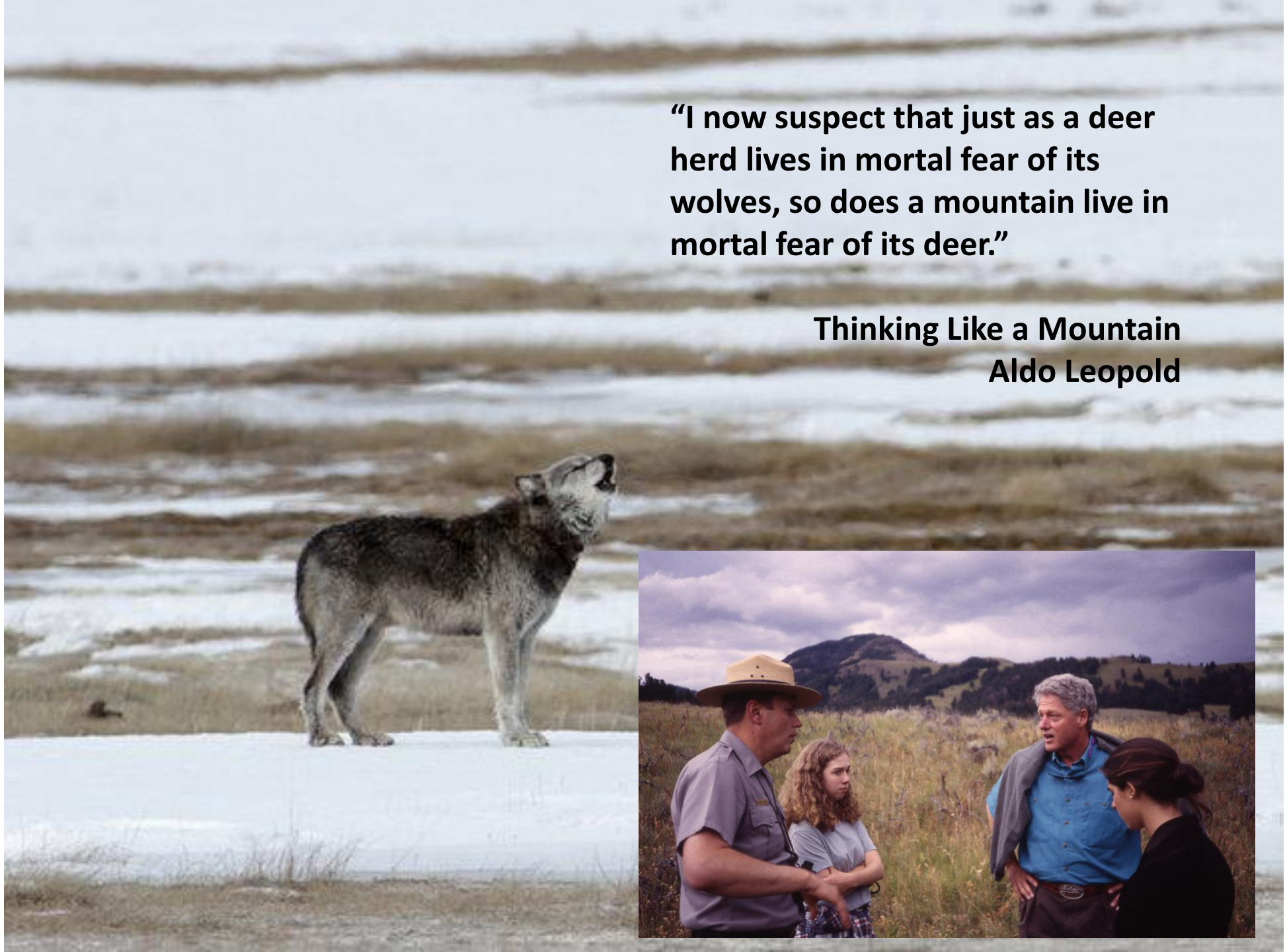
Table 14: Summary of Costs for Maryland's Interim (2017) and Final (2025) Chesapeake Bay Restoration Strategies

Source Sector	Cost of 2017 Strategy 2010 - 2017 (Millions)	Cost of 2025 Strategy[a] 2010 - 2025 (Millions)
Agriculture	**$498**	**$928**
Municipal Wastewater	**$2,368**	**$2,368**
Major Municipal Plants	$2,306	$2,306
Minor Municipal Plants	$62	$62
Stormwater	**$2,546**	**$7,388**
MDOT[c]	$467	$1,500
Local Government	$2,079	$5,888
Septic Systems	**$824**	**$3,719**
Septic System Upgrades	$562	$2,358
Septic System Connections	$237	$1,273
Septic System Pumping	$25	$88
TOTAL	**$6,236**	**$14,403**

a. Cumulative total.
b. Costs are in 2011 dollars unless otherwise noted in Appendix C.
c. Maryland Department of Transportation (MDOT) costs are segregated from other stormwater costs due to their non-standard cost structure. Cost estimates were provided by MDOT.


Nitrogen
100
80
60
40
20
0
Goals
53.7
1985
2002
2009
TS
TMDL


Phosphorus
12
9
6
3
0
Goals
5.4
1985
2002
2009
TS
TMDL

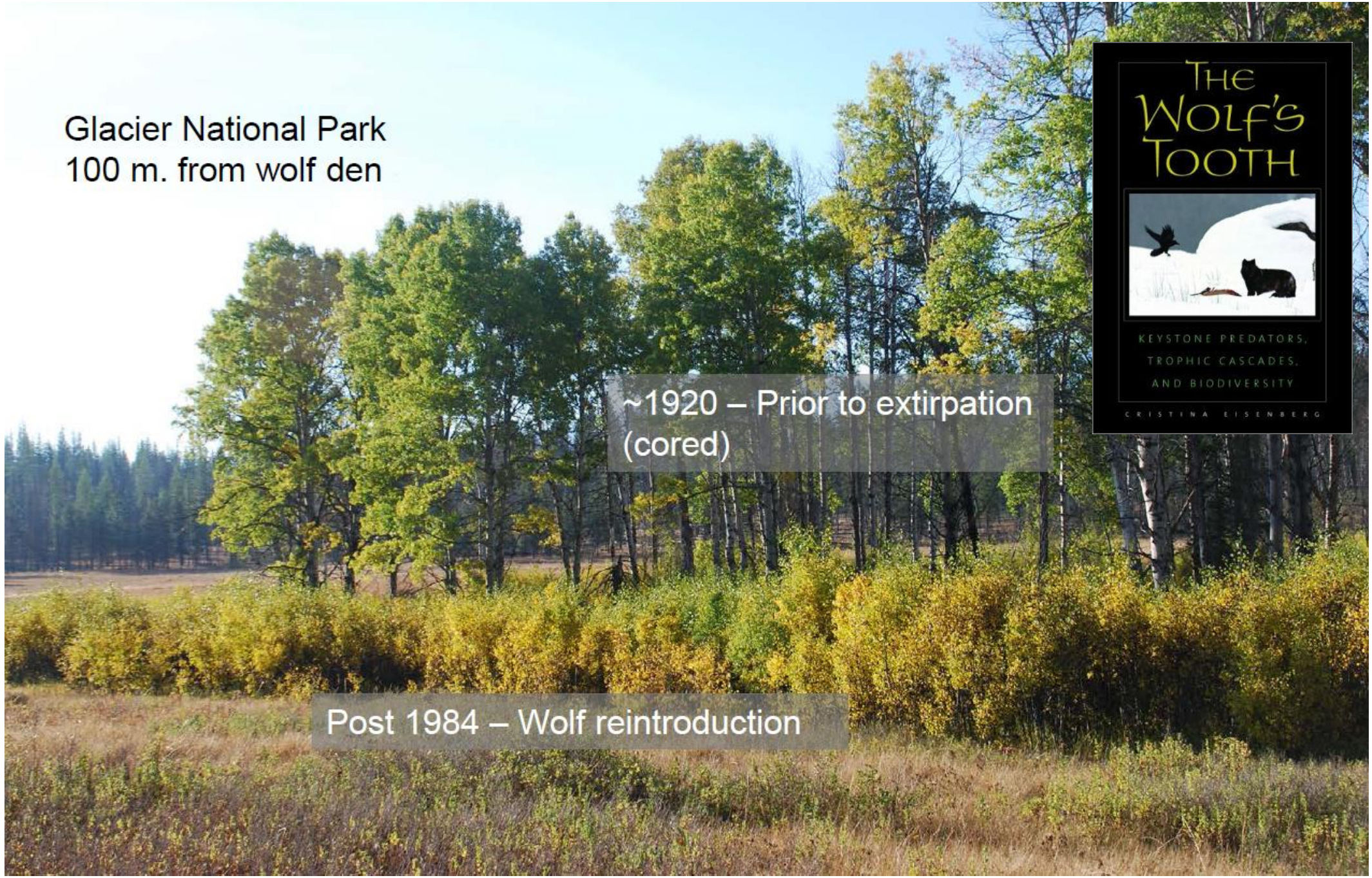


“I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer.”

Thinking Like a Mountain
Aldo Leopold

Restoration of wolves to Yellowstone has changed ungulate grazing, benefiting riparian veg, other species.

Source: Ripple and Breshta 2004


Glacier National Park
100 m. from wolf den
~1920 – Prior to extirpation (cored)
Post 1984 – Wolf reintroduction
THE WOLF'S TOOTH
KEYSTONE PREDATORS, TROPHIC CASCADES, AND BIODIVERSITY
CRISTINA EISENBERG

Bridge Creek, Oregon

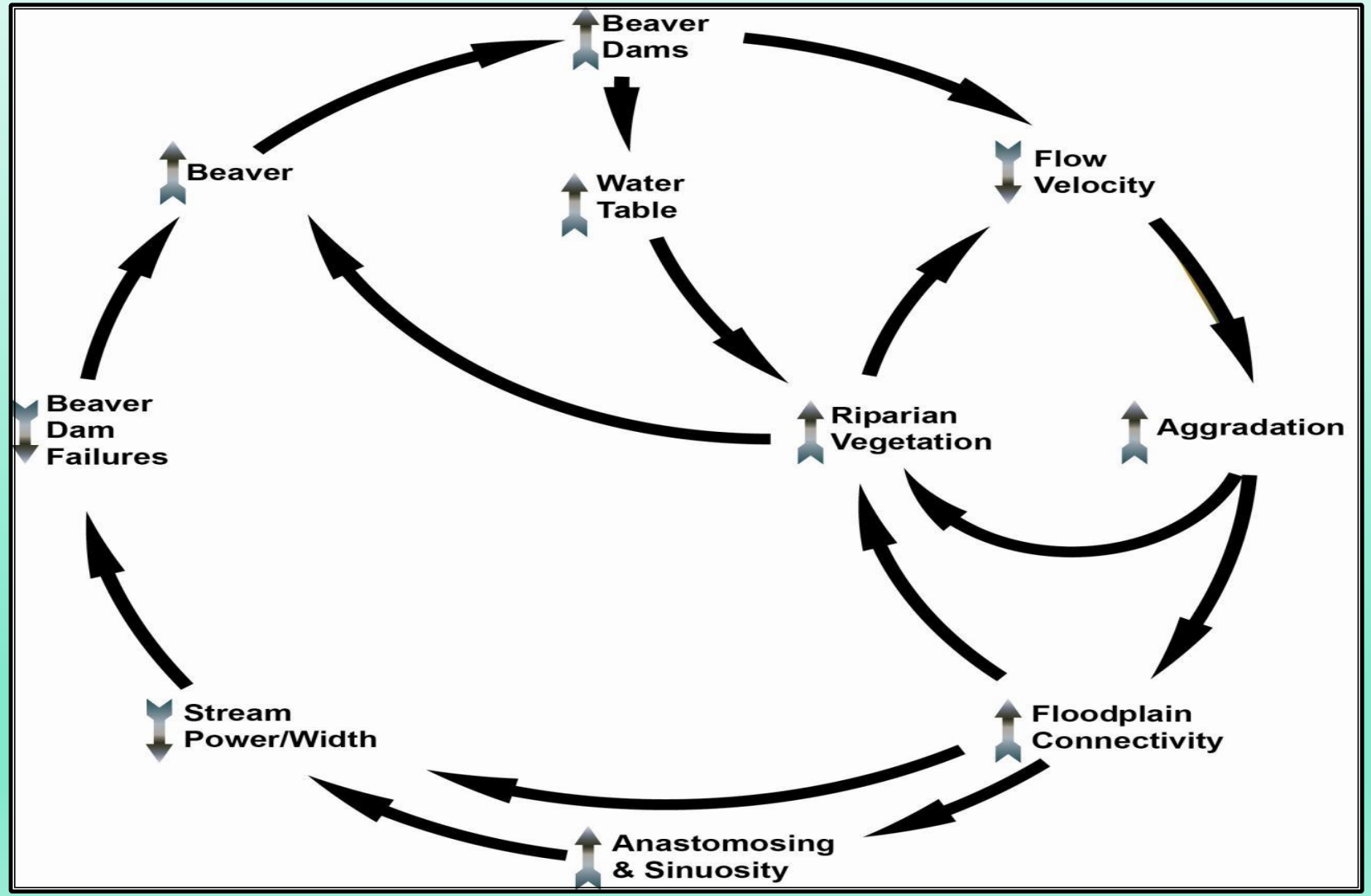
- NOAA Funding
- Objective is to improve salmonid habitat
- 10 year study
- Beaver dam analogs
- Several meters of aggradation in 5 years

Beaver Dam Analogs – BDA's

Outside the Box Thinking

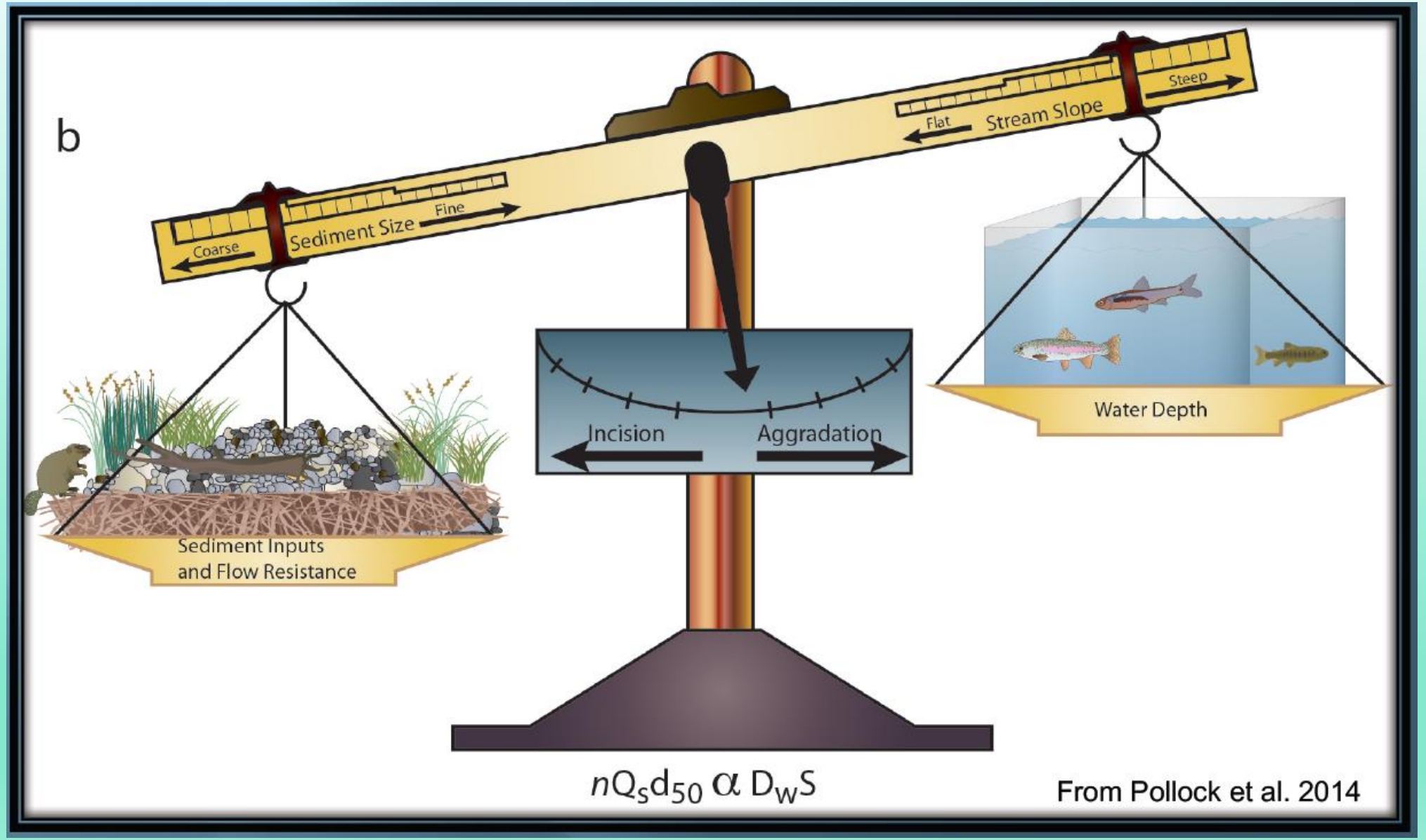
- Direct flows into the hillside.
- Widens the floodplain and spreads out energy.
- Beaver dams trap sediment, increase floodplain connectivity, and establish wetlands.
- “Fight fire with fire.”

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



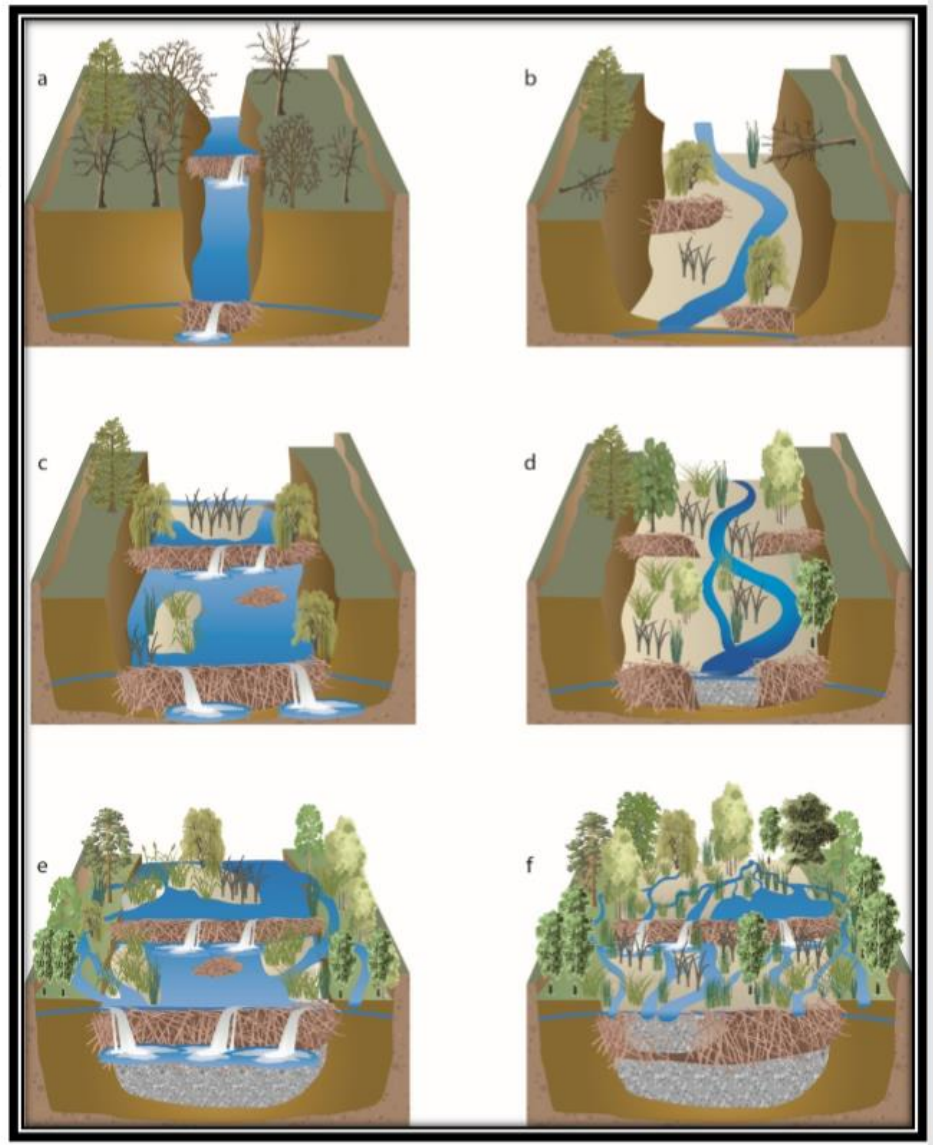
Pollock et al. 2014


Is your creek missing me?
WORTH A DAM
KEYSTONE


b
Coarse
Sediment Size
Fine
Flat
Stream Slope
Steep
Incision
Aggradation
Sediment Inputs
and Flow Resistance
Water Depth
$nQ_s d_{50} \alpha D_w S$
From Pollock et al. 2014

Beaver in incised streams

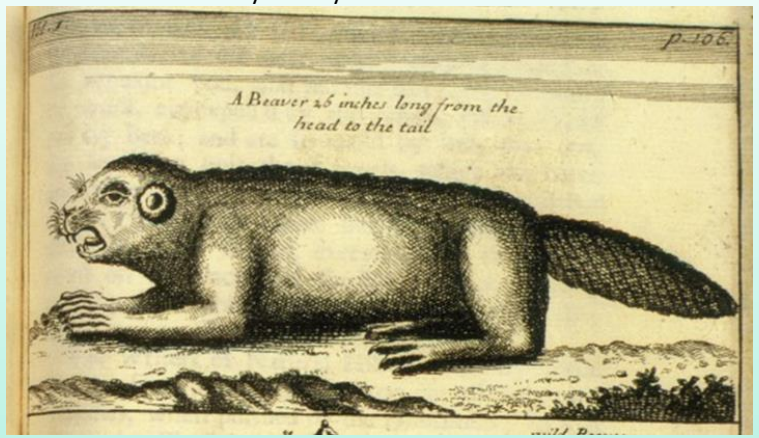
"Recovery possible in years to decades instead of decades to centuries"



Pollock et al., 2014. using beaver dams to restore incised stream ecosystems. *Bioscience*, 64(4).

Photo Credit: Canadian Museum of History

Louis Armand, Baron de Lahontan drawing of a beaver circa 1687
Photo Credit: Newberry Library

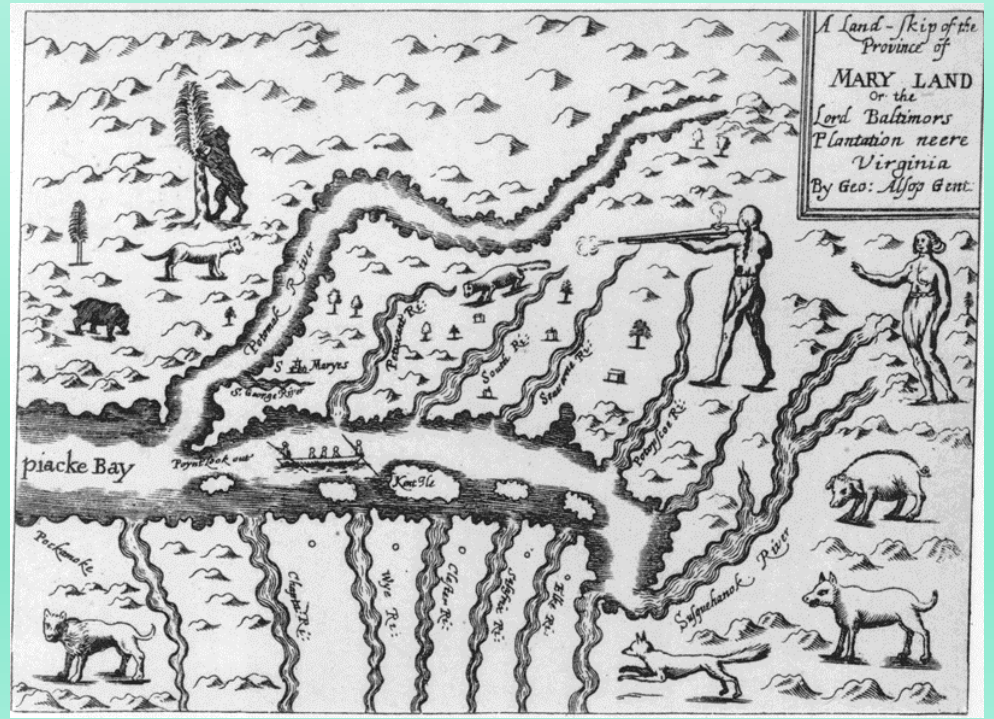


"Claiborne's elaborate preparations and largescale operation brought in 7488 pounds of beaver pelts (worth £4493 at 12 s./lb.)...in the six years before Kent Island's takeover by Maryland in 1638." – Fredrick J. Fausz, "Present at the Creation"

Captain John Smith's map of Virginia 1612 Photo Credit: Old-Maps.com

In spring of 1632, Henry Fleet returned to trade for beaver pelts along the Potomac River, only to find that…

"Charles Harmar…had just cleared both sides of the [Potomac] river, taking some fifteen hundred pounds of pelts back to the Eastern Shore. After receiving 114 pelts as a goodwill offering from the Piscataway tayac fleet, journeyed up to the Nacotchtanks and traded for eight hundred pounds of beaver…with the expectation of getting six thousand pounds the next year" – Fredrick J. Fausz, "Present at the Creation"



George Alsop's 1666 "Land-skip" map Photo Credit: University of Delaware

Photo Credit: Canadian Geographic

"In 1643-44 also, over 5700 pounds of beaver pelts were mentioned in debt cases, at a time when one pound was worth between 12s. and 24s., or from 36 to 144 pounds of tobacco. Beaver prices in this two-year period were two to three times higher than they had been only five years before, whereas tobacco prices remained relatively stable (and low) at 3 to 4 pence per pound" – Fredrick J. Fausz, "Present at the Creation"

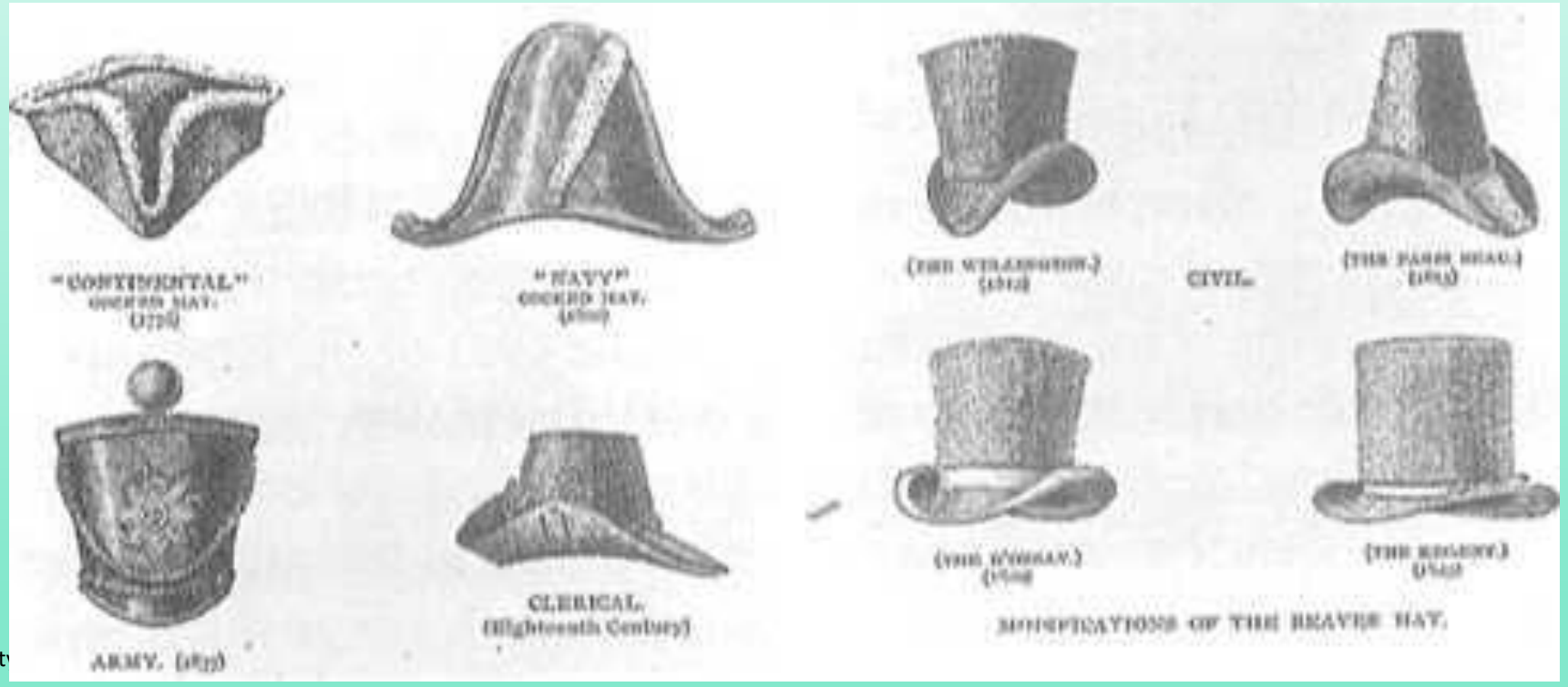
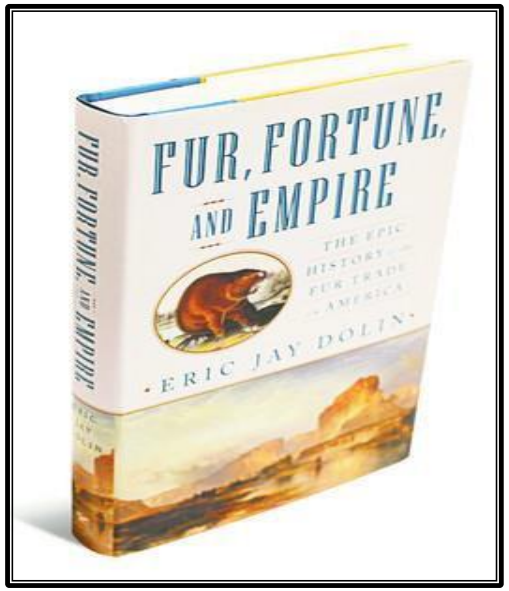


Photo Credit: Portland State University

"On more than one occasion, colonists found themselves so deeply in debt for beaver pelts that they mortgaged, or had to put up as security, a large portion of their property" – Fredrick J. Fausz, "Present at the Creation"

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



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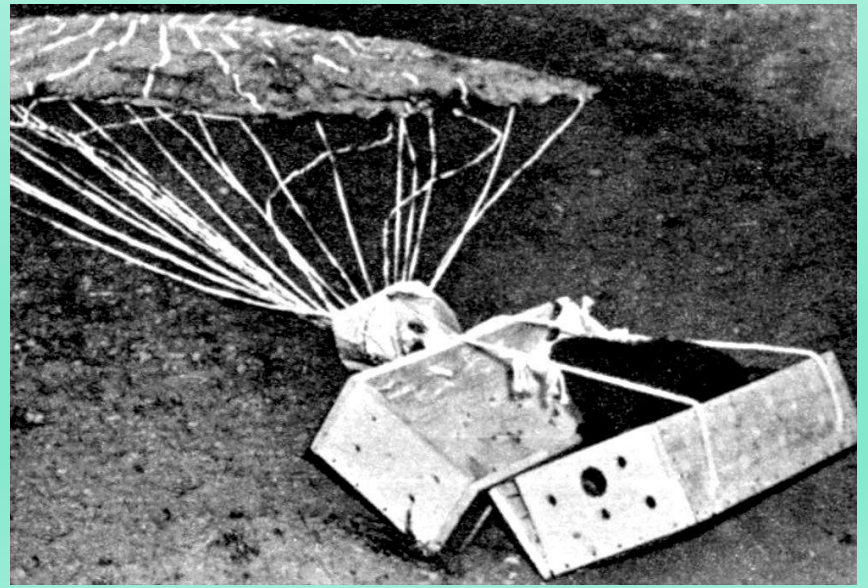


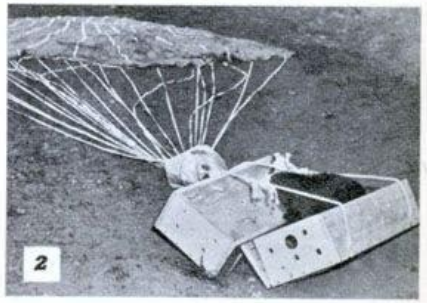
Airborne Beavers Fight Floods

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.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AGENTS OF REGENERATION

Beavers in Devon

Enclosed Beaver Project

In 2011 a male and female beaver were introduced into a three hectare fenced enclosure in the Tamar headwaters, where their impacts are being studied in detail. Most of the results presented in this document are from this research site.

The Enclosed Beaver Project is situated on private land in the headwaters of the River Tamar and upstream of Roadford Lake.

The 900 m perimeter fence has electric strands to prevent beavers climbing and a wildmesh apron on the inside to prevent them burrowing underneath. This fencing cost approximately £36/m to construct.

The beavers live in a large lodge situated on the banks of a pond. The lodge has increased in size every winter as more sticks and silt are built on top by the beavers, and willow sticks and branches are placed in the water to create a nearby winter food cache.

Since 2011, 13 ponds of varying sizes have been constructed by the beavers. The dramatic engineering of the watercourse in this site has provided a perfect opportunity to study the impacts of beaver dams on a wide range of different subjects.

Partners and funders

The Enclosed Beaver Project site is owned by John and Elaine Morgan who have kindly allowed this wetland area within their farm to be managed by the beavers. Additional funding has come from Natural England through Higher Level Stewardship (HLS).

The beavers are owned and managed by the Derek Gow Consultancy. The initial fencing and other infrastructure was funded by Viridor Credits Environmental Company and the Truell Charitable Foundation.

In 2012, Westland Countryside Stewards began funding the project allowing the University of Exeter to carry out detailed research work on the hydrological and water quality implications of the beaver dams.

Funding is currently being sought to continue this project.

River Otter Beaver Trial

In March 2015 two families of wild-living beavers of unknown origin were captured from the River Otter and proven to be healthy before being released back into the river as part of a five year licensed trial.

The River Otter Beaver Trial area covers the entire 250 km^2 of the Otter catchment containing 594 km of watercourse. The river rises in the predominately pastoral landscape of the Blackdown Hills, before flowing through highly productive agricultural land in its middle and lower reaches. The River Otter enters the sea at Budleigh Salterton.

In February 2015 five beavers were captured by the Animal and Plant Health Agency (APHA). They were given detailed health examinations by beaver experts from the Royal Zoological Society of Scotland (RZSS), who confirmed they were healthy Eurasian beavers and fit for re-release.

Photo: Nick Upton / Naturepl.com

The beavers were released back into their territories in March 2015. At the start of the trial approximately nine beavers were identified, living in two family groups.

Photo: Nick Upton / Naturepl.com

In the early stages, beaver activity was concentrated in the lower reaches of the river where there is sufficient deep water, and so they have not needed to build dams. As their numbers have increased and they have moved into sub-optimal areas, they are begining to build dams in the ditches and headwater streams. These are now the subject of detailed research work.

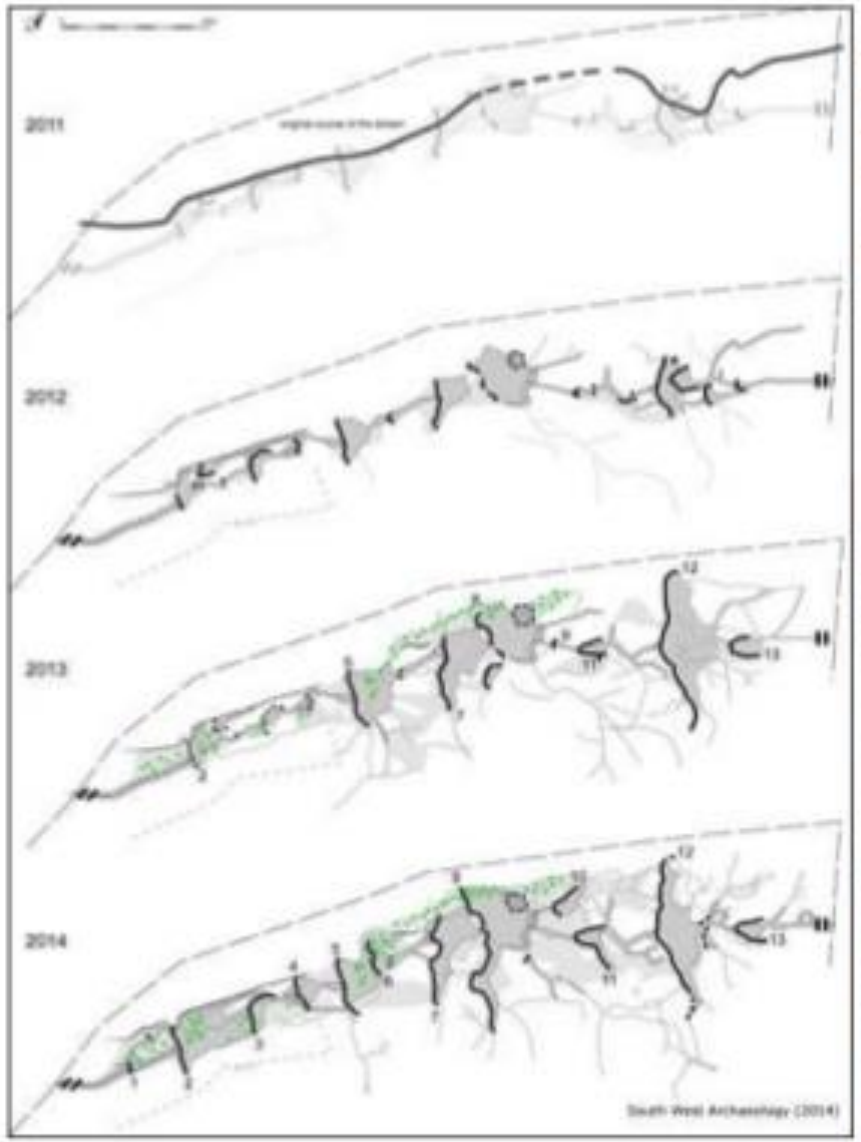
Partners and funders

The River Otter Beaver Trial is led by Devon Wildlife Trust working in partnership with The University of Exeter, the Derek Gow Consultancy, and Clinton Devon Estates. Expert independent advice is also provided by the Royal Zoological Society of Scotland, Roisin Campbell-Palmer, Professor Alastair Driver, Professor John Gurnell, and Gerhard Schwab, an international beaver expert based in Bavaria.

Funding for the ROBT comes from Devon Wildlife Trust (DWT), the Royal Society for Wildlife Trusts (RSWT), Peter de Haan Charitable Trust, Garfield Weston Foundation, University of Exeter and from the generous donations from the public.

In 2016, Devon Wildlife Trust launched a crowdfunding campaign to encourage the public to donate to the project in return for a series of unusual things such as beaver chips, guided walks or the appearance of Nora the beaver mascot at your event: www.supportdevonbeavers.org/

Devon Beaver Project: Overview



- Fenced 1.8 ha site in North Devon, UK
- 1st order tributary draining from IMG
- A pair of beavers introduced in 2011
- Dramatically changed site from small first order tributary running through wet woodland, to a diverse mosaicked wetland environment.

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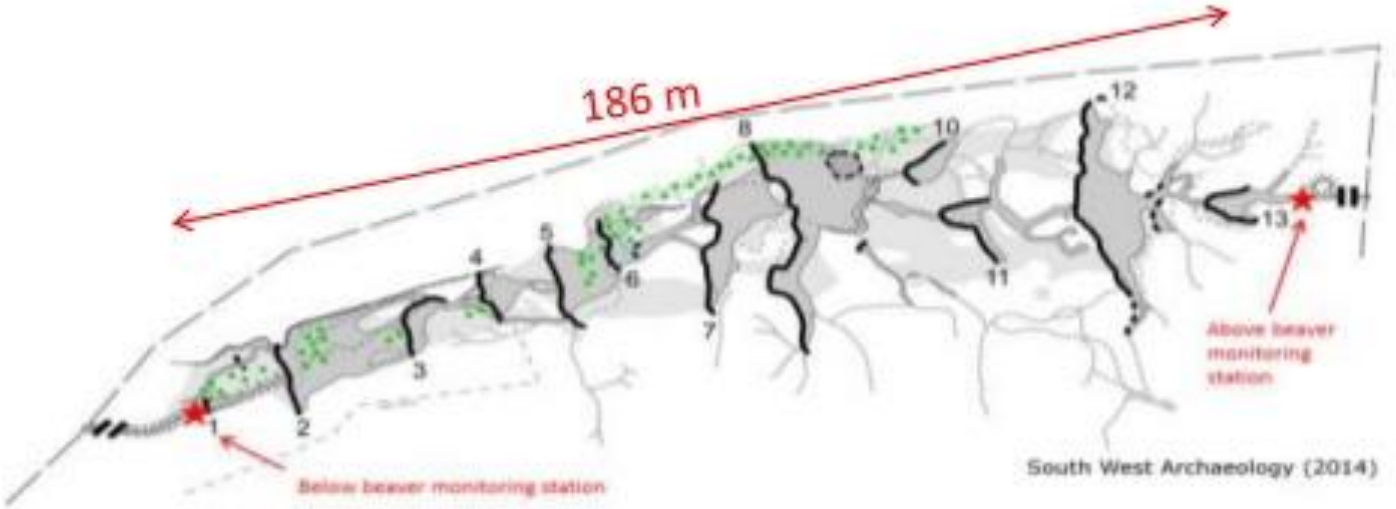
Devon Beaver Project: Experimental Design



Quantifying Water Quality and Quantity entering, leaving and stored in the site:

1. Flow in and out (continuous monitoring) and pond storage.
2. Rainfall in (continuous monitoring).
3. pH, suspended sediment, dissolved organic carbon, nitrogen, phosphate, colour (flow based monitoring).

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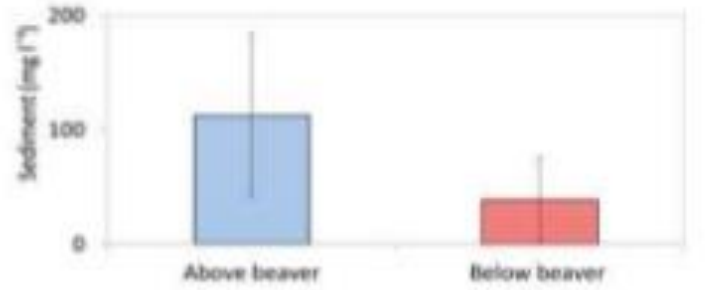
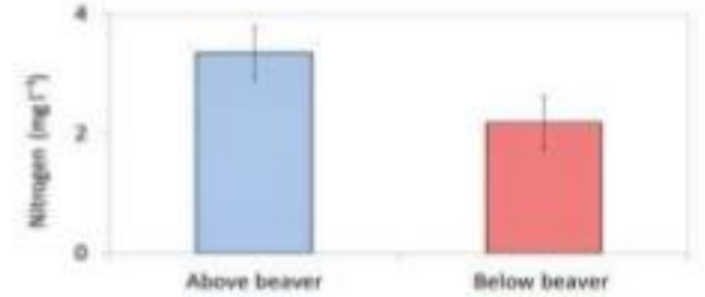
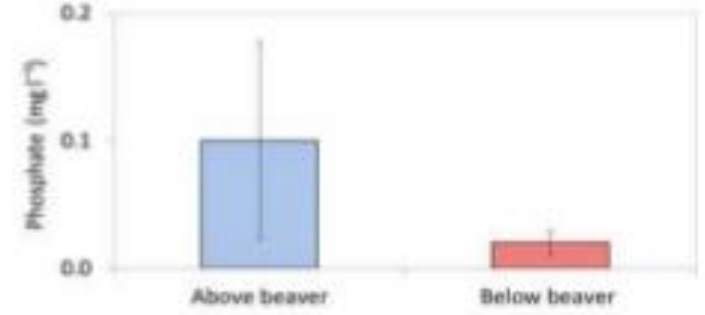
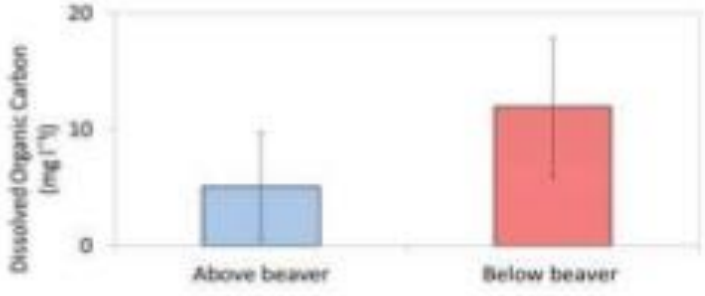
Devon Beaver Project Results – water quality









Storm monitoring (17 events, 178 samples above, 119 below), suggests site may act as a sink or filter for diffuse water pollutants from agriculture (suspended sediment, nitrogen and phosphate).

However, more organic matter in the site, so potentially results in a greater loss of dissolved organic carbon than comparative agricultural land.

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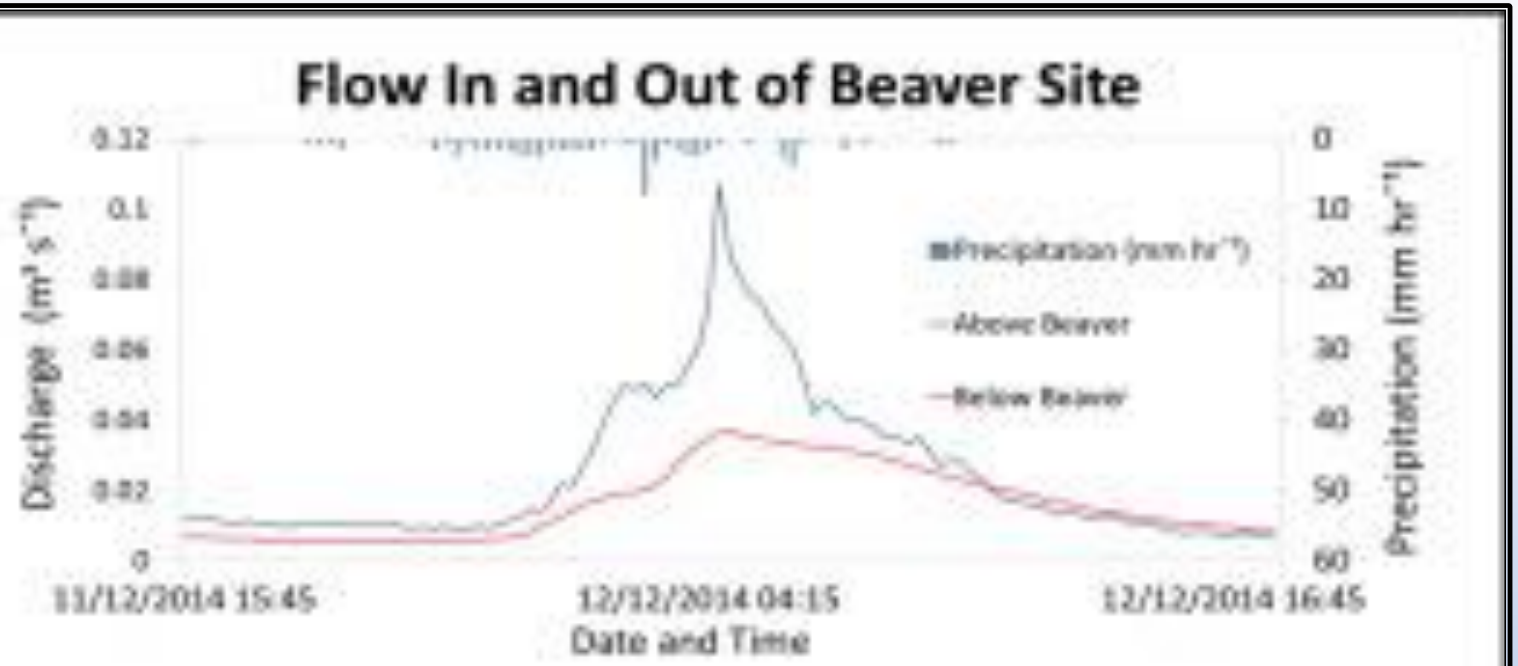

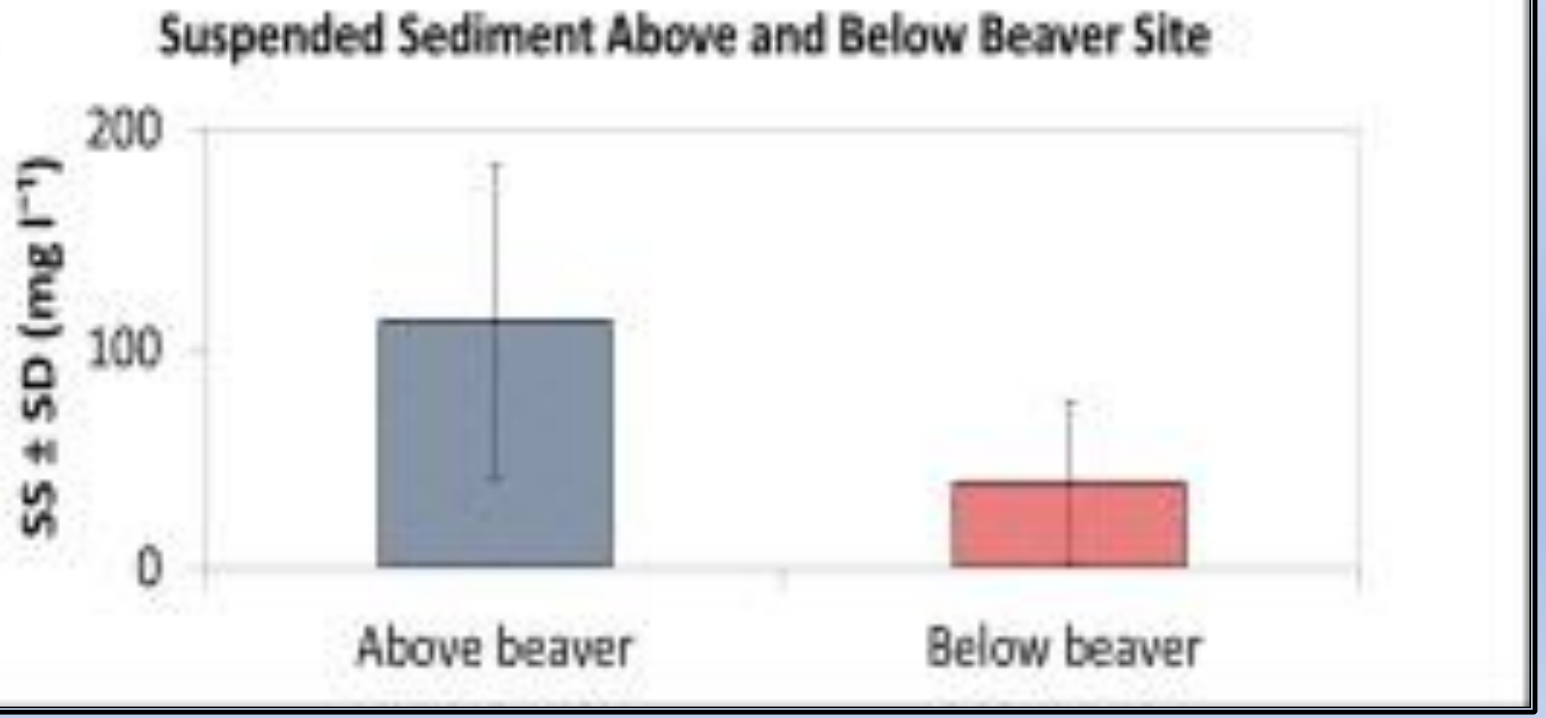

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Water Quality Improvements due to Beaver

New England study of beaver ponds

- At a density of 0.7 beaver ponds/square km, beaver ponds in Southern New England can remove 5-45% of watershed nitrate loading in rural watersheds.*

Devon Wildlife Trust

- 60% reduction in suspended sediment
- 4x less sediment delivered downstream during storm events. Net sediment storage.
- 35% overall reduction in Nitrogen.
- >70% reduction in Phosphorus.

Rural North Carolina study on effects of beaver ponds on water quality

- reduced nitrate concentrations 20%.
- Reduced suspended sediment by 40%.**

**Lazar and Gold, et al. (2015)*

***Bason et al. (2017)*


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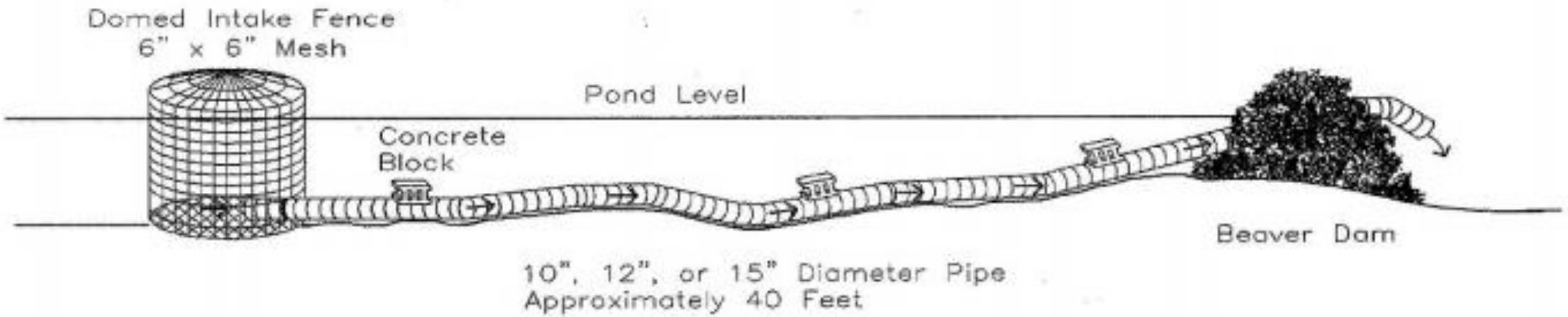
BEL AIR

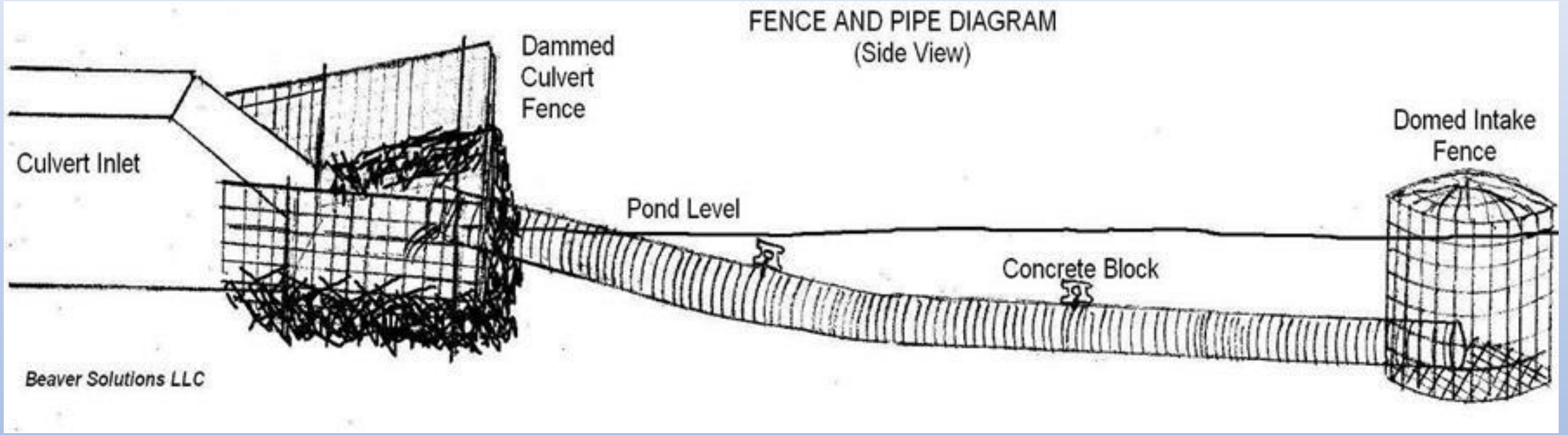
Beaver INSTITUTE™

BEAVER SOLUTIONS

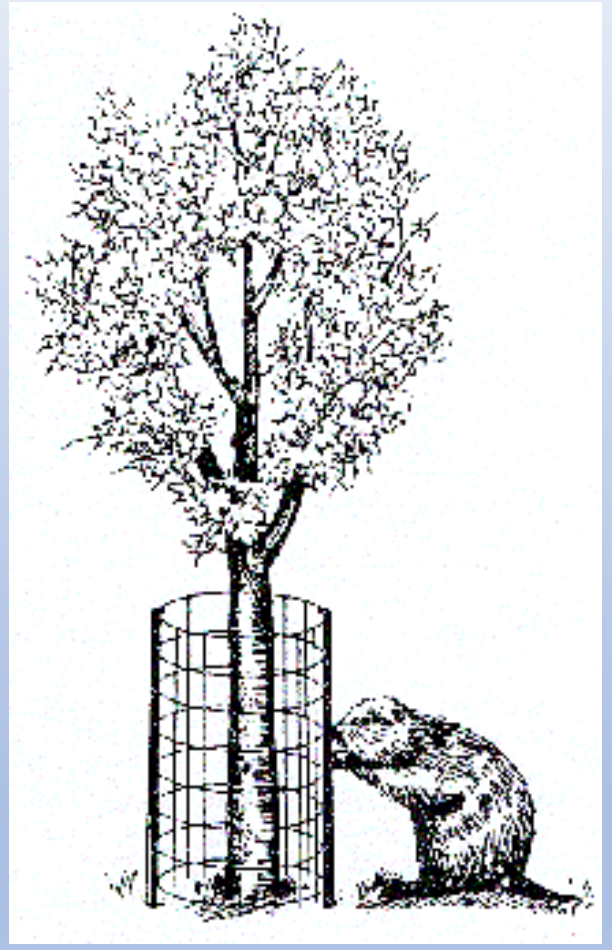
Flexible Pond Leveler™

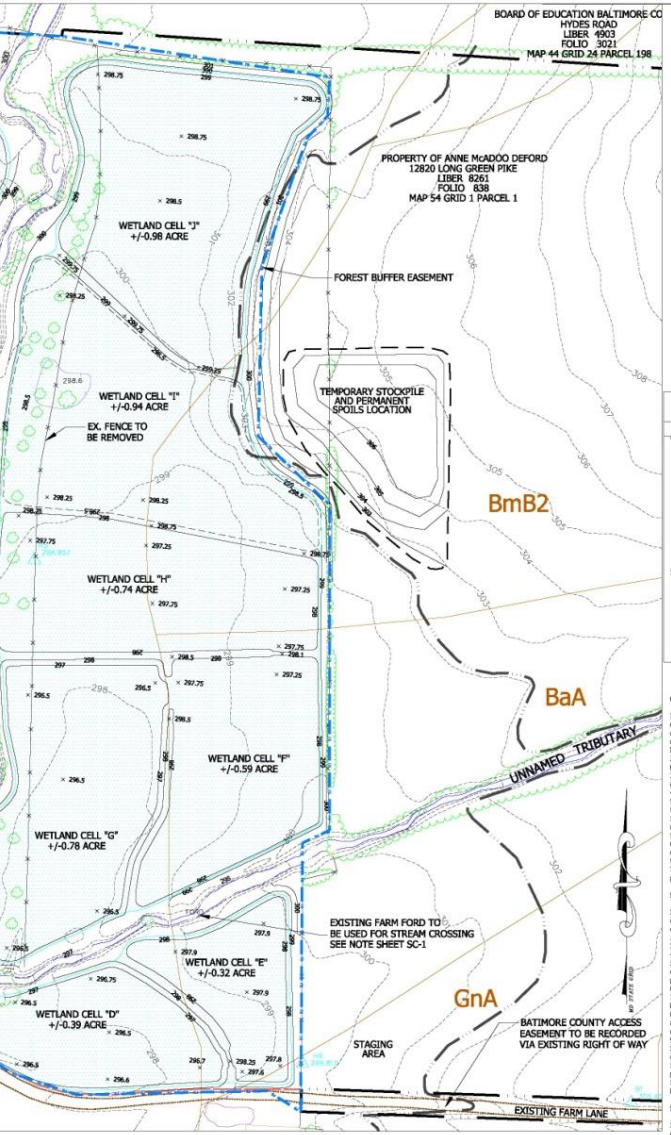
When flooding from a beaver dam threatens human property, health or safety, a Beaver Solutions Flexible Pond Leveler™ pipe system can be a very effective solution. This flow device will create a permanent leak through the beaver dam that the beavers cannot stop. This eliminates the need for repeated trapping despite the presence of beavers.




FENCE AND PIPE DIAGRAM
(Side View)
Dammed
Culvert
Fence
Culvert Inlet
Pond Level
Concrete Block
Domed Intake
Fence
Beaver Solutions LLC

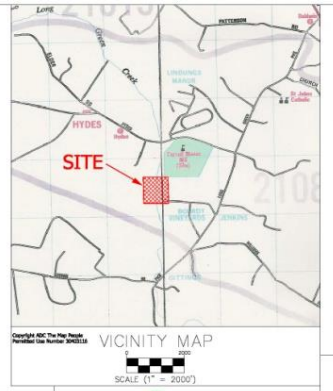
Tree Protection





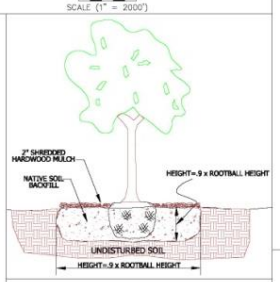
MITIGATION SUMMARY

MITIGATION TYPE PROPOSED	PALUSTRINE FORESTED WETLAND
APPROX. IMPACT AREA MITIGATED	3.75 ACRES (+/- 0.5 ACRE)
TOTAL MITIGATION REQUIRED	7.5 ACRES (+/- 1.0 ACRE)
TOTAL MITIGATION PROPOSED	8.3 ACRES



FORESTED WETLAND PLANTING SCHEDULE: 8.3 ACRES

	Quantity	Scientific Name	Common Name	Size	Condition	Spacing
Trees:	275	Plantanus occidentalis	Sycamore	1" Caliper	Container	15' Random Spacing
	150	Nyssa sylvatica	Blackgum	1" Caliper	Container	15' Random Spacing
	150	Amelanchier canadensis	Canadian Serviceberry	1" Caliper	Container	15' Random Spacing
	150	Acer rubrum	Red Maple	1" Caliper	Container	15' Random Spacing
	150	Quercus palustris	Pin Oak	1" Caliper	Container	15' Random Spacing
	275	Betula nigra	River Birch	1" Caliper	Container	15' Random Spacing
	150	Populus deltoides	Cottonwood	1" Caliper	Container	15' Random Spacing
	150	Salix nigra	Black Willow	1" Caliper	Container	15' Random Spacing
	150	Alnus serrulata	Smooth Alder	1" Caliper	Container	15' Random Spacing
	150	Fraxinus pennsylvanica	Green Ash	1" Caliper	Container	15' Random Spacing
Total:	1750					
Shrubs:	200	Viburnum dentatum	Southern Arrowwood	1/8" Caliper	Container	7' Random Spacing
	3	Ilex verticillata (Male)	Winterberry	1/8" Caliper	Container	7' Random Spacing
	157	Ilex verticillata (Female)	Winterberry	1/8" Caliper	Container	7' Random Spacing
	200	Viburnum cassinoides	Wild Raisin	1/8" Caliper	Container	7' Random Spacing
	200	Cornus amomum	Silky Dogwood	1/8" Caliper	Container	7' Random Spacing
	200	Sambucus canadensis	Elderberry	1/8" Caliper	Container	7' Random Spacing
	200	Aronia arbutifolia	Red Chokeberry	1/8" Caliper	Container	7' Random Spacing
Total:	1160					



Container Grown and Bailed and Burlapped Stock

GENERAL NOTES

1. This Phase II wetland mitigation plan has been prepared for Middle River Business Center, LLC for the purpose of creating approximately 7.5 acres (+/- 1.0 acre) of forested nontidal wetlands within the floodplain of Long Green Creek, designated by the Maryland Department of the Environment as a Use III (Natural Trout Waters). This mitigation project is required to address in part the wetland mitigation requirements for impacts to wetlands associated with the Crossroads @ 695 (a.k.a. AV Williams) project. The mitigation project area is currently in use as a seasonal pasture.
2. Existing topography was derived from Baltimore County 5-foot contour interval mapping. 1-foot contours were surveyed in the field by Wingo Aerial Mapping Co., Inc.
3. The Contractor shall notify Ecotone, Inc. and the landowner's representative at least two (2) weeks prior to start of grading operations within the project area.
4. The Contractor is responsible for the location of all underground utilities prior to the start of construction. Any damages to utilities as a result of grading or other activities will be the sole responsibility of the Contractor and shall be repaired at the Contractors expense.
5. The Contractor will be responsible for any damage to private property, including but not limited to fences and private roads resulting from the execution of this contract. Repairs for any such damage will be made at the Contractors expense to the satisfaction of the private property owner and the Ecotone, Inc.
6. All machinery, equipment and supplies for the project shall be stored in an upland location so as not to disturb any environmentally sensitive areas or agricultural uses on the site. The location of this storage area will be determined during the on-site pre-construction meeting for the project.
7. All rough and finish grading work will be started at the lowest proposed elevation of the wetland creation area and proceed up-slope to minimize soil compaction.

SEQUENCE OF CONSTRUCTION NOTES

1. An on-site pre-construction meeting will be held by Ecotone, Inc. with the grading contractor (including the equipment operators to be used on the project), Inspection & Enforcement, and E2R staff to discuss project objectives, on-site conditions, and necessary grading practices, and to minimize compaction of subgrade within the wetland creation area.
2. All necessary grading and sediment and erosion control permits must be obtained prior to start of construction.
3. Install all necessary erosion and sediment control measures and devices.
4. Any standing water shall be removed from the wetland creation area during grading and planting operations.
5. Unless otherwise indicated by Ecotone, Inc. during the pre-construction meeting, strip the topsoil from the wetland creation area and stockpile as indicated on the grading plan. Rough grade the wetland creation area to 5" below the proposed final grade or as determined in the field by Ecotone, Inc.
6. Rough grade the upland buffer areas, tying into existing grades and maximizing disposal of excess cut materials.
7. Any remaining excavated material from the wetland creation area shall be removed to a location specified by the landowner's representative.
8. Following rough grading, Ecotone, Inc. will inspect grades for conformance with the plan and convey any necessary adjustments based on field conditions. Acceptance of rough grading will be given by Ecotone, Inc. upon satisfactory completion of the grading shown on these grading plans along with any required field adjustments.
9. After acceptance of rough grades, evenly distribute the stockpiled topsoil over the wetland creation area.
10. Acceptance of final grades for the wetland creation area shall be given by Ecotone, Inc. upon satisfactory completion of the grading shown on these grading plans along with any required field adjustments.
11. Seed the wetland creation area and disturbed upland buffer areas as specified under the seeding specifications of this plan set.
12. Remove erosion and sediment control devices after the project area is fully stabilized or when approved by the Baltimore County Sediment Control Inspector.

SEEDING SPECIFICATIONS

1. Prior to seeding, remove any mounds or surface irregularities not in conformance with grading plan. Areas that have experienced washing out, rilling, or sediment deposition shall be reconstructed and grades re-established by the Contractor in accordance with the plan or as otherwise directed by Ecotone, Inc.
2. After bringing the wetland creation area to final grades, loosen soil by discing or scarifying to a depth of at least 3 inches.
3. Prior to seeding, remove all trash, debris and large objects such as stones that might interfere with the seeding operation.
4. Seeding outside of the wetland area for this project shall consist of Perennial Ryegrass (Lolium multiflorum) sown at a rate of 50 lbs per acre. Sow seed with a broadcast spreader or brillion seeder and press into contact with the soil surface using a cultipacker or other similar equipment. Seed should be applied in two different directions to ensure even coverage.
5. Mulch the seeded areas using straw at a rate of 100 bales per acre.

PLANTING SPECIFICATIONS

GENERAL

1. The Contractor shall notify Ecotone, Inc. and the land owner's representative at least two (2) weeks prior to start of planting within the project area so that planting zones may be marked in the field and the land owner can make any necessary preparations related to the agricultural activities on the areas surrounding the project site.
2. The Contractor is responsible for the location of all underground utilities prior to the start of construction. Any damages to utilities as a result of planting or other activities will be the sole responsibility of the Contractor and shall be repaired at the Contractors expense.

STANDARDS

1. Planting material will conform to the current issue of the "American Standards for Nursery Stock", published by the American Association of Nurserymen.
2. The root system of container-grown plant material shall be white, well-developed, and well-distributed throughout the growing media, with the roots extending to the inside face of the container, and the container size must conform to the size specified. Plants not meeting these criteria will be rejected.
3. Foliage of non-dormant plants shall appear healthy, with no leaf spots, damage, discoloration, or wilting, and no evidence of insects on the plant. Plants not meeting these criteria will be rejected.
4. Planting materials may be substituted upon written approval from Ecotone, Inc. and the Maryland Department of the Environment.

STORAGE AND DELIVERY

1. Seed shall be delivered in containers having labels reporting the origin, purity, and germination percentage of the seed, and the date of germination testing of the seed.
2. All container-grown plants shall be clearly and correctly labeled to allow confirmation of species and quantities. At least 25% of each species in every shipment shall have legible labels securely attached prior to delivery to the site.
3. All plants delivered to the project site must have thoroughly moist soil/root masses. Dry or light-weight plants shall be rejected.
4. All rejected material shall be immediately removed from the project site.
5. All plants delivered to the project site shall be stored in a cool, shaded location, and watered regularly so that roots are kept moist until time of planting.

PRODUCTS

1. Straw shall be from small grain species such as wheat or barley, and shall be free of rot, mildew, and noxious weed seeds.

PLANTING PROCEDURES

1. Planting shall be performed in accordance with the current edition of the Landscape Contractors Association "Landscape Specification Guidelines" and as specified below.
2. Plants shall be randomly installed within the planting area, using the plant spacing specified in the plant schedule as a guide.
3. Container-grown stock shall be planted during the periods of September 1 - November 15 or April 1 - June 15. Planting outside of these specified dates is not permissible without approval from Ecotone, Inc.
4. Planting shall not occur during periods of sub-freezing temperatures, when the ground is frozen or excessively wet or dry, or when other conditions not generally accepted as suitable for planting persist.
5. For each plant to be installed, excavate a planting hole at least 12 inches wider than the width of the root ball and to a depth which leaves approximately 1/8 of the root ball above existing grade.
6. Remove the plant by cutting or inverting the container.
7. Using a knife or sharp blade, make 4 to 5 one-inch deep vertical cuts along the root ball.
8. Install plant in the center of the hole, with approximately 1/8 of the root ball above surrounding grade.
9. Backfill planting hole with native soil. Any surplus soil remaining after planting shall be evenly scattered around plants.
10. Water each plant thoroughly after backfilling until the backfilled soil is saturated.
11. All woody material must be planted erect. Plants leaning greater than 10 degrees from perpendicular must be straightened or replanted by the Contractor.

MAINTENANCE AND GUARANTEE

1. Plant material shall be maintained by the Contractor for one full year from the date of final inspection and acceptance by Ecotone, Inc. Maintenance shall include the removal and one-time replacement of all dead or diseased woody vegetation.
2. The Contractor shall guarantee a 100% survival of all plants for the one year period stated above, except in the case of damage by fire, animal damage, vandalism, or other events beyond the Contractors ability to control.
3. Plants which are 25% dead or more shall be considered dead.
4. Replacement plants shall be of the same type, size, and variety as the plants specified herein, or substitutions approved by Ecotone, Inc. Replacement plants shall be provided and installed subject to the requirements of these plans and specifications.

MONITORING AND PROTECTION MECHANISM

1. The wetland creation area will be permanently protected by means of a forest buffer easement recorded in the Land Records of Baltimore County, Maryland.
2. The wetland creation area will be maintained by Ecotone, Inc. or their assigns for a three-year period following completion of construction for the purpose of preventing the establishment of invasive/noxious weed plant species.
3. Performance monitoring will be performed in accordance with MDE requirements. Annual wetland mitigation monitoring reports will be submitted to E2R with each request for E2R inspection of the completed mitigation.

UTILITY NOTIFICATION

"Ecotone, Inc. makes no representation as to the existence or non-existence of any utilities at the construction site. Shown on these construction drawings are those utilities which have been identified. It is the responsibility of the landowners or operators and contractors to assure themselves that no hazard exists or damage will occur to utilities. It is suggested that Miss Utility be contacted at: 1-800-257-7777.

EXISTING FENCE

FOREST BUFFER EASEMENT

SOILS LEGEND

SYMBOL	SOIL DESCRIPTION
Cu	Codorus silt loam
BaA	Baile silt loam, 0-3% slope
BmB2	Baltimore silt loam, 3-8% slope, moderately eroded
GnA	Glenville silt loam, 0-3%slope
HaB2	Hagerstown silt loam, 3-8% slope, moderately eroded

HERBACEOUS WETLAND SEED MIX

Common Name	Botanical Name	Min. % Purity	Min. % Germ.	% of Mix (by weight)	Seeding Rate (lbs/ac)
Soft Rush	Juncus effusus	90	85	1	0.3
Wool Grass	Scirpus cyperinus	90	85	1	0.3
New England Aster	Aster novae-angliae	90	85	1	0.3
Creeping Bentgrass	Agrostis palustris	90	85	15	4.5
Lurid Sedge	Carex lurida	90	85	12	3.6
Fox Sedge	Carex vulpinoidea	90	85	25	7.5
Perennial Ryegrass	Lolium multiflorum	90	85	45	13.5
				Total	30 lbs/ac

ECOTONE, INC.

DRAWN BY:	DATE	REVISION	DATE: 09/27/2005 SIGNATURE
RBB			

PLAN PREPARED FOR:
ECOTONE, INC.
P. O. BOX 5

LONG GREEN FARM
OFF-SITE MITIGATION AREA

W-1


MOULTRIE
CAMERA 1
16 MAR 2018 05:33 am

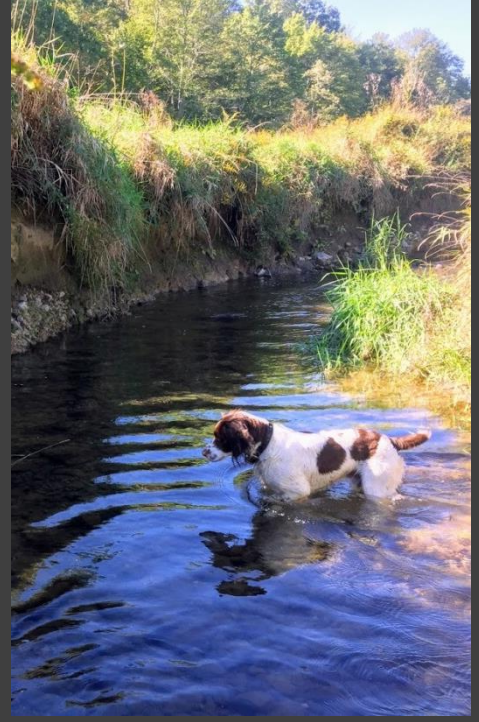
Beaver Management in Maryland

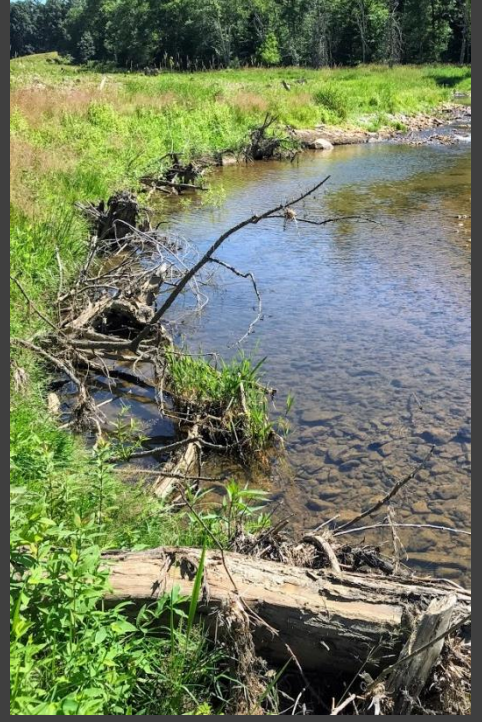
- Approximately 1,000-3,000 beaver trapped and killed annually. Population is growing.
- Recreational and management trapping by landowners, County and State agencies.
- Live trapping and relocation infeasible/not permitted.
- Minimal use of low flow management devices.
- Most management involves trapping.

Furbearer Seasons, Bag Limits, Locations and Resident Requirements, 2018-2019				
Species	**Open Season**	**Location**	**Bag Limit**	**Possession Limit**
Beaver – Trapping Only	Dec. 15-March 15	All counties **except** Allegany and Garrett	No limit	No limit
Beaver – Trapping Only	Dec. 1-March 15	Allegany and Garrett counties	No limit	No limit

Chesapeake Bay Management and Policy: Leverage ecosystem services of the North American Beaver:

- Manage beaver in lieu of trapping
- Promote floodplain reconnection projects
- Incorporate beaver into watershed education programs
- Modify trapping regulations



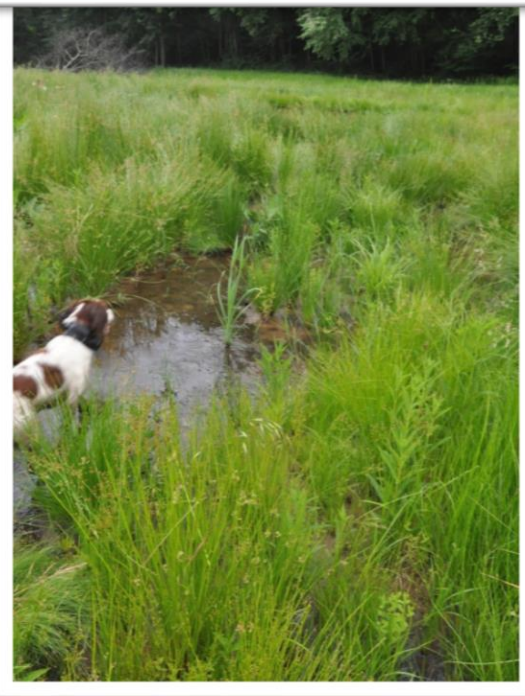


Stream restoration design to encourage beaver colonization

- Disperse energy across the ENTIRE floodplain.
- Leave oxbows, wet meadows
- Regenerative species - willow, alder, dogwood
- Wide easement
- Landowner education
- Stage 0 restoration – low stream power per unit width

Ecological Amnesia

“The current c th high, fine-grained b connected from groundw t condition of swampy m ing streams” (Walter & Me



Soft rush	*Juncus effusus*	20%	FACW
Straw Colored Flat Sedge	*Carex straminea*	12%	OBL
Canada rush	*Juncus canadensis*	7%	OBL
Barnyard grass	*Echinochloa crusgalli*	7%	FACU
Cattail	*Typha latifolia*	5%	OBL
Tussock sedge	*Carex stricta*	5%	OBL
Lurid Sedge	*Carex lurida*	3%	OBL
Square stem Money flower	*Mimulus ringus*	<2%	FACW
Walter Millet	*Echinochla walteri*	<2%	FACW
Pennsylvania smartweed	*Polygonum pensylvanicum*	<2%	FACW
Rice Cutgrass	*Leersia oryzoides*	<2%	OBL
Slender St. Johns Wort	*Hypericum mutilum*	<2%	FACW
Eastern burreed	*Sparganium americanum*	<2%	OBL
Jewelweed	*Impatiens capensis*	<2%	FACW
Blunt Spike rush	*Eleocharus obtusa*	<2%	OBL
American Water horehound	*Lycopus americanus*	<2%	OBL
American Water Wort	*Elatine americana*	<2%	OBL
Seedbox	*Ludwigia paulustris*	<2%	OBL
Beaked spike rush	*Eleocharis rostellata*	<2%	OBL
False Nettle	*Bohemaria cylindrica*	<2%	OBL
Boneset	*Eupatorium perfoliatum*	<2%	FACW
Soft Stem Bulrush	*Scirpus validus*	<2%	OBL
Woolgrass	*Scirpus cyperinus*	<2%	FACW
White Clover	*Trifolum repens*	<2%	FACU
Duck Potato	*Saggittaria latifolia*	<2%	OBL
Swamp milkweed	*Asclepias incarnata*	<2%	OBL
Littleleaf Goldenrod	*Solidago graminacea*	<2%	FAC
White Aster	*Aster vimminuem*	<2%	FAC
Arrow arum	*Peltandra virginica*	<2%	OBL
Black Eyed Susan	*Rudbeckia hirta*	<2%	FACU
Arthraxon	*Arthraxon hispidus*	<2%	NI
Morning Glory	*Ipomea eriocarpa*	<2%	FACU
Goldenrod	*Solidago spp*	<2%	FACU
Speedwell	*Veronica anagallis-aquatica*	<2%	OBL

RIVER RESEARCH AND APPLICATIONS

River Res. Applic. (2013)

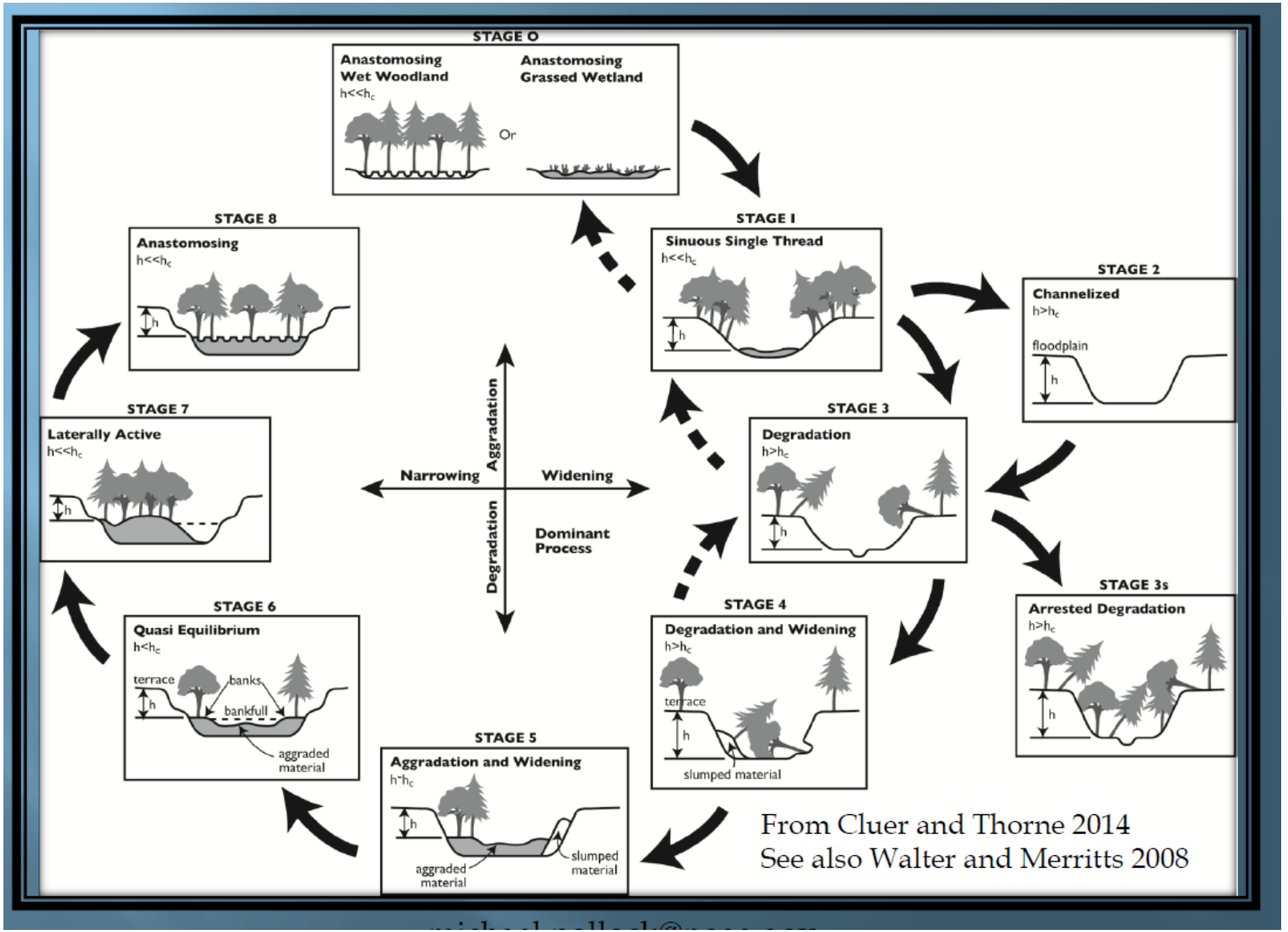
Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/rra.2631

2013

A STREAM EVOLUTION MODEL INTEGRATING HABITAT AND ECOSYSTEM BENEFITS

B. CLUER[a]* and C. THORNE[b]

[a] *Fluvial Geomorphologist, Southwest Region, NOAA's National Marine Fisheries Service, Santa Rosa, California, USA*
[b] *Chair of Physical Geography, University of Nottingham, Nottingham, UK*


STAGE 0
Anastomosing
Wet Woodland
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Or
Anastomosing
Grassed Wetland
STAGE 1
Sinuous Single Thread
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h
STAGE 2
Channelized
h>hc
floodplain
h
STAGE 3
Degradation
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STAGE 3s
Arrested Degradation
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STAGE 4
Degradation and Widening
h>hc
terrace
h
slumped material
STAGE 5
Aggradation and Widening
h~hc
h
aggraded material
slumped material
STAGE 6
Quasi Equilibrium
h<hc
terrace
banks
bankfull
h
aggraded material
STAGE 7
Laterally Active
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STAGE 8
Anastomosing
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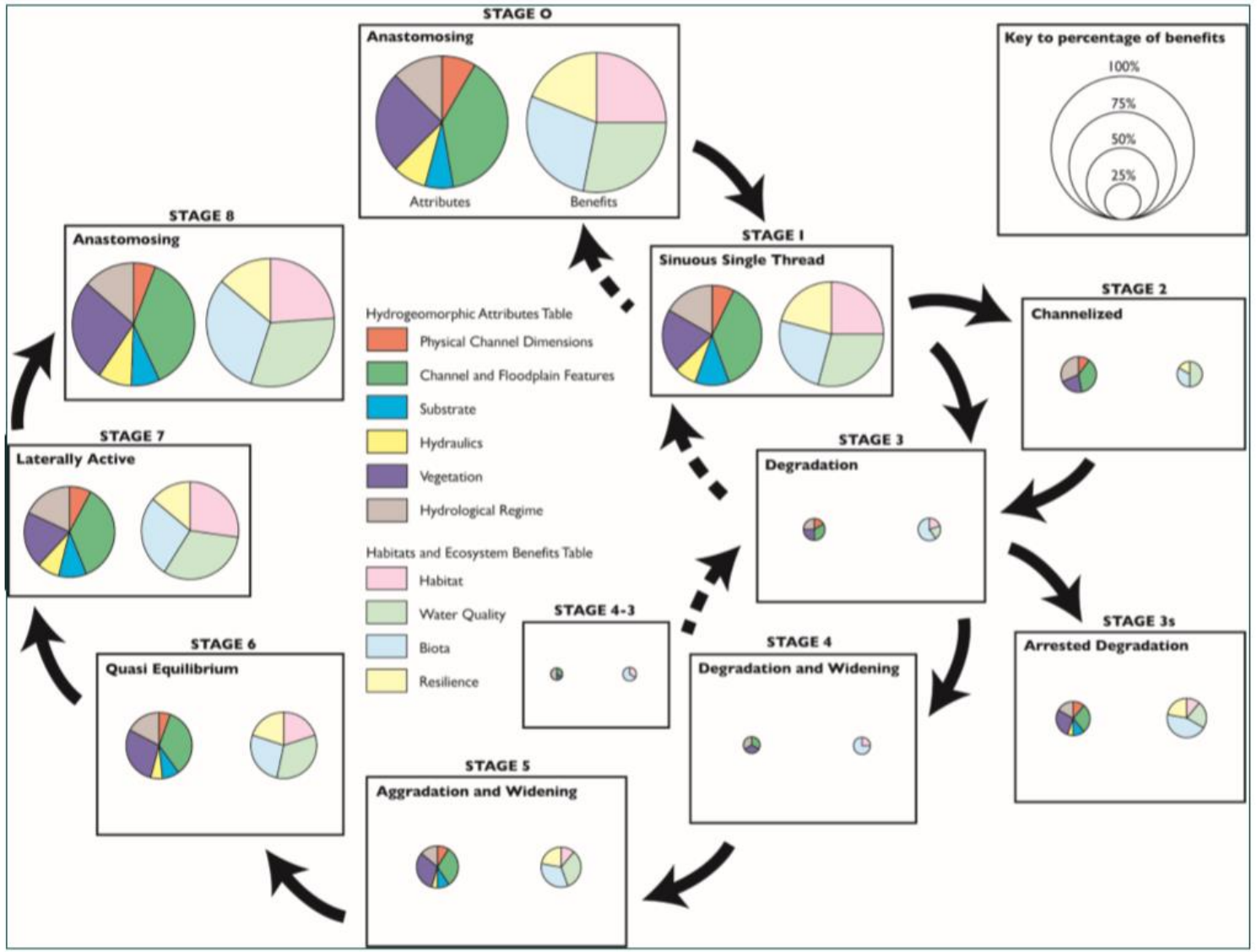
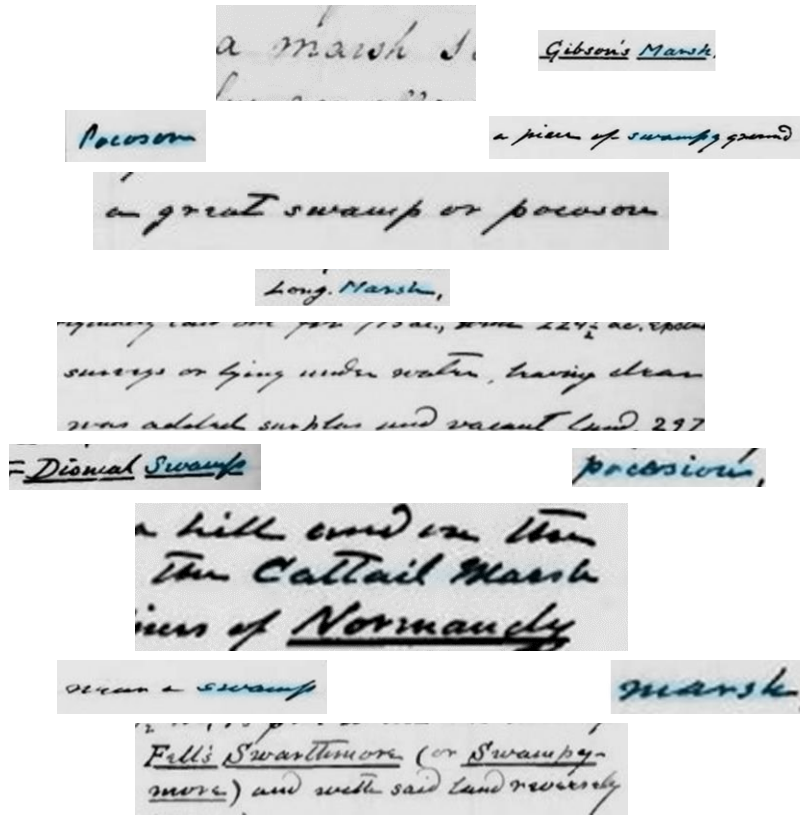
Aggradation
Narrowing
Widening
Degradation
Dominant Process
From Cluer and Thorne 2014
See also Walter and Merritts 2008



Cluer and Thorne, RRA, 2013

Historical Streams

- Property surveys reference swamps, pocosins, marshes, moors
  - Pocosin- of Algonquin origin meaning “swamp on a hill”
- Multithreaded wetland complexes



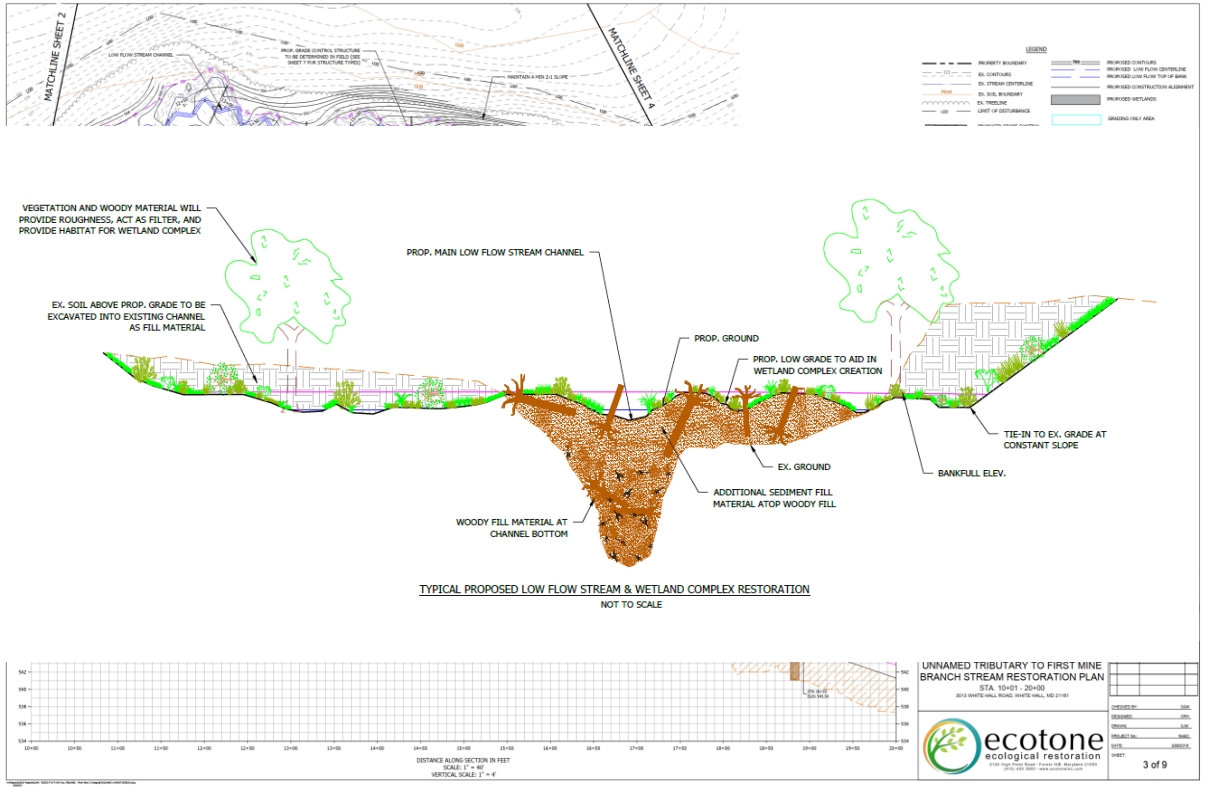
79- **Timber Swamp** – Surveyed 20 Aug. 1736; granted 30 Oct. 1738 to Aquila Paca for 30 acres - (The Balance (of a Warrant for 50 ac. granted to Wm (7 Sept. 1731) Beginning at a W.O. in a swamp

From the original Patent recorded in Land Office in Liber E.I., No 2, folio 76 – C.W.N.

7. Gilbert's Addition – Surveyed 8 Mar. 1716 for Jarvis Gilbert, and
From "T. W.," No. 306
granted to for
50 acres. Beginning at three .. W. O ... at the
head of a little swamp on the N. side of
the N. E. Branch of Swan Creek "and nigh halfe a mile to
"y^e Eastward of the said Jarvis's plantation"; and –

Design approach

- Fill channel
- Incorporate clay blocks
- Let the water do the work
- Lots of wood



“Move Forward Dam It”

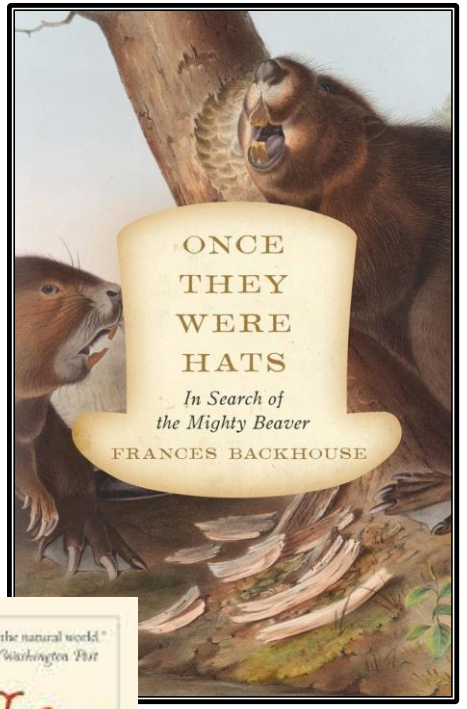
Good Reads:

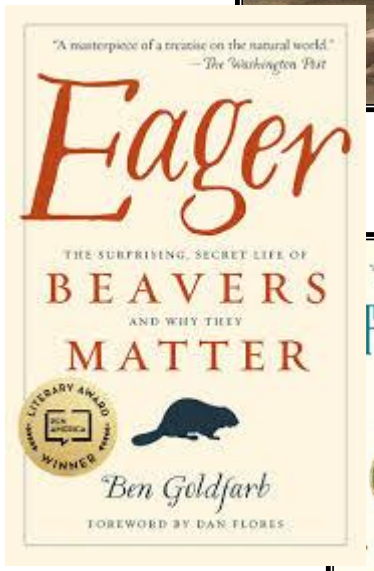
Once They Were Hats by Frances Backhouse
The American Beaver and His Works by Lewis Henry Morgan
Fur, Fortune, and Empire, The History of the Fur Trade in America by Eric Jay Dolin

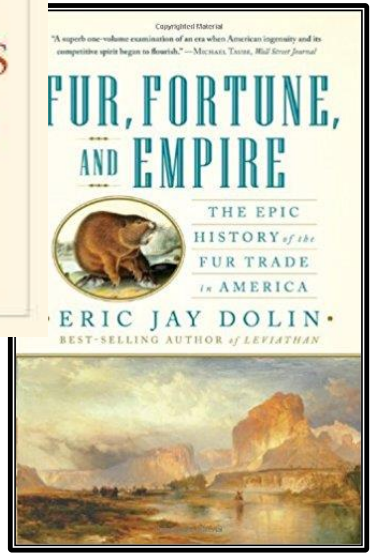
Eager: The Suprising Secret Life of Beavers and Why They Matter by Ben Goldfarb

Upcoming conferences:

BeaverCON 2020, Hunt Valley, MD. www.beavercon.org







BeaverCON 2020

DATE: MARCH 3rd-5th, 2020
LOCATION:
Delta Hotel Hunt Valley
245 Shawan Road,
Hunt Valley, MD 21031

Learn the most effective beaver management practices to resolve beaver conflicts, improve water quality, and facilitate ecological restoration!

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- **The latest research and best management practices for "Nature's Engineer", the North American beaver**

- **Beaver conflict resolution**
- **Ecological benefits of beavers**
- **European reintroduction**
- **Beaver as agents for ecological restoration**
- **Additional Resources and Trainings**

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Questions?
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Email BeaverCON: info@beavercon.org

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THINK LIKE A MOUNTAIN

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Scott McGill

smcgill@ecotoneinc.com

Stream Restoration Symposium 2019

Lessons Learned from Stream Restoration in Other Jurisdictions

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