Régénérer les cours d'eau et Hydrater la terre en s'inspirant du castor

Baptiste Morizot
Maître de conférences
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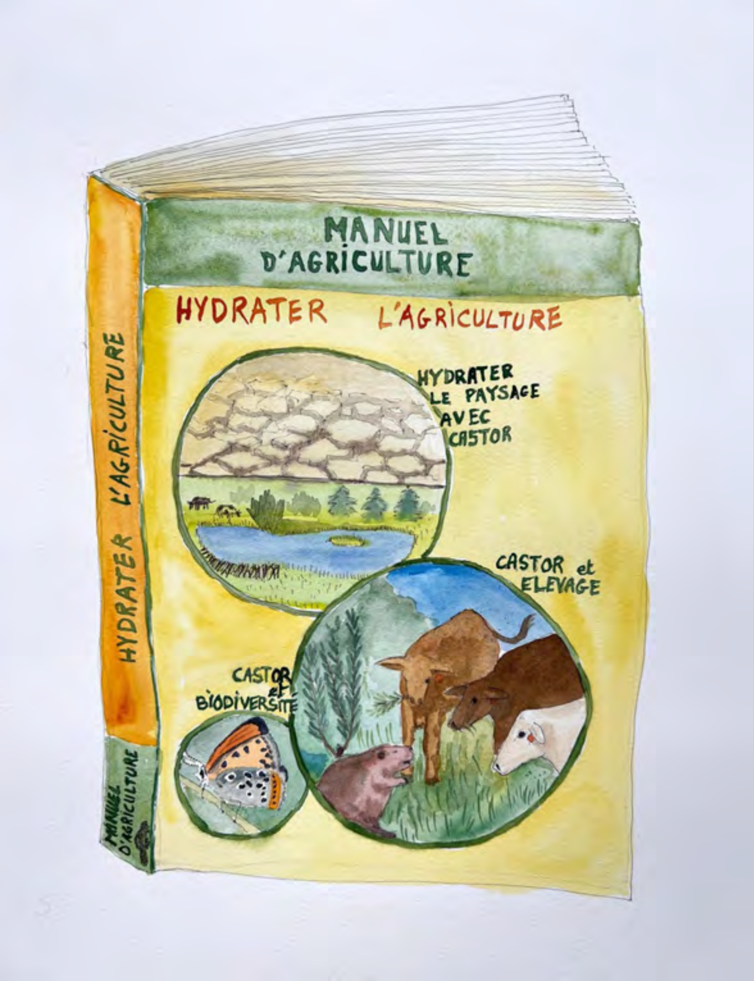
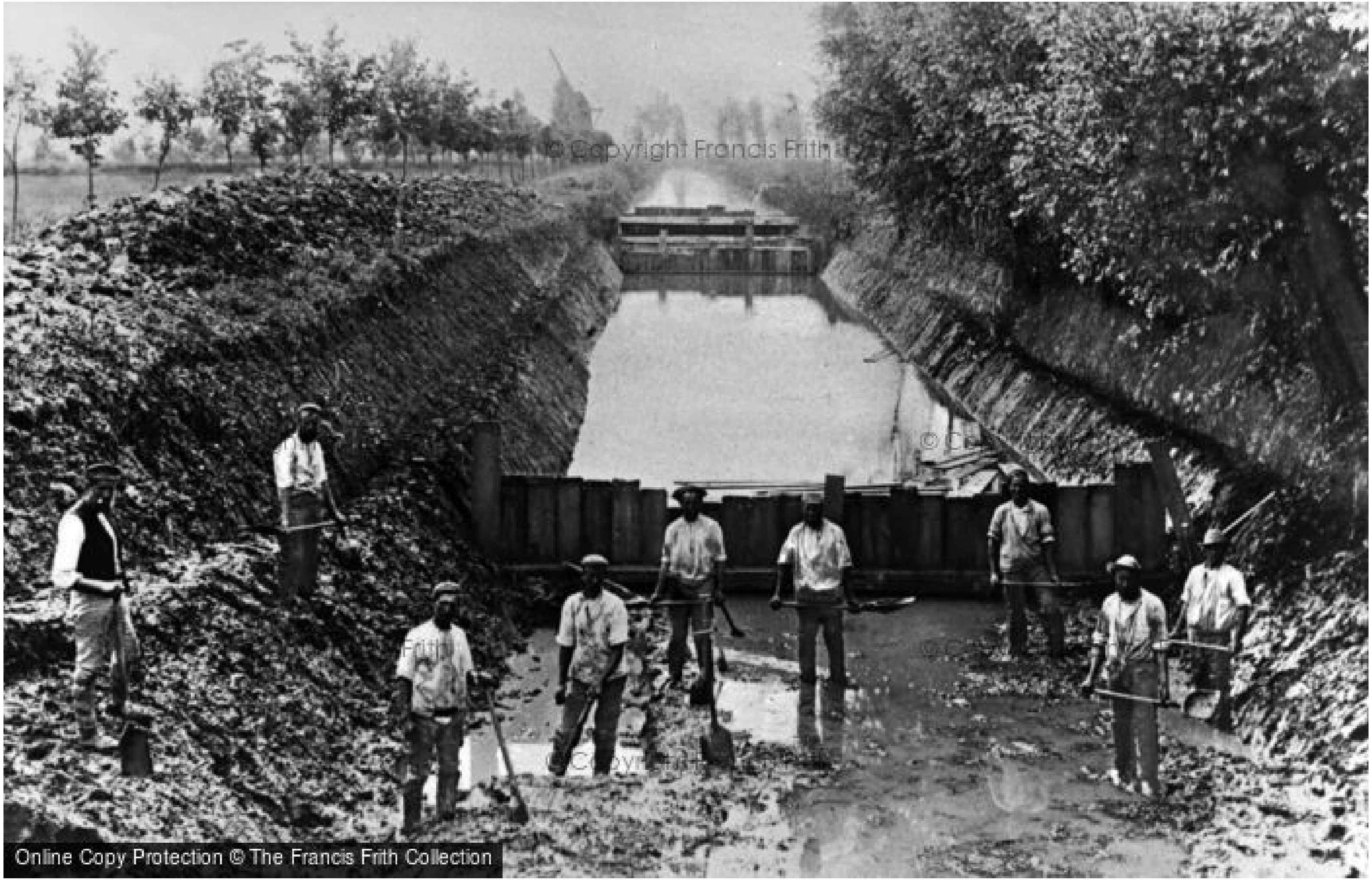


Aquarelle de Suzanne Husky

G. Barnard, *Fontaine Saint-Andéol, Vivarais* (détail), *in* Taylor J., Nodier C., De Cailleux A. (1833), *Voyages pittoresques et romantiques dans l'ancienne France. Voyages en Languedoc*.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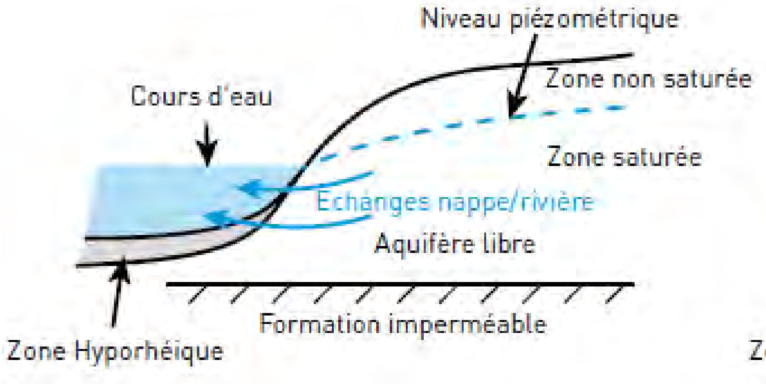
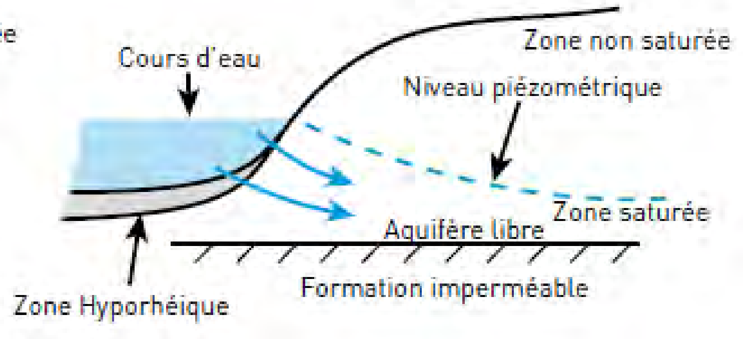
Le castor revient

Doty Ravine (California)

Aquarelle de Suzanne Husky





Les échanges nappe-rivière

La conductivité hydraulique et les gradients de charge sont les principaux moteurs des échanges entre la nappe d'accompagnement et la rivière (Vernoux et al., 2010). Plus la conductivité hydraulique est grande plus les flux échangés sont potentiellement importants.

Si le niveau piézométrique dans la rivière est inférieur à celui la nappe d'eau souterraine, comme c'est le cas souvent à l'étiage, alors la nappe alimente la rivière. Si le niveau piézométrique de la rivière est supérieur à celui de la nappe, comme cela peut être le cas en hautes eaux, alors c'est la rivière qui recharge la nappe.

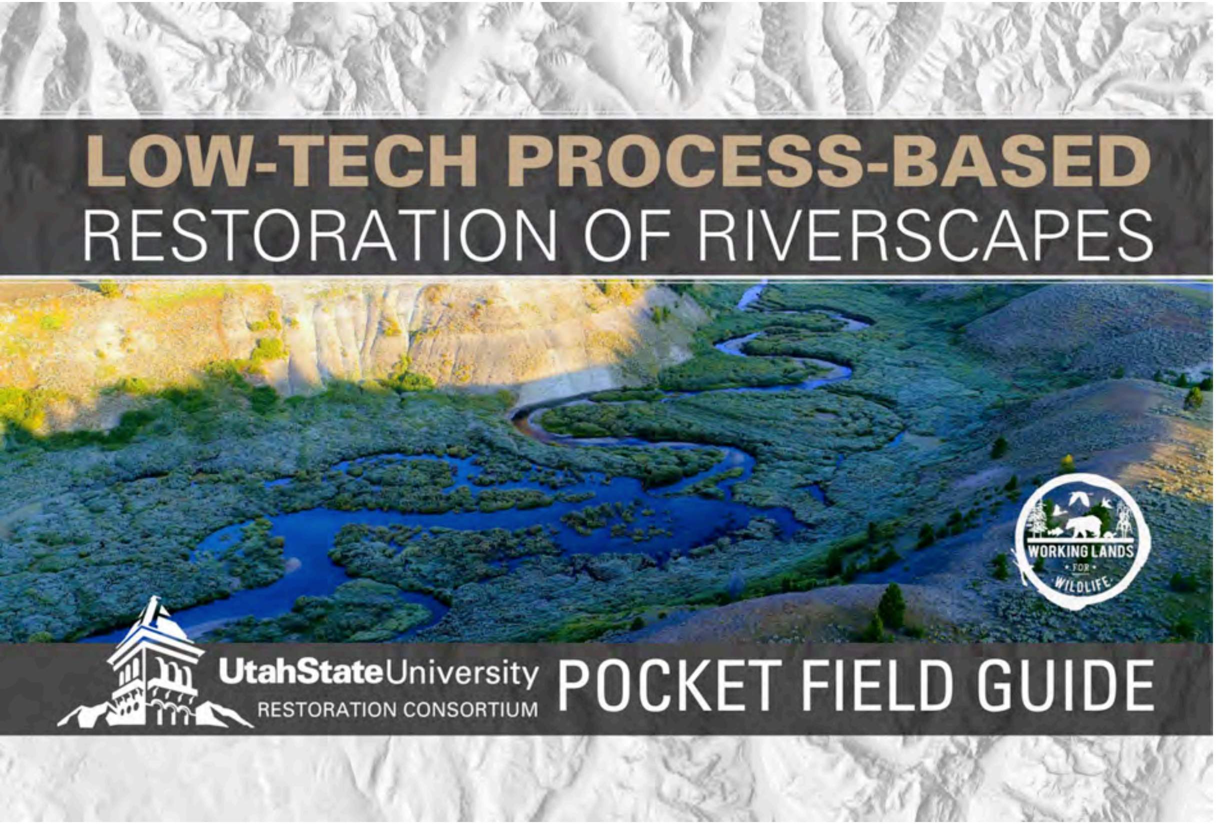
Cette recharge peut se faire également grâce aux débordements dans la plaine alluviale lors des inondations. A noter également que si le niveau de la rivière est égal à celui de la nappe, il n'y a pas d'échange.

Guide de restauration des cours d'eau
Agence de l'eau Rhône Méditerranée Corse
2020

De l’ère du drainage à l’ère de la retenue

- L’enjeu est de passer d’un âge du drainage à un âge de la retenue : d’un monde structurellement déshydraté à un modèle de gestion des bassins versants centré sur la réhydratation. Pour cela, le programme proposé par la nouvelle pensée hydrologique est : **ralentissez l’eau, diffusez l’eau sur les terres, infiltrez l’eau dans les sols, conservez l’eau, et partagez l’eau avec toute les formes de vie.**

Or cette découverte tardive des hydrologues de ce qu’il faudrait faire, c’est ni plus ni moins que ce que font les castors sur les cours d’eau et les bassins versants depuis **huit millions d’années**. Ce qu’il faut apprendre à faire pour activer enfin une approche guérisseuse envers nos bassins de vie, c’est ce qu’ils ont toujours fait.



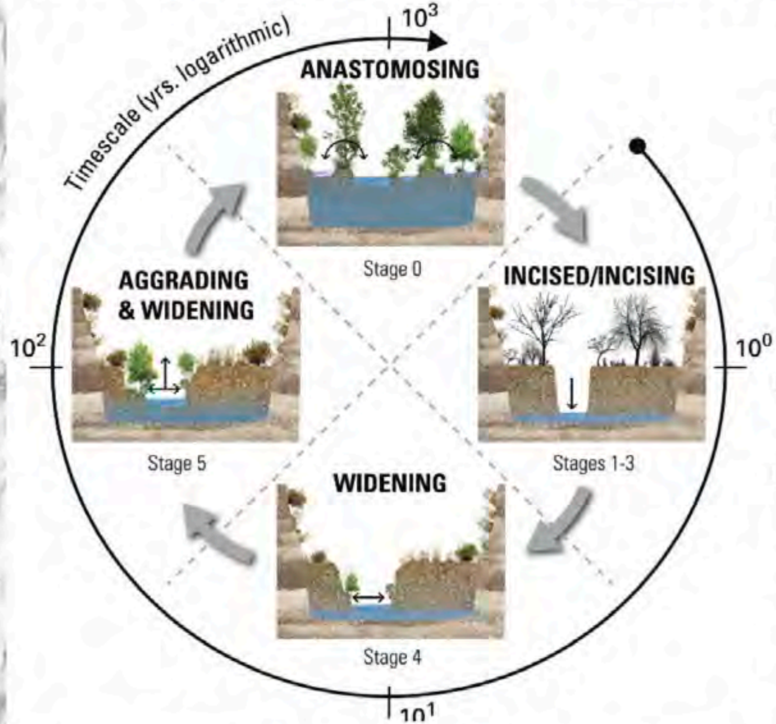
Low-tech process-based
restoration
with beaver mimicry

Joe Wheaton
Utah State University

RIVERSCAPE EVOLUTION MODEL

Q: What are current riverscape **conditions?**
Geomorphic?
Riparian?
- to sustain wood accumulation and/or beaver dam activity

Q: What is **recovery potential?**



- Historically, most healthy riverscapes were in an anastomosing geomorphic condition (i.e., Stage 0; *see page 2).*
- Flows would have been dispersed into multiple channels spread out across a valley bottom, separated by well-vegetated floodplain wetlands and forests, boasting regular structurally-forced flooding.
- Due to a variety of impairments, many such riverscapes rapidly incised, and are locked in degraded incised states.
- Recovery to an anastomosing Stage 0 condition, is achieved by widening (with lateral bank erosion) and aggradation. The lateral erosion process helps rebuilding valley bottom topography with connected floodplains by creating the accommodation space, a source of sediment to build new floodplains in that space, and wider areas for flood-flows to spread out onto.

See Figure 1.5 of the **LTPBR Design Manual & Cluer & Thorne (2014):** DOI: 10.102.rra.2631

J. Wheaton, S. Bennett, N. Bouwes, J. Maestas, S. Shahverdian, *Low-Tech Process-Based Restoration Manual*, Utah State University.

RIVERSCAPES PRINCIPLES:

1. **Streams need space.** Healthy streams are dynamic, regularly shifting position within their valley bottom, re-working and interacting with their floodplain. Allowing streams to adjust within their valley bottom is essential for maintaining functioning riverscapes.

2. **Structure forces complexity and builds resilience.** Structural elements, such as beaver dams and large woody debris, force changes in flow patterns that produce physically diverse habitats. Physically diverse habitats are more resilient to disturbances than simplified, homogeneous habitats.

3. **The importance of structure varies.** The relative importance and abundance of structural elements varies based on reach type, valley setting, flow regime and watershed context. Recognizing what type of stream you are dealing with (i.e., what other streams it is similar to) helps develop realistic expectations about what that stream should or could look (form) and behave (process) like.

4. **Inefficient conveyance of water is often healthy.** Hydrologic inefficiency is the hallmark of a healthy system. More diverse residence times for water can attenuate potentially damaging floods, fill up valley bottom sponges, and slowly release that water later elevating baseflow and producing critical ecosystem services.

View of a beaver-dammed wetland after a wildfire in Baugh Creek, Idaho.

J. Wheaton, S. Bennett, N. Bouwes, J. Maestas, S. Shahverdian, *Low-Tech Process-Based Restoration Manual*, Utah State University.

Beaver-dynamics and wildfire

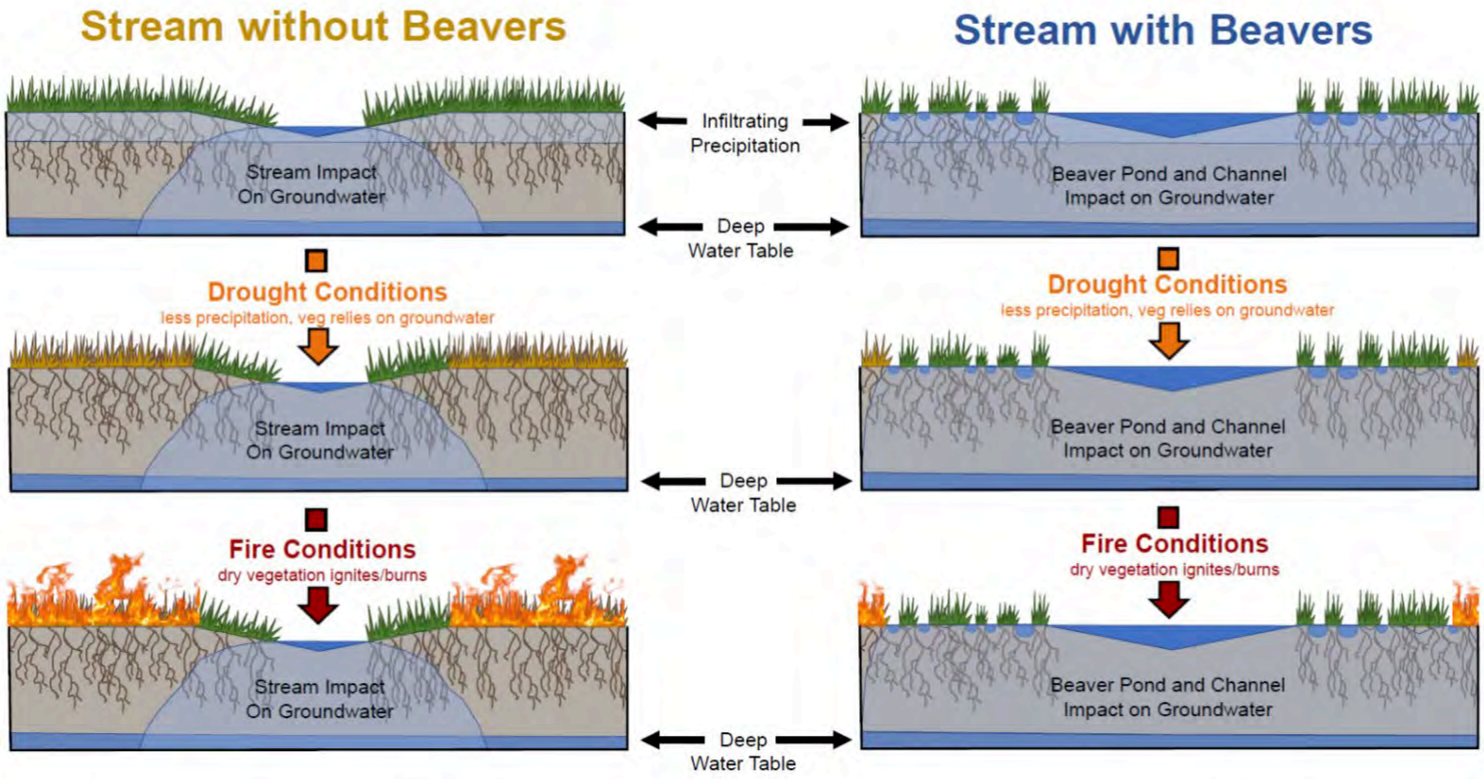
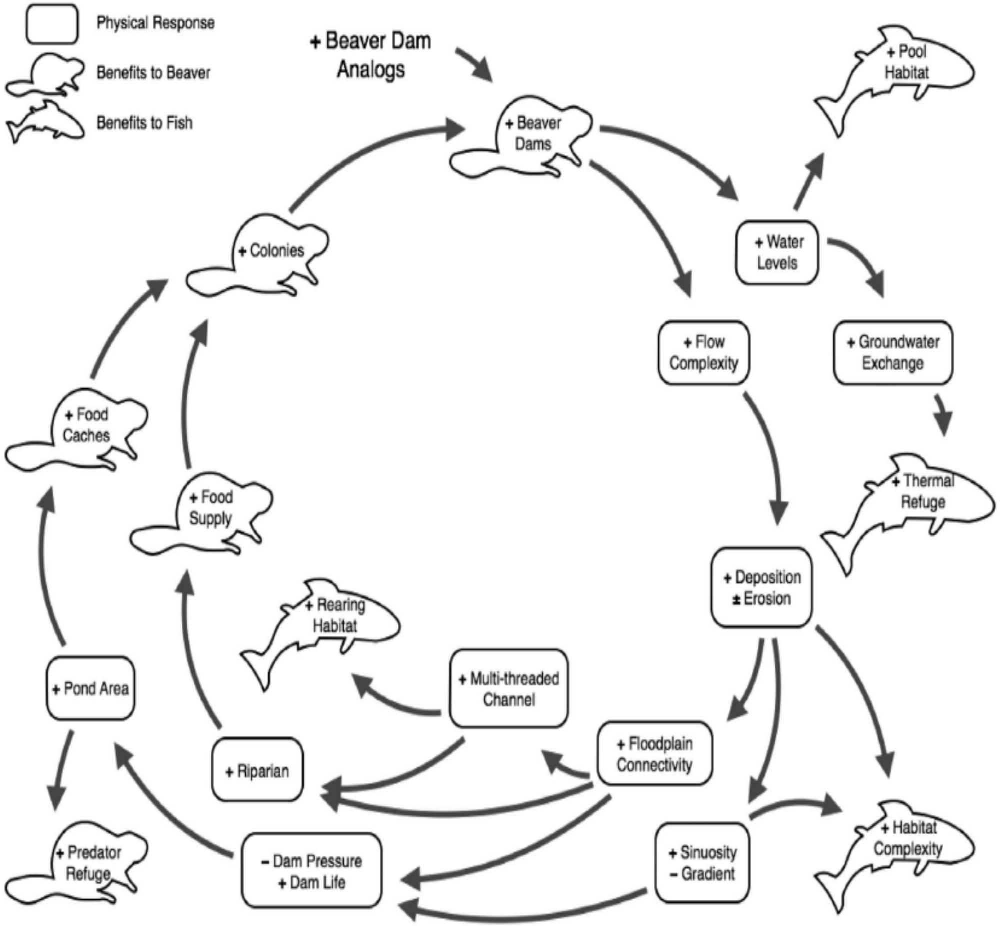
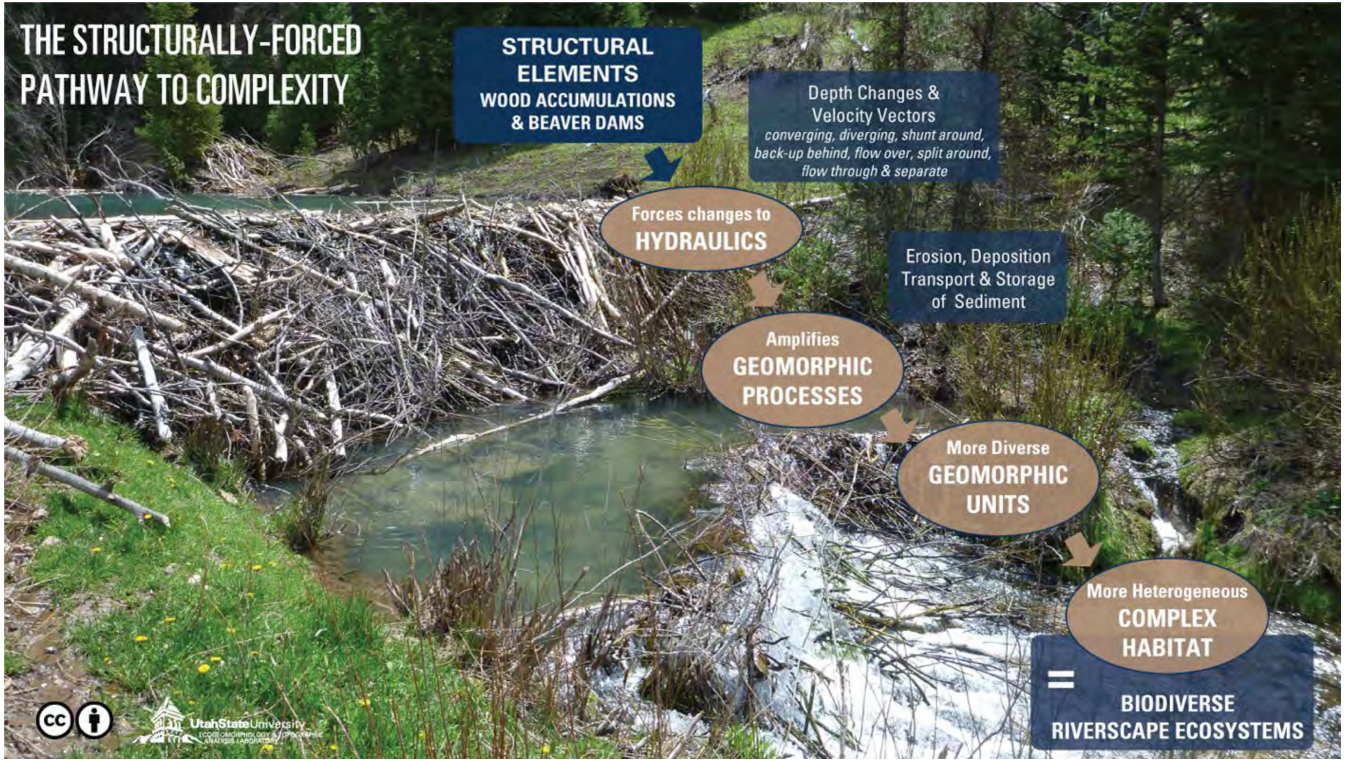


Figure from Fairfax, E. and Whittle, A. (2020), Smokey the Beaver: beaver-dammed riparian corridors stay green during wildfire throughout the western USA. Ecol Appl. Accepted Author Manuscript. doi:10.1002/eap.2225



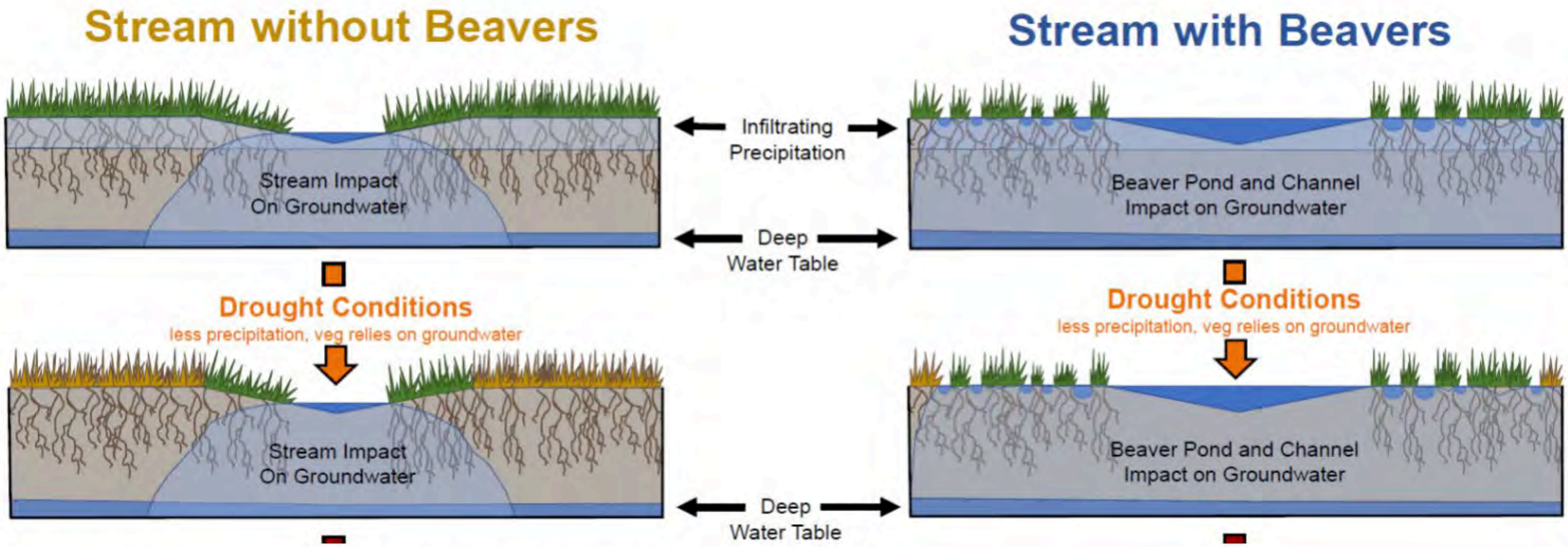
« En 2016, l'équipe a publié un article retentissant dans *Scientific Reports*, comparant le sort des jeunes truites arc-en-ciel de Bridge Creek à celui des poissons d'un autre cours d'eau, appelé Murderers Creek, où l'équipe n'a pas construit de BDA. Les résultats sont sans équivoque : les chenaux, bassins et mares de Bridge Creek ont produit près de trois fois plus de poissons que le ruisseau témoin appauvri, et les taux de survie des truites arc-en-ciel étaient 52 % plus élevés. L'étude a également révélé que les truites arc-en-ciel adultes franchissaient plus de deux cents barrages pour se rendre dans les frayères, faisant mentir l'idée selon laquelle les castors entravent le passage des poissons. » Goldfarb, *op. cit.,* p. 171-172.

Voir Pollock, M.M., J.M. Wheaton, N. Bouwes, C. Volk, N. Weber, and C.E. Jordan, *Working with beaver to restore salmon habitat in the Bridge Creek intensively monitored watershed: Design rationale and hypotheses*. 2012, U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-120, 47 p.



At nearly 2 meters height, this natural beaver dam on Bridge Creek, Oregon, substantially exceeded most fish passage guidelines for instream structures, which generally call for a maximum "jump" elevation of 15-20 cm between the upstream and downstream water elevations of a structure. Nonetheless, adults and juveniles of steelhead trout were able to pass the structure, as documented by PIT tag data, and there is a well-distributed population of steelhead upstream of this dam and the dozens of other dams further downstream. (Julie Maenhout is in foreground, photographer, unknown).

Beaver-dynamics and drought

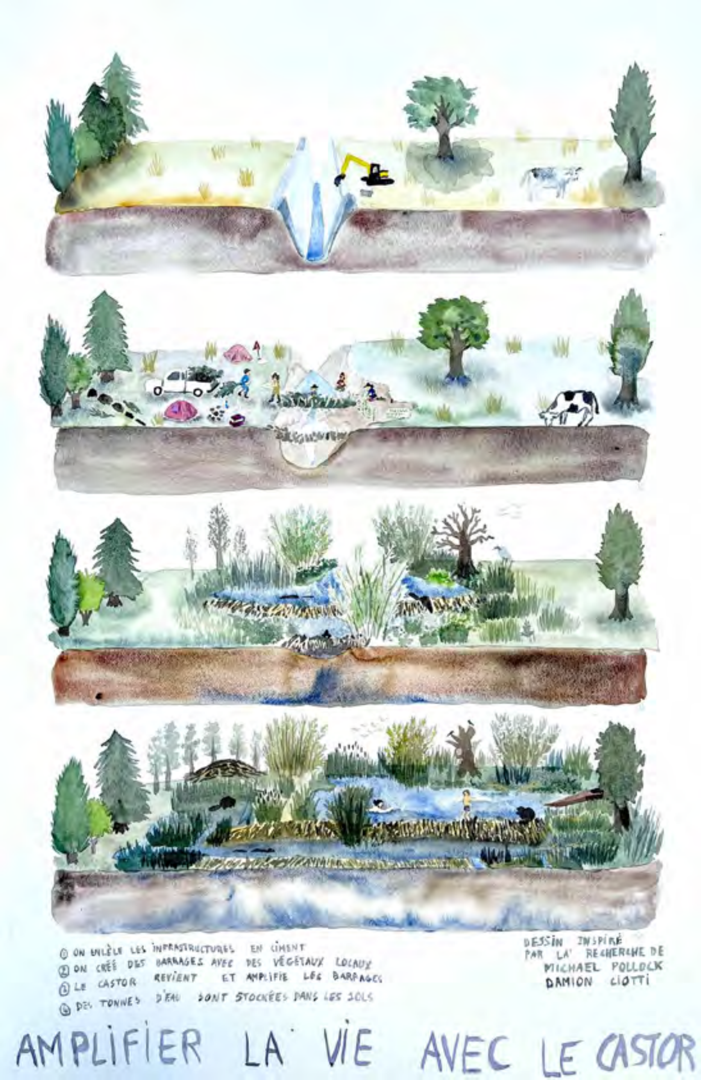


Conceptual model created by Dr. Emily Fairfax (2017). CC BY-NC-ND

Tour a Stream with a Beaver Expert!

Emily Fairfax, PhD., is an ecohydrologist and assistant professor of environmental science and resource management at CSU Channel Islands. Emily researches how beavers, which are native to California, change waterways and riparian ecosystems. In particular, she studies how beaver damming makes drought and fire resistant patches in the landscape. Her students and colleagues can affirm that when Emily says she can talk about beavers for hours, she's not kidding.

Join Dr. Emily as she takes us on a tour of a typical beaver pond and surrounding areas.



Aquarelle de Suzanne Husky

RESTORATION PRINCIPLES:

5 **It's okay to be messy.** When structure is added back to streams, it is meant to mimic and promote the processes of wood accumulation and beaver dam activity. Structures are fed to the system like a meal and should resemble natural structures (log jams, beaver dams, fallen trees) in naturally 'messy' systems. Structures do not have to be perfectly built to yield desirable outcomes. Focus less on the form and more on the processes the structures will promote.

6 **There is strength in numbers.** A large number of smaller structures working in concert with each other can achieve much more than a few isolated, over-built, highly-secured structures. Using a lot of smaller structures provides redundancy and reduces the importance of any one structure. It generally takes many structures, designed in a complex to promote the processes of wood accumulation and beaver dam activity that lead to the desired outcomes.

7 **Use natural building materials.** Natural materials should be used because structures are simply intended to initiate process recovery and go away over time. Locally sourced materials are preferable because they simplify logistics and keep costs down.

8 **Let the system do the work.** Giving the riverscape and/or beaver the tools (structure) to promote natural processes to heal itself with stream power and ecosystem engineering, as opposed to diesel power, promotes efficiency that allows restoration to scale to the scope of degradation.

9 **Defer decision making to the system.** Wherever possible, let the system make critical design decisions by simply providing the tools and space it needs to adjust. Deferring decision making to the system downplays the significance of uncertainty due to limited knowledge. For example, choosing a floodplain elevation to grade to based on limited hydrology information can be a complex and uncertain endeavor, but deferring to the hydrology of that system to build its own floodplain grade reduces the importance of uncertainty due to limited knowledge.

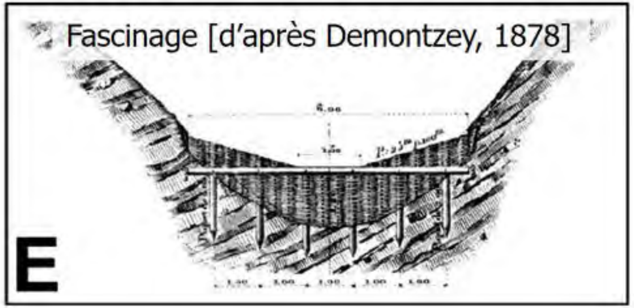
10 **Self-sustaining systems are the solution.** Low-tech restoration actions in and of themselves are not the solution. Rather they are just intended to initiate processes and nudge the system towards the ultimate goal of building a resilient, self-sustaining riverscape.

STRUCTURAL ADDITIONS NOT A NEW IDEA…

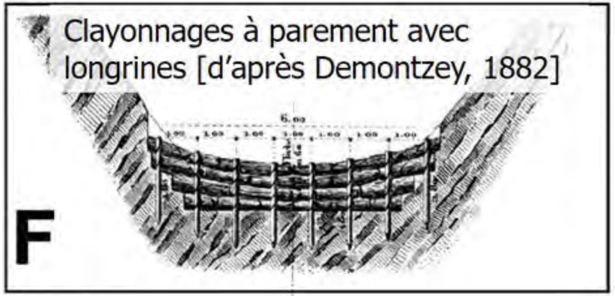
'Exemples de correction hydraulique torrentielle' – Figure 66 from Frédéric Liébault (2003); used extensively in afforestation in France in 1870s-1890s

Série de barrages rustiques en pierres sèches [Demontzey, 1894]

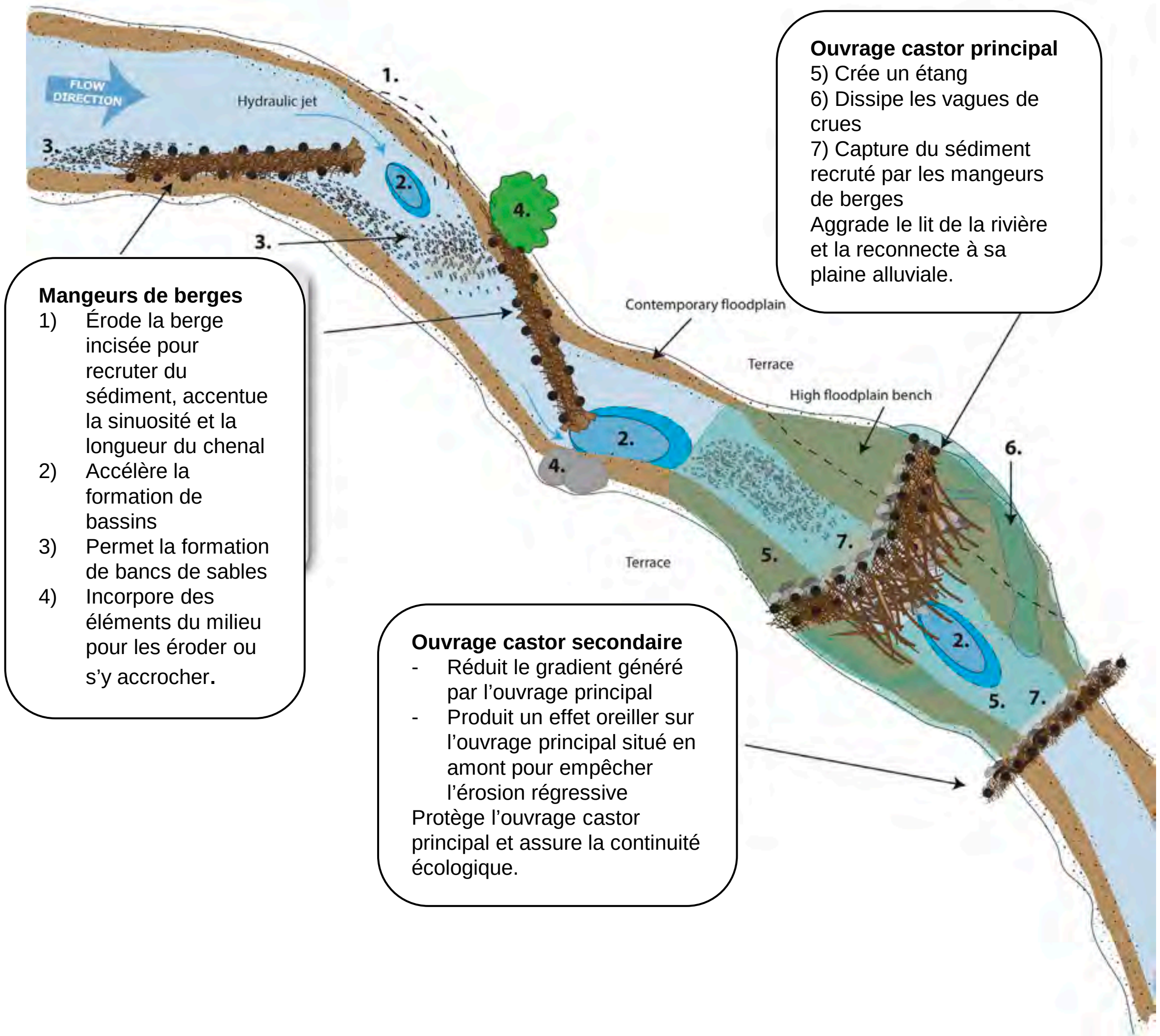
Fascinages vivants [Demontzey, 1894]



Fascinage [d'après Demontzey, 1878]



Clayonnages à parement avec longrines [d'après Demontzey, 1882]



Rivière Lierne – juin 2023

Régénération basée sur les processus : médecine castor

Projet de complexes d'ouvrages : le design est un complexe composé de 4 structures qui fonctionnent ensemble de manière organique. Deux mangeurs de berge en amont érodent du sédiment latéralement, ce sédiment est stocké dans les bassins de castor juste en aval, pour réparer le lit de rivière et lutter contre l'incision.
L'ouvrage castor principal réouvre des chenaux secondaires pour reconnecter la rivière à sa plaine alluviale.

SCHEMATIC TABLE OF CONTENTS

POSTLESS BDA

- BDAs are built to initially mimic a natural beaver dam (i.e., backwater upstream, such that a pond is created), but most BDAs are intended to promote beaver dam activity at some point thereafter.
- Many of the benefits of natural beaver dams, come from their ephemeral nature, and whether dams are actively maintained, blown-out, breached, filled in and/or abandoned.
- Postless BDA design are inspired by how beavers build dams; without fence posts, a hydraulic post pounder or heavy equipment. Like natural beaver dams, the postless BDA is appropriate in areas that can already support beaver dams.

PLANFORM VIEW