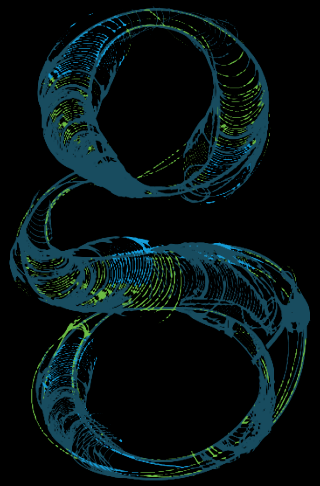
Process Based Restoration & Floodplain Reconnection



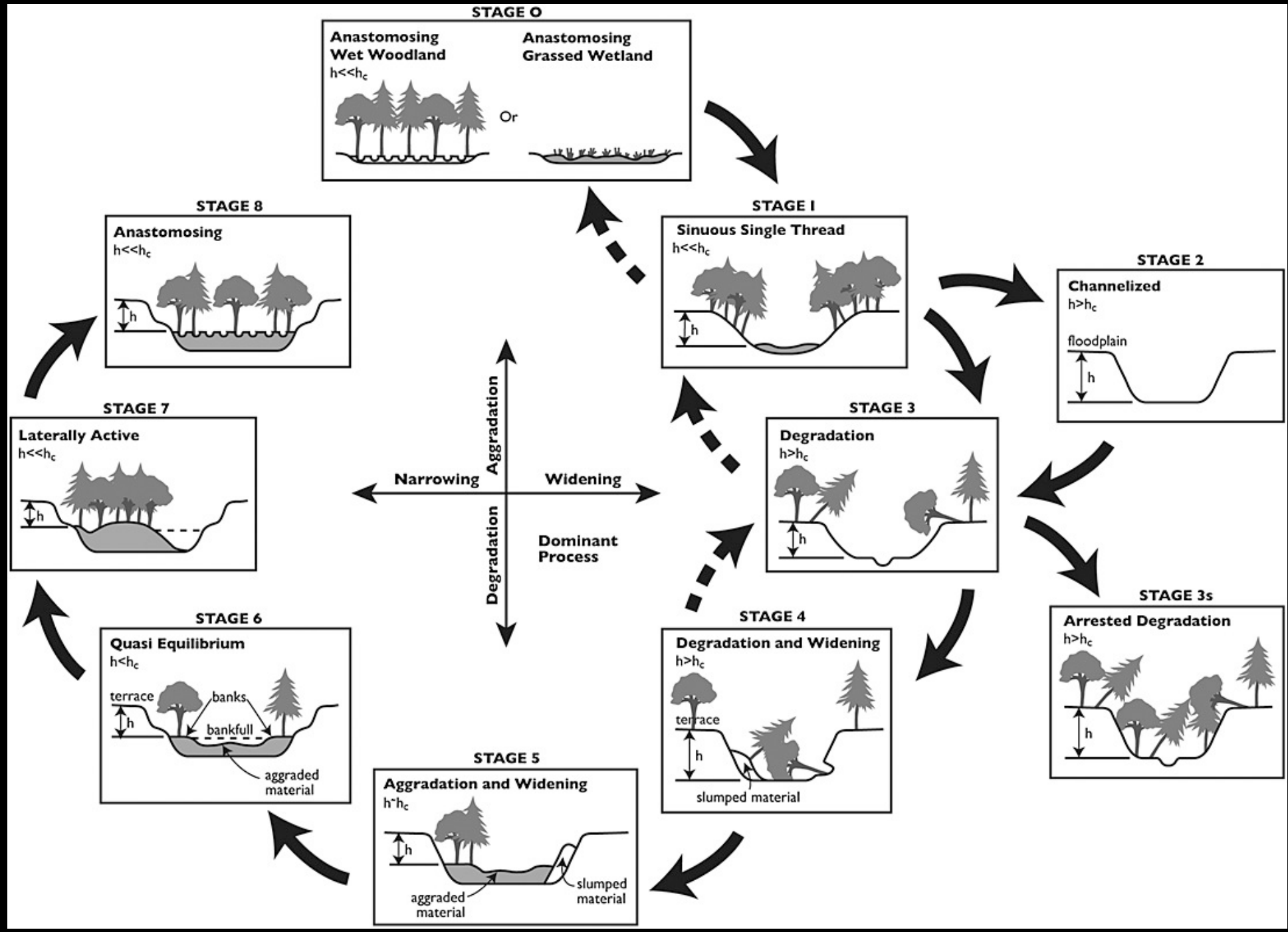
Amy Sacry, Restoration Ecologist
Geum Environmental Consulting, Inc.

The Science Behind Process Based Restoration

STREAM EVOLUTION MODEL
(Cleur and Thorne, 2013)

Stage 0:
Introduces a pre-disturbance channel form comprised of multiple stable channels and wetlands

Generally applies to wide, low gradient valley bottoms (depositional/ response reaches)



STREAM EVOLUTION MODEL
(Cleur and Thorne, 2013)

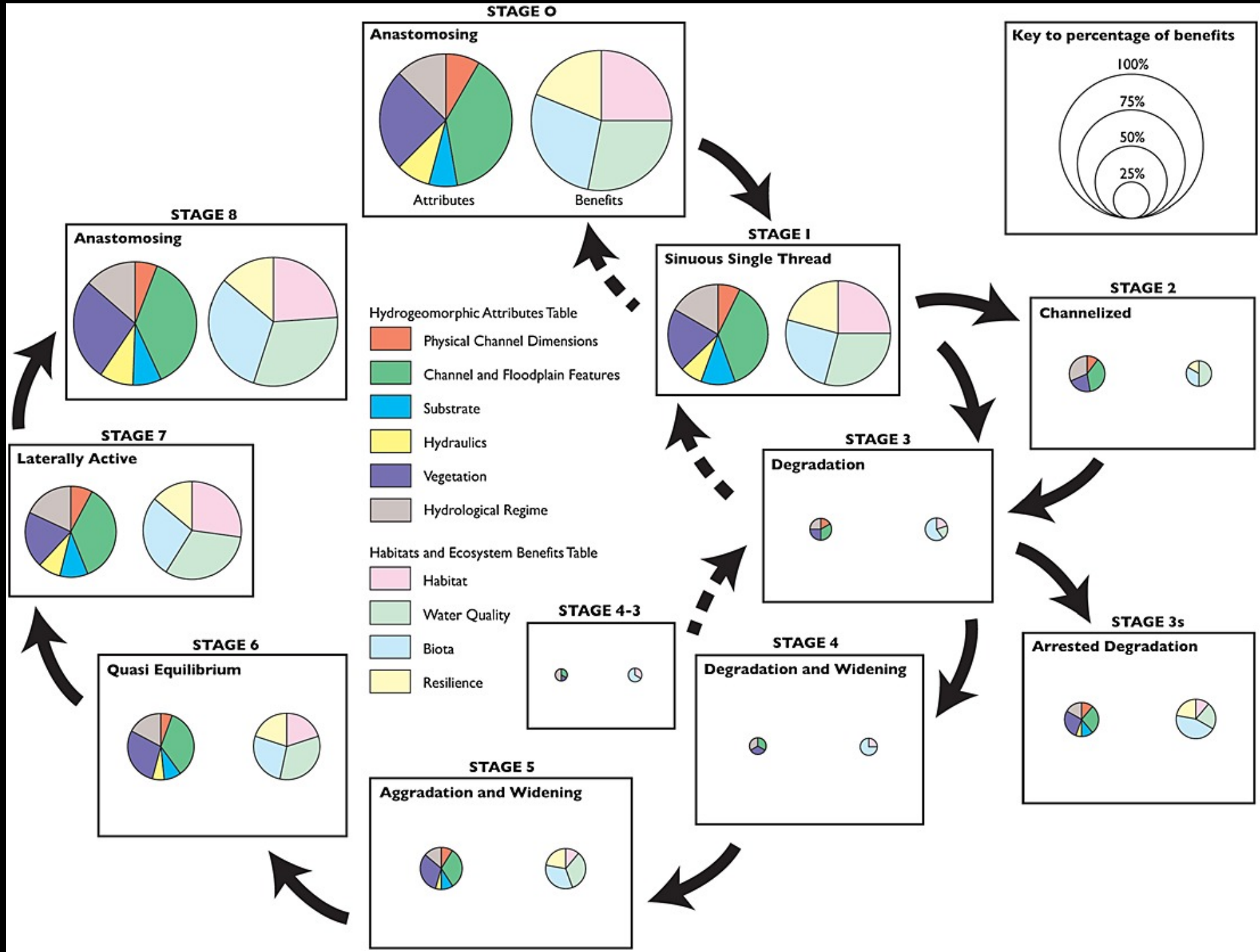
Stage 0 maximizes floodplain connectivity, supports diverse vegetation types and habitats

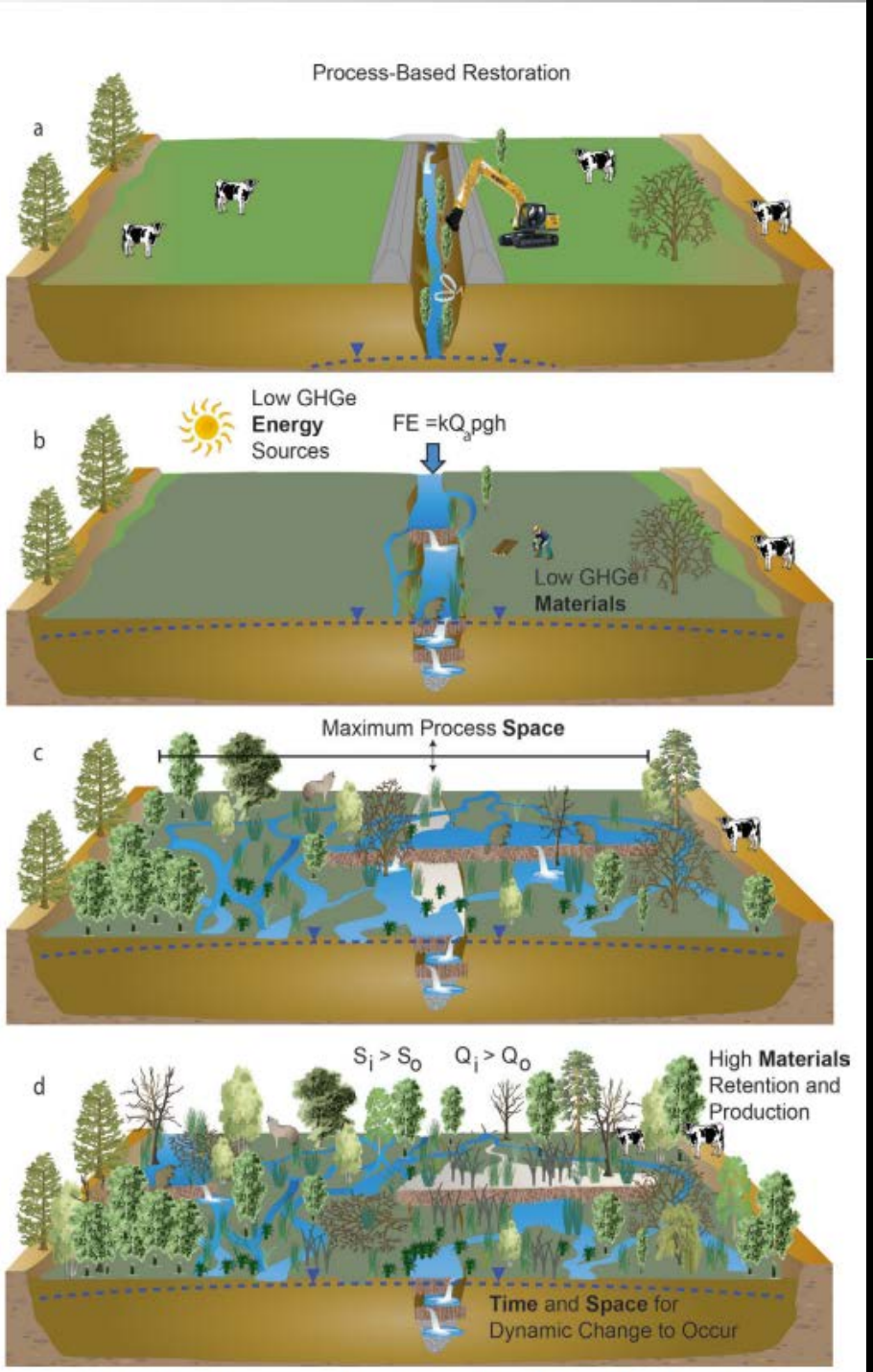
AND

Maximizes ecosystem benefits

AND

Provides overall ecosystem resilience



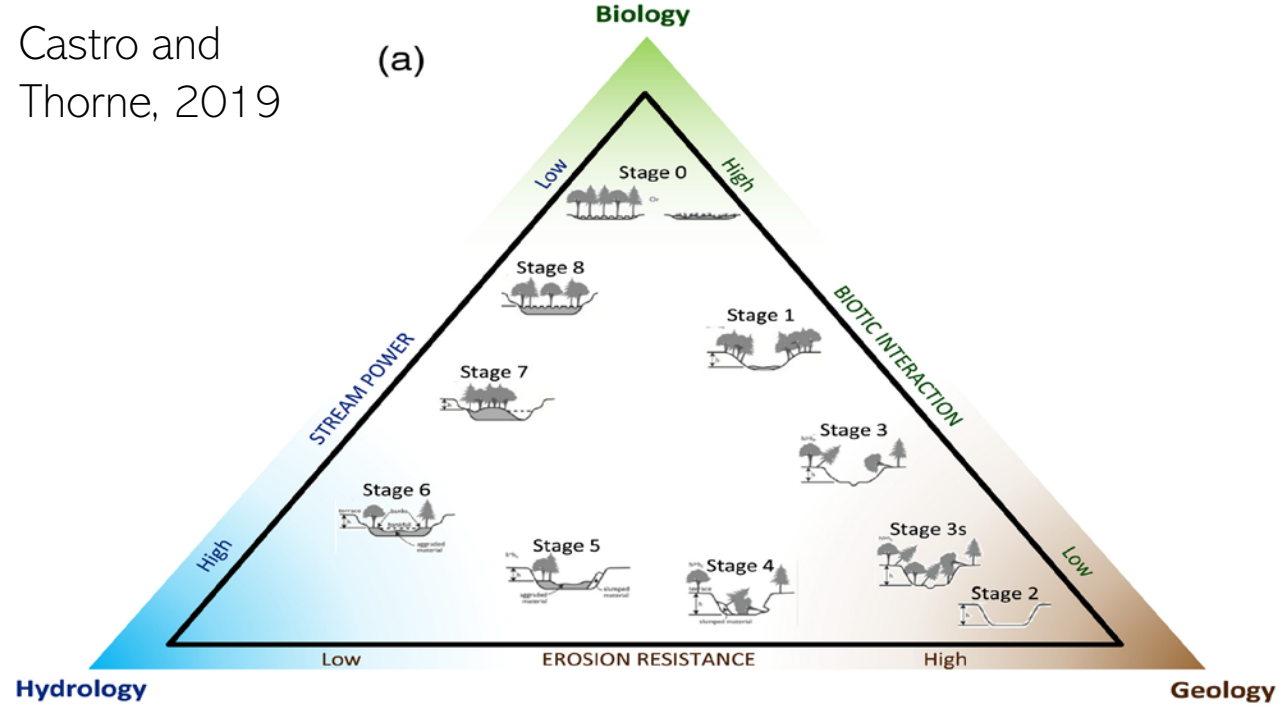


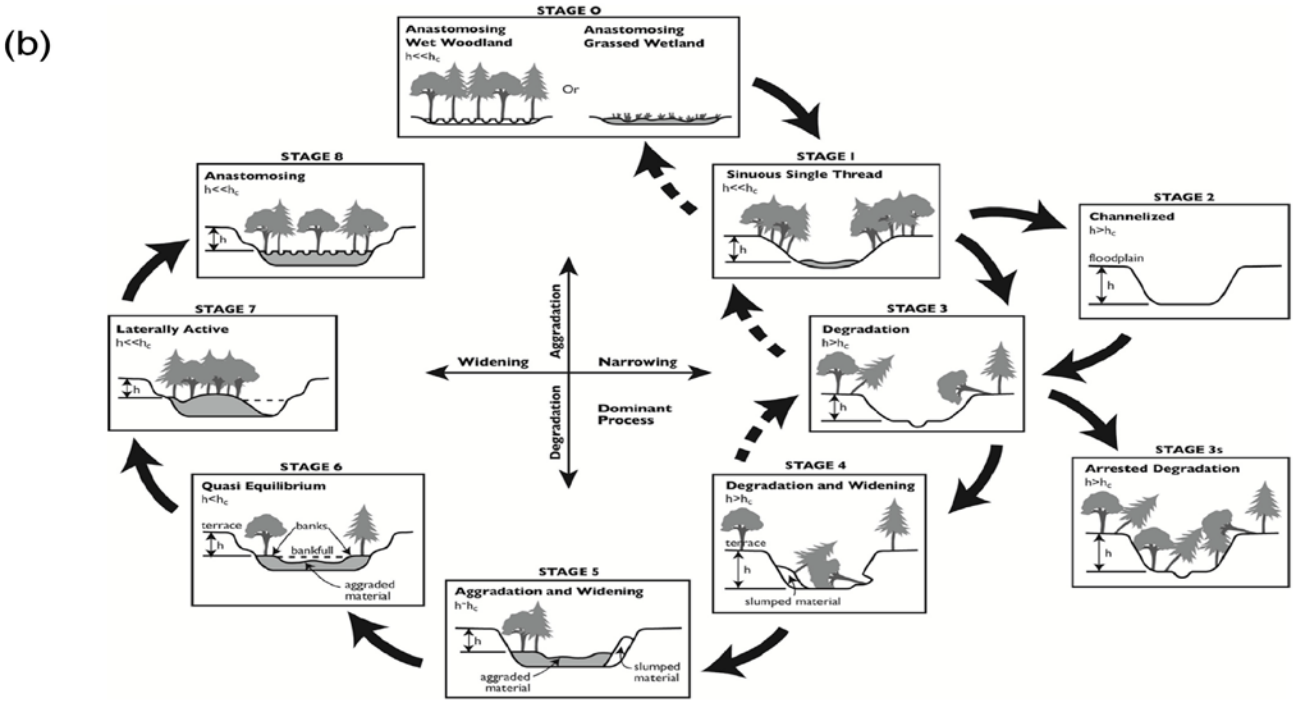
Ciotti et al 2021 "Design Criteria for Process-Based Restoration of Fluvial Systems"

Process Based Restoration enhances natural processes to promote stream evolution

Madison Conservation District

Castro and Thorne, 2019



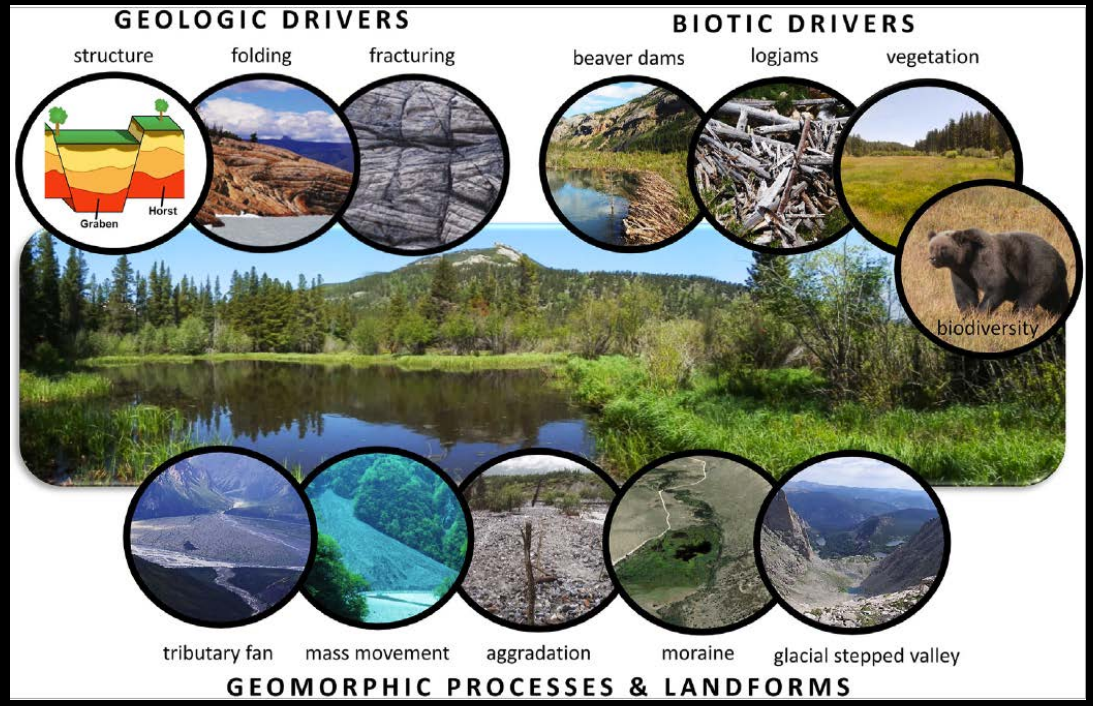


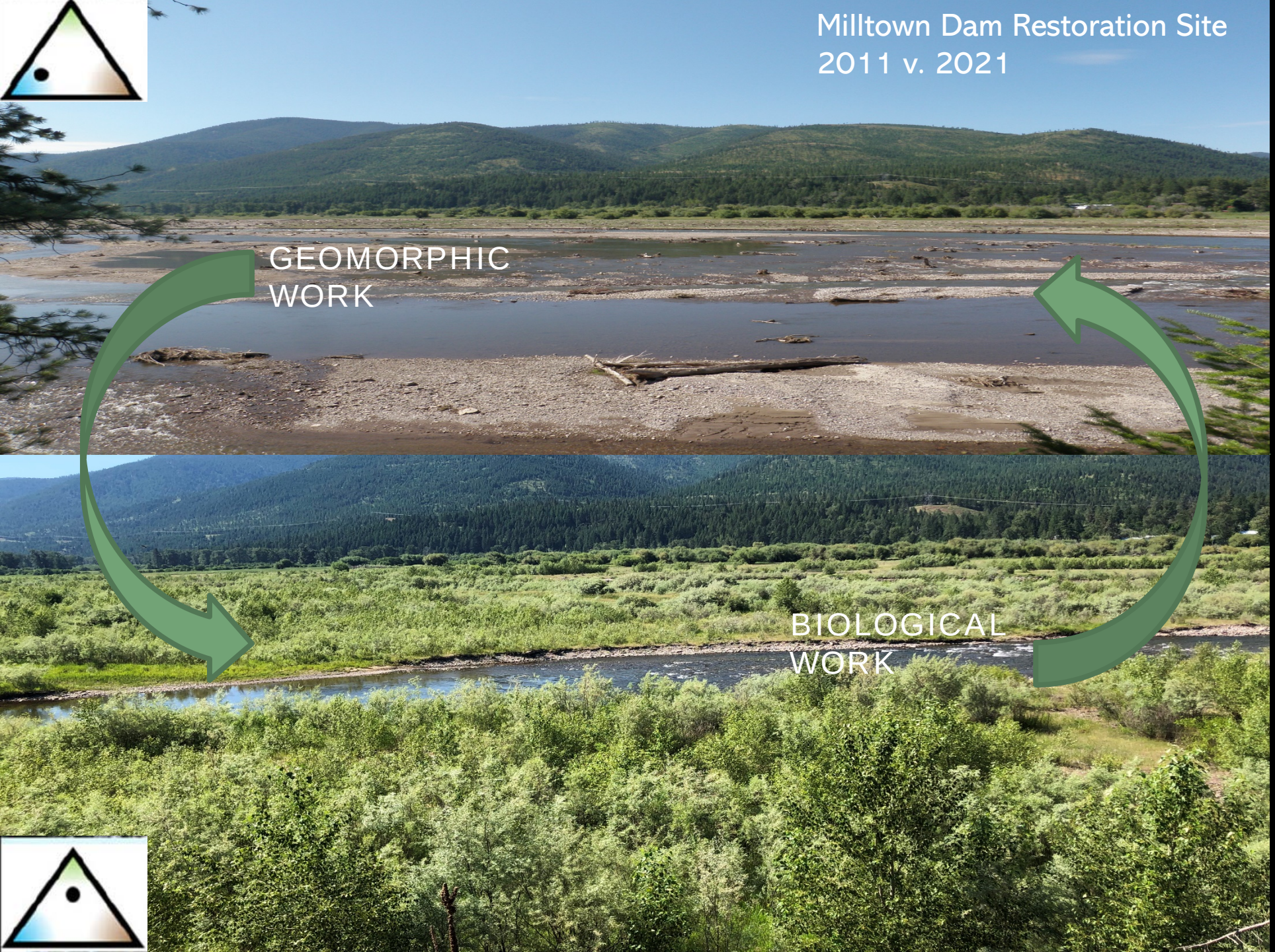
Stream Evolution Triangle

Significance of high-level drivers varies by stream type, may vary temporally, and may be multiple drivers

- Biotic Drivers of Stream Evolution:
  - Plants/OM
  - Large Wood
  - Animals – Beaver, Spawning salmon, Apex predators
  - Invertebrates
  - Algae/Biofilm

Wohl et al., 2021





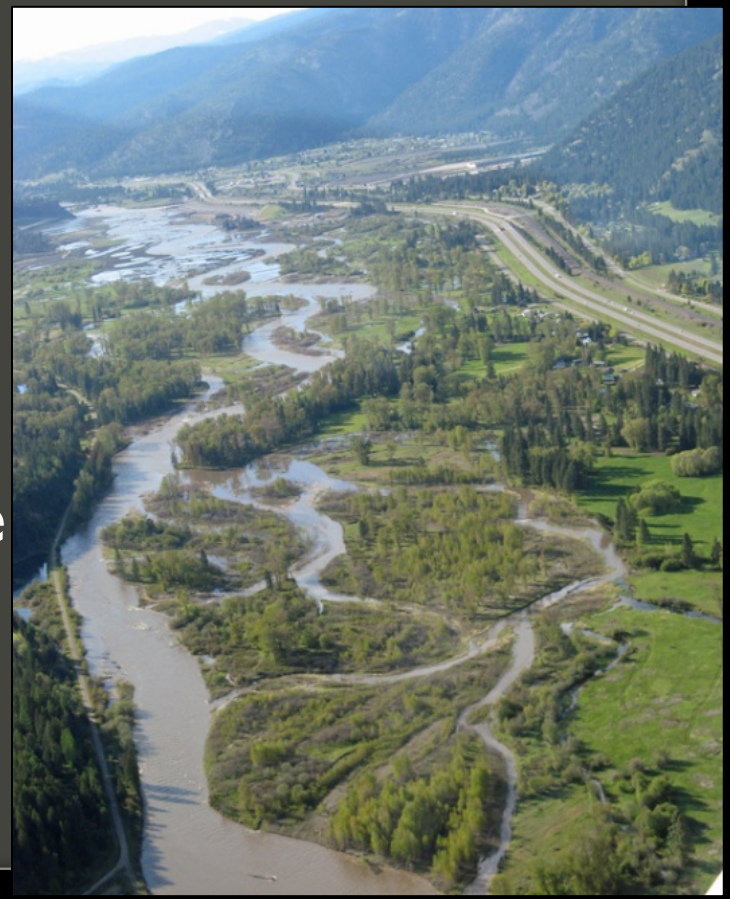
"For post disturbance recovery to be robust and enduring and to re-establish a healthy and functional ecosystem some degree of biological uplift is essential."

Castro and Thorne, 2019

Hydrologic Connectivity

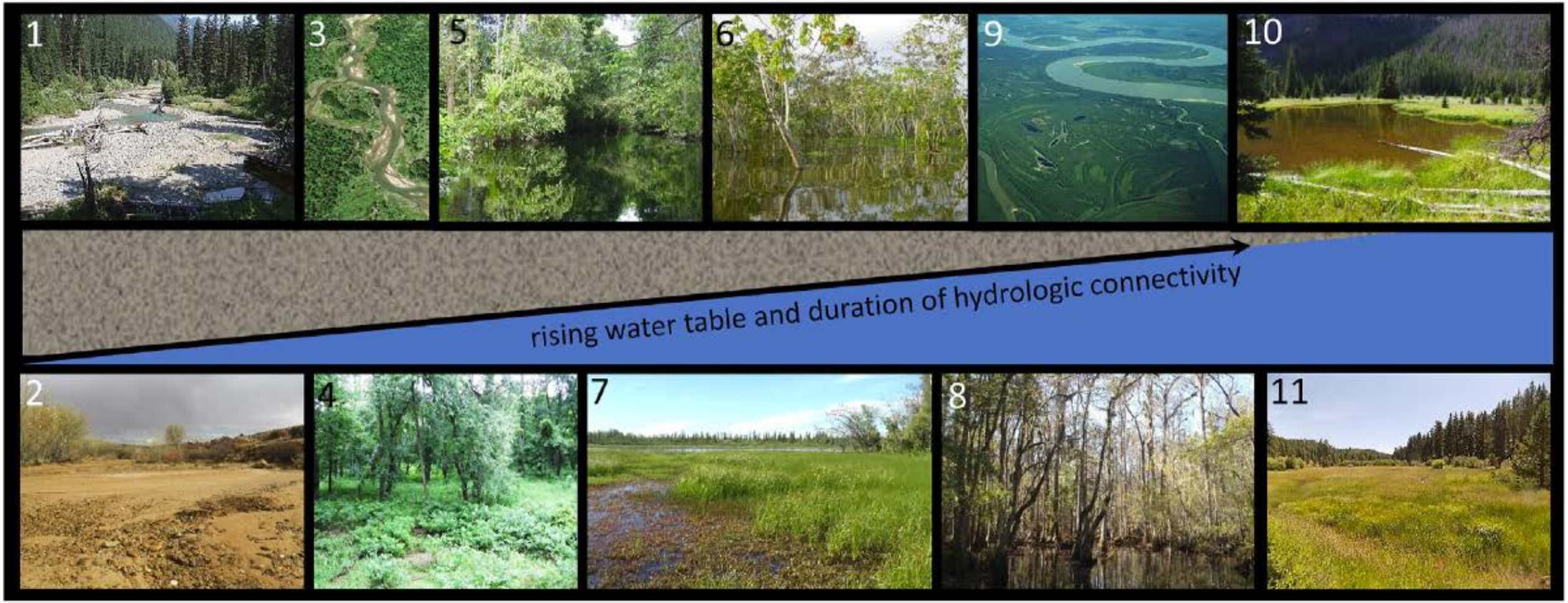
- Flood Pulse Concept (FPC) – pulsing of river discharge drives the degree of connectivity
- Riparian and floodplain function is maximized by connectivity with the river – lateral, longitudinal, vertical and temporal
- Linked to frequency, seasonality and duration of surface flooding and groundwater and river channel water levels
- Timing of connectivity linked to life histories of some riparian plant species

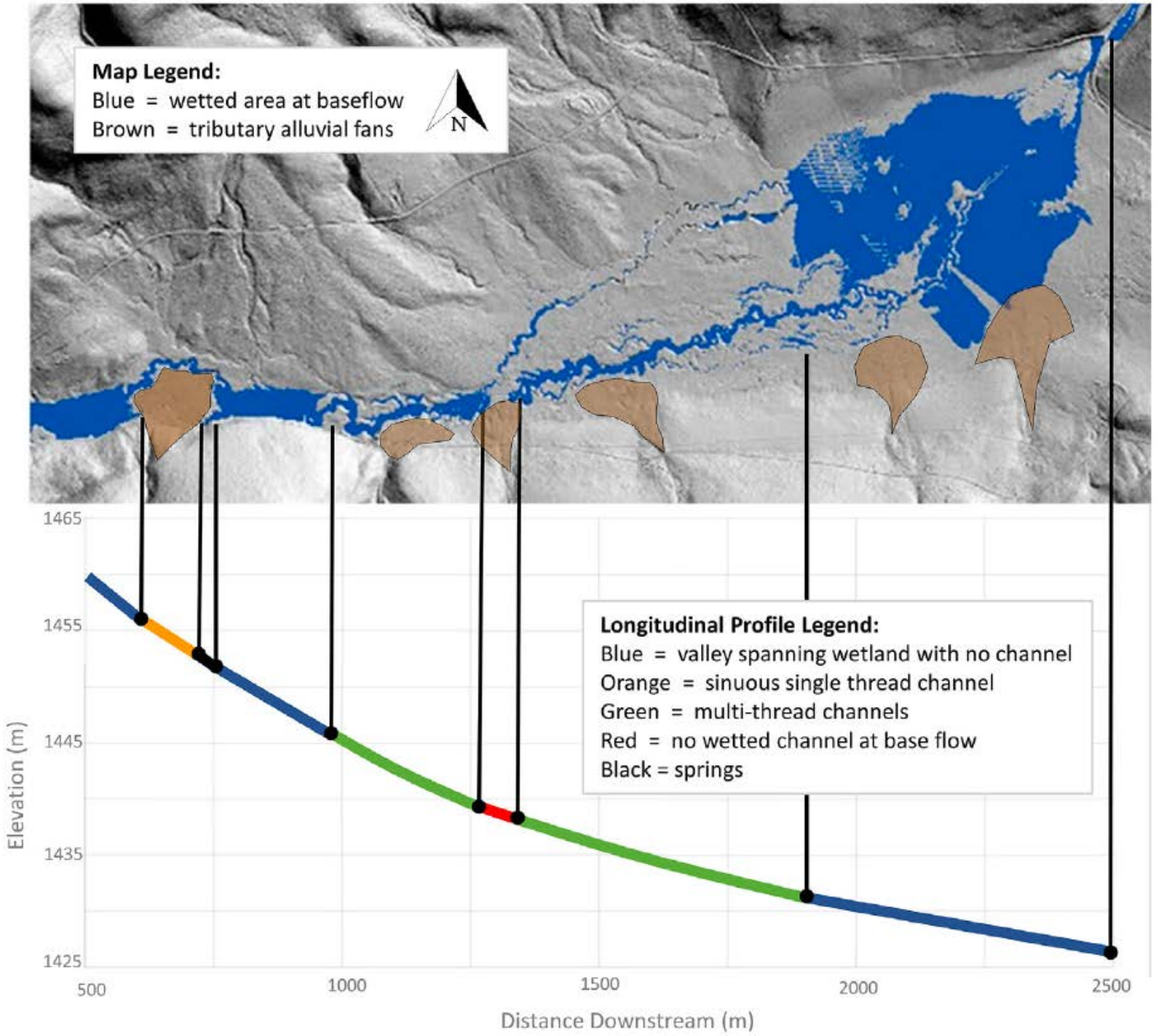
DRIVES MOST ECOLOGICAL PROCESSES



Degree to which you can maximize longitudinal, lateral, vertical and temporal connectivity varies with gradient and valley confinement

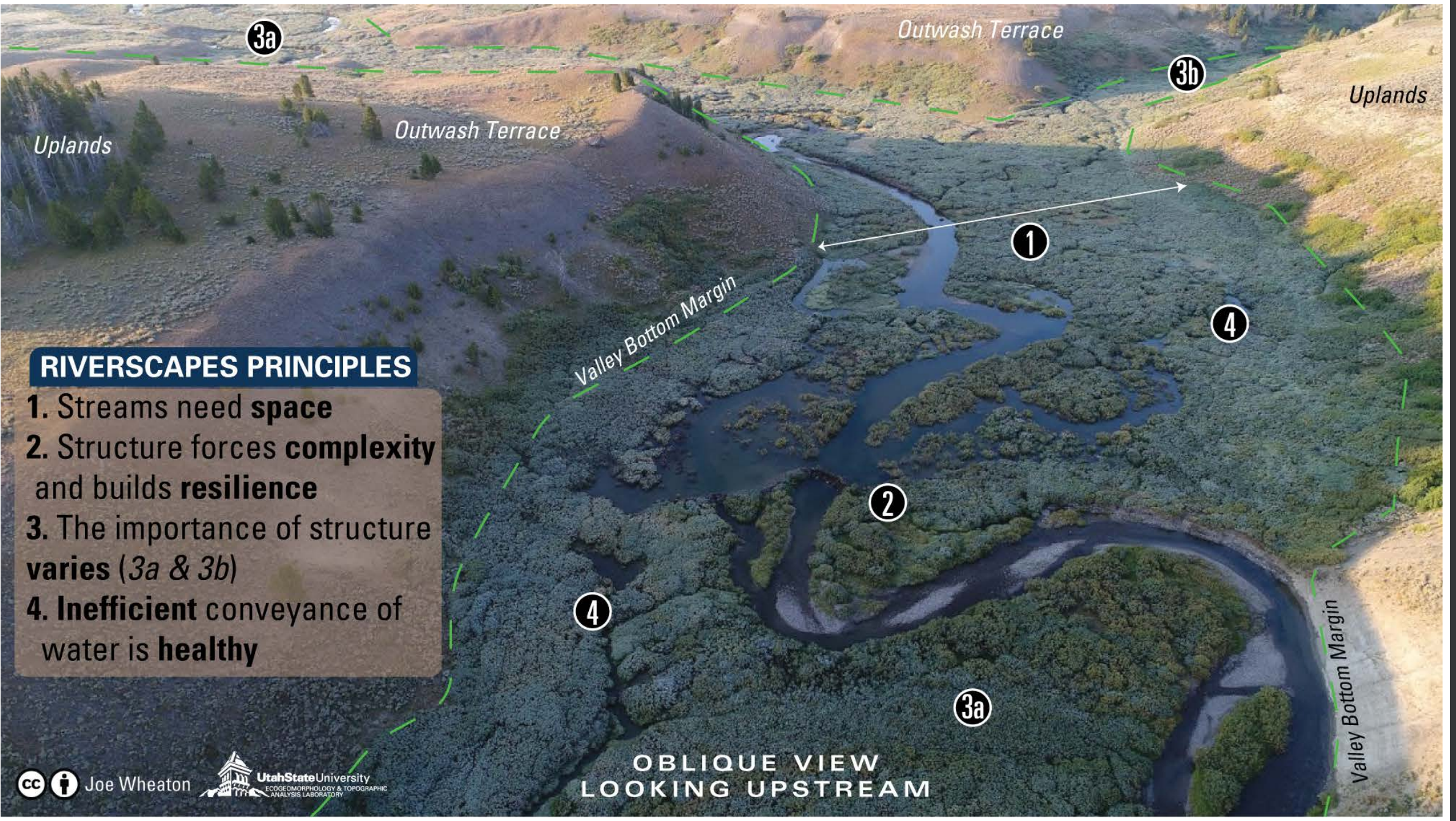
Wohl, et al. 2021

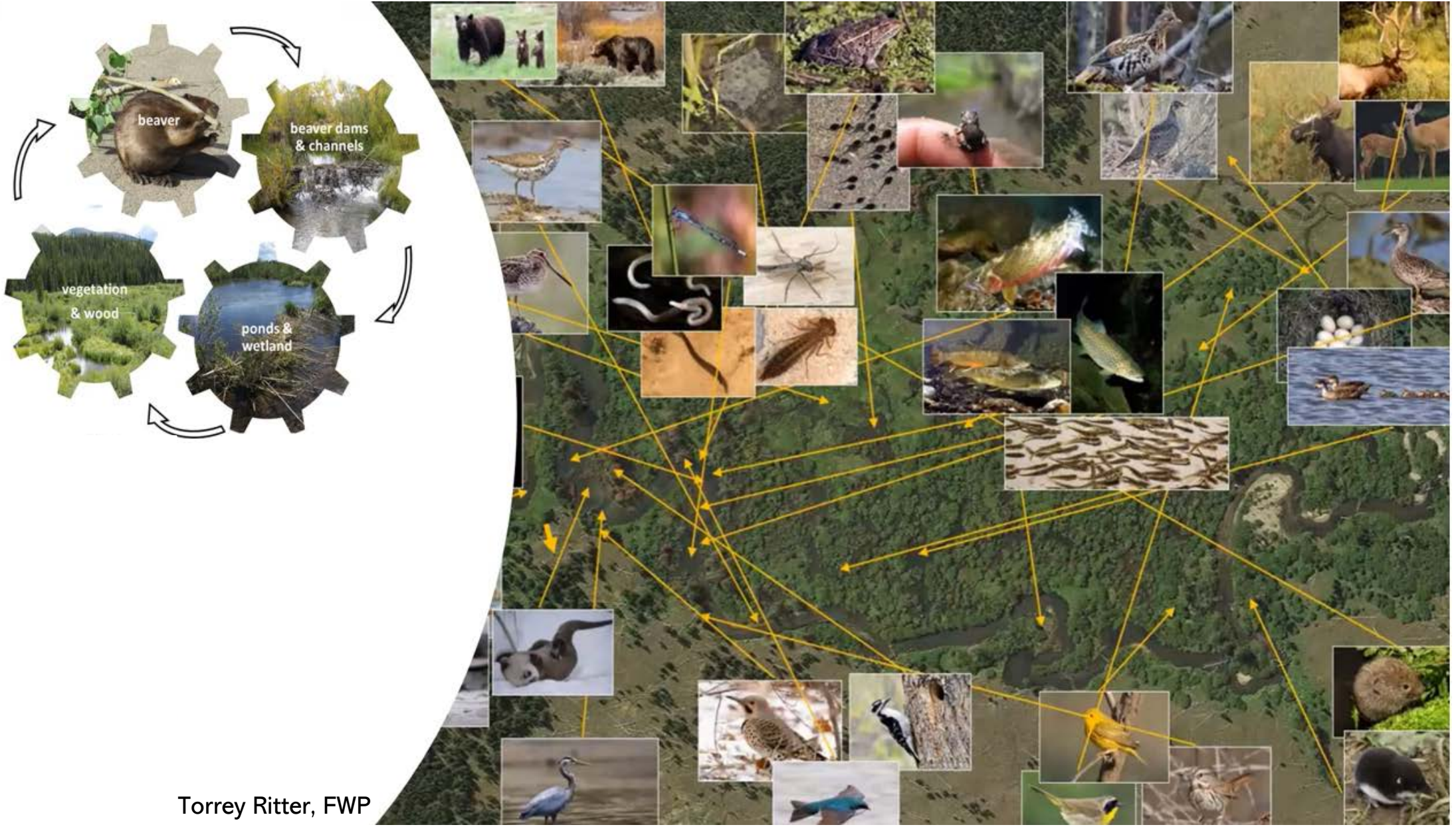




Degree to which you can maximize longitudinal, lateral, vertical and temporal connectivity varies with gradient and valley confinement

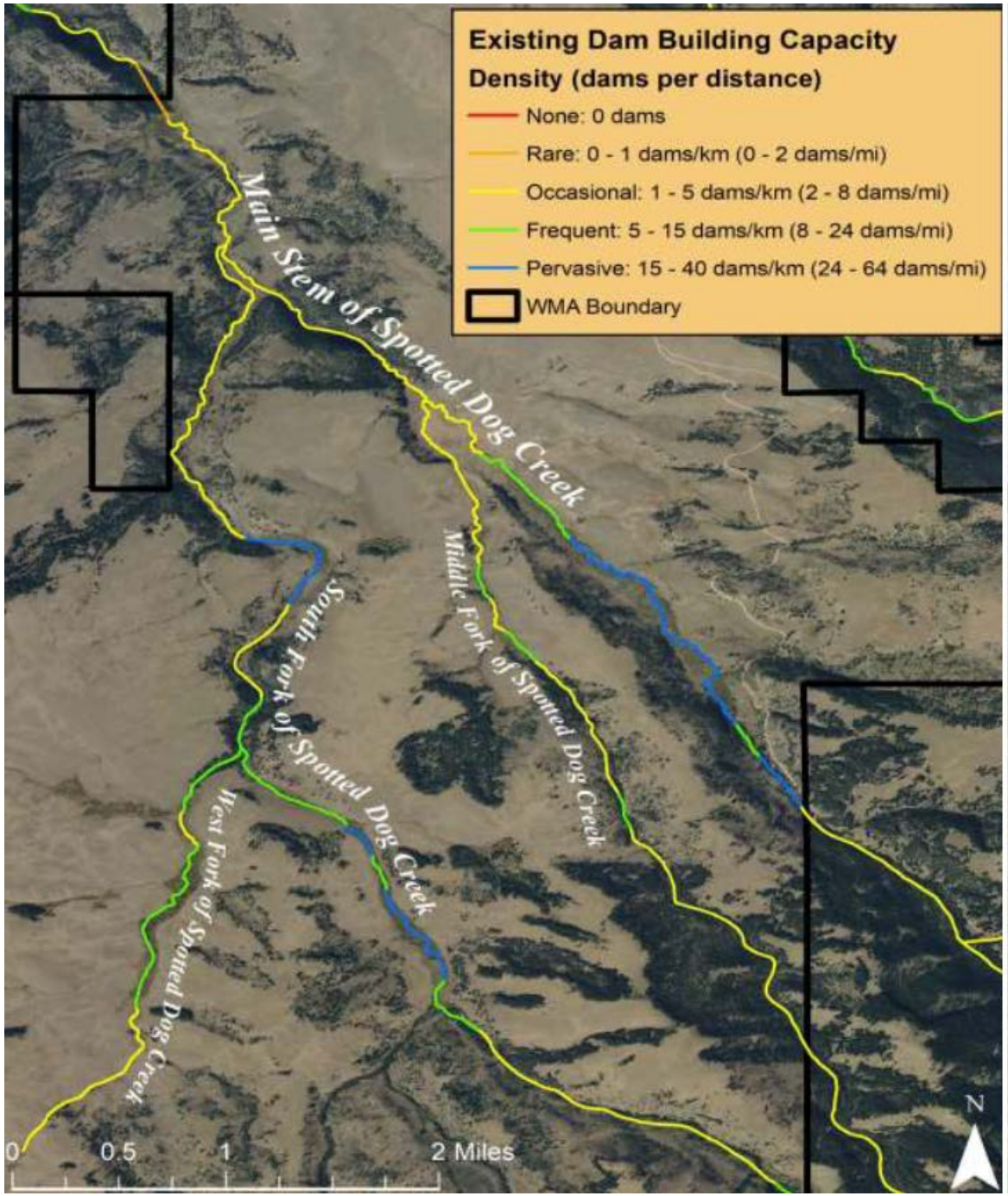
Wohl, et al. 2021

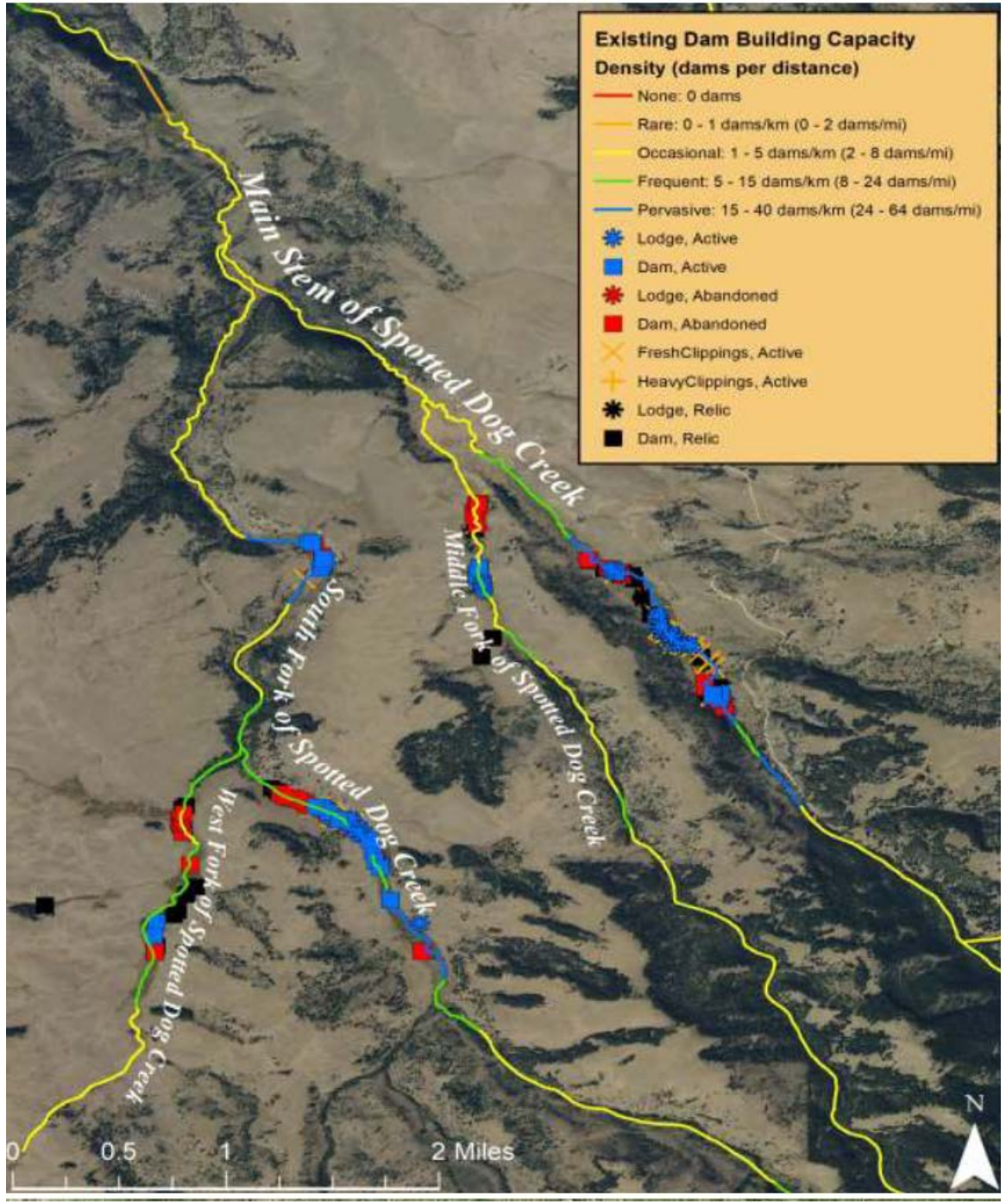

3a
Outwash Terrace
3b
Uplands
Uplands
Outwash Terrace
1
Valley Bottom Margin
4
RIVERSCAPES PRINCIPLES
1. Streams need space
2. Structure forces complexity and builds resilience
3. The importance of structure varies (3a & 3b)
4. Inefficient conveyance of water is healthy
2
4
3a
Valley Bottom Margin
OBLIQUE VIEW
LOOKING UPSTREAM
Joe Wheaton
UtahStateUniversity
ECOGEOMORPHOLOGY & TOPOGRAPHIC ANALYSIS LABORATORY



Torrey Ritter, FWP

“A keystone species is one whose presence allows certain plants and animals to exist in an area where they may not otherwise occur. Beaver activity, especially building dams, causes dramatic changes to streams and riparian areas, including creating a diversity of habitat niches that other species can fill.”


Existing Dam Building Capacity
Density (dams per distance)
None: 0 dams
Rare: 0 - 1 dams/km (0 - 2 dams/mi)
Occasional: 1 - 5 dams/km (2 - 8 dams/mi)
Frequent: 5 - 15 dams/km (8 - 24 dams/mi)
Pervasive: 15 - 40 dams/km (24 - 64 dams/mi)
WMA Boundary
Main Stem of Spotted Dog Creek
Middle Fork of Spotted Dog Creek
South Fork of Spotted Dog Creek
West Fork of Spotted Dog Creek
0
0.5
1
2 Miles
N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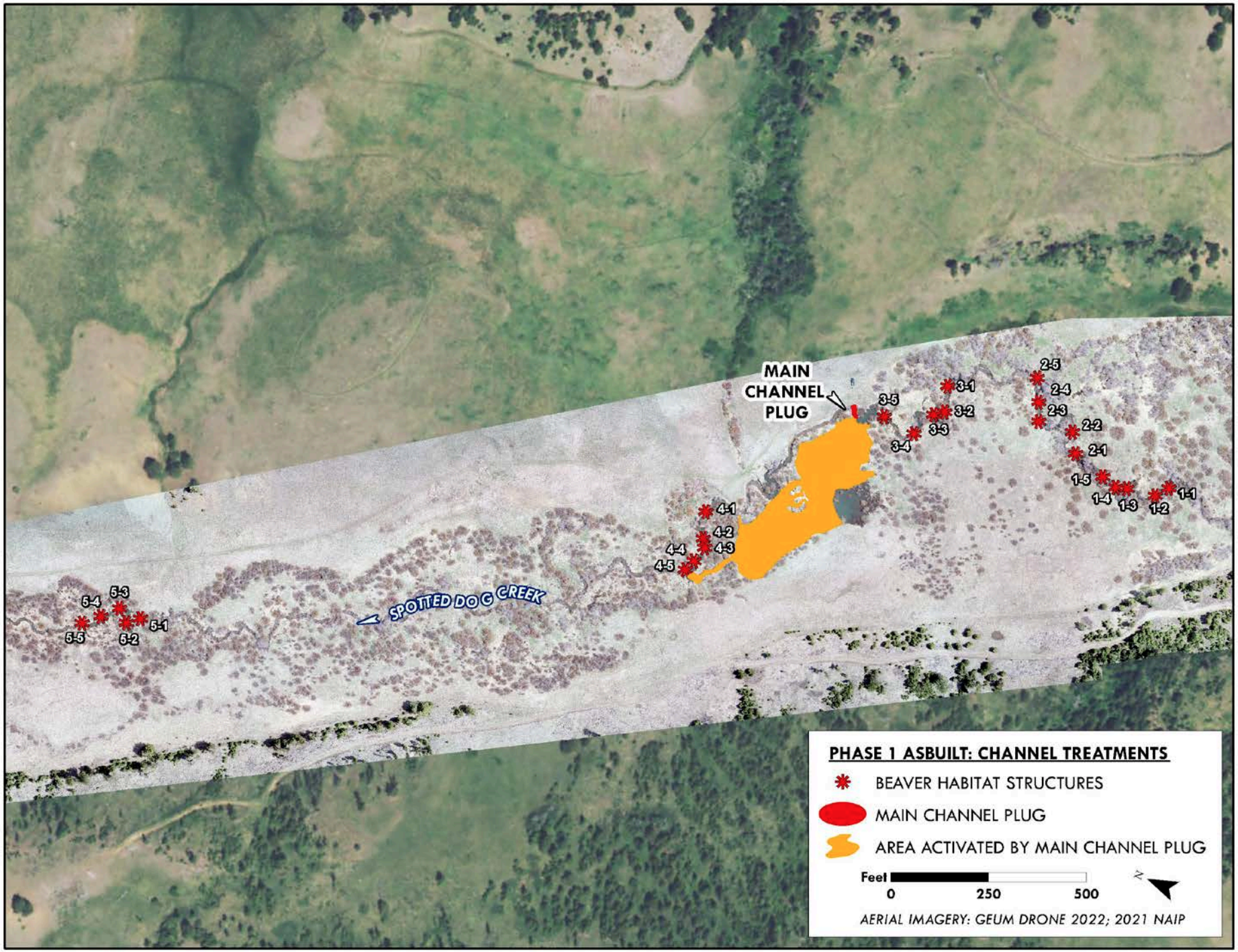
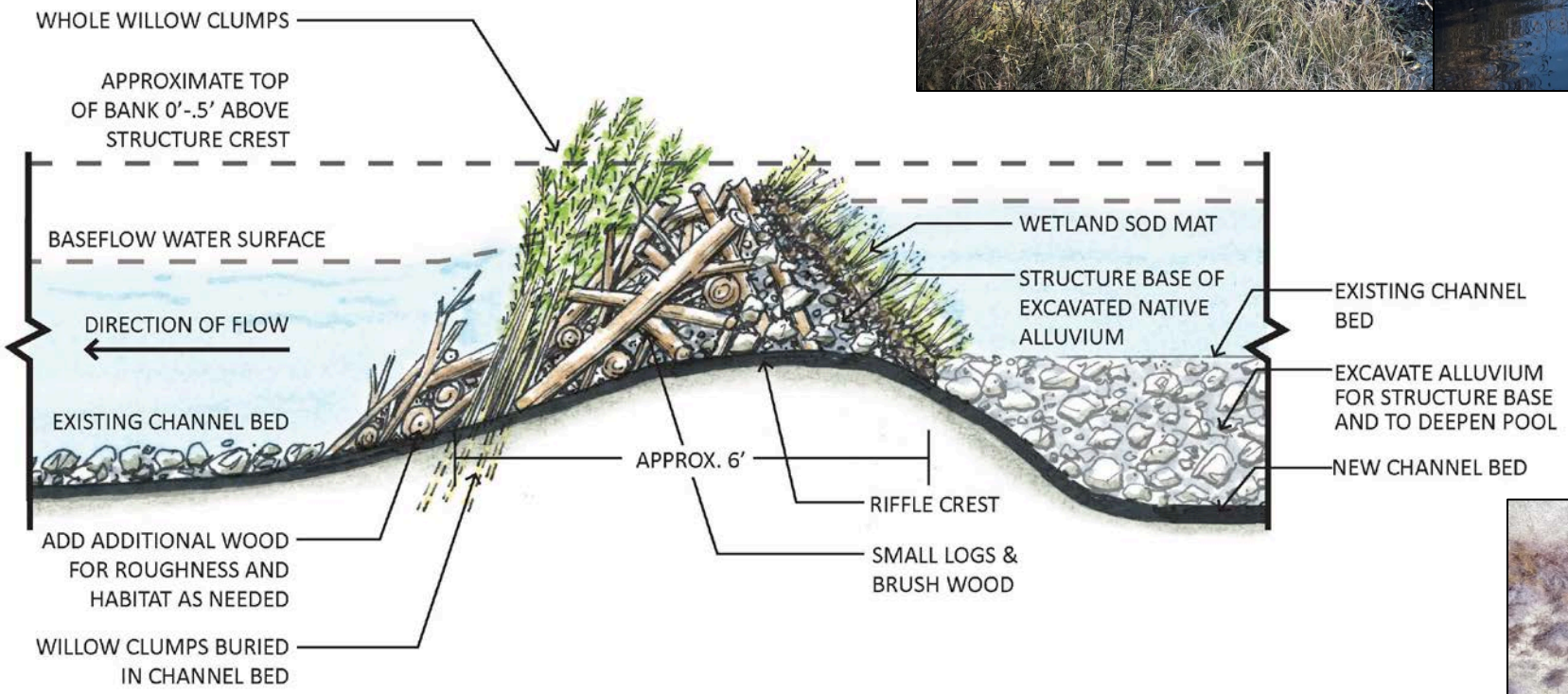
Frequent: 5 - 15 dams/km (8 - 24 dams/mi)
Pervasive: 15 - 40 dams/km (24 - 64 dams/mi)
Lodge, Active
Dam, Active
Lodge, Abandoned
Dam, Abandoned
FreshClippings, Active
HeavyClippings, Active
Lodge, Relic
Dam, Relic
Main Stem of Spotted Dog Creek
Middle Fork of Spotted Dog Creek
South Fork of Spotted Dog Creek
West Fork of Spotted Dog Creek
0
0.5
1
2 Miles
N

Spotted Dog Creek near Avon, Montana

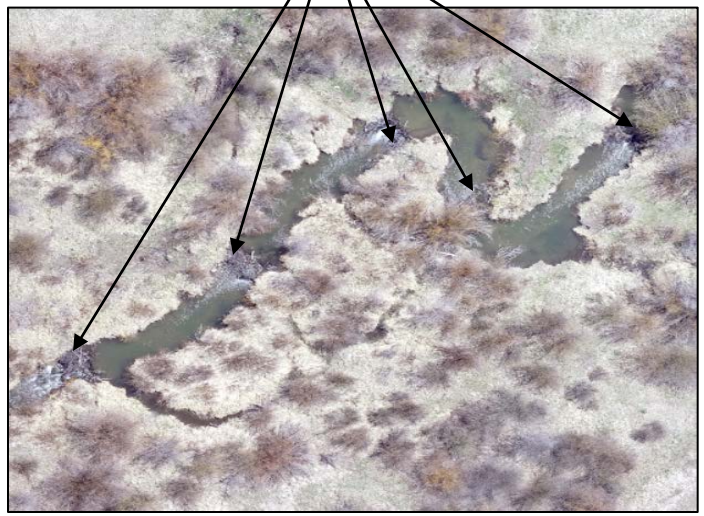


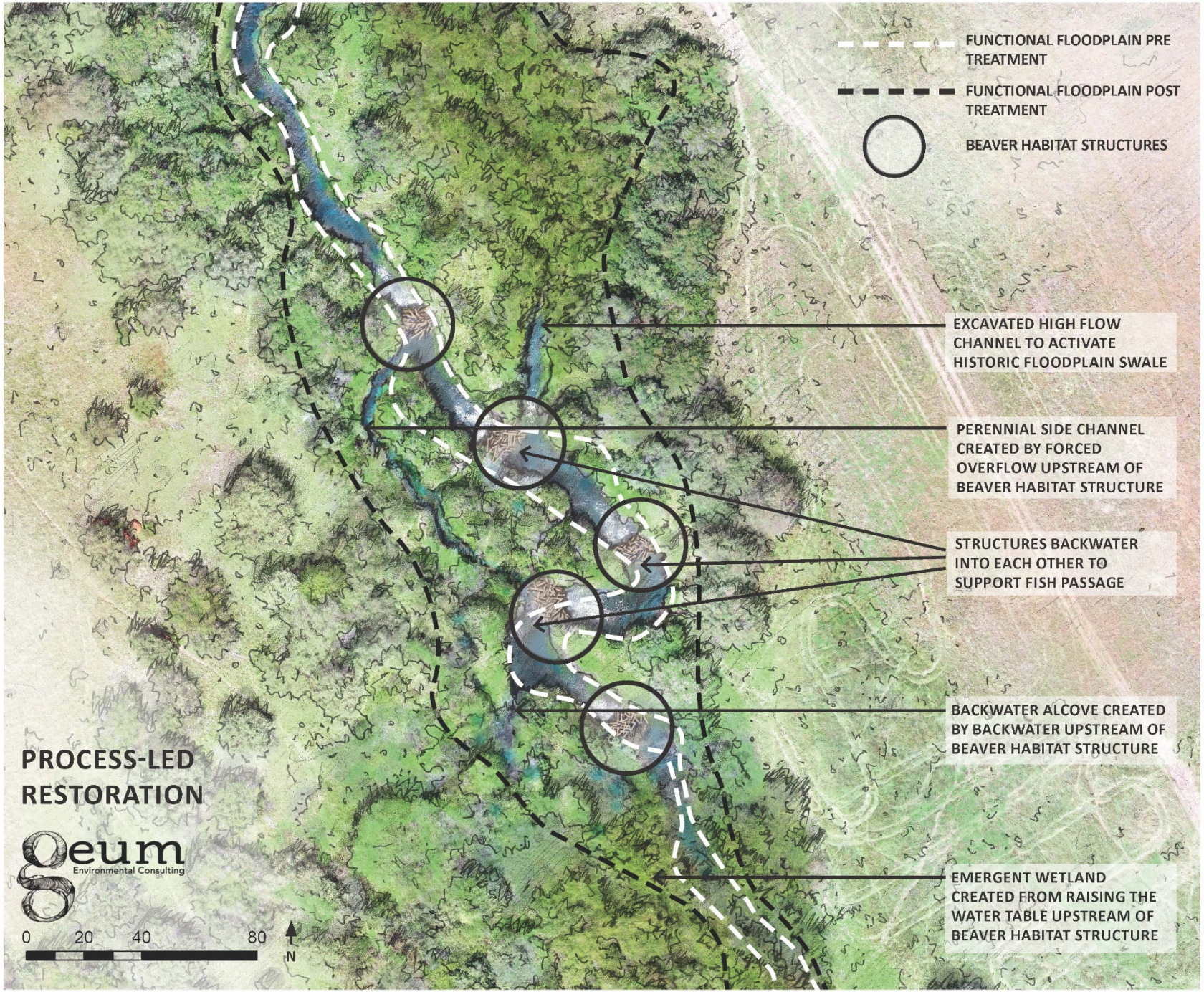
- Increase beaver populations
- Alter sediment dynamics
- Improve water availability/ increase capacity of floodplain to store water
- Improve riparian /wetland habitat (create river-wetland corridor)

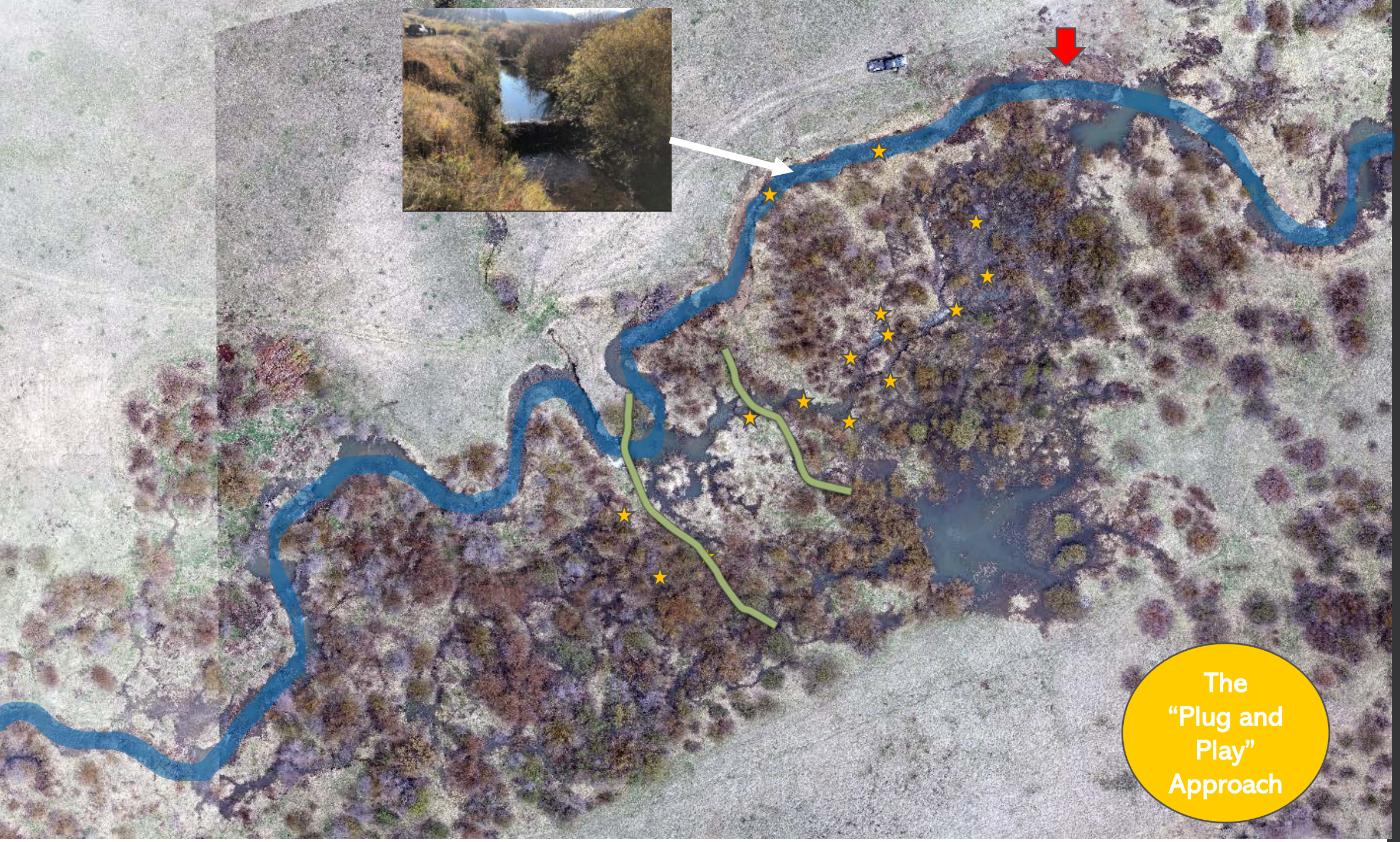
Beaver Habitat Structures

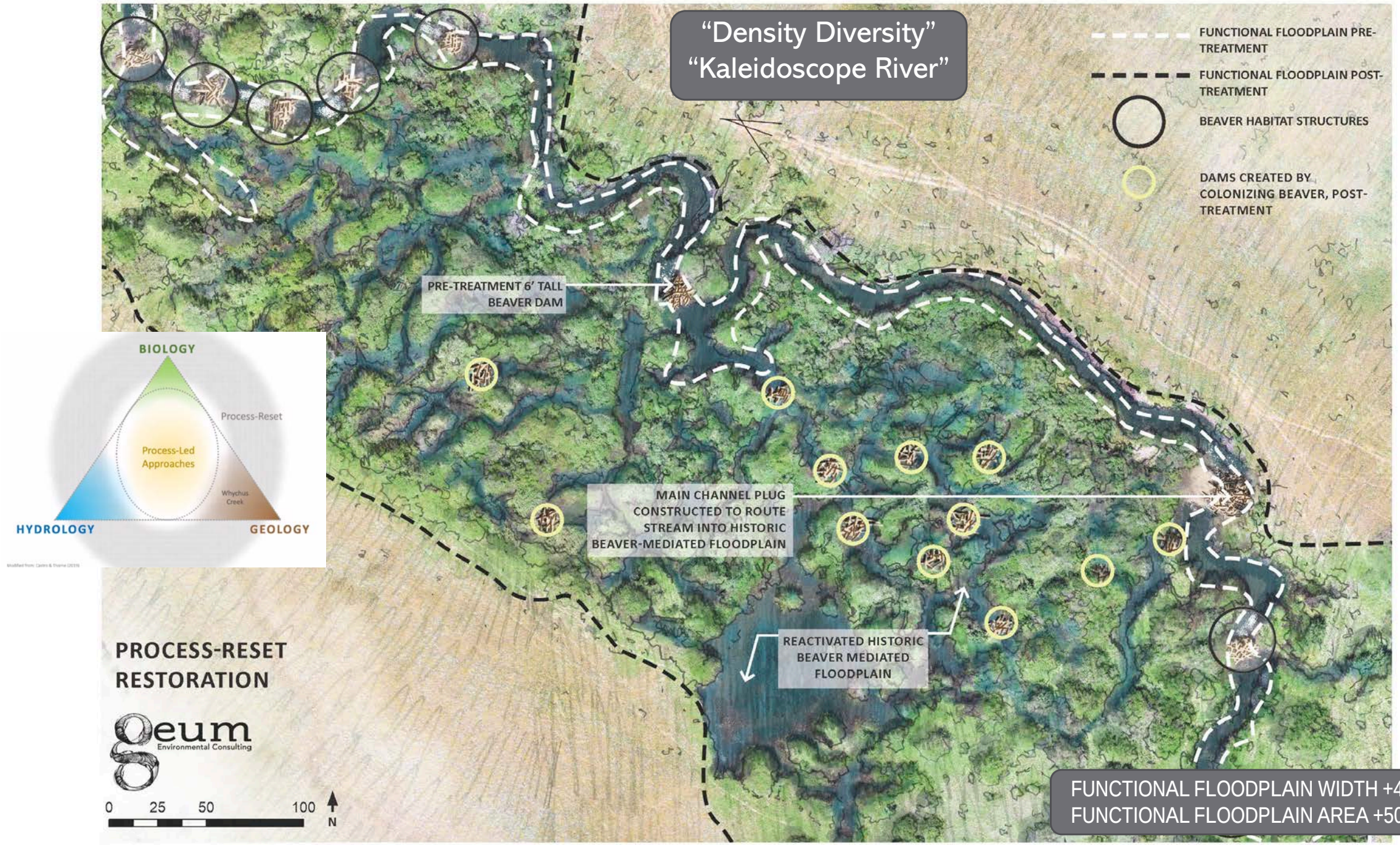


INSTALLED IN SERIES TO BACKWATER INTO UPSTREAM STRUCTURE




FUNCTIONAL FLOODPLAIN PRE TREATMENT
FUNCTIONAL FLOODPLAIN POST TREATMENT
BEAVER HABITAT STRUCTURES
EXCAVATED HIGH FLOW CHANNEL TO ACTIVATE HISTORIC FLOODPLAIN SWALE
PERENNIAL SIDE CHANNEL CREATED BY FORCED OVERFLOW UPSTREAM OF BEAVER HABITAT STRUCTURE
STRUCTURES BACKWATER INTO EACH OTHER TO SUPPORT FISH PASSAGE
BACKWATER ALCOVE CREATED BY BACKWATER UPSTREAM OF BEAVER HABITAT STRUCTURE
EMERGENT WETLAND CREATED FROM RAISING THE WATER TABLE UPSTREAM OF BEAVER HABITAT STRUCTURE
PROCESS-LED RESTORATION
Geum
Environmental Consulting
0 20 40 80
N


The
“Plug and
Play”
Approach

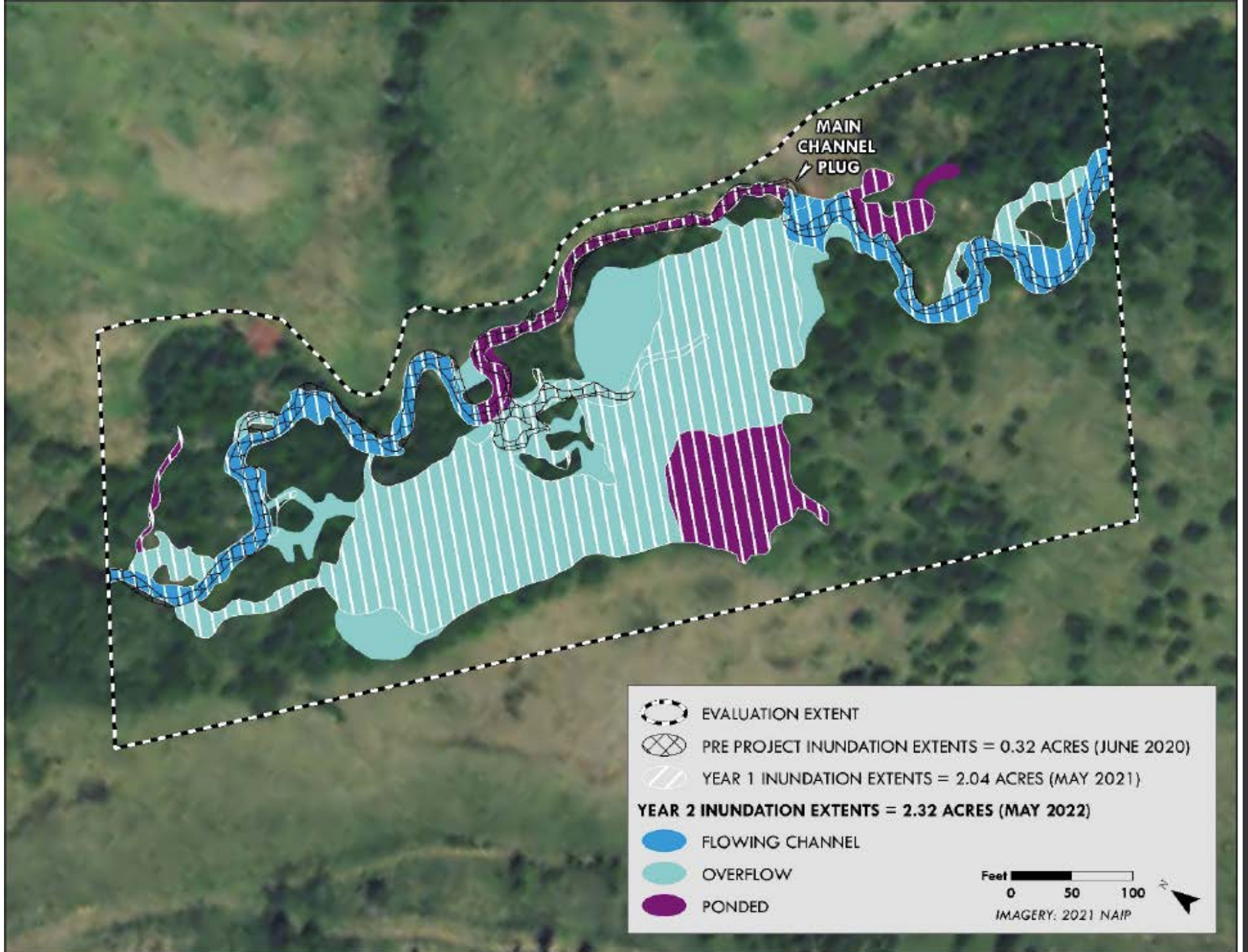

"Density Diversity"
"Kaleidoscope River"
FUNCTIONAL FLOODPLAIN PRE-TREATMENT
FUNCTIONAL FLOODPLAIN POST-TREATMENT
BEAVER HABITAT STRUCTURES
DAMS CREATED BY COLONIZING BEAVER, POST-TREATMENT
PRE-TREATMENT 6' TALL BEAVER DAM
MAIN CHANNEL PLUG CONSTRUCTED TO ROUTE STREAM INTO HISTORIC BEAVER-MEDIATED FLOODPLAIN
REACTIVATED HISTORIC BEAVER MEDIATED FLOODPLAIN
BIOLOGY
Process-Reset
Process-Led Approaches
Whychus Creek
HYDROLOGY
GEOLOGY
PROCESS-RESET RESTORATION
Geum Environmental Consulting
0 25 50 100
N
FUNCTIONAL FLOODPLAIN WIDTH +400'
FUNCTIONAL FLOODPLAIN AREA +500%

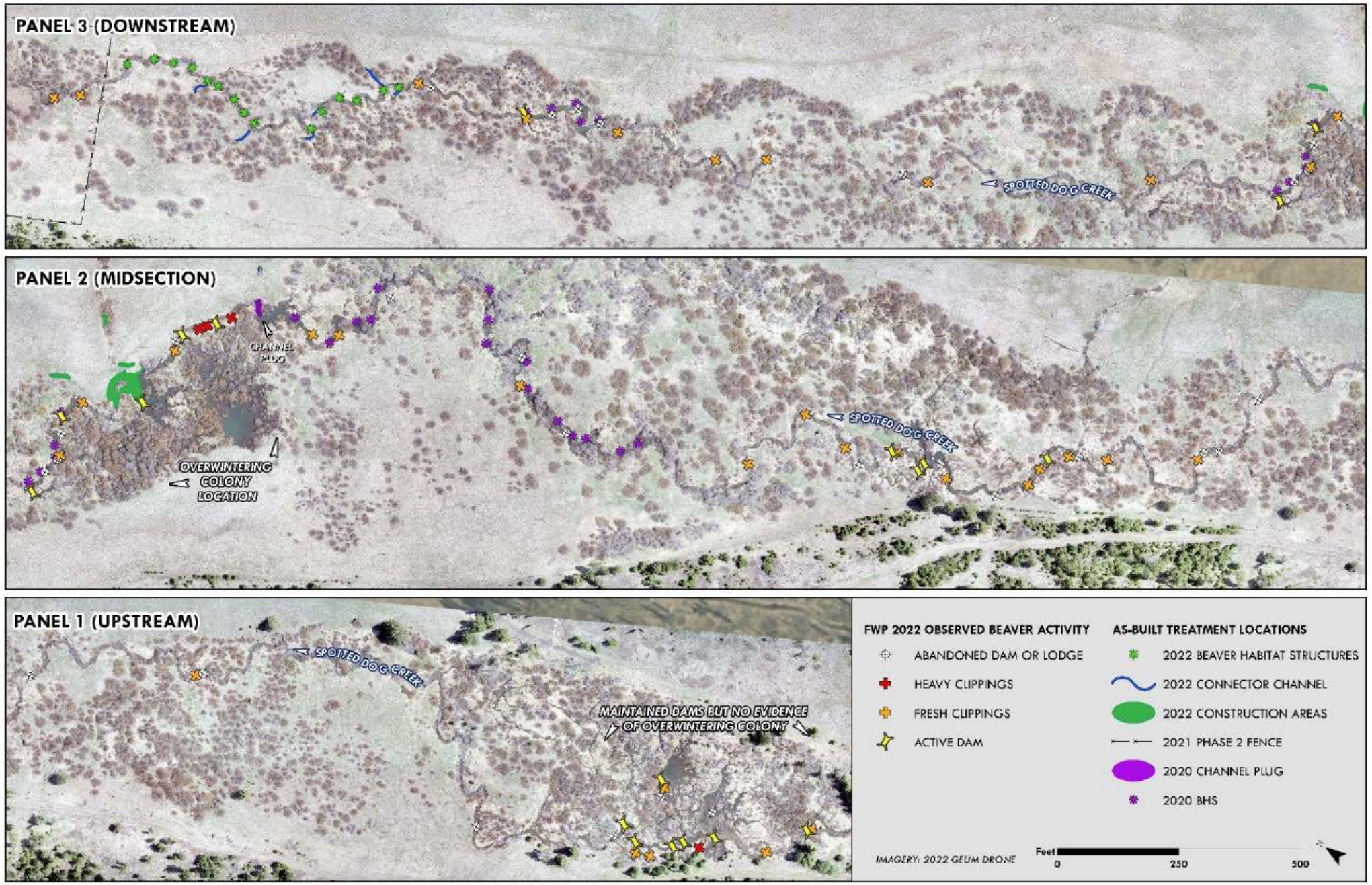
Monitoring

- Inundation area and type of inundation
- Greenline vegetation
- Beaver use
- Sediment accumulation upstream of structures

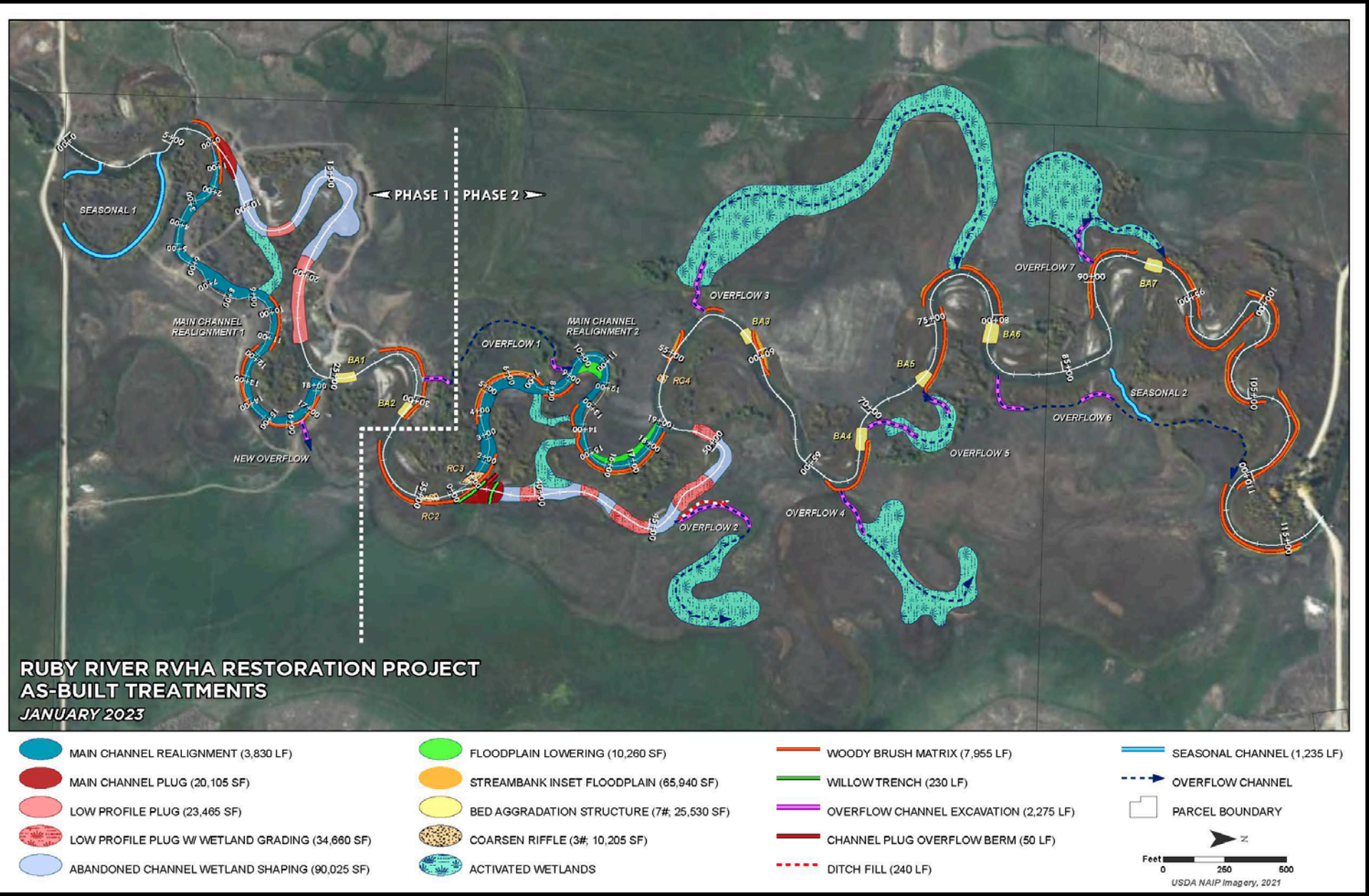
Adding in 2023:

- Temperature
- Fish movement (population level response)
- Flow
- Bird surveys



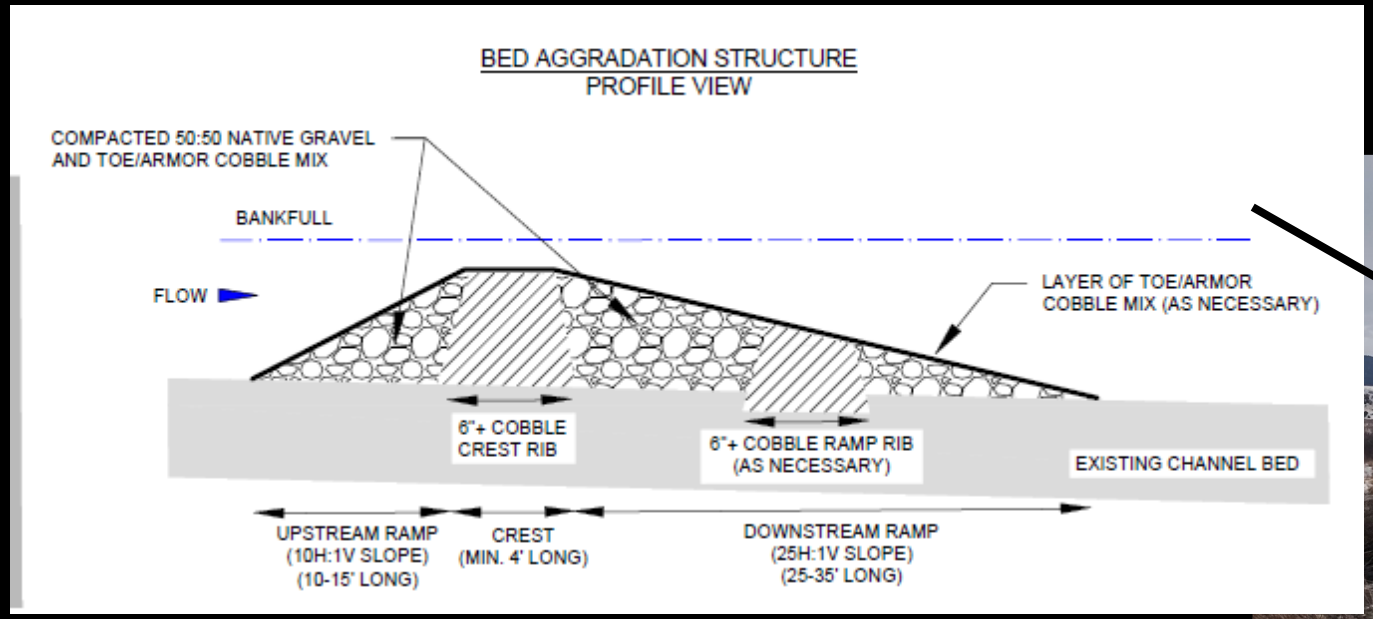

PANEL 3 (DOWNSTREAM)
SPOTTED DOG CREEK
PANEL 2 (MIDSECTION)
CHANNEL PLUG
OVERWINTERING COLONY LOCATION
SPOTTED DOG CREEK
PANEL 1 (UPSTREAM)
SPOTTED DOG CREEK
MAINTAINED DAMS BUT NO EVIDENCE OF OVERWINTERING COLONY
FWP 2022 OBSERVED BEAVER ACTIVITY
ABANDONED DAM OR LODGE
HEAVY CLIPPINGS
FRESH CLIPPINGS
ACTIVE DAM
AS-BUILT TREATMENT LOCATIONS
2022 BEAVER HABITAT STRUCTURES
2022 CONNECTOR CHANNEL
2022 CONSTRUCTION AREAS
2021 PHASE 2 FENCE
2020 CHANNEL PLUG
2020 BHS
IMAGERY: 2022 GEUM DRONE
Feet
0
250
500

Ruby River upstream of Ruby Reservoir

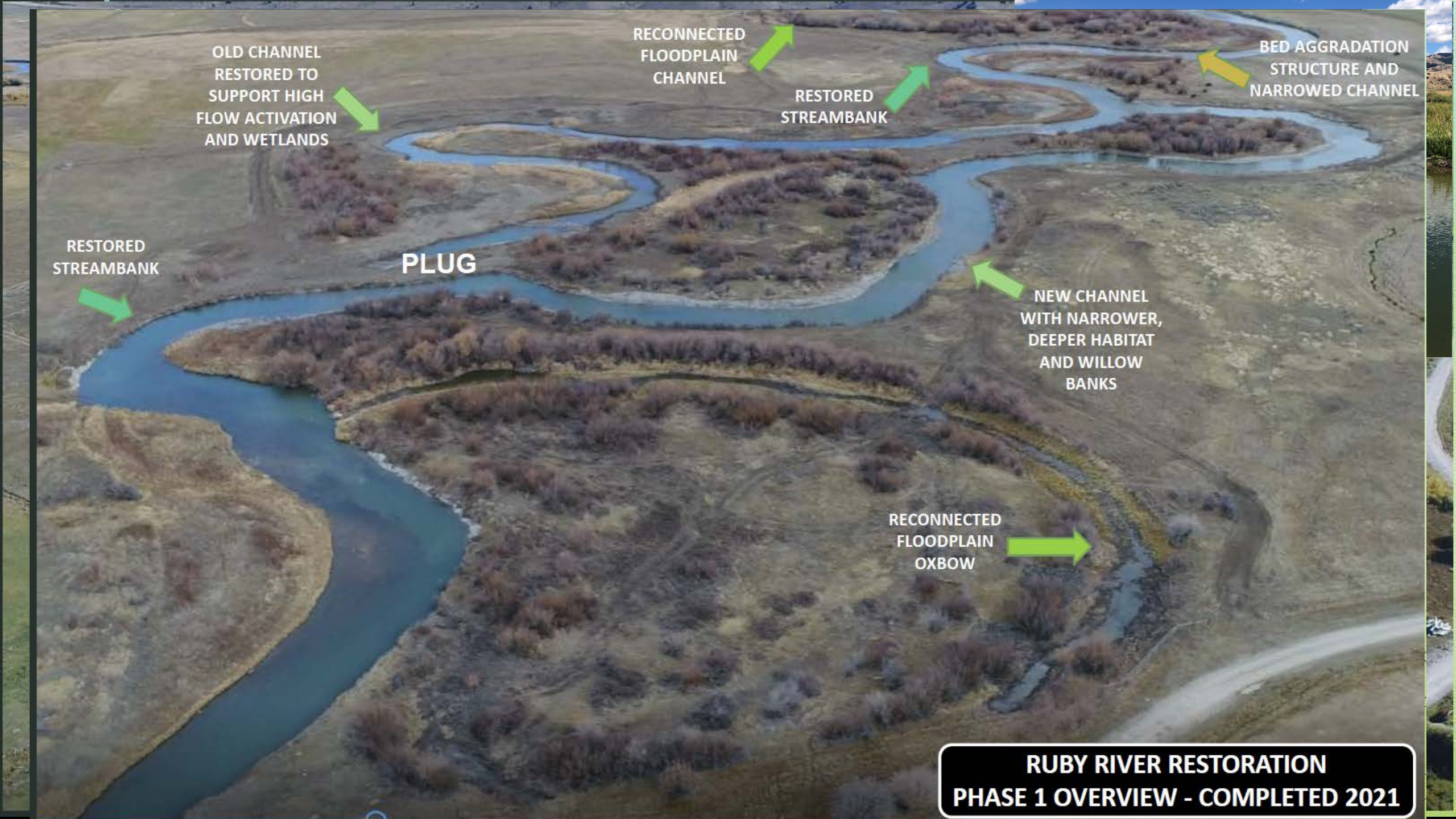


GOAL: Increase floodplain connectivity

- Narrow channel
- Raise bed elevation
- Pilot channels into abandoned floodplain features
- Two main channel realignments to increase functional floodplain width



Narrow Channel and Raise Channel Bed to increase high flow floodplain connection and raise water table


OLD CHANNEL RESTORED TO SUPPORT HIGH FLOW ACTIVATION AND WETLANDS
RECONNECTED FLOODPLAIN CHANNEL
RESTORED STREAMBANK
BED AGGRADATION STRUCTURE AND NARROWED CHANNEL
RESTORED STREAMBANK
PLUG
NEW CHANNEL WITH NARROWER, DEEPER HABITAT AND WILLOW BANKS
RECONNECTED FLOODPLAIN OXBOW
RUBY RIVER RESTORATION
PHASE 1 OVERVIEW - COMPLETED 2021

2022 (Year 1)
Peak Flow
11,400 cfs
(approx. 5-year event)


Bed aggradation structure
Bed aggradation structure


Bed aggradation structure
Bed aggradation structure