

“Stage 0” Alluvial Valley Restoration on the South Fork McKenzie River below Cougar Dam



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Fisheries Biologist
U.S. Forest Service
Willamette National Forest



Presentation Outline

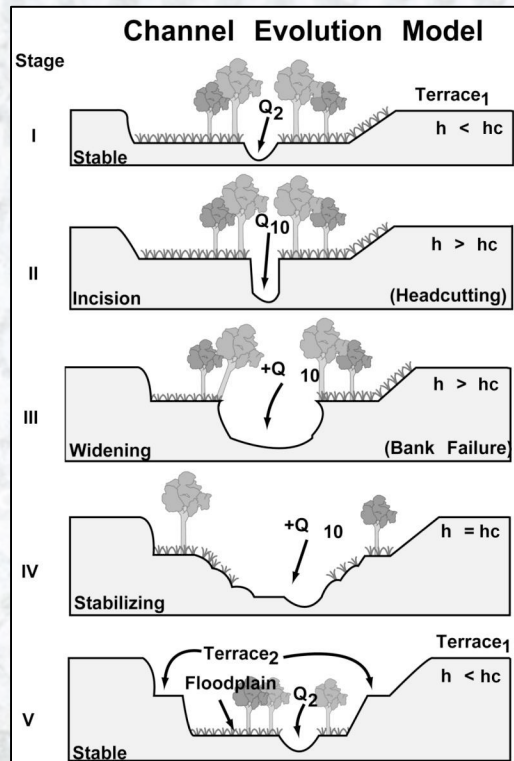
- What is “Stage 0” Restoration?
- U.S. Forest Service Stage 0 Projects in Oregon
- Lower South Fork McKenzie River Floodplain Enhancement Project

A STREAM EVOLUTION MODEL INTEGRATING HABITAT AND ECOSYSTEM BENEFITS

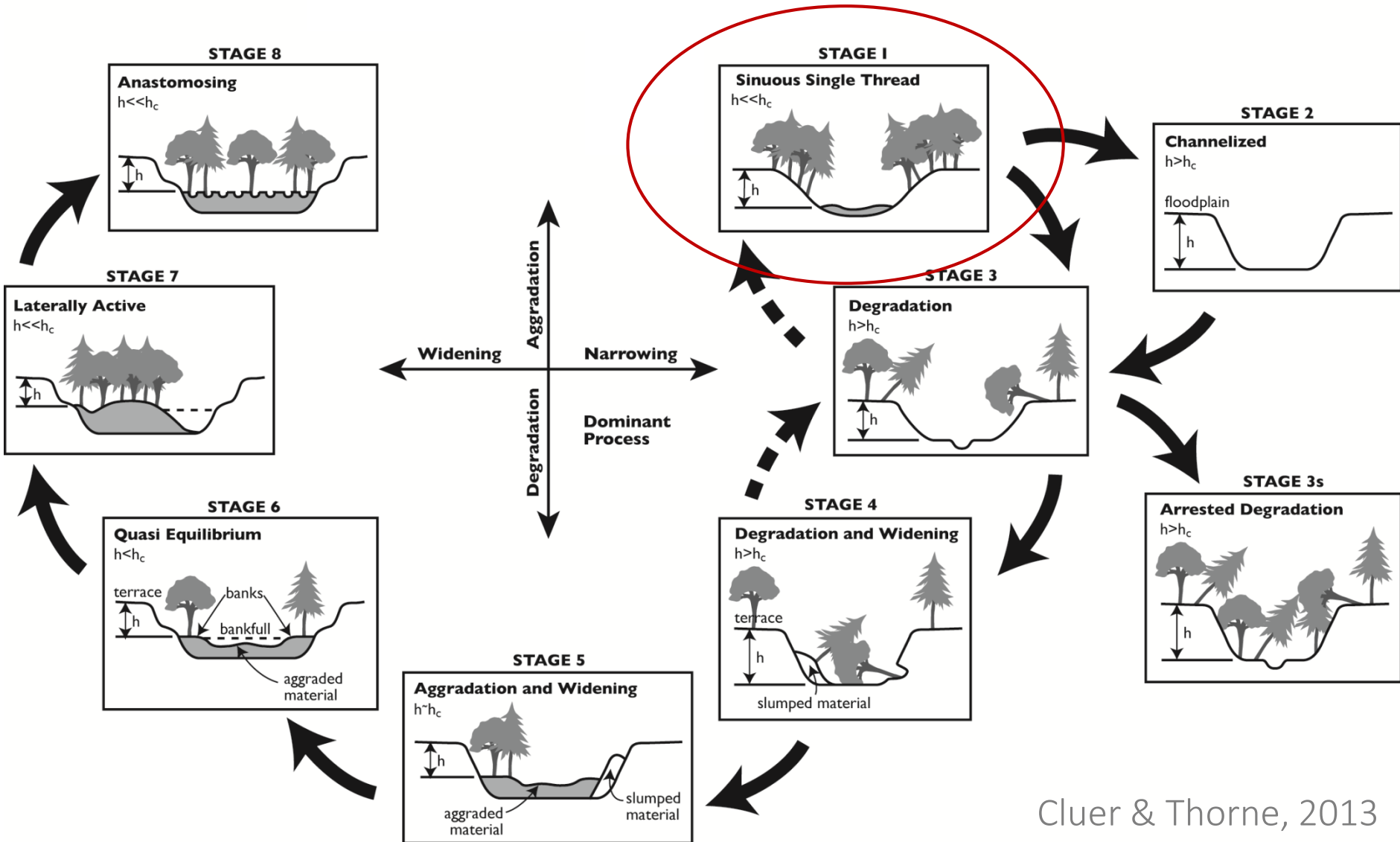
B. CLUER^{a*} and C. THORNE^b

^a *Fluvial Geomorphologist, Southwest Region, NOAA's National Marine Fisheries Service, Santa Rosa, California, USA*

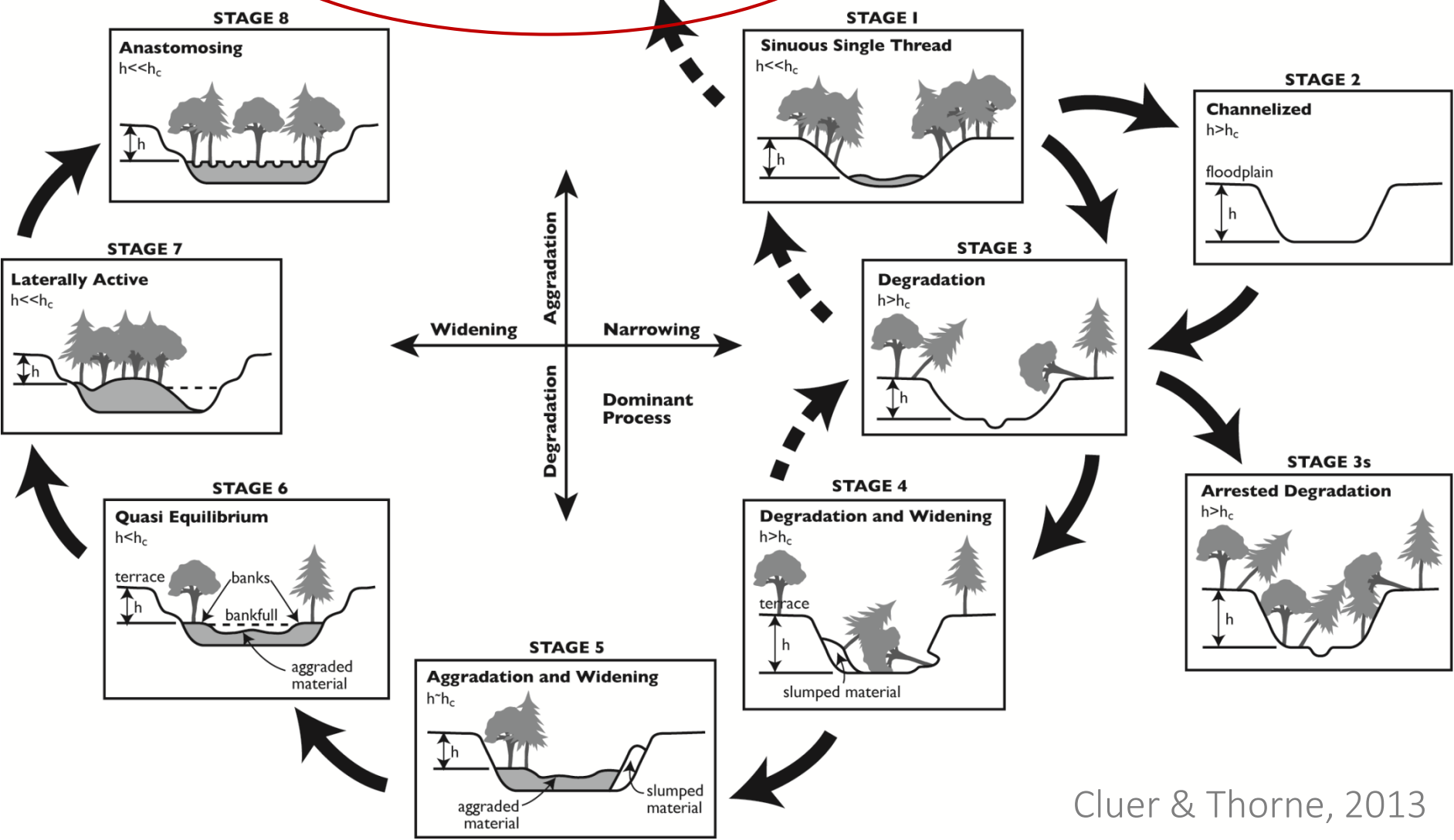
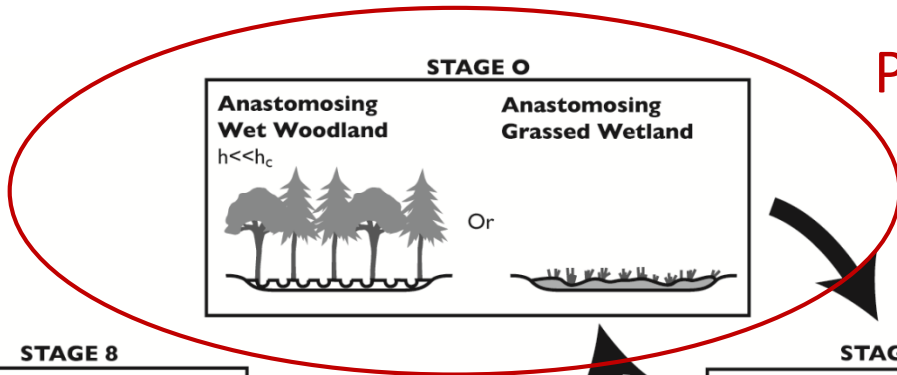
^b *Chair of Physical Geography, University of Nottingham, Nottingham, UK*



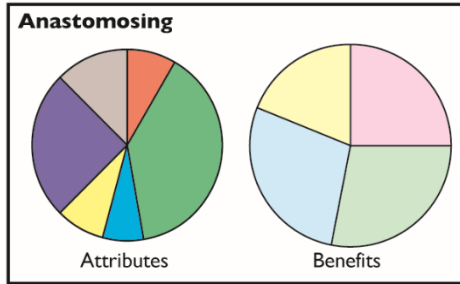
Pre-disturbance Condition Classic Channel Evolution Model



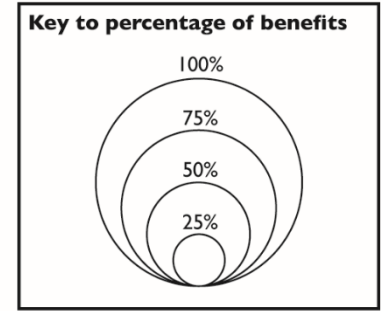
Pre-disturbance Condition - Updated Stream Evolution Model



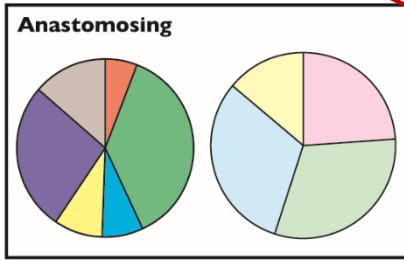
STAGE 0



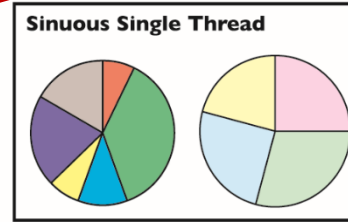
Greatest Ecosystem Benefits



STAGE 8

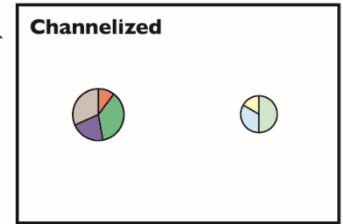


STAGE 1

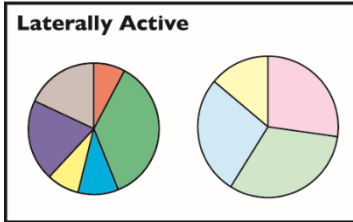


- Hydrogeomorphic Attributes Table
- Physical Channel Dimensions
 - Channel and Floodplain Features
 - Substrate
 - Hydraulics
 - Vegetation
 - Hydrological Regime
- Habitats and Ecosystem Benefits Table
- Habitat
 - Water Quality
 - Biota
 - Resilience

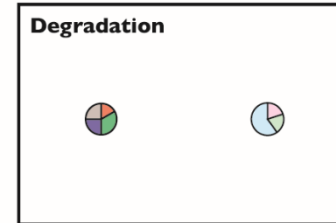
STAGE 2



STAGE 7



STAGE 3



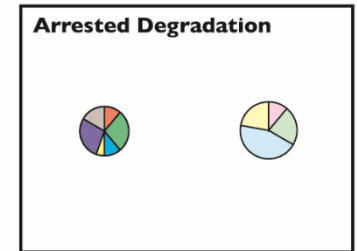
STAGE 4-3



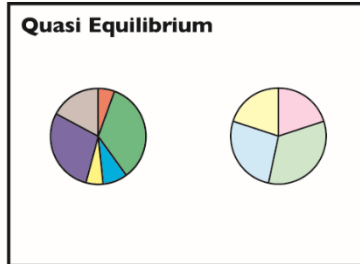
STAGE 4



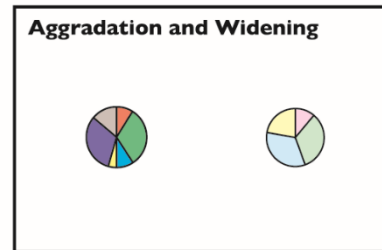
STAGE 3s



STAGE 6

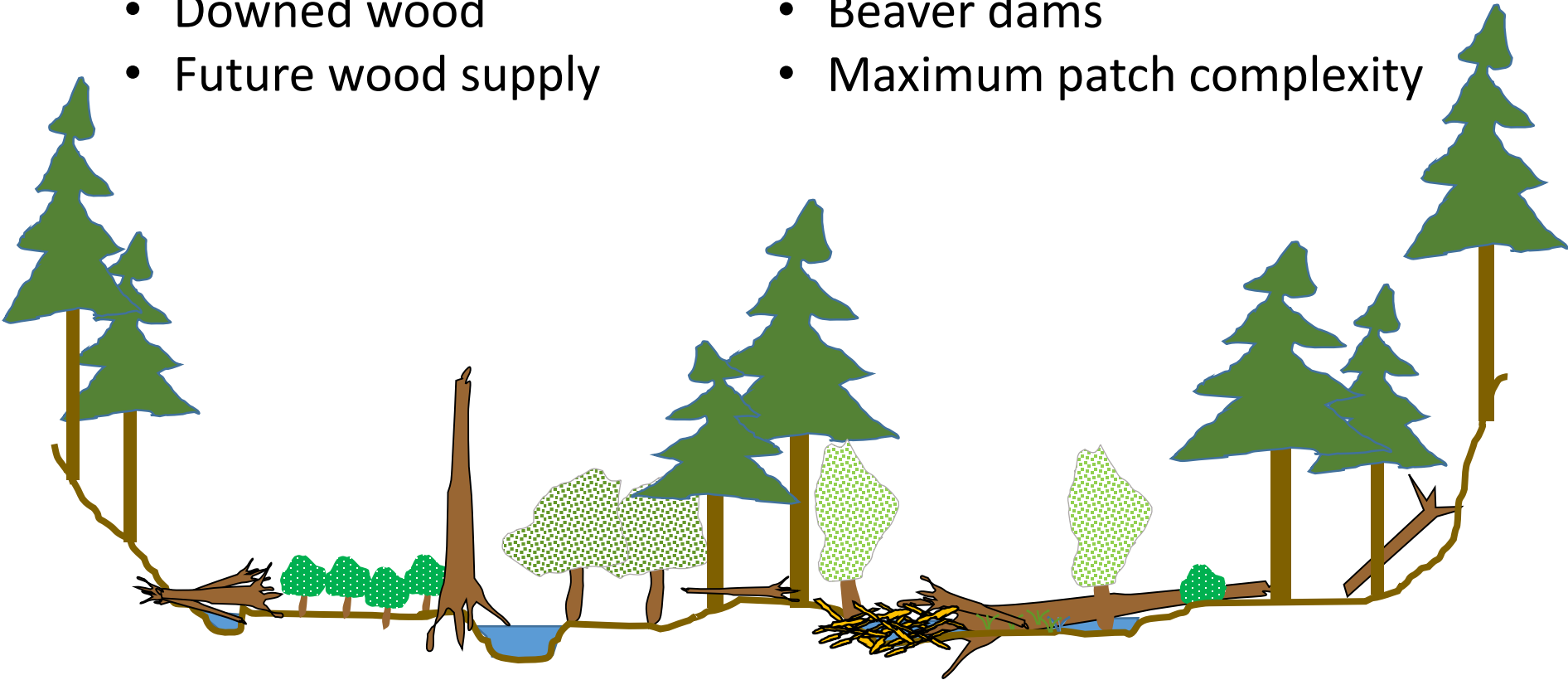


STAGE 5



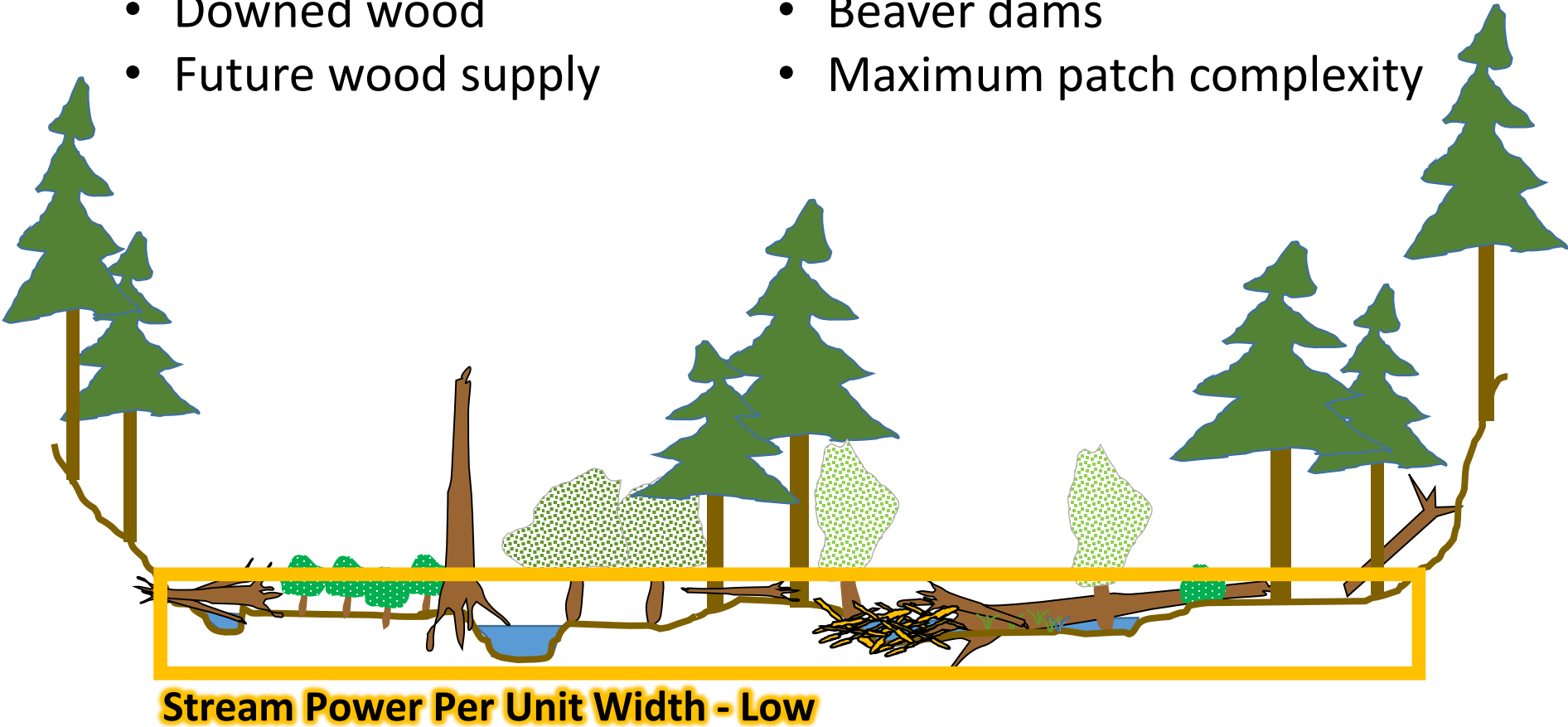
Historic Floodplain Condition in Depositional Environments

- Vegetation diversity
- Multiple flow paths
- Downed wood
- Future wood supply
- High water table
- Frequent floodplain inundation
- Beaver dams
- Maximum patch complexity



Historic Floodplain Condition in Depositional Environments

- Vegetation diversity
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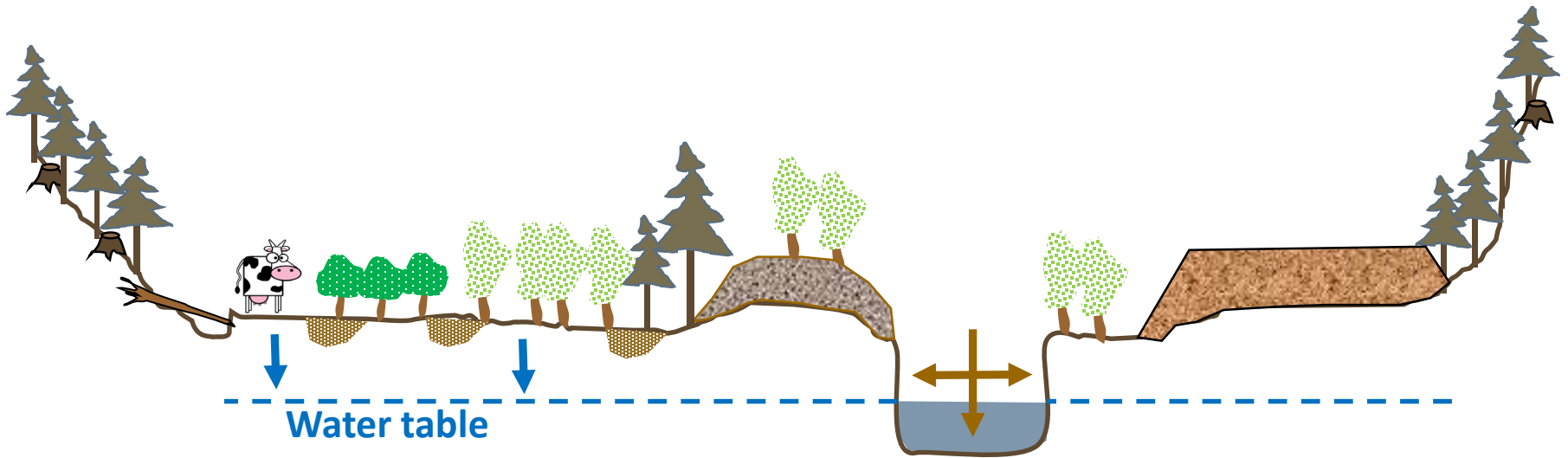


Impacts:

- Road building
- Dam construction
- Conifer harvest/wood removal
- Channelization
- Blocking/filling side channels
- Grazing and farming
- Beaver trapping

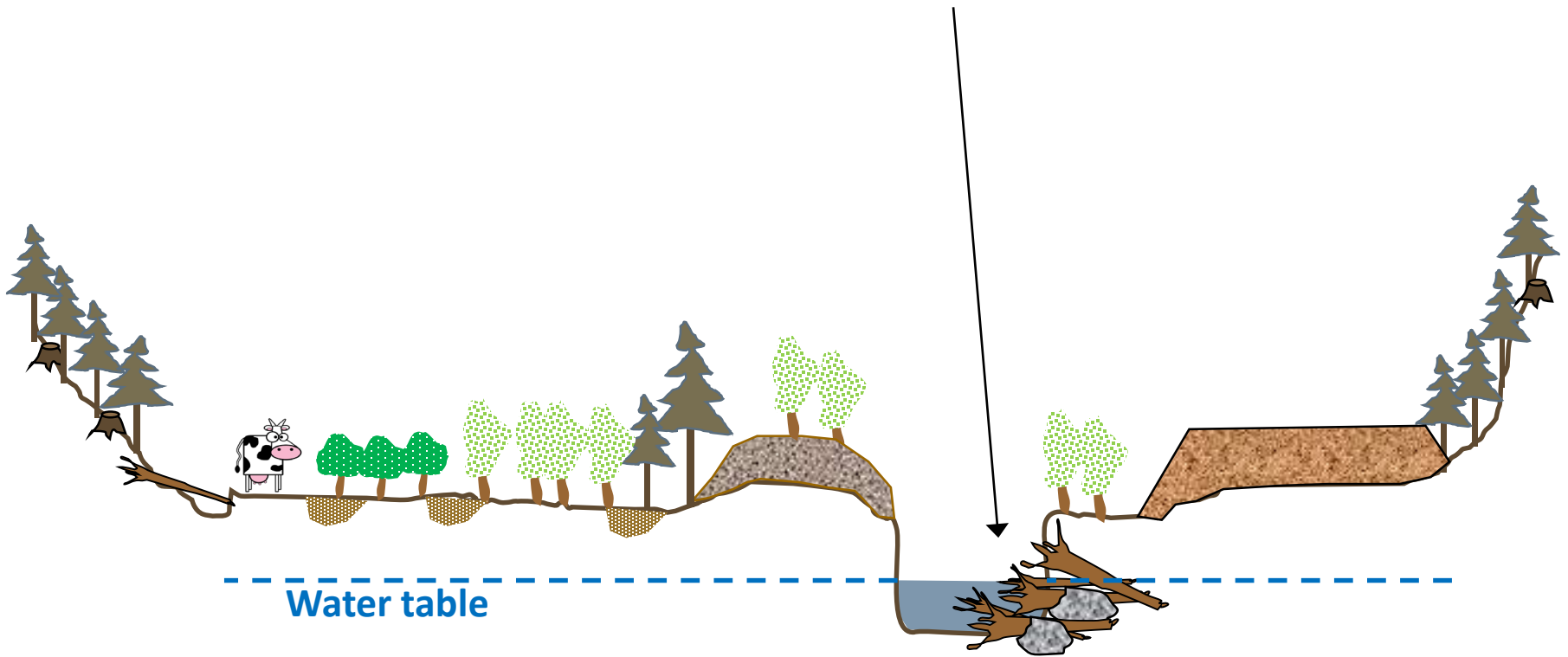
Leads to:

- Single incised channel
- Loss of water table/floodplain connectivity
- Altered vegetation types
- Altered stream power (deposition→transport)
- Minimal large wood and habitat complexity
- Coarse, armored substrate

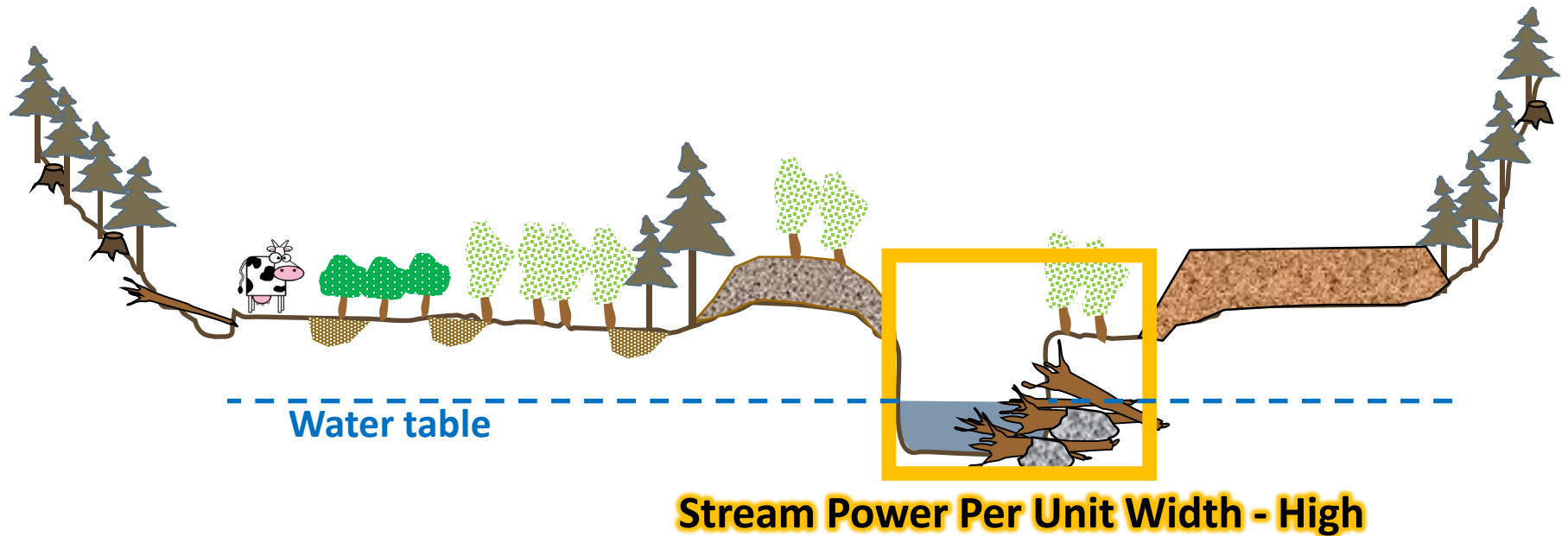


Stream Evolution Model
Stages 2-6

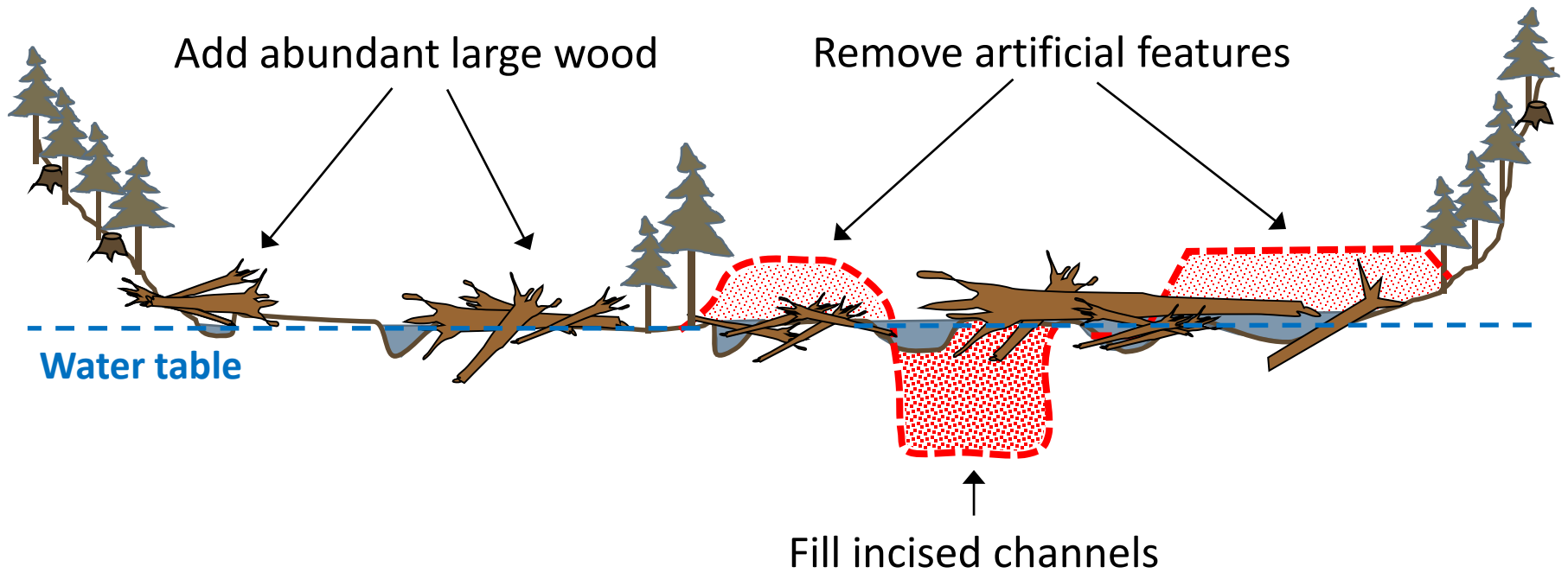
Channel-centric, form-based restoration (1980s to present)



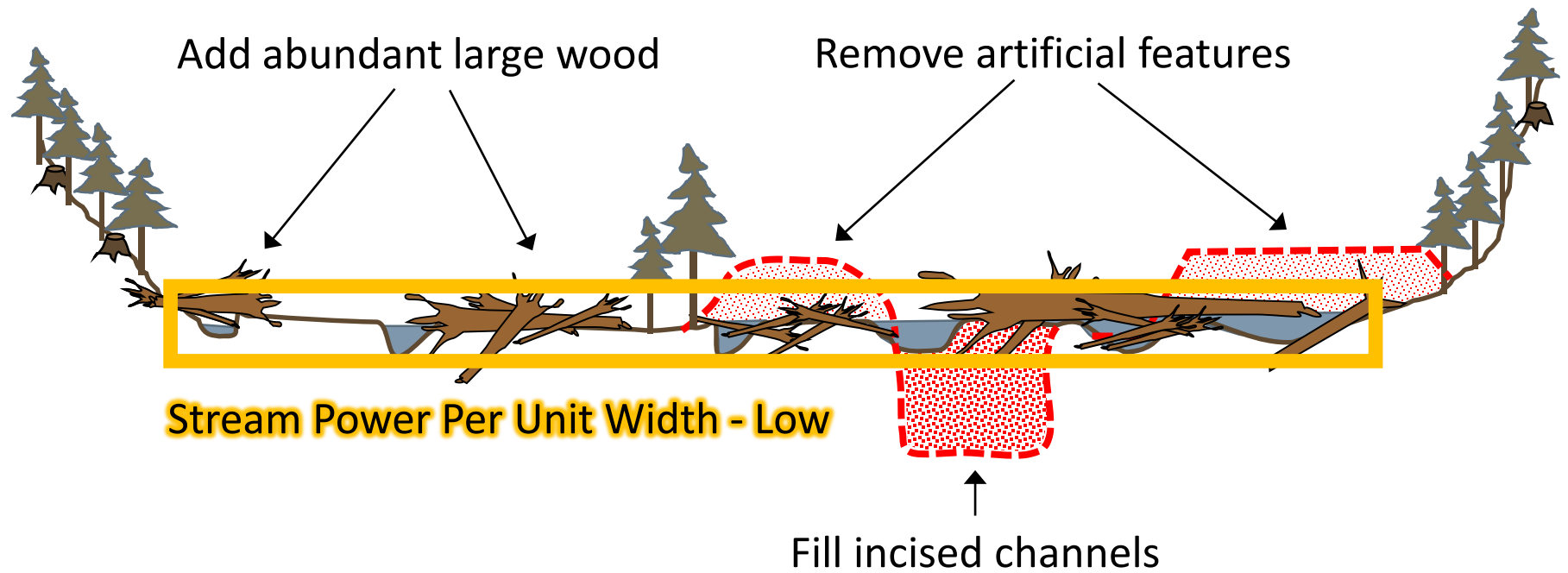
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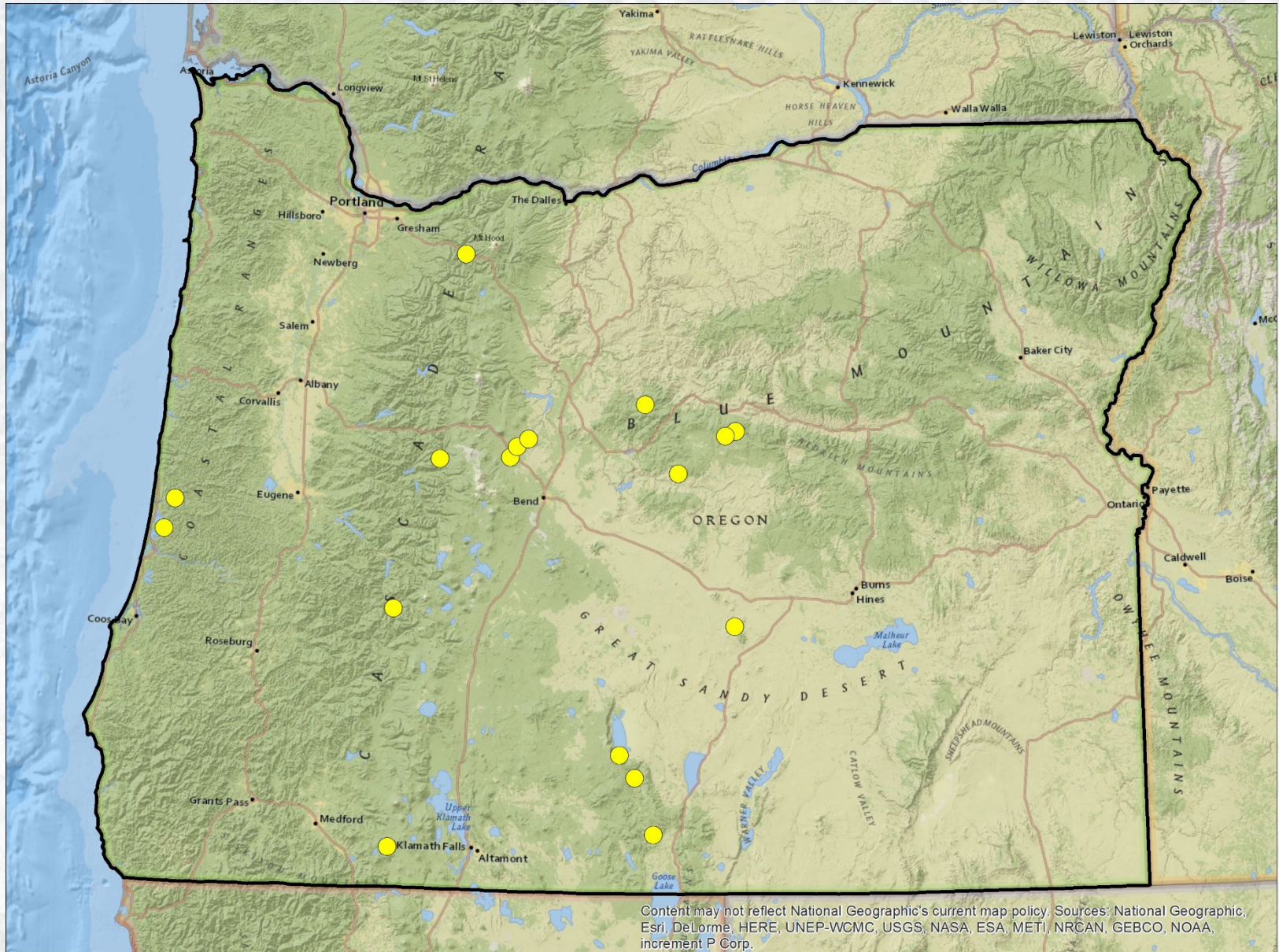
Stage 0, process-based restoration



Stage 0, process-based restoration



U.S. Forest Service Stage 0 Projects in Oregon



Dick Creek – Ochoco National Forest

Before



Dick Creek – Ochoco National Forest



Dick Creek – Ochoco National Forest

Before



During



Immediately After



Dick Creek – Ochoco National Forest

Before



During



Immediately After



3 Years After



Fivemile & Bell Creeks - Siuslaw National Forest

Before

Fivemile Creek



1 Year After



Whychus Creek - Deschutes National Forest



Deer Creek – Willamette National Forest

Before



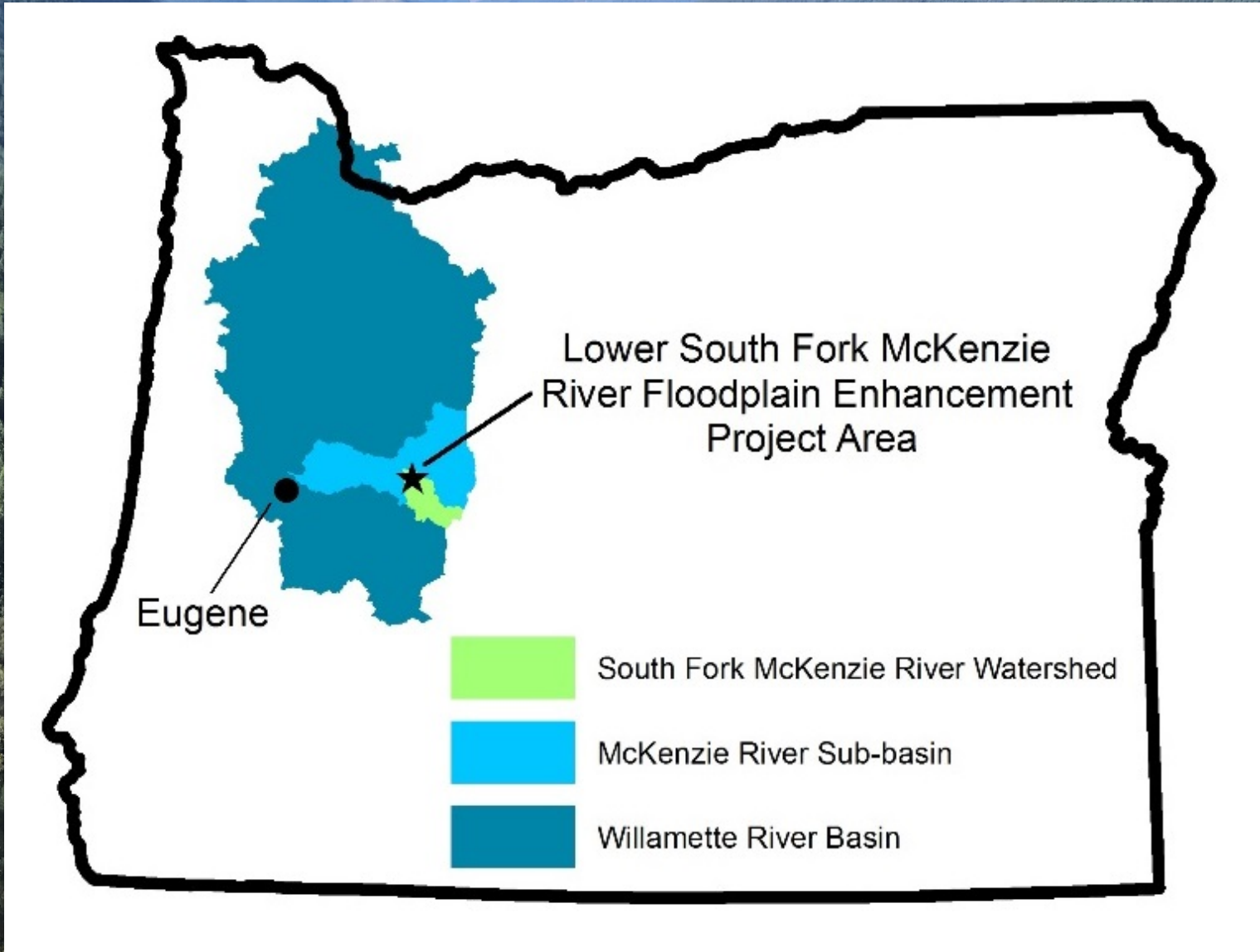
Immediately After

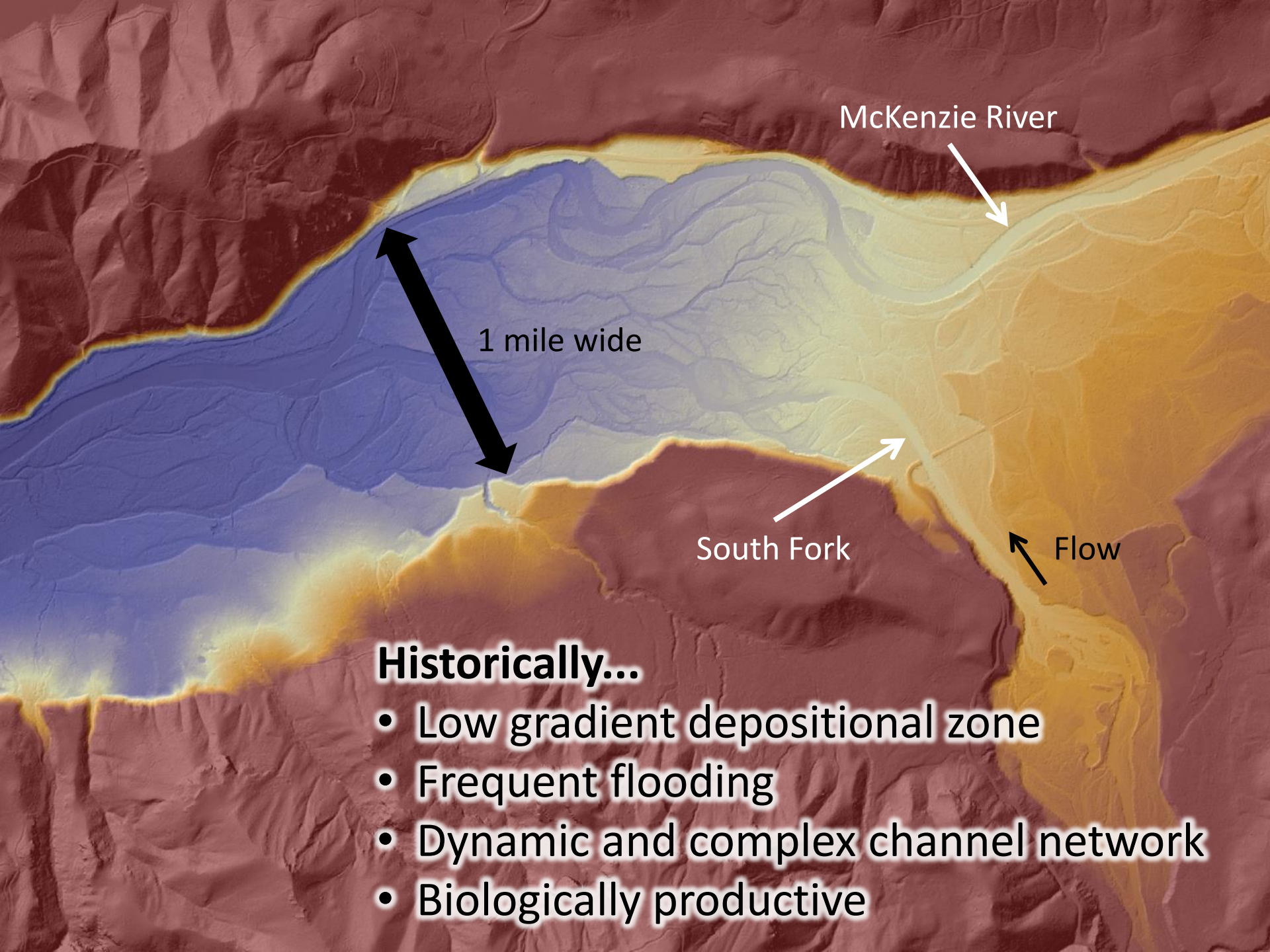


1 Year After









McKenzie River

1 mile wide

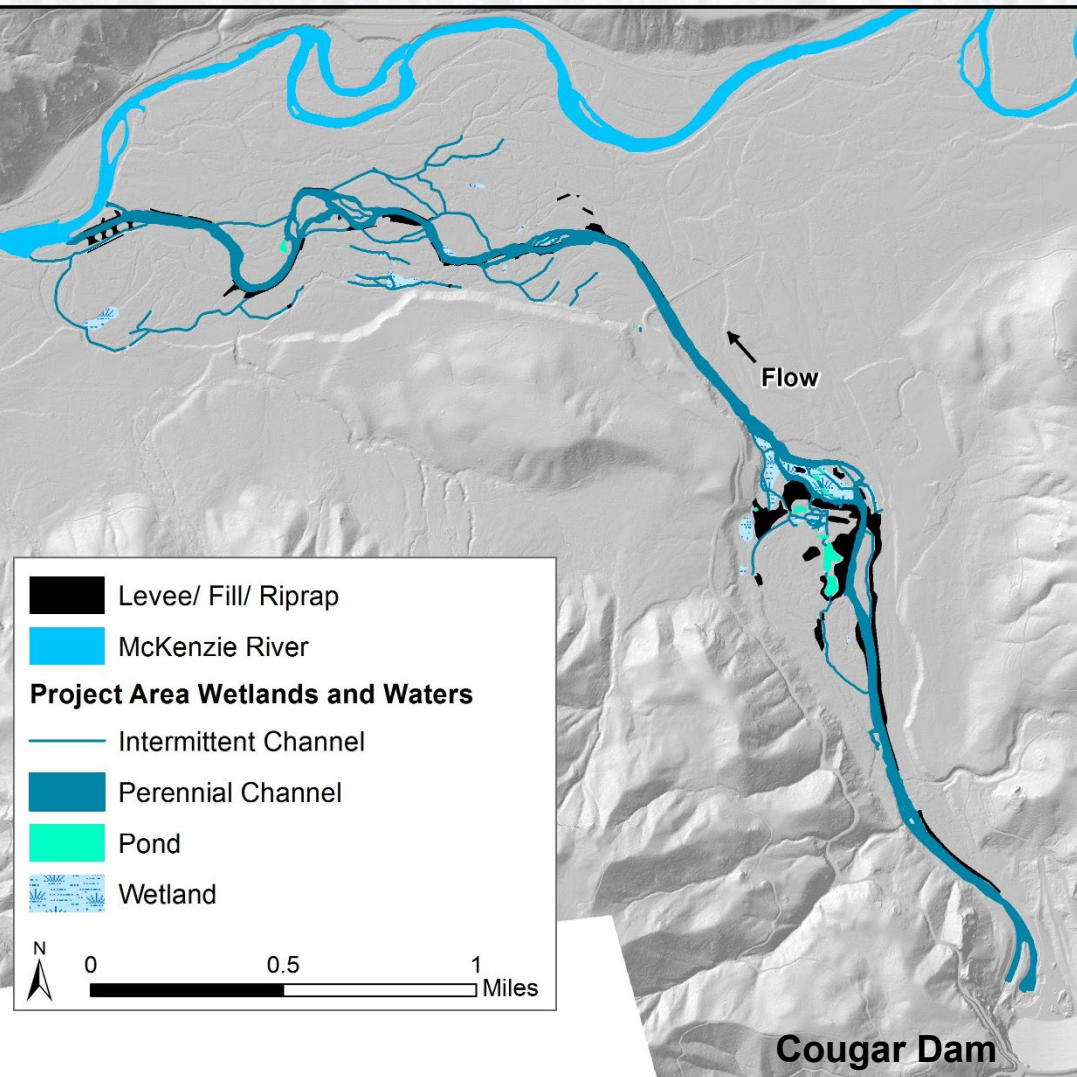
South Fork

Flow

Historically...

- Low gradient depositional zone
- Frequent flooding
- Dynamic and complex channel network
- Biologically productive

Pre-project Conditions



- **Cougar Dam (RM 4.2)**
 - Cut off wood, sediment, nutrient supply
 - Altered flow, temperature regime
- **Levees/riprap/fill**
 - Straightened and channelized river
 - Disconnected floodplain and side channels
- **Stream cleaning/logging**
 - Removed wood and left legacy roads, berms, ditches

Pre-project Conditions

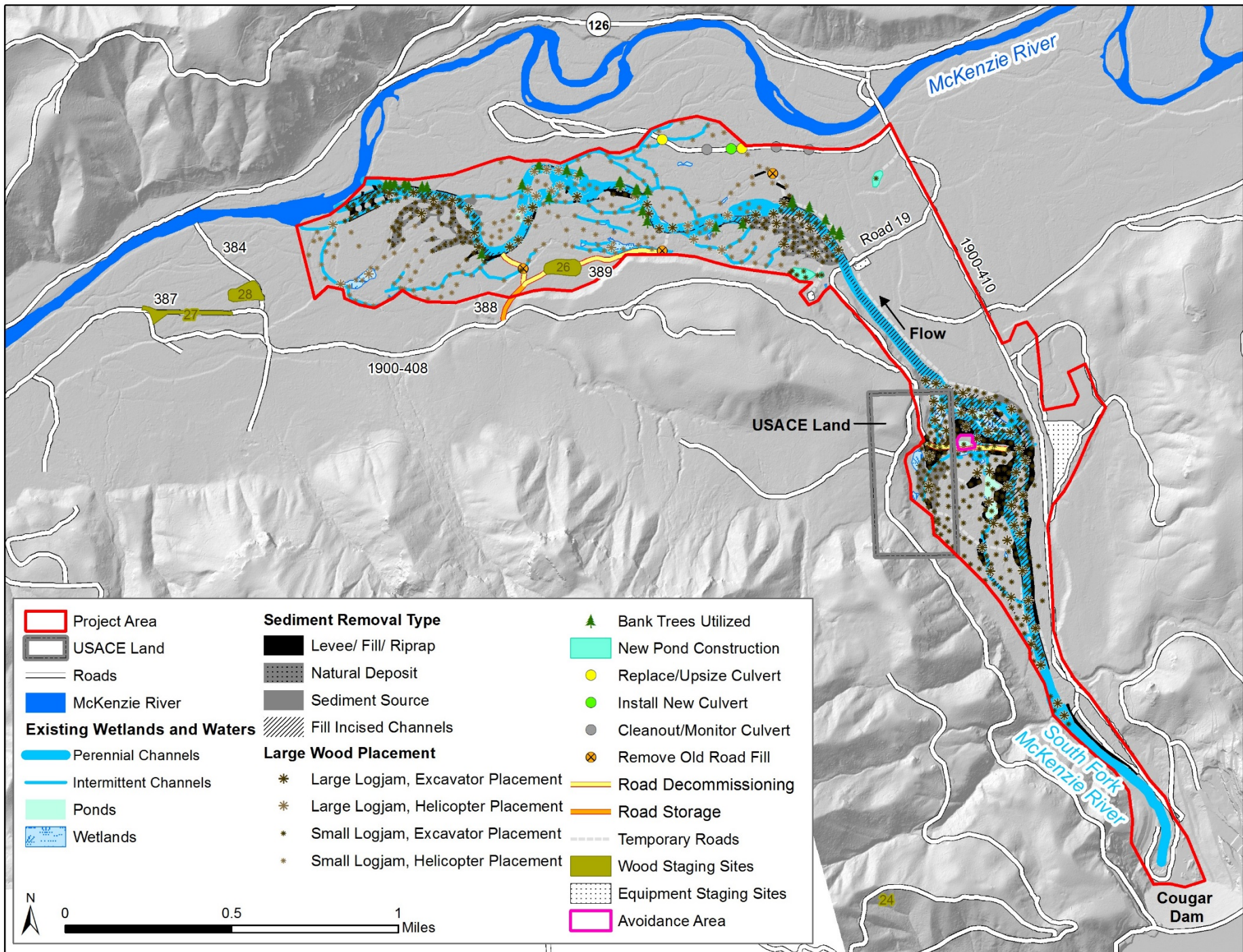
- Channel incision (up to 14 feet in places)
- <30% of historic floodplain being utilized
- < 3 pools/mile; 80% loss of pools since 1937 (Minear 1994)
- <20 pieces of large wood/mile
- Lack of spawning, rearing, foraging, overwintering habitat

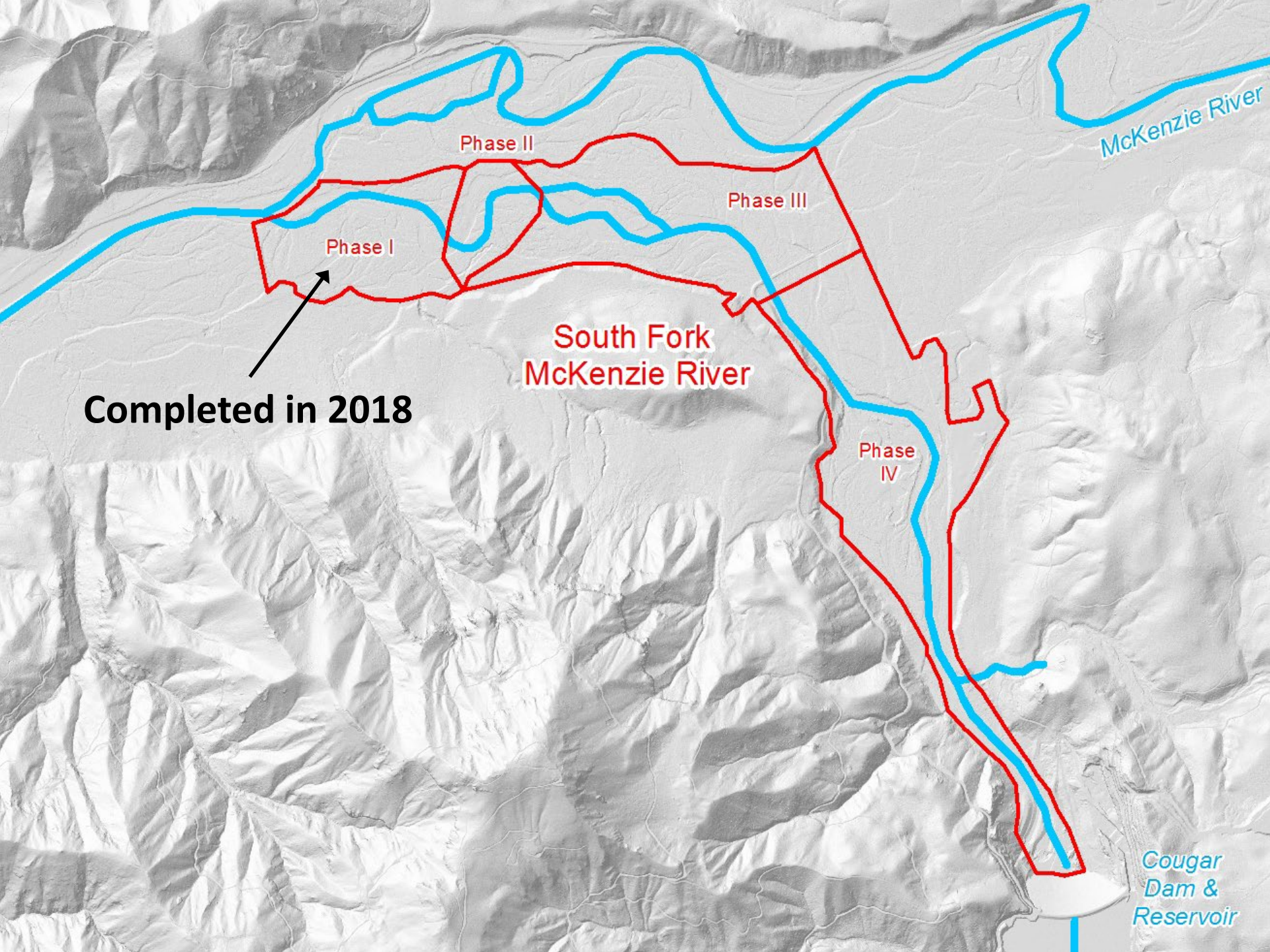


Project Goals

1. Restore (to the extent practicable) the physical, chemical, and biological processes that maintain a healthy, diverse, and resilient floodplain ecosystem
2. Restore a hydrologically connected, well-functioning, anastomosing channel network and floodplain
3. Increase habitat availability, diversity, and quality for ESA-Threatened spring Chinook salmon and bull trout, Pacific lamprey, and other native aquatic and riparian species







McKenzie River

Phase II

Phase III

Phase I

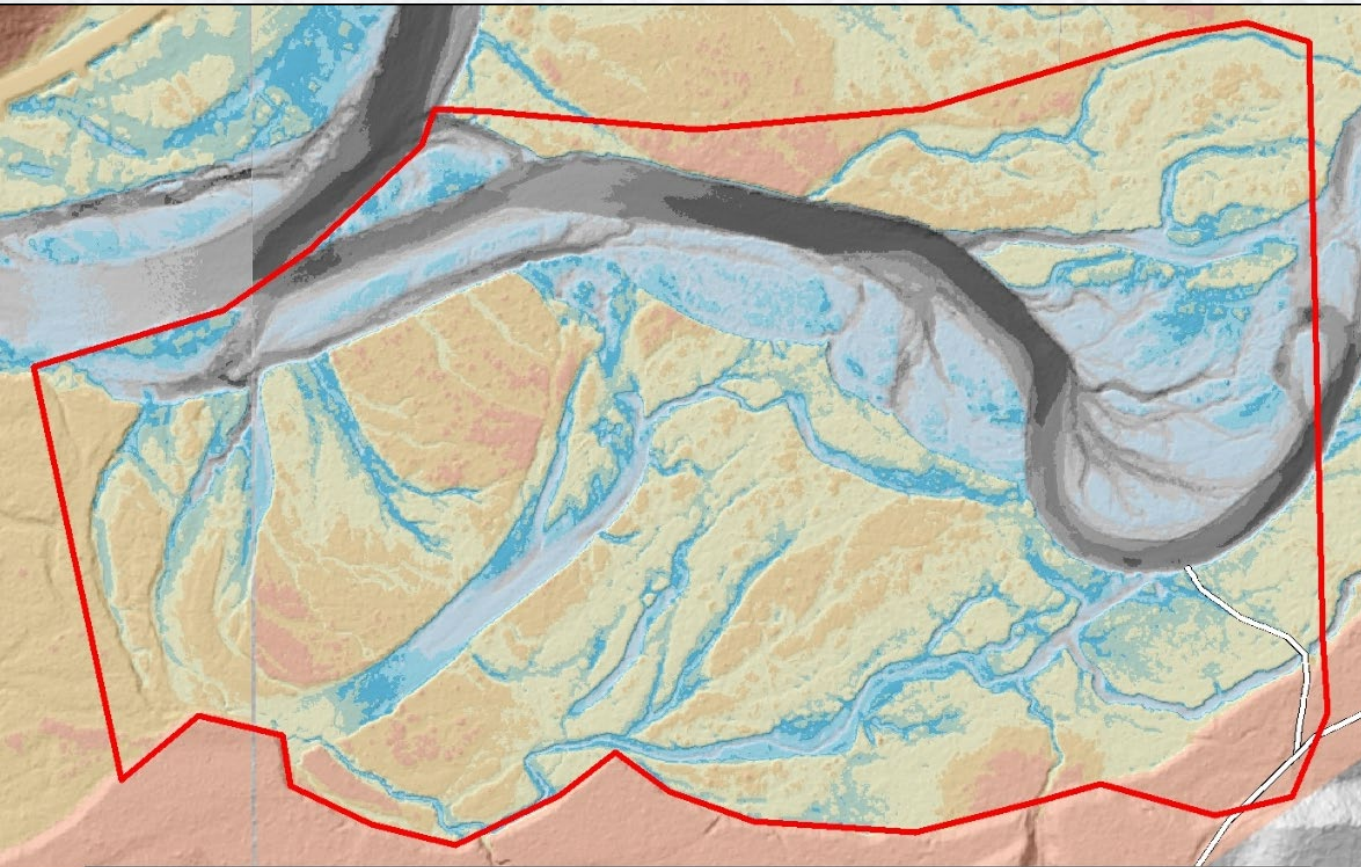
South Fork
McKenzie River

Phase
IV

Completed in 2018

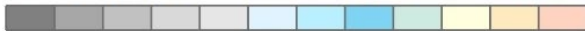
Cougar
Dam &
Reservoir

Phase I Design




 Phase I Project Area (150 acres)

Elevation (ft) Relative to Target Elevation (0 to -1 ft)

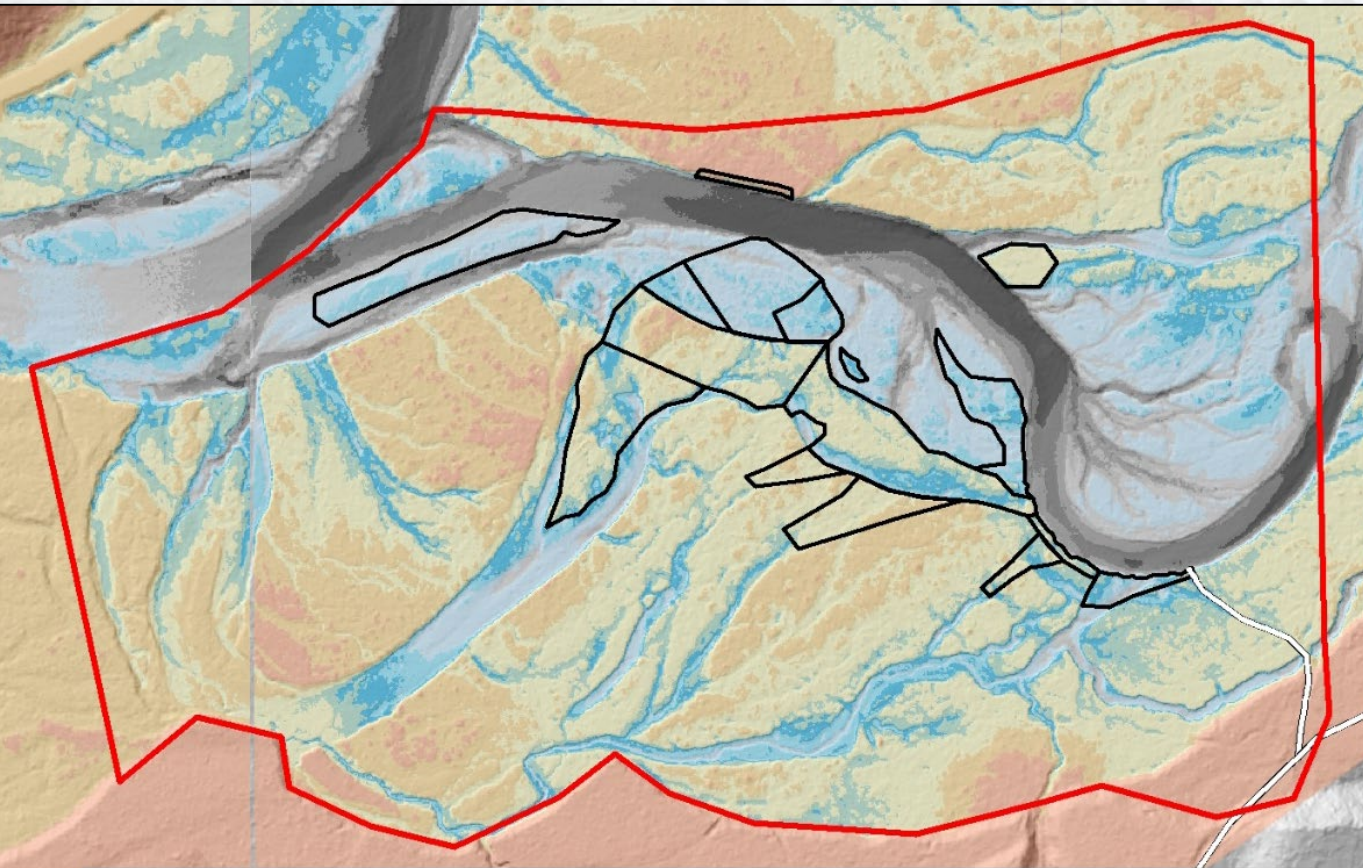


1 5 3 2 1 0 1 2 3 5 1 1
1 5 3 2 1 0 1 2 3 5 1 1

0 250 500 1,000 Feet 

- Project Area = 150 acres
- Geomorphic Grade Line Methodology (Powers et. al. 2018) used to develop Relative Elevation Map
- Target Elevation = Light Blue

Phase I Design

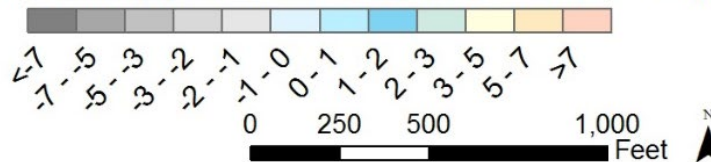


CUT ZONES

- 12.5 acres
- 85,000cy of sediment
- ~1,500 whole trees

 Phase I Project Area (150 acres)  Phase I Cut Zones (12.5 acres)

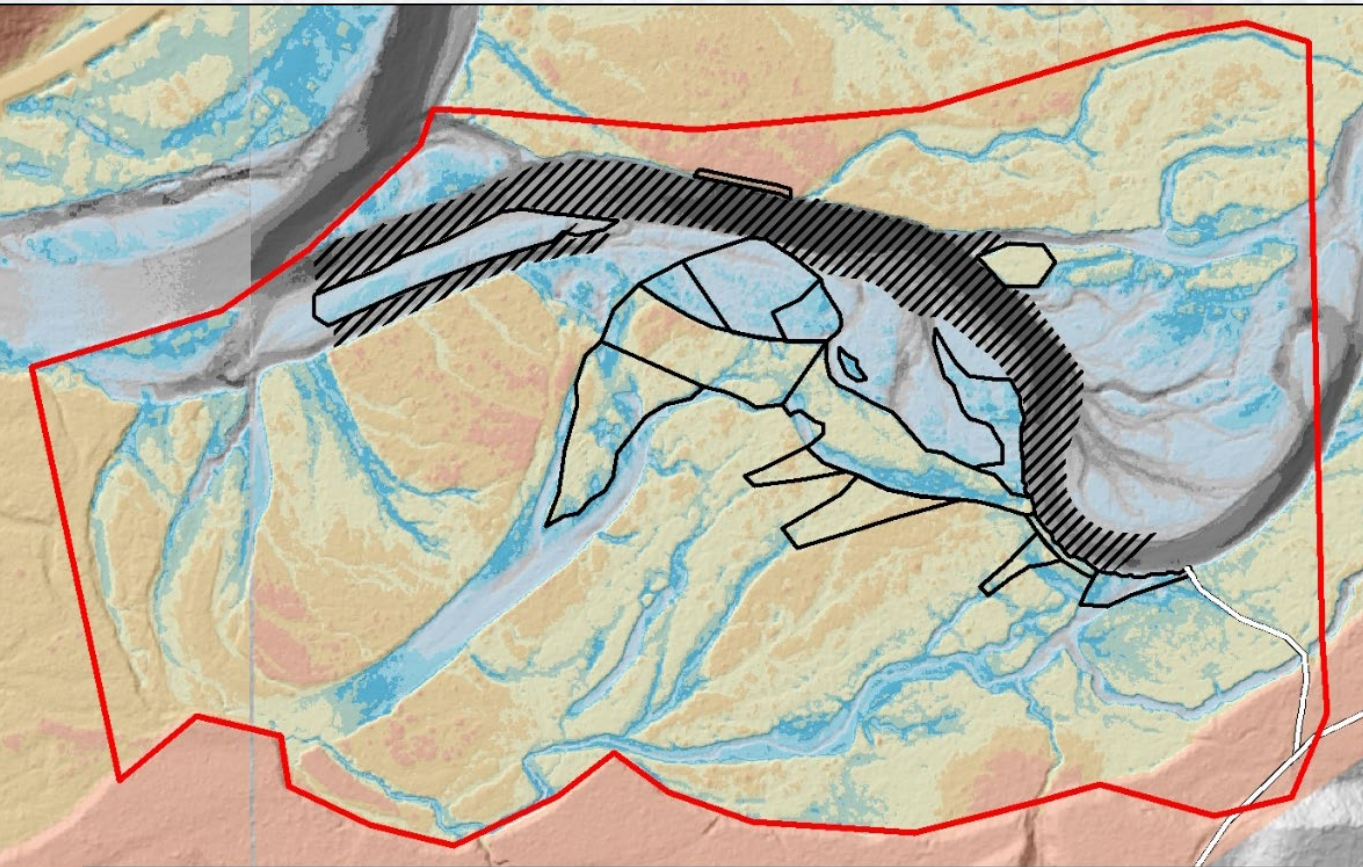
Elevation (ft) Relative to Target Elevation (0 to -1 ft)





Phase I Design

FILL ZONES

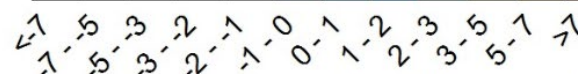
- 11.9 acres
- 85,000cy of sediment



 Phase I Project Area (150 acres)  Phase I Cut Zones (12.5 acres)

 Phase I Fill Zones (11.9 acres)

Elevation (ft) Relative to Target Elevation (0 to -1 ft)

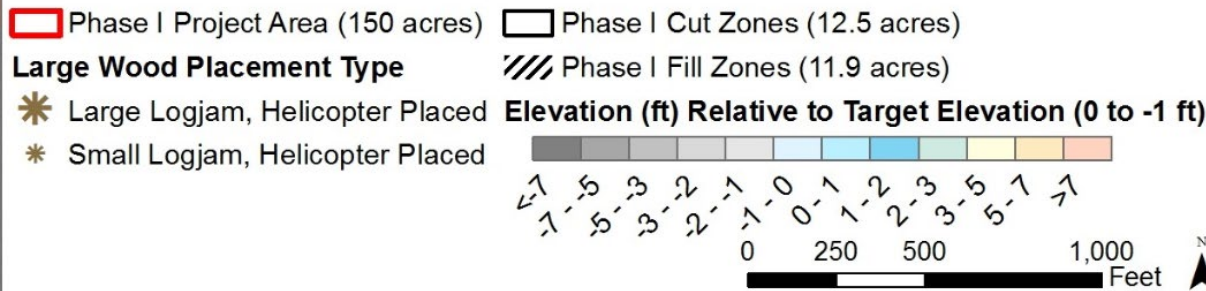
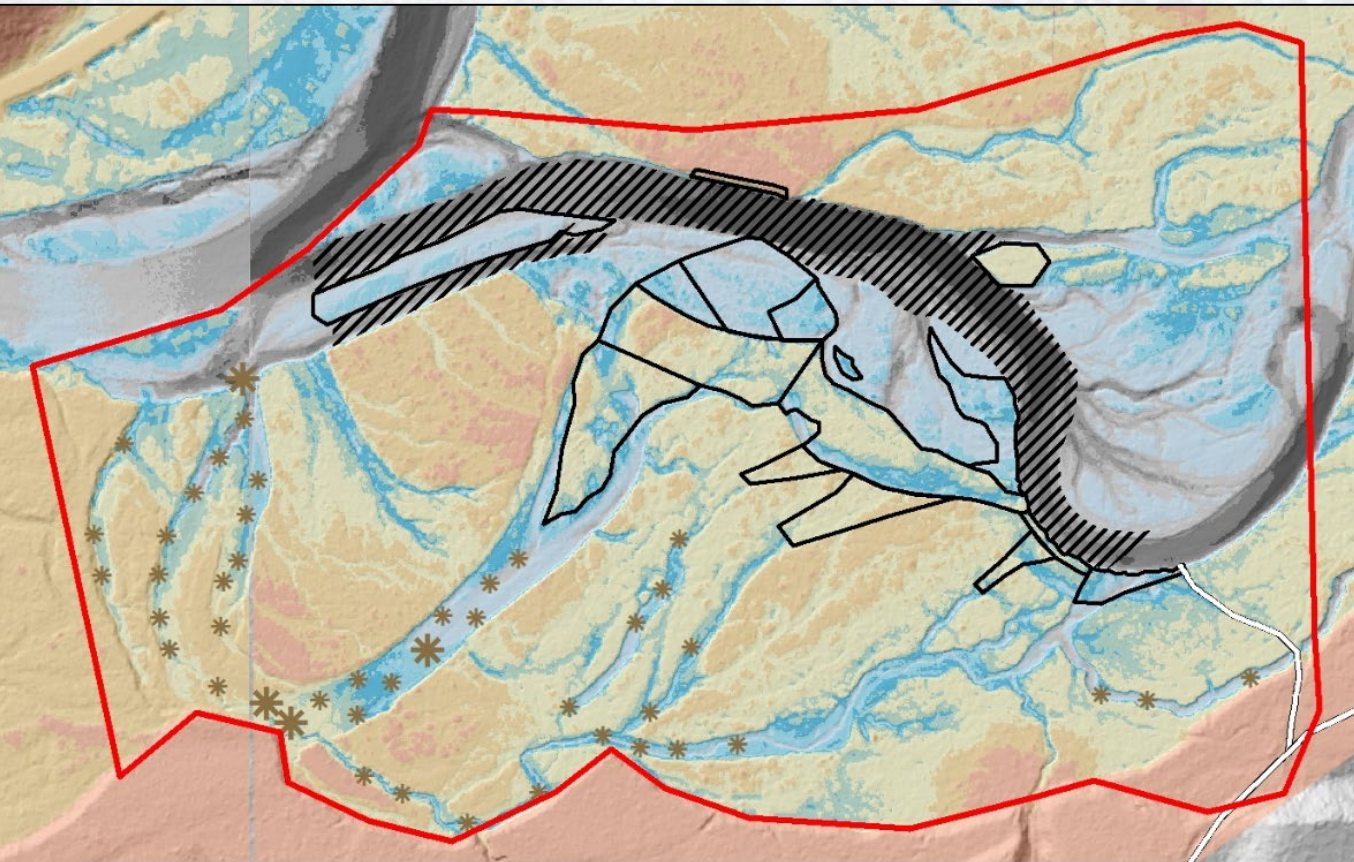


0 250 500 1,000 Feet

N

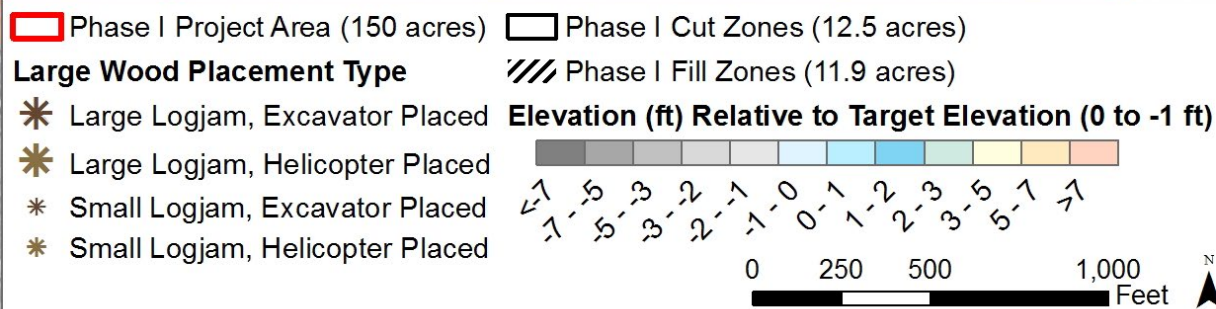
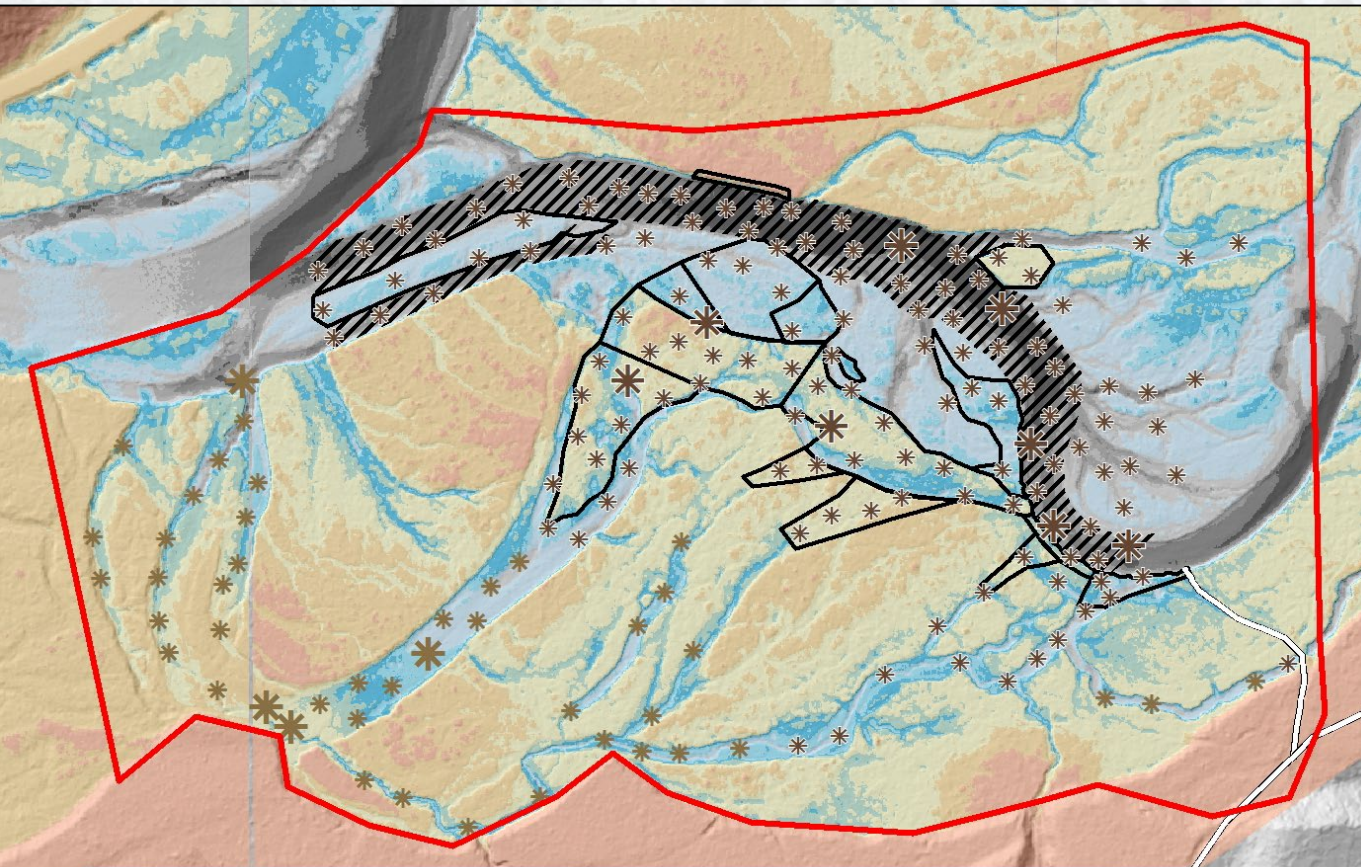
Phase I Design

- 300 trees harvested from upland sites and placed via helicopter



Phase I Design

- 2,700 trees were harvested onsite and from upland sites and placed via excavator



Mainstem Diversion (350 cfs)



Fish Salvage



De-watered Channel



Cut Zones



Cut Zones



Filling Incised Channel



Filling Incised Channel



Large Wood Placement



Re-watering and Project Completion



Re-watering and Project Completion







Newly Wetted Floodplain Channels



Newly Wetted Floodplain Channels



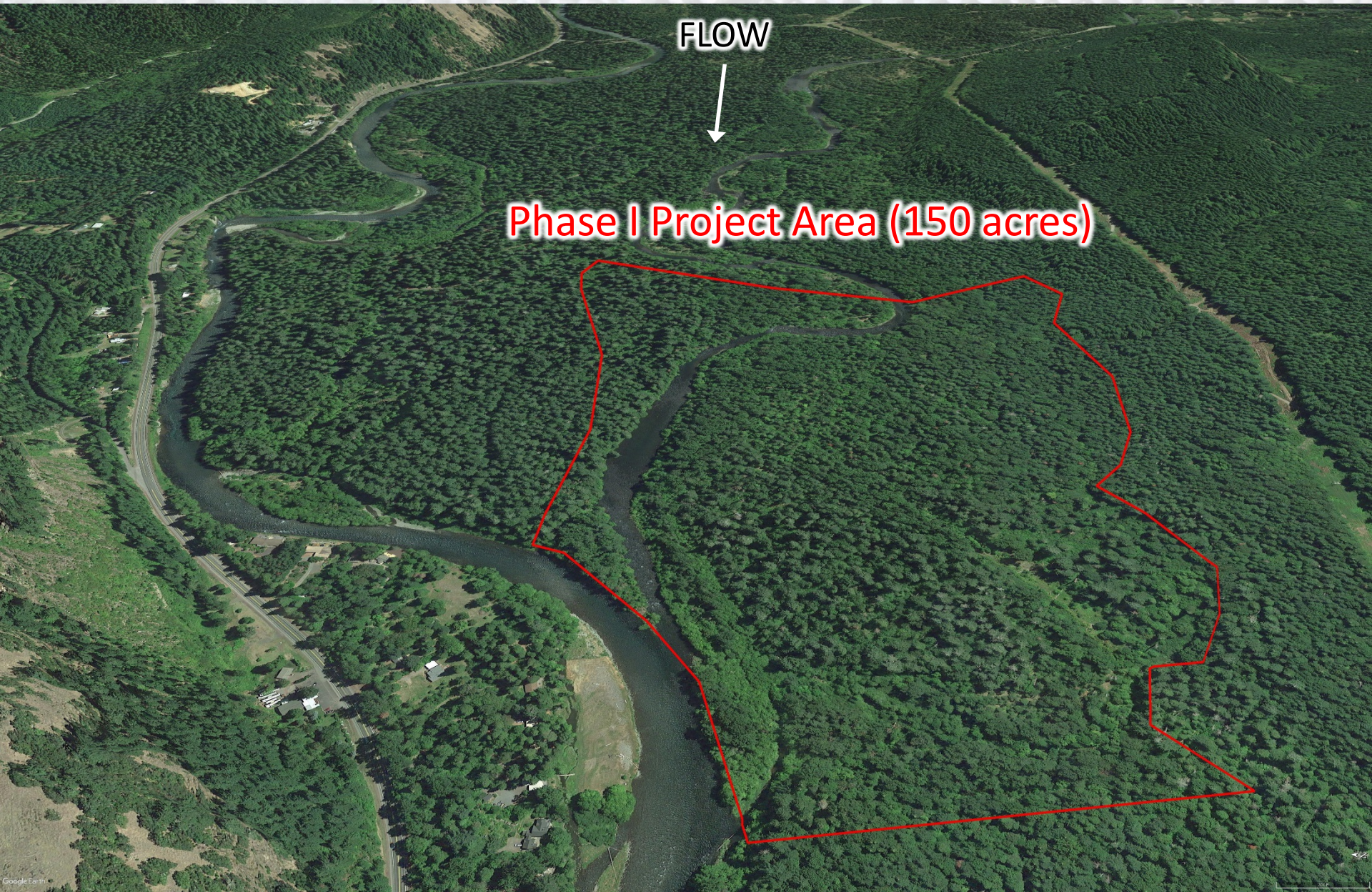
1,350 cfs December 2018



1,350 cfs December 2018



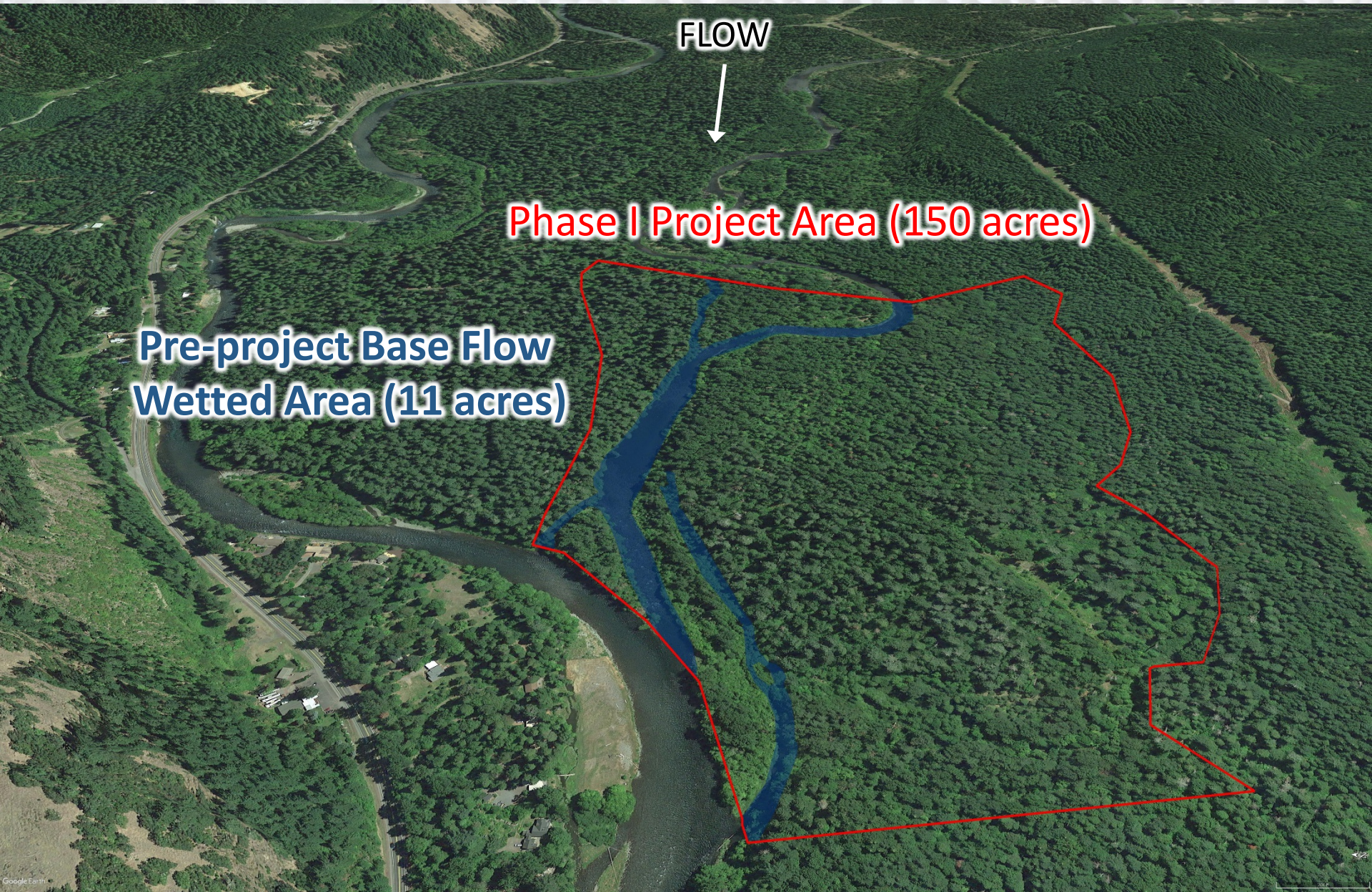
Base Flow Wetted Area



FLOW

Phase I Project Area (150 acres)

Base Flow Wetted Area

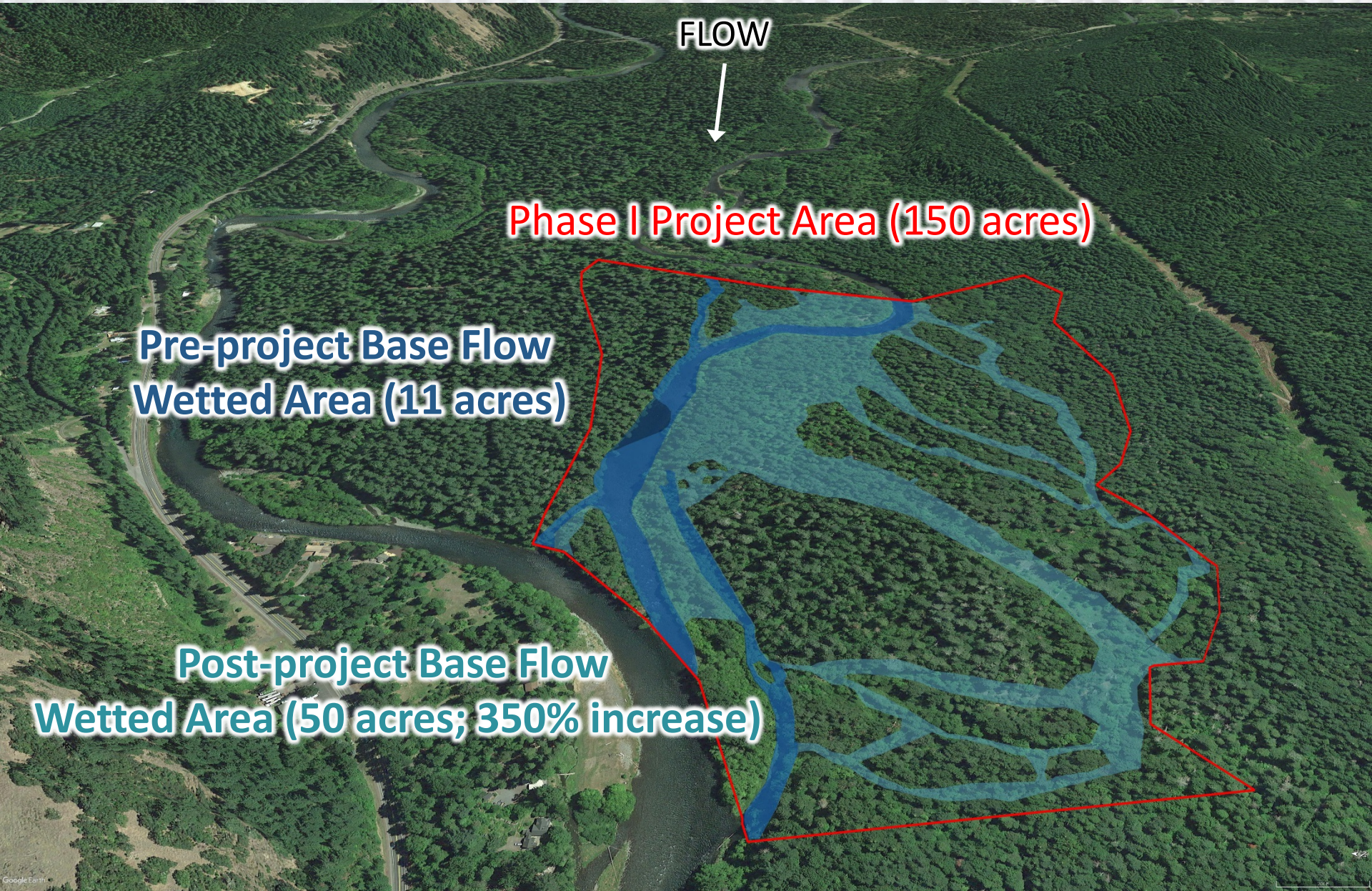


FLOW

Phase I Project Area (150 acres)

Pre-project Base Flow
Wetted Area (11 acres)

Base Flow Wetted Area



FLOW

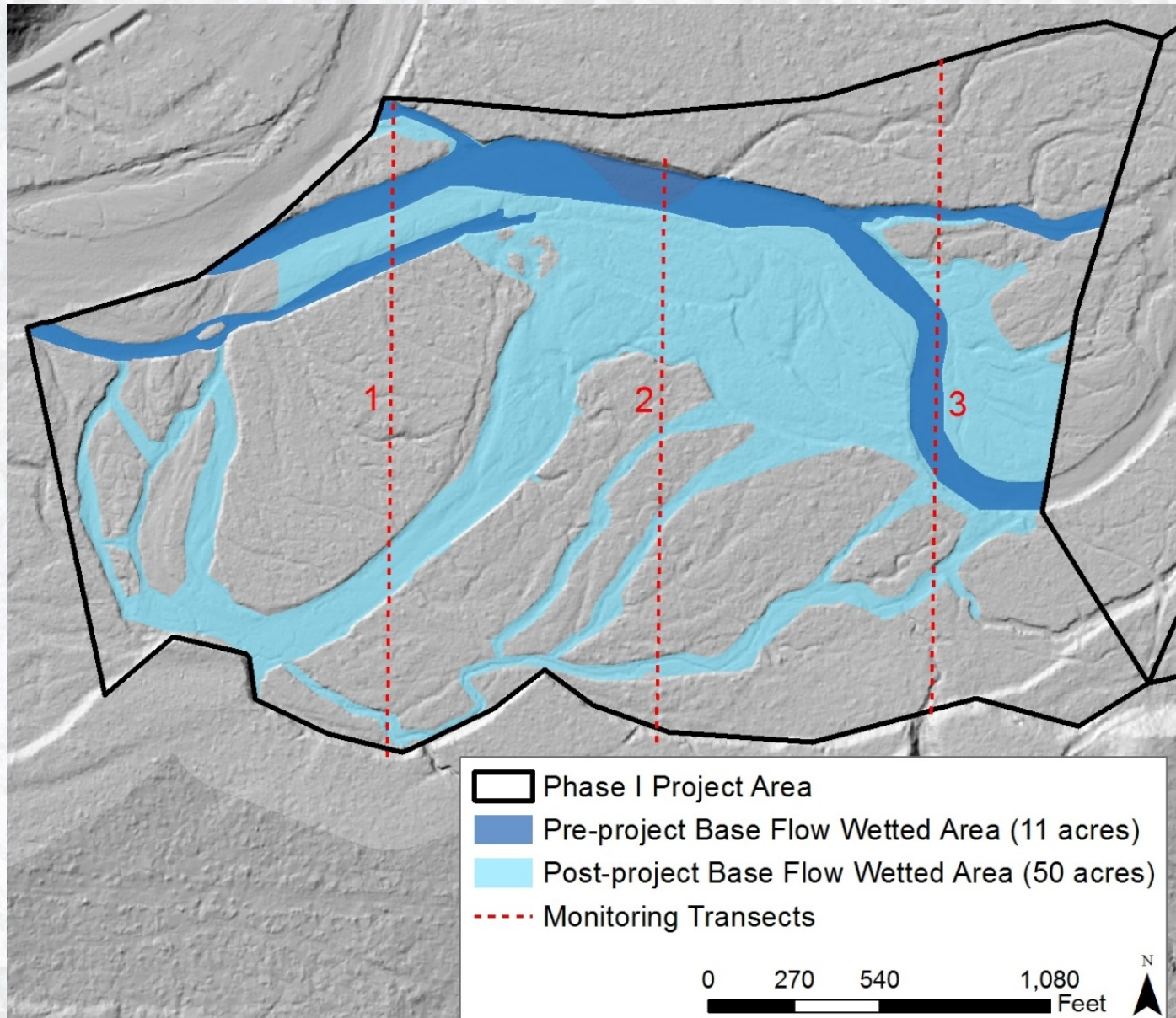


Phase I Project Area (150 acres)

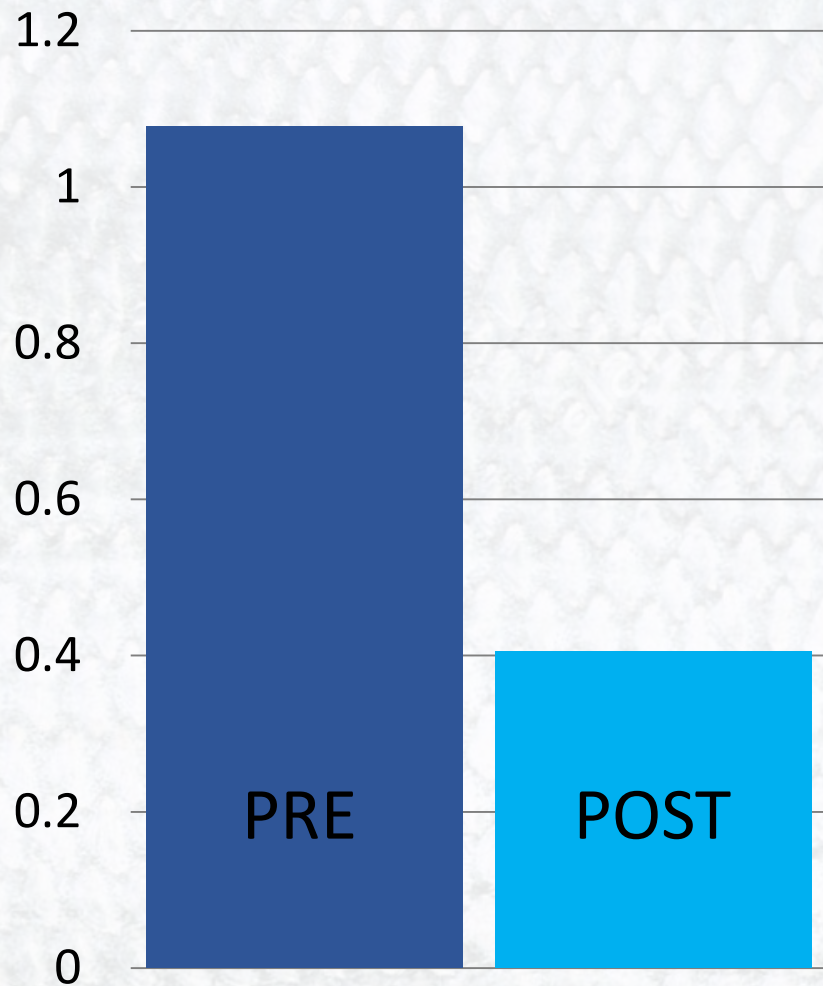
**Pre-project Base Flow
Wetted Area (11 acres)**

**Post-project Base Flow
Wetted Area (50 acres; 350% increase)**

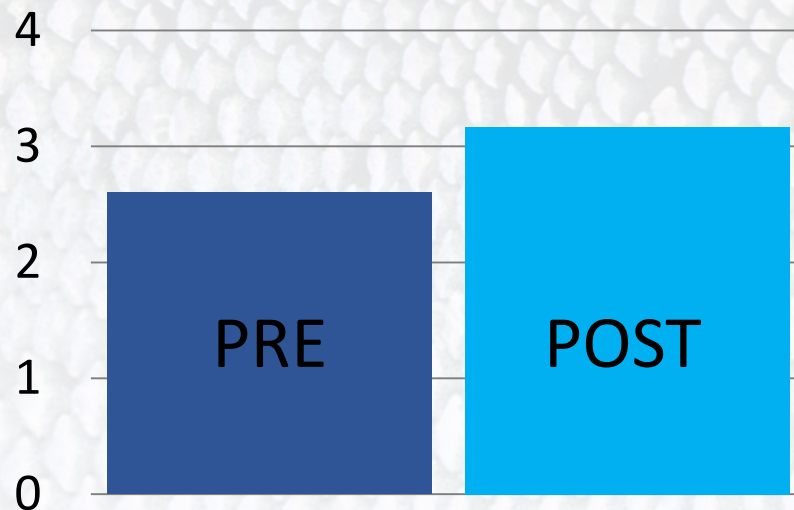
Preliminary Monitoring Data



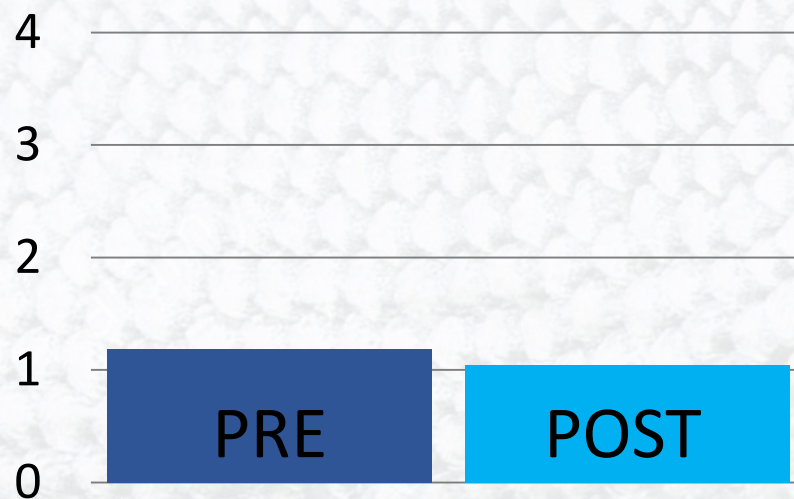
Mean Velocity (ft/sec)



Max Depth (ft)



Mean Depth (ft)



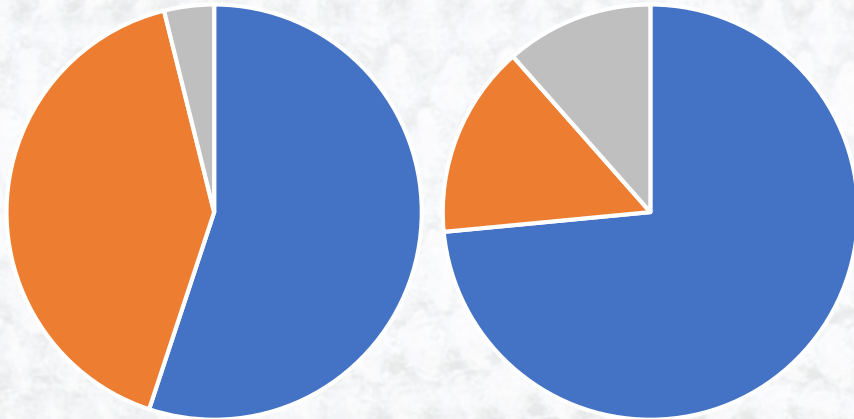
Geomorphic Features



Mean

Pre-project

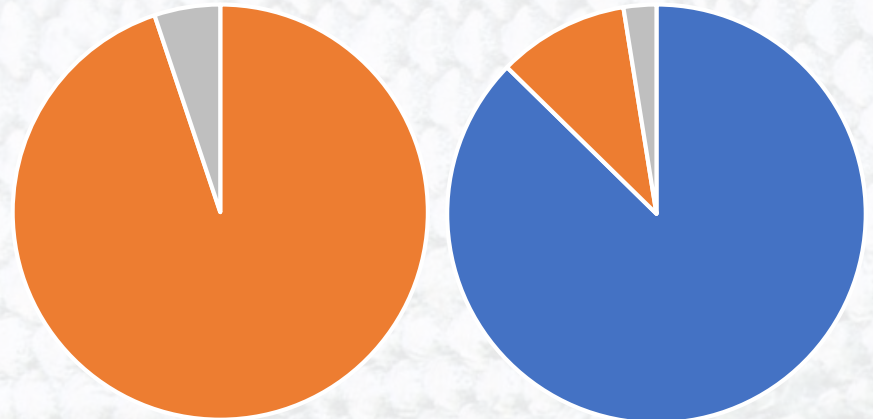
Post-project



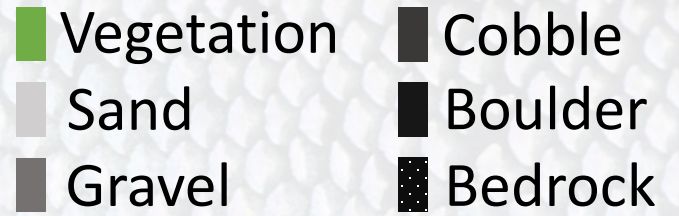
Transect 3 Only

Pre-project

Post-project



Substrate Size Classes – Transect 3



Pre-project



Post-project



Chinook Redd Counts



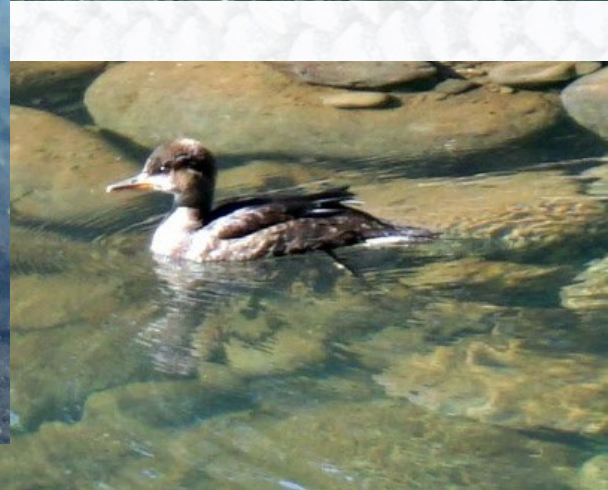
Spring Chinook Salmon Redd Density in McKenzie Sub-basin

- 2nd highest (Normandeau)
- 5th highest (ODFW)

Table 8. Reach length, redd counts and number of redds per kilometer by river and reach.

River Reach	Reach Length (km)	# of Redds	Redds/km
South Fork McKenzie	7.08	55	7.77
Cougar to Bridge	3.70	12	3.24
Bridge to Upstream Habitat Restoration	2.41	29	12.02
Upstream Habitat Restoration to Mouth	0.97	14	14.50
McKenzie	115.53	374	3.24
Spawning Channel to Olallie	1.61	15	9.32
Olallie to Belknap	1.61	29	18.02
Belknap to Paradise	5.31	22	4.14
Paradise to McKenzie Trail	2.41	12	4.97
McKenzie Trail to McKenzie Bridge	2.57	5	1.94
McKenzie Bridge to Hamlin	13.35	22	1.65
Hamlin to S.F. McKenzie	0.48	0	0
South Fork McKenzie to Forest Glen	3.86	5	1.29
Forest Glen to Rosboro Bridge	9.17	108	11.78
Rosboro Bridge to Ben Kay	10.46	29	2.77
Helfrich to Leaburg Lake	7.08	15	2.12
Leaburg Dam to Leaburg Landing	9.65	106	10.98
Leaburg Landing to Deerhorn	3.38	1	0.30
Deerhorn to Hendricks	12.23	5	0.41
Hendricks to Bellinger	8.85	0	0
Bellinger to Hayden	7.08	0	0
Hayden to Armitage	16.41	0	0
Lost Creek	7.72	24	3.11
Spring to Cascade	3.70	0	0
Cascade to Limberlost CG	0.80	5	6.22
Limberlost CG to Split Point	2.41	14	5.80
Split Pt to Hwy 126 Bridge	0.80	5	6.22
Horse Creek	21.72	90	4.14
Pothole Creek to Trail Bridge	2.74	2	0.73
Trail Bridge to Separation Creek	1.77	0	0
Separation Creek to Road Access	2.41	2	0.83
Road Access to Braids	3.38	8	2.37
Braids to Avenue Creek	1.93	6	3.11
Avenue Creek to Horse Creek Bridge	5.63	58	10.30
Horse Creek Bridge to Mouth	3.86	14	3.63

Rapid Biological Response



Biological Monitoring

- Spring Chinook salmon redd density
- Residence timing, growth and survival of juvenile spring Chinook (Luke Whitman, ODFW)
- Macroinvertebrate species richness by habitat type
- Occupancy, species richness, and abundance of focal native fishes and amphibians (eDNA, snorkel surveys)
- Food Web Study (USFS PNW Researchers/OSU)
 - How does Stage 0 Restoration affect fish carrying capacity?
 - How does Stage 0 Restoration alter ecological stability as reflected in the structure and dynamics of the river food web?

Take Home Points

- This aggressive Stage 0 approach has high initial disturbance in cut/fill zones, but the hydro-geomorphic response is immediate
- The biological community is recolonizing rapidly
- Intact, re-wetted relic floodplain channels provide immediate complex habitat and refuge
- Huge “bang for the buck” at \$13,000/acre - Total Phase I Project Cost of \$2 million

Acknowledgements

Project Core Team (DREAM TEAM)

- Jared Weybright, Executive Director, McKenzie Watershed Council (Project Co-manager)
- Paul Powers, Fisheries Biologist, Deschutes National Forest
- Johan Hogervorst, Hydrologist, Willamette National Forest
- Nick Grant, Hydrologist, Willamette National Forest
- Mickey Means-Brous, Fisheries Technician, Willamette National Forest

Contractors

- BCI Contracting Inc.
- Columbia Helicopters

Project Funders

- U.S. Forest Service
- Oregon Watershed Enhancement Board
- Bonneville Power Administration/ Pacific States Marine Fisheries Commission (Pacific Lamprey Conservation Initiative)
- Drinking Water Providers Partnership



QUESTIONS?

