WOOD IS ONLY PART OF THE SOLUTION

WOODS ROLE IN RESTORING FLUVIAL GEOMORPHIC PROCESSES IN DISTURBED TIMBERLAND WATERSHEDS

2020 Large Wood Technical Field School

Salmonid Restoration Federation

Trout Unlimited

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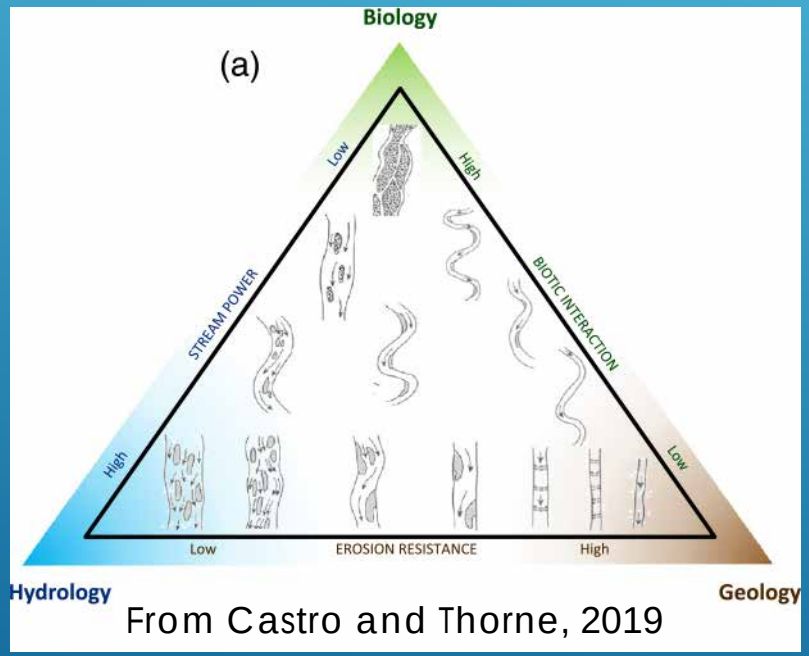
GOALS OF THIS TALK

- 1) Provoke thoughts that encourage restorationists to closely examine dysfunctional PROCESSES that lead to less than desirable fish habitat in their watersheds
- 2) Provide some fundamental observations of existing dysfunctional fluvial geomorphic processes, in heavily disturbed watersheds, so restorationists can consider the role large wood will play in restoring their watershed to fully functioning conditions.
- 3) Provide a scientific basis for a general understanding that simply adding wood for habitat may not be the best approach to recovering anadromous fish populations…it can't hurt, but it may only provide short term benefits if the fundamental watershed processes are not functioning.
- 4) Provide a few ideas on how to use wood to facilitate process recovery

WHAT GOVERNS STREAM MORPHOLOGY?

AND IN TURN AVAILABLE HABITAT

Water, Wood and Sediment



From Castro and Thorne, 2019

DYNAMIC EQUILIBRIUM

A STATE OF BALANCE BETWEEN CONTINUING PROCESSES

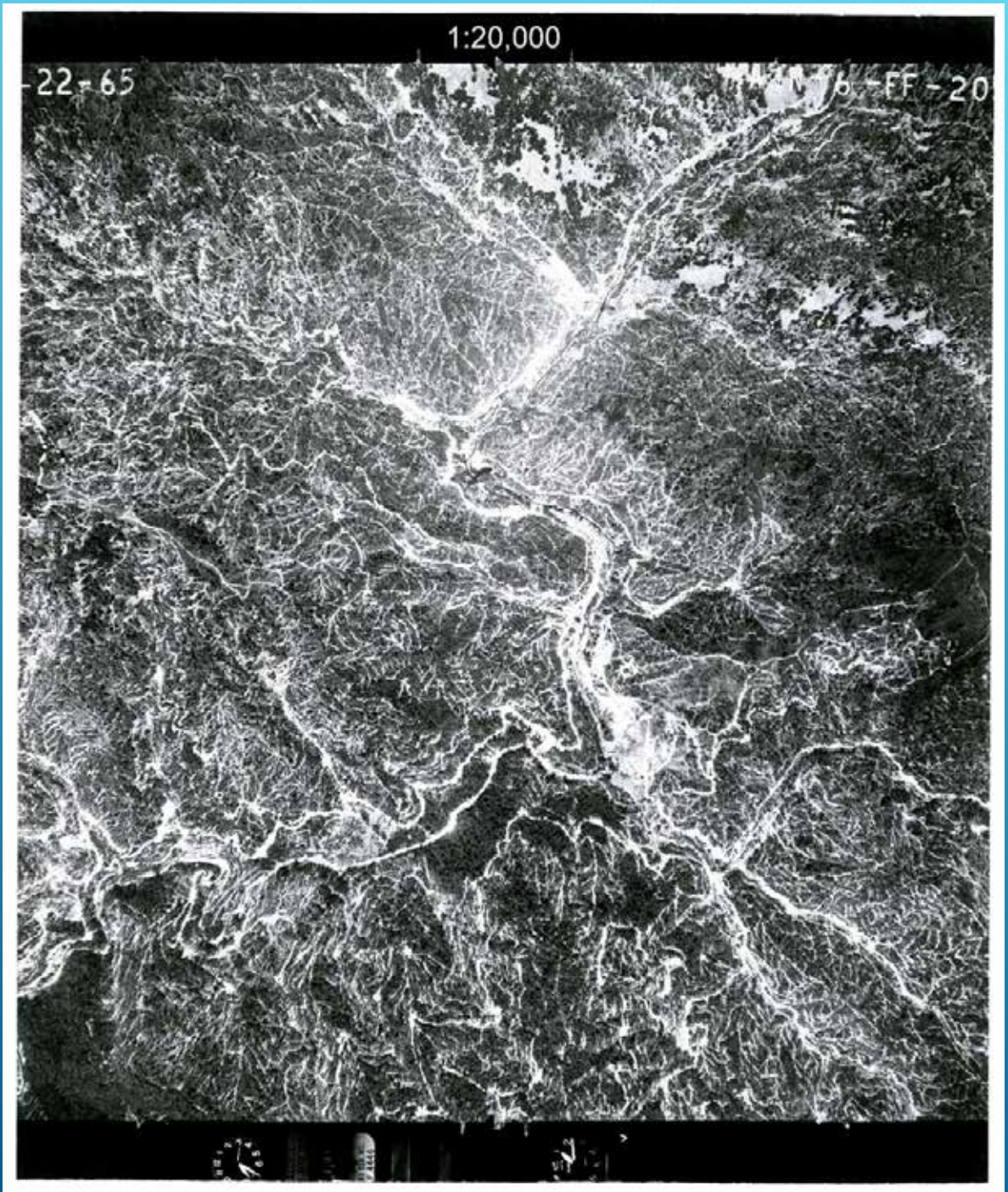
- Water, vegetation (including large wood) and sediment all constantly interact with each other in a river channel.
- As the characteristics of one element change, the other elements change to form new fluvial geomorphic conditions consistent with the characteristics of the fundamental processes
- Fluvial geomorphic conditions are not static in a river, they vary around a quasi-stable state depending on stochastic inputs from the fundamental driving processes such as variability in runoff or large sediment inputs from landslides. This is dynamic equilibrium.

LET'S LOOK AT SOME OF THESE DISTURBANCES IN HEAVILY LOGGED WATERSHEDS, AND HOW THEY'RE MANIFEST IN OUR STREAM CHANNELS

HYDROLOGY

- Road and skid trail construction
  - Rapidly routes water off the landscape into the stream system
  - Intercepts and drains shallow ground water into the stream system
  - Creates hillside gullies which drain shallow groundwater resources

In other non-forested watersheds hydrology may be impacted by impermeable surfaces, land conversion, ect.



ROAD AND SKID TRAIL CONSTRUCTION

Garcia River Watershed…1965

A QUICK CALCULATION

- The watershed is subjected to 7′ (84″) of rain per year
- Assume a watershed has 120 miles (633,600′) of road
- The average road width is 12′
- The road system as a whole exhibits 50% hydrologic connectivity

- Calculate amount of rainfall that lands on the road
  - (633,600′ x 12′) x 7′ = 53,222,400 cu. ft. of water
- Calculate runoff
  - 53,222,400 cu. ft. x 0.5 = 26,611,200 cu. ft. of water runoff from road
- Convert to gallons
  - 26,611,200 cu. ft. x 7.48 gal./cu. ft. = 199,051,776 gallons per year

RIPARIAN DISTURBANCES

RIPARIAN DISTURBANCES

- Changes the species composition and size classes of the riparian trees
- Eliminates or significantly suppresses naturally recruitable trees that exhibit the size and durability required to provide fluvial geomorphic services for the stream system
- Resets the process of succession to its beginning stages
- If left to regrow without proper management, can result in a decent looking riparian corridor that meets almost none of the criteria that can be used to define a fully functioning riparian zone.

SED

SOME ATTRIBUTES OF A FULLY FUNCTIONING RIPARIAN ZONE

Developed in coastal Washington for coniferous forests

- Basal area- ≥ 300 sq. ft. / acre
- Quadratic mean diameter- ≥ 21 inches
- Snags- ≥ 3 /acre
- Large downed wood- 2400 cu. Ft. /acre
- Vertical stand structure- maintain at least 2 canopy layers
- Species diversity- Maintain at least 2 main canopy tree species suited to the site

From Bigley and Deisenhofer, 2006

WATERSHED SCALE SEDIMENT BUDGETS

- Where does the substrate in a creek come from in a heavily forested environment?....Where does it go?....How is it regulated?
- Input-Storage-Output

Input

uplands (landslides, debris torrents)

gullies

Storage/Input

Streambanks

Channels

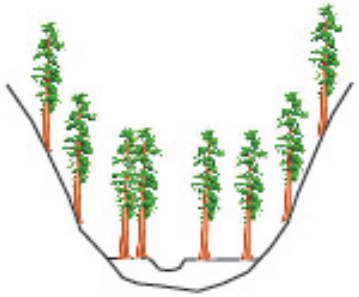
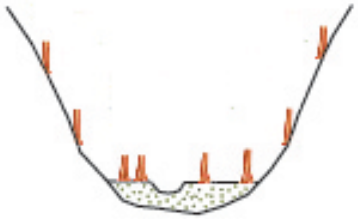
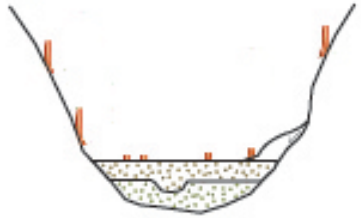
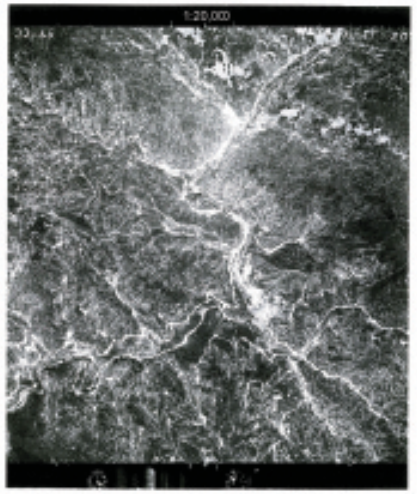
Upstream of poorly designed stream crossings

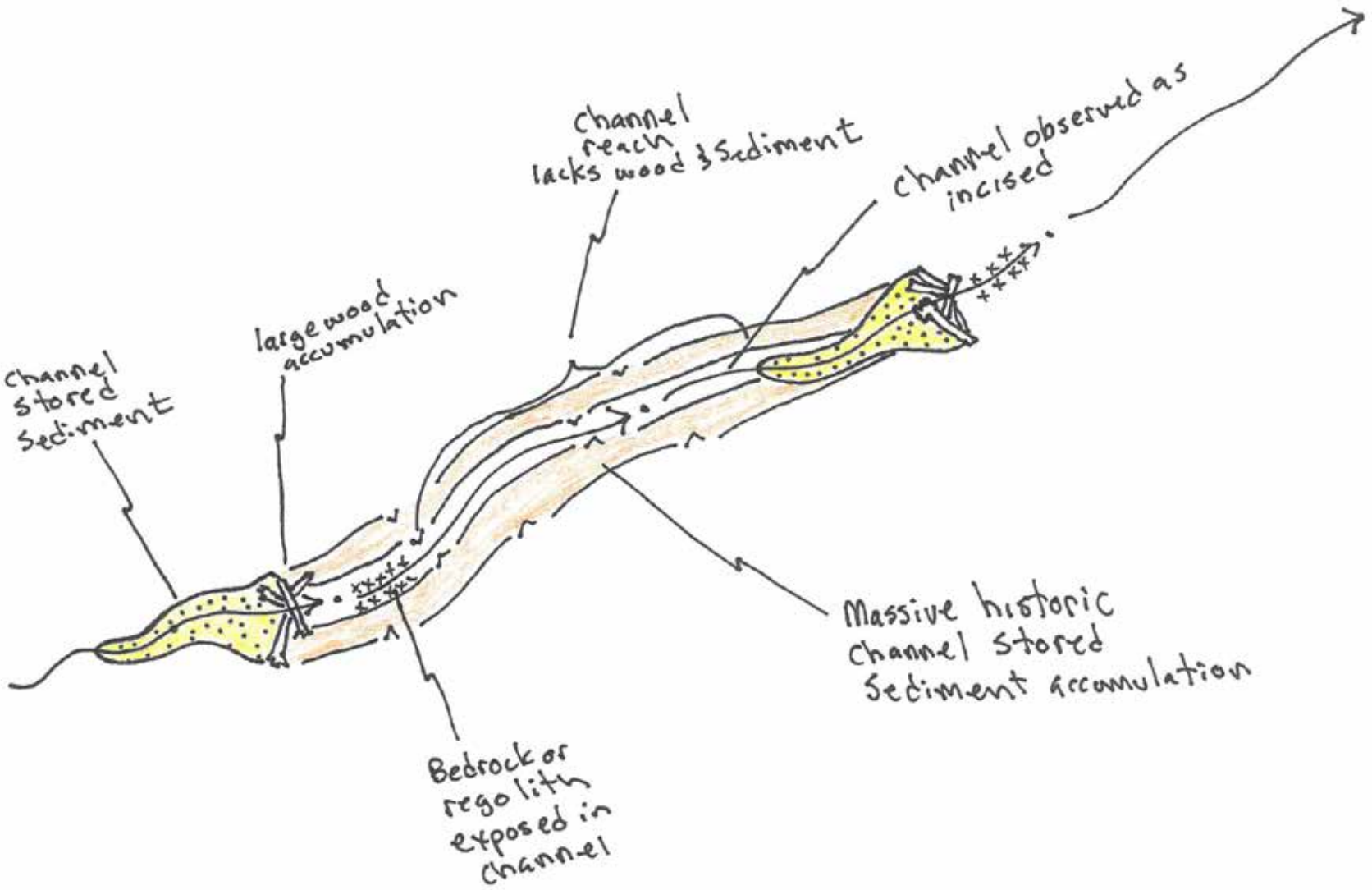
ANTHROPOGENIC INFLUENCED SEDIMENT DELIVERY

SO HOW DO THESE DISTURBANCE EVENTS CONSPIRE TO DEGRADE FISH HABITAT?

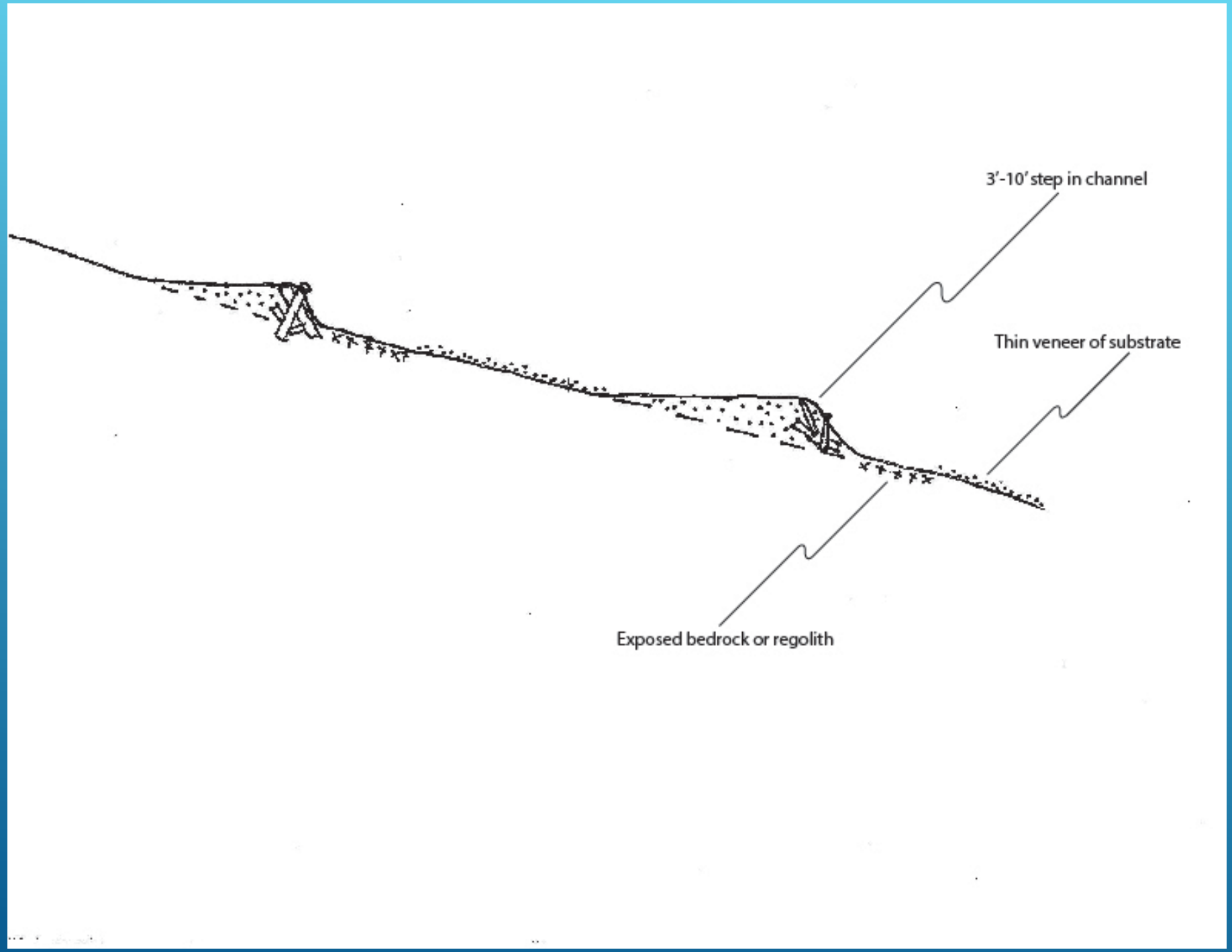
- Hydrology
  - Increased runoff from roads and impermeable surfaces allows for unnatural peaks in storm hydrographs
- Riparian Disturbances
  - Destruction of riparian zones significantly degrades the existing large wood features, breaks the natural process of wood recruitment and retention to streams and significantly reduces other riparian services (food production, nutrient delivery, ect.)
- Sediment budget alterations
  - Road construction and extensive clearcutting caused most of the streamside landslides to fail over a short period of time, where under undisturbed conditions, they would have individually delivered into the stream over thousands of years.

Channel Evolution Model for Heavily Managed Landscapes in Some Northern California Streams

Status	Original Conditions	Immediate Post Disturbance Conditions	Post Disturbance Geomorphic adjustment (after storm events)	Current Conditions
Typical Cross section				
Defining Characteristics	- Riparian dominated by old growth conifer - Floodplain fully connected to channel - Sediment input and output in balance -Bank heights low and relatively stable - Biogeomorphic system resilient to natural disturbance events - Habitat diverse and resilient	- Riparian and hillside mostly devoid of trees - Floodplain unprotected - Sediment input higher than sediment output - Bank heights low and unstable - Biogeomorphic system highly vulnerable to natural disturbance events - Habitat vulnerable	- Riparian and hillside mostly devoid of trees - Floodplain buried by heavy sedimentation - Sediment being stored in channel reaches - minimal channel banks evident - Biogeomorphic system succumbs to anthropogenic disturbance - Habitat severely impacted	- Riparian dominated by hardwoods - Floodplain disconnected from channel due to incision through recent sediment deposits - Sediment locked in storage by hardwood forest, no basal flare observed on old growth stumps - Channel banks relatively stable and supported by tree roots - Biogeomorphic system dysfunctional and out of balance with watershed characteristics. - Habitat simplified
Representative photo				



Typical map view along a stream channel subjected to alterations to its hydrologic, biologic, and geologic processes



Typical profile along a stream channel subjected to alterations to its hydrologic, biologic, and geologic processes

Large wood accumulation on Chimney Rock Creek.

Note:
(1) Large step in channel
(2) Sediment accumulated upstream of jam
(3) Lack of jump pool

Remnants of blown out jam

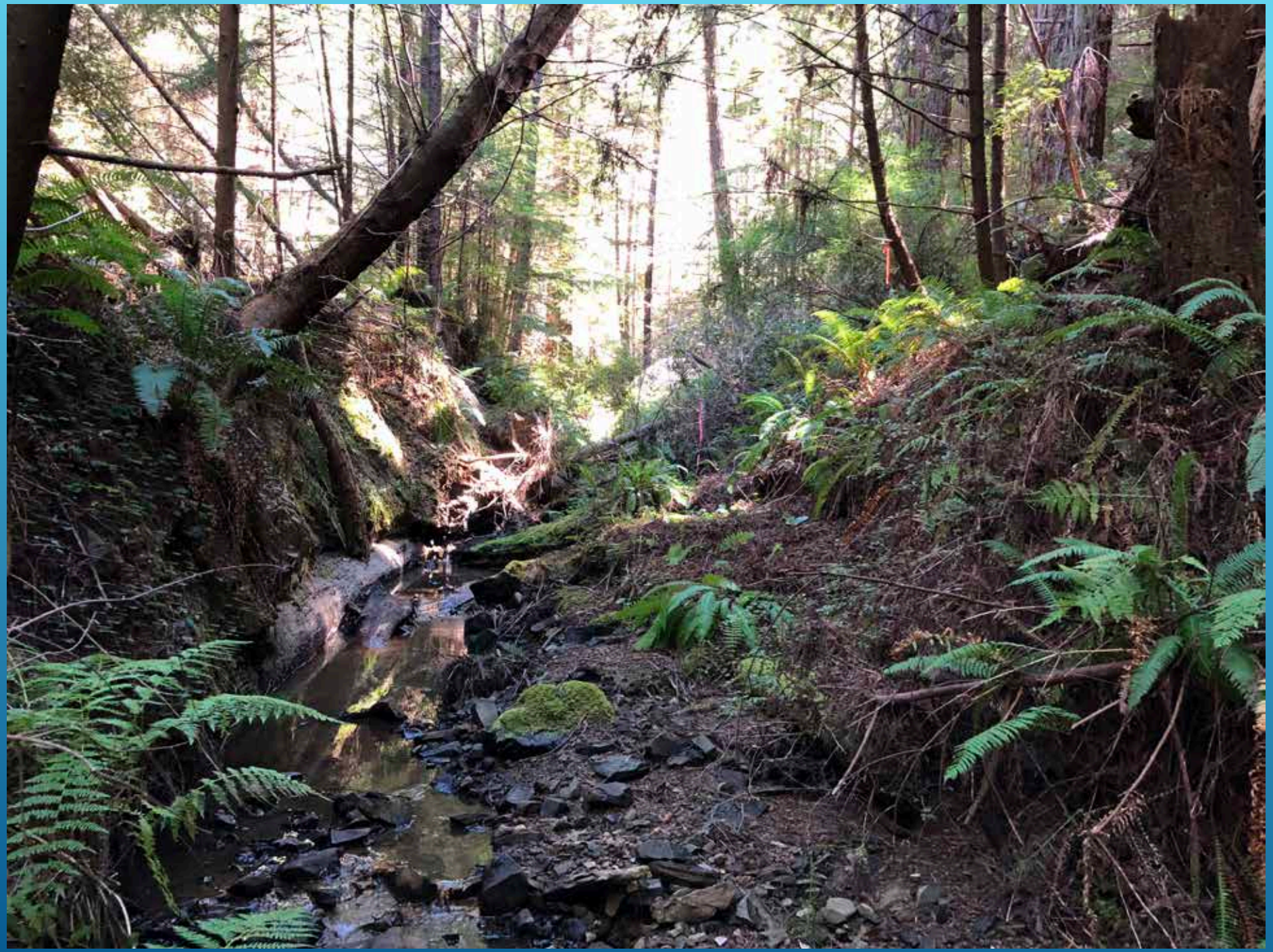
Note:

(1) Incision into sediment accumulation

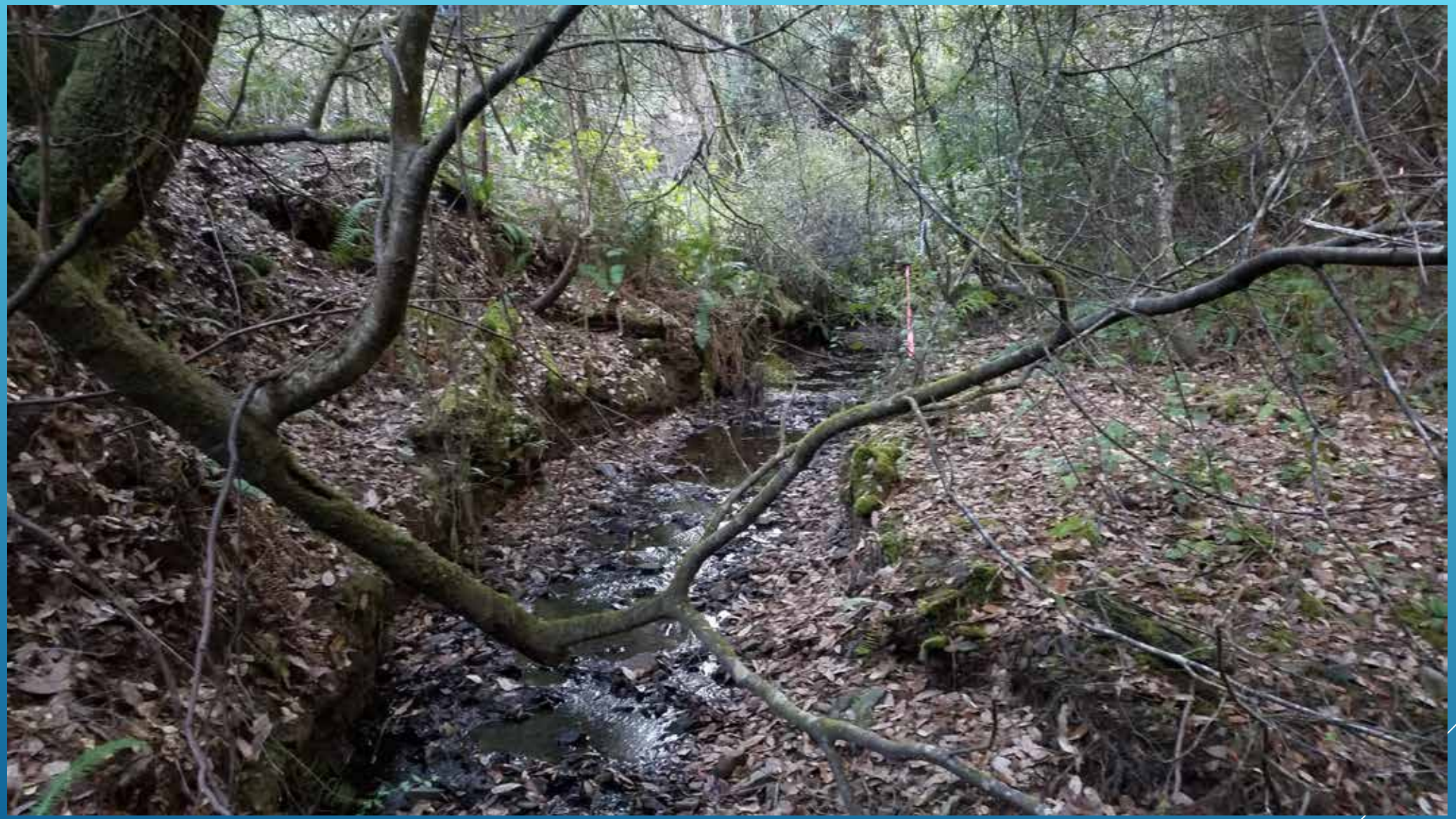
(2) Buried alders

(3) Suspended substrate

What's missing here?

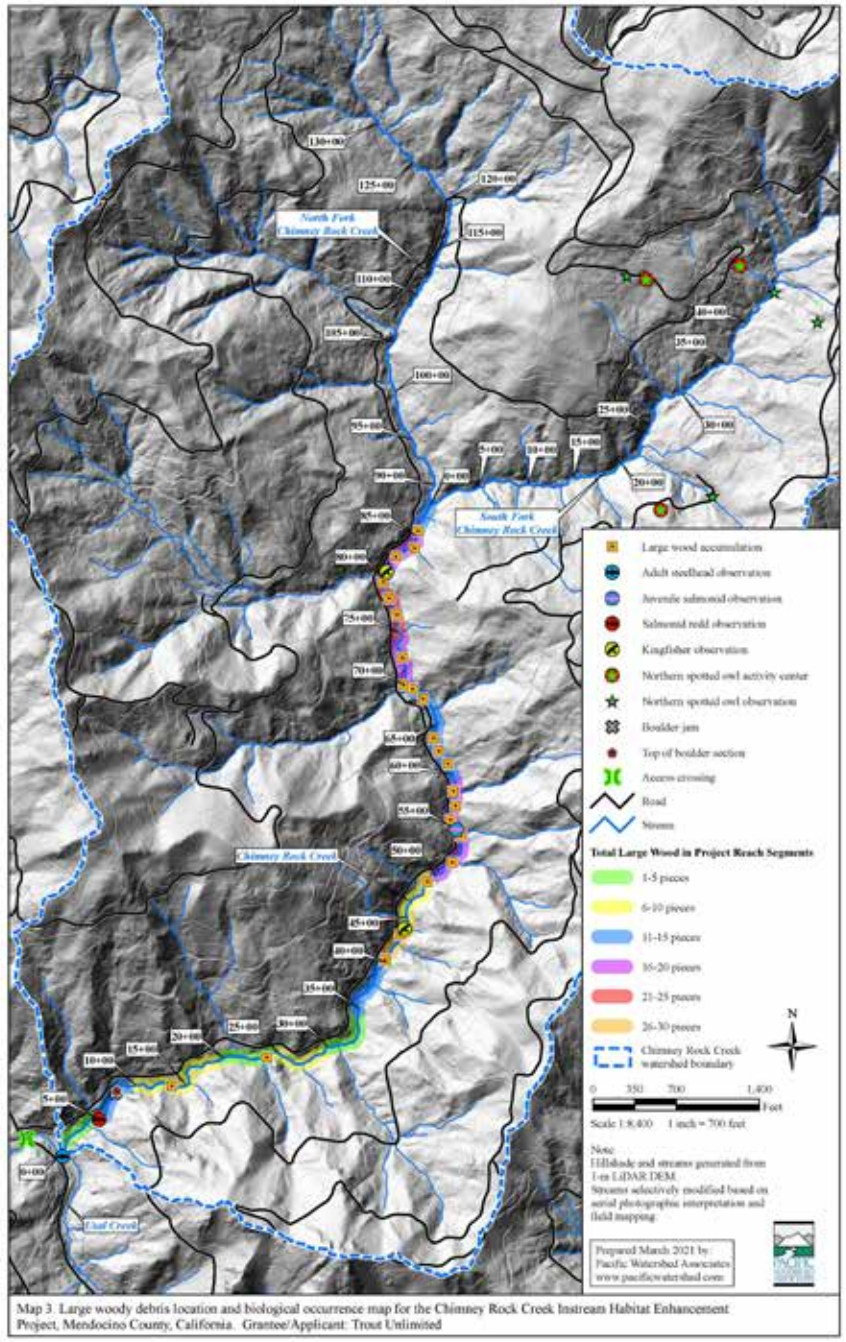


Incision into anthropogenic deposit, down to regolith

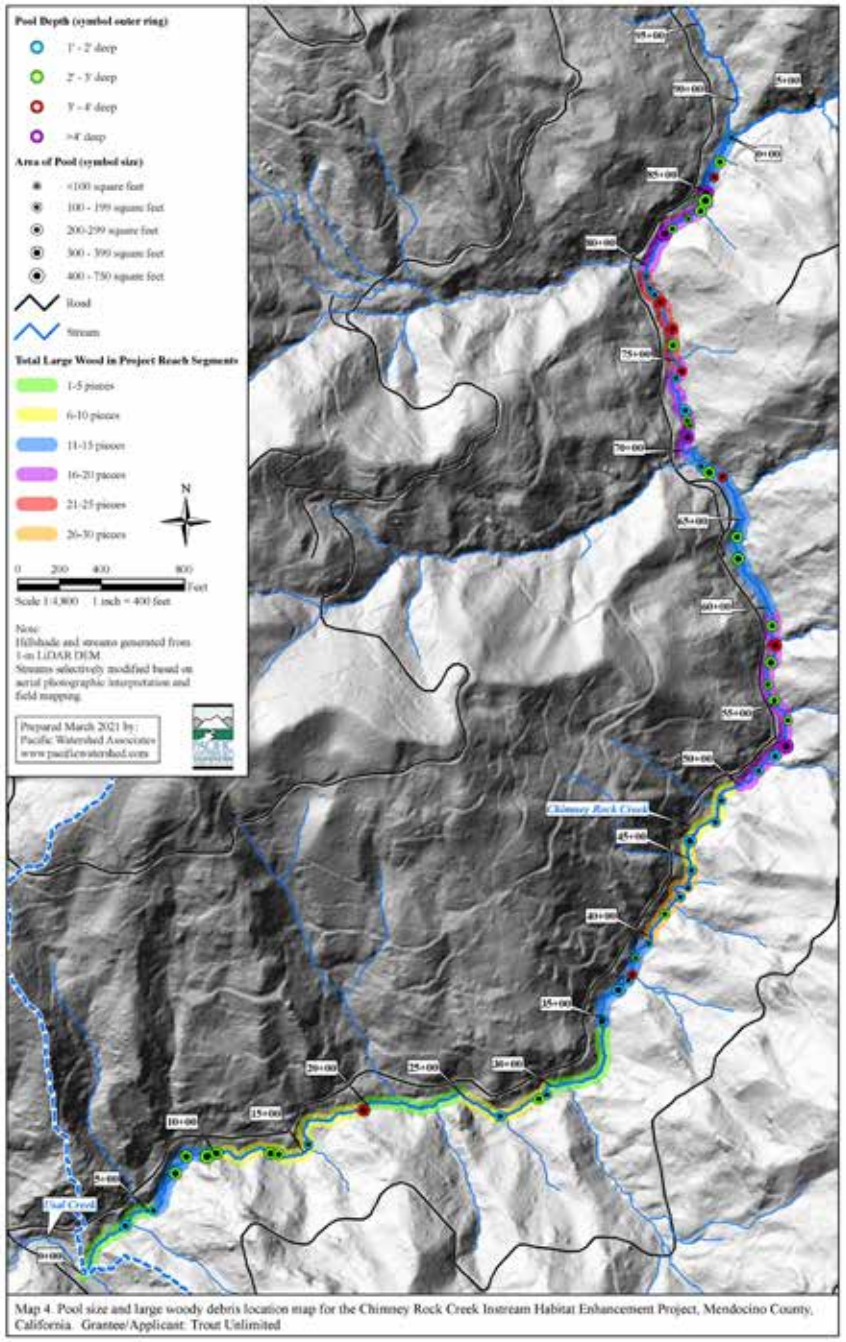


Beginning of incision into large anthropogenic deposit

OK….WHAT'S THIS WORKSHOP ABOUT AGAIN? OH YEAH…..WOOD……



Map 3. Large woody debris location and biological occurrence map for the Chimney Rock Creek Instream Habitat Enhancement Project, Mendocino County, California. Grantee/Applicant: Trout Unlimited

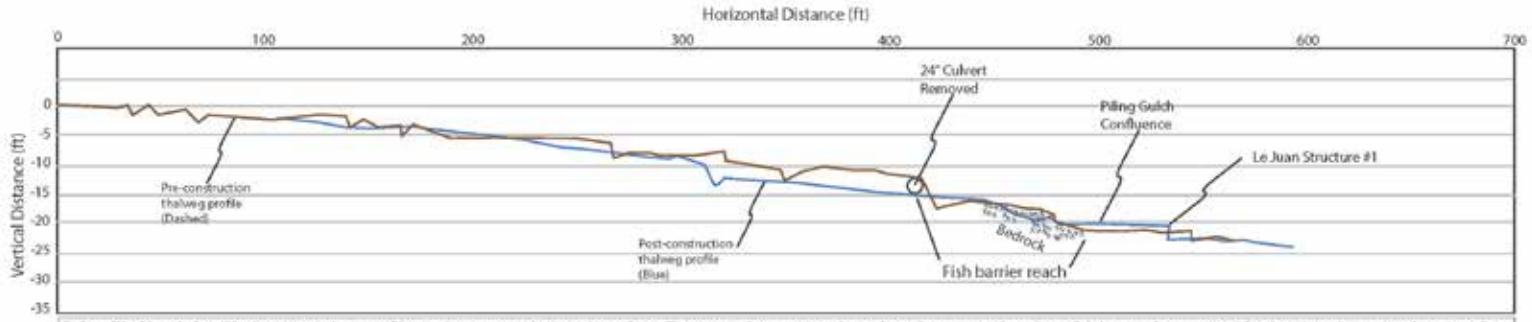


Map 4. Pool size and large woody debris location map for the Chimney Rock Creek Instream Habitat Enhancement Project, Mendocino County, California. Grantee/Applicant: Trout Unlimited

The 10,000' view

Planning maps from Chimney Rock Creek

PRE AND POST CONSTRUCTION LONG PROFILES, LNF NOYO RIVER, MENDOCINO CA



Before (Black) and after (Blue) stream thalweg profiles on the upper Little North Noyo River. The pre-implementation channel conditions contributed to a fish barrier, that persisted for decades, where a combination of a bedrock cascade and an arrested head-cut resulted in non-passable conditions for anadromous fish. The thalweg profile was modified through a combination of: (1) adding several channel spanning wood structures downstream of the bedrock to raise the channel bed, (2) chiseling the edge of the bedrock exposed in the channel bottom with a hydraulic excavator, and (3) removing a 24" culvert that was maintaining a large step in the channel.

LITTLE NORTH FORK NOYO PRE-IMPLEMENTATION CONDITIONS

Upper reach

Lower reach

LITTLE NORTH FORK NOYO POST-IMPLEMENTATION CONDITIONS

2 Examples of “LeJuan” structures

Little North Fork Noyo
downstream of the headcut

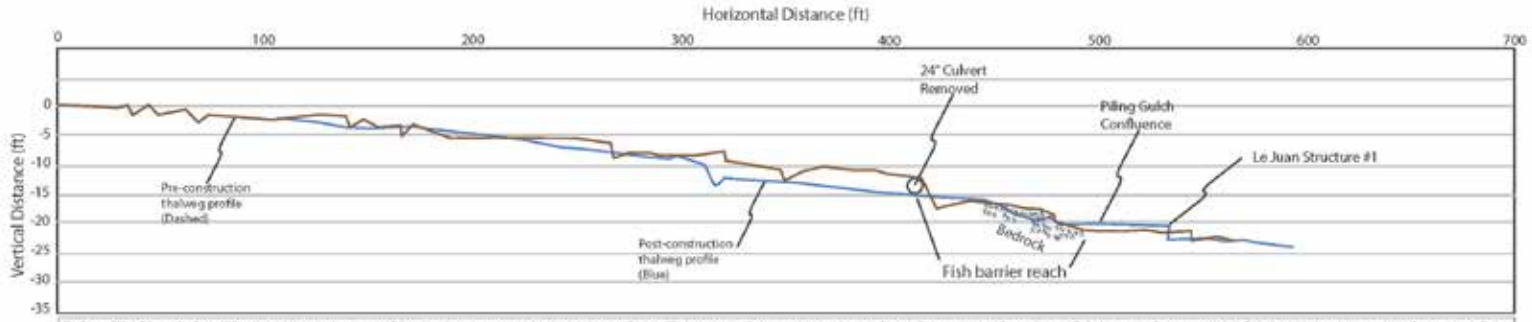
The “LeJuan” wood structures

Pistol butt Le Juan wood structure

Little North Fork Noyo
Upstream of headcut

Wood designed to deflect stream into massive sediment accumulation

PRE AND POST CONSTRUCTION LONG PROFILES, LNF NOYO RIVER, MENDOCINO CA



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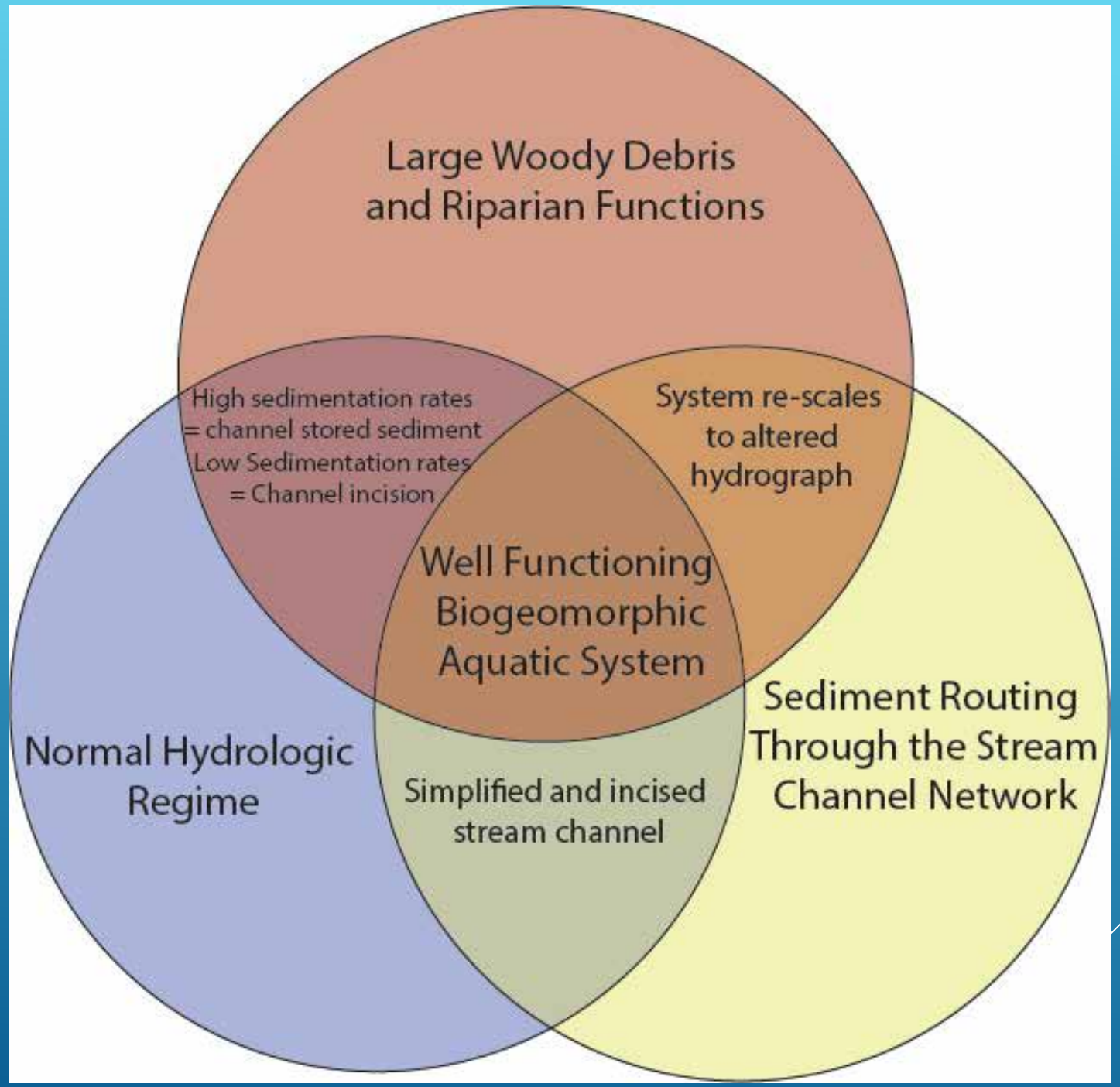
CONCLUSIONS/RECOMMENDATIONS

- Fully characterize your target streams past and ongoing disturbances and existing conditions to inform your designs
- Identify dysfunctional processes in your watershed and try to address them with a comprehensive project ….What role can large wood play in addressing the dysfunctionalities?
  - Hydrology- upgrade/decom roads
  - Riparian- characterize and plan riparian improvements
  - Sediment budgets- identify areas lacking or unnaturally storing channel stored sediment and design around redistribution
- Design at the reach scale, think past simply building habitat
- Implement your wood loading project concurrently with other projects that reduce increased runoff in the watershed, restore the riparian zones to fully functioning conditions
- Wood is not a panacea
- Go big or go home!


Large Woody Debris
and Riparian Functions
High sedimentation rates
= channel stored sediment
Low Sedimentation rates
= Channel incision
System re-scales
to altered
hydrograph
Well Functioning
Biogeomorphic
Aquatic System
Normal Hydrologic
Regime
Simplified and incised
stream channel
Sediment Routing
Through the Stream
Channel Network