Accelerated Recruitment: Cost-Efficient Restoration Techniques for Enhancing Instream Habitat

Large Wood Technical Field School 11/11/21

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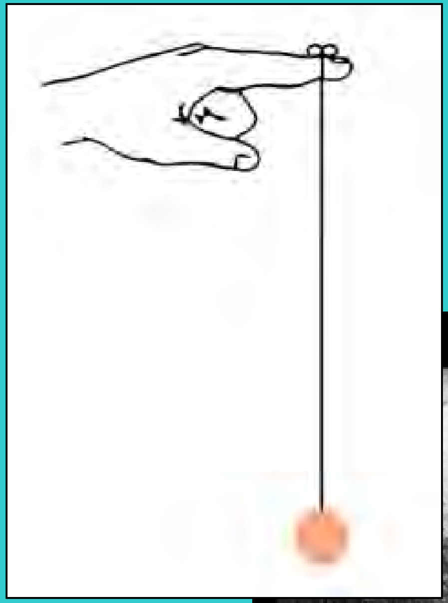
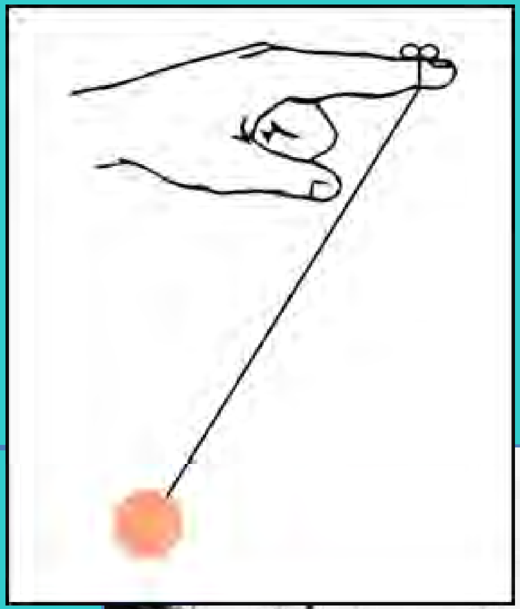
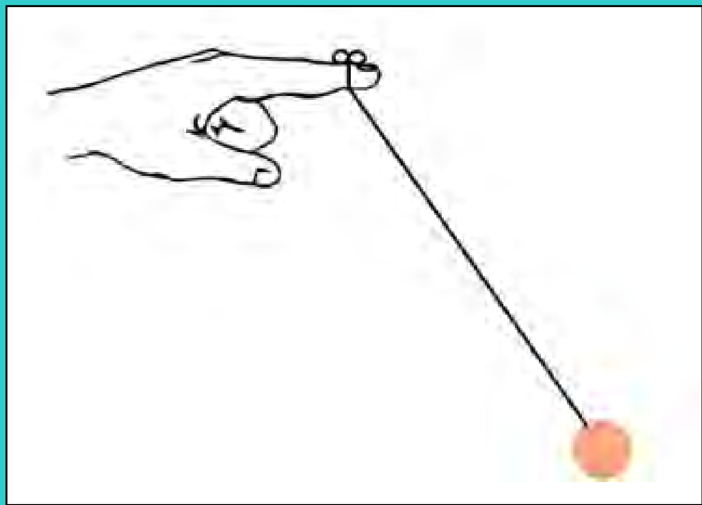


Phase 1: 1,000,000+ years of wood loading

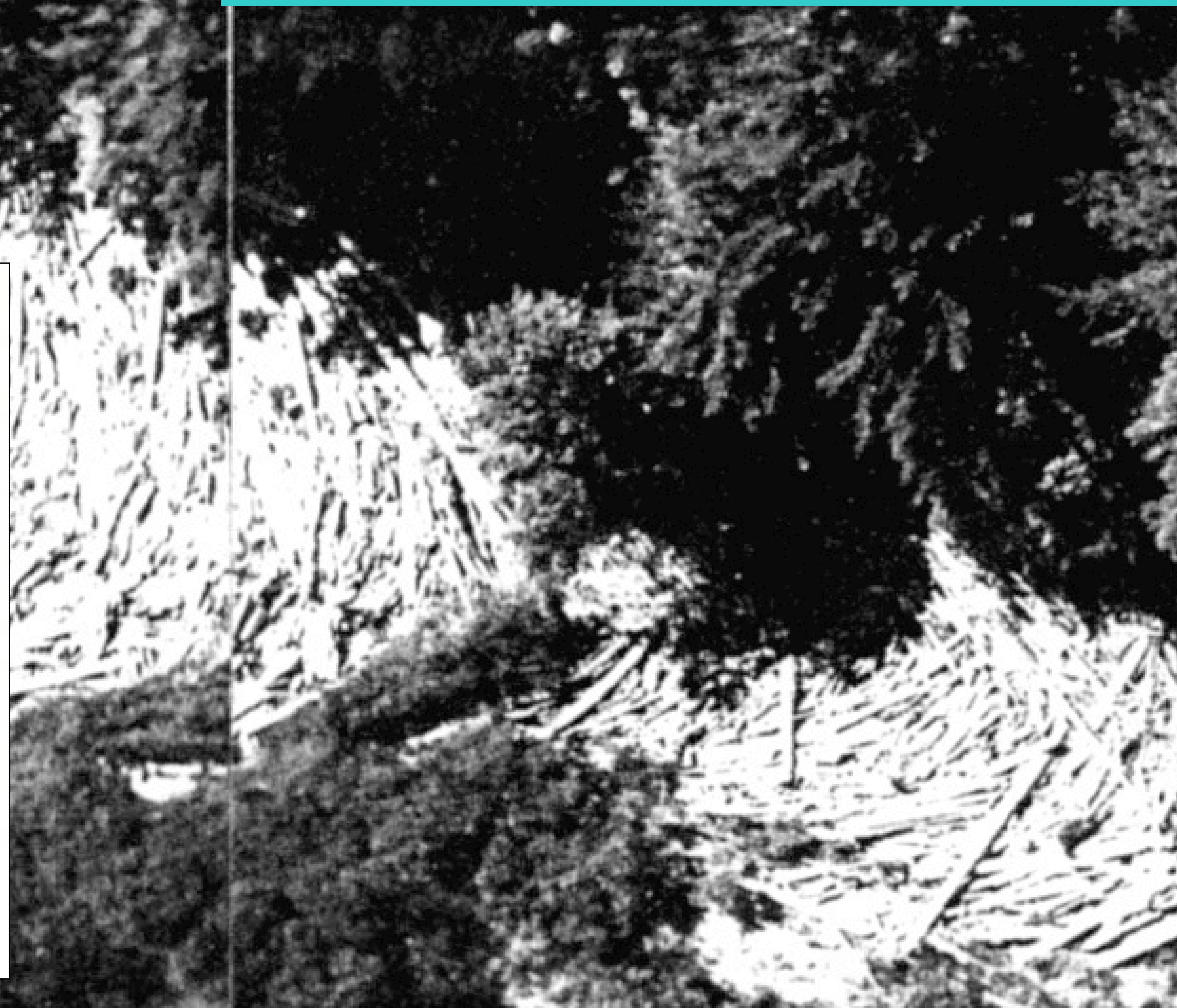


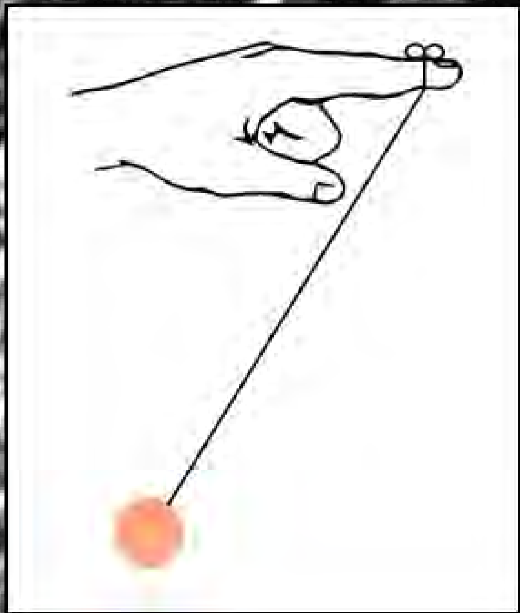
<u>Phase 2: Early Logging</u> (1860s – 1920s)
Instream and streamside tree and wood clearing/splash dam logging

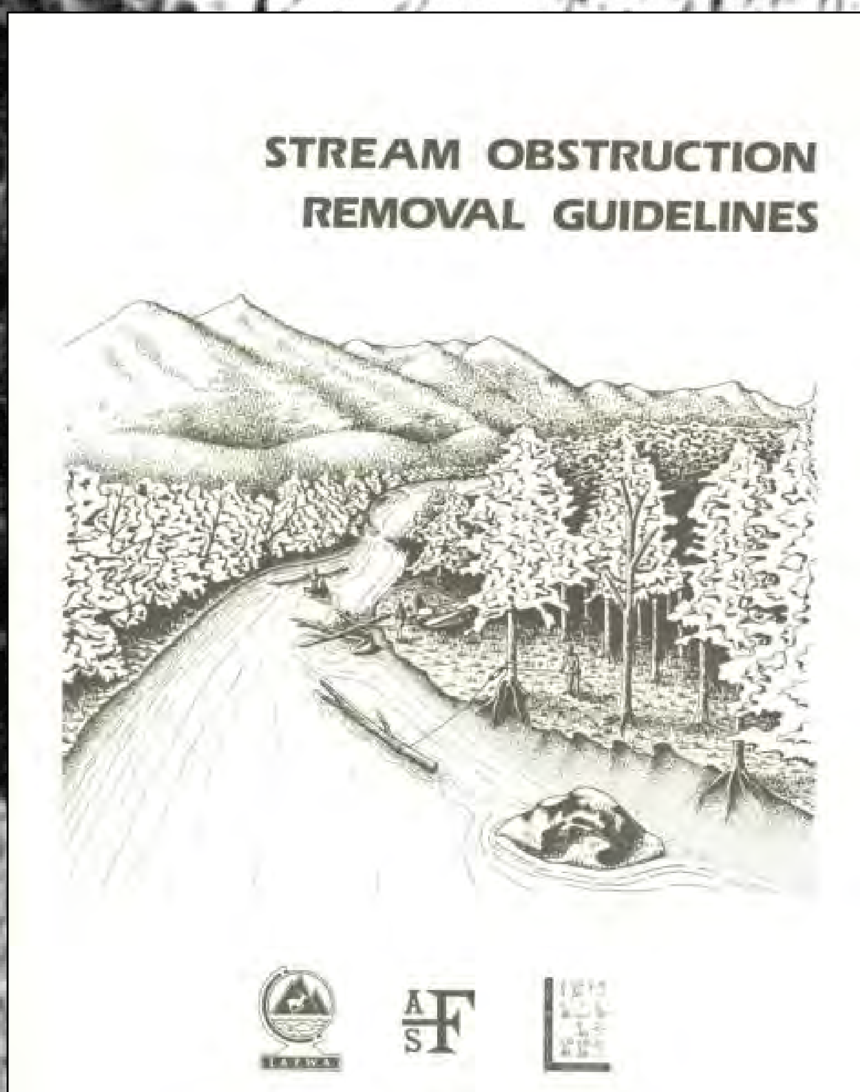


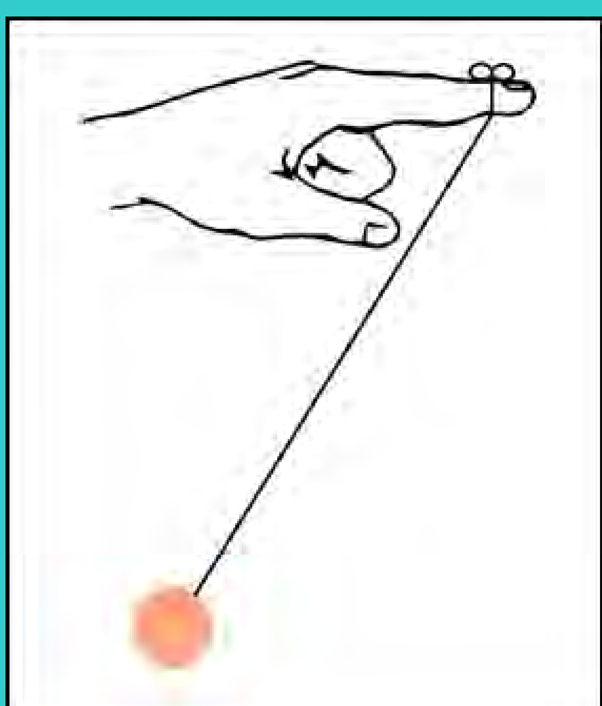
Phase 3: Post WW-II Logging
(1940s – 1970s) Excessive wood loading

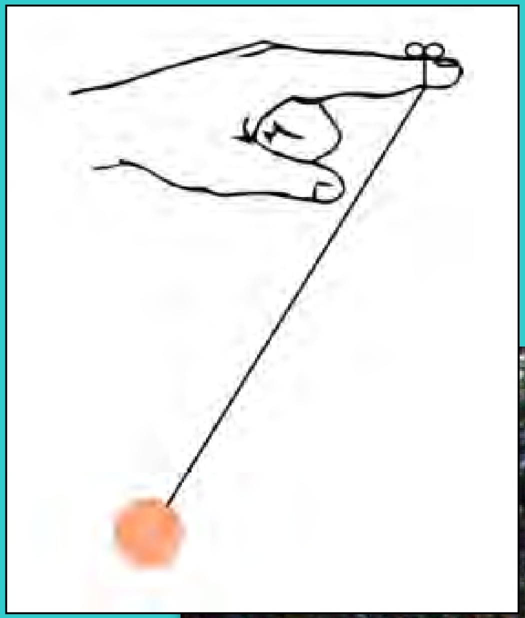
Phase 4: Stream Clearing (1970-80s)











Phase 5 (Present)
Waiting for riparian corridors to mature

Large Woody Debris (LWD) Function

- Create/maintain pool scour, backwater and side channel habitat
- Sort/store sediments including spawning gravel and increase floodplain connectivity
- Function as cover from predation, increase stream production and food availability
- Provide high velocity refugia during winter

Restoration Strategies

- Our strategy:
  - Increase pace and scale
  - Rapid, efficient accelerated recruitment of large wood as a stop-gap measure
  - ‘Nucleate’ the stream with functional key LWD pieces
  - Natural LWD recruitment is the goal

Techniques through Experience

- 14 years placing wood
- 60+ number of unique projects
- 3100+ structures
- 6500+ pieces of LWD
- No professional training in engineering or similar.
- Re-imagining why/where we move big wood in the woods
- This is just one tool in the restoration tool box

Design/Build Approach

- Structure designer is onsite for implementation everyday
- Oversee/modify designs in real time as necessary ‘field fitting’
- Refined/revised through real world, on the ground situations and processes
- Critical to success of any one piece of wood, structure, project, etc

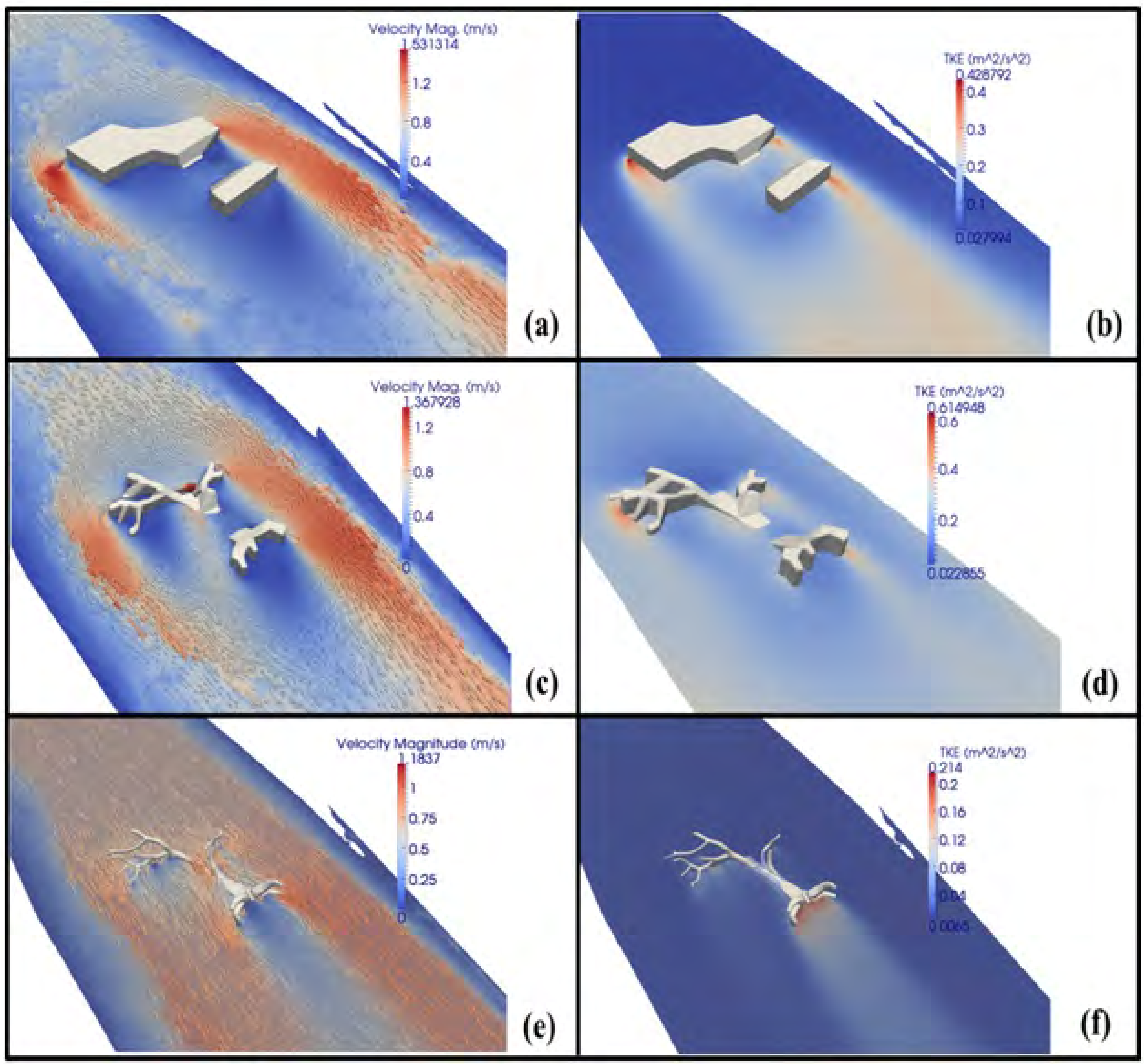
Implementation Methods

- Using rubber tired equipment to directly place logs through riparian roughness elements
- Use skidder to winch logs from onsite/upslope
- Direct falling near-stream conifers where appropriate
- Whole tree tipping/placing with excavator
- Sourcing logs onsite/near project area


CATERPILLAR

Structure Design Considerations

1. Evaluation of pre-existing in stream conditions including local channel morphology, thalweg location and quality of instream shelter. Prioritization of aggradated pools, flatwater, avoid tail outs/riffles
2. Orientation of riparian roughness elements for wedging/anchoring of LWD
3. Availability of equipment access
4. Log source ie. upslope trees, salvageable logs, direct falling, or offsite (delivered) logs
5. Potential disturbance to riparian resources
6. Infrastructure/aesthetic concerns



Characterizing the Impact of Geometric Simplification on Large Woody Debris Using CFD

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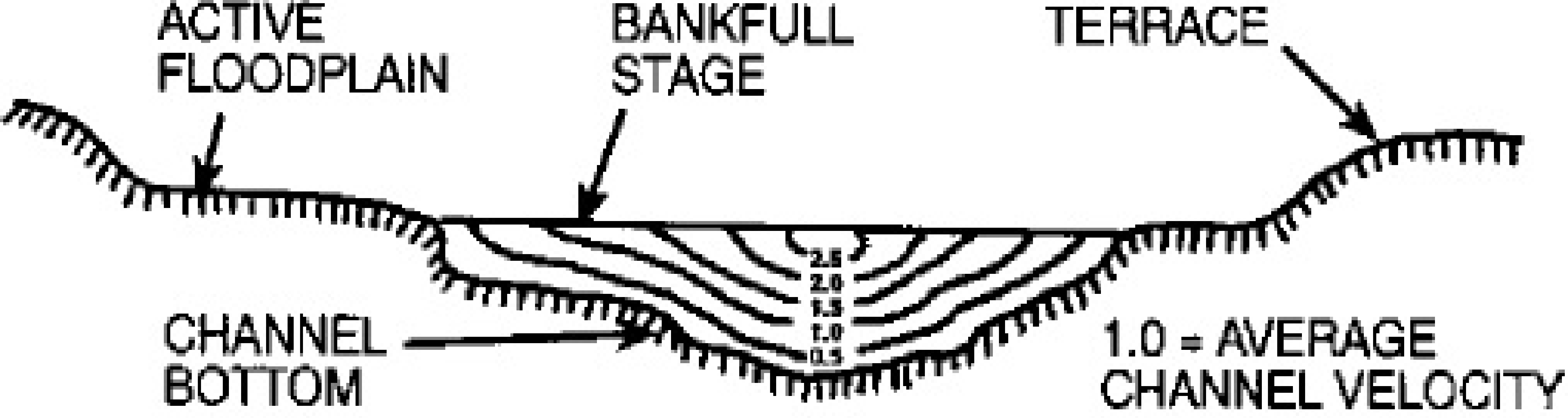
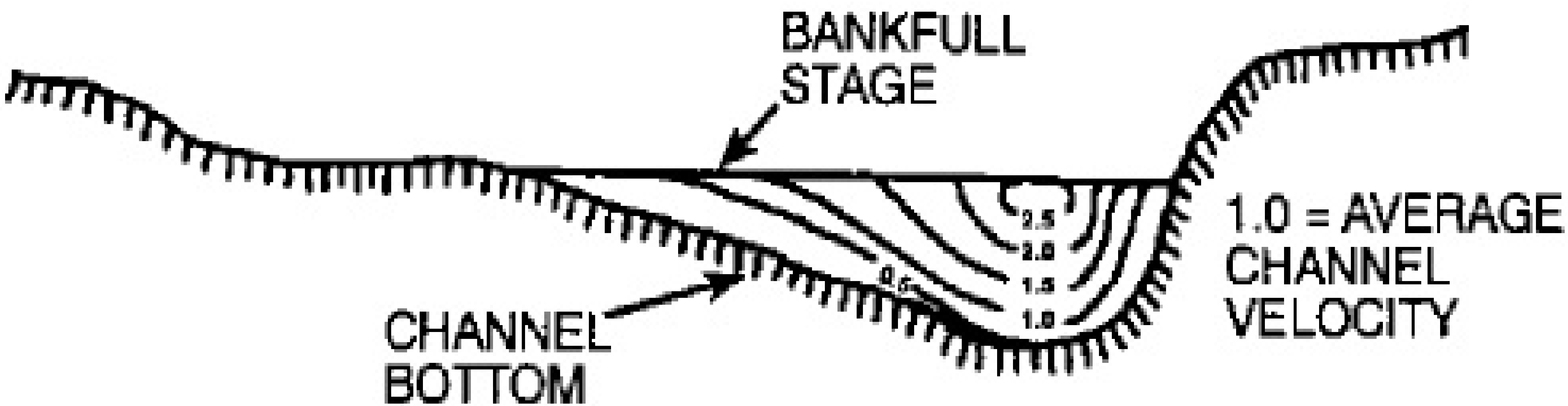


(a) STRAIGHT CHANNEL



(b) CHANNEL BEND

‘Throttle the Channel’

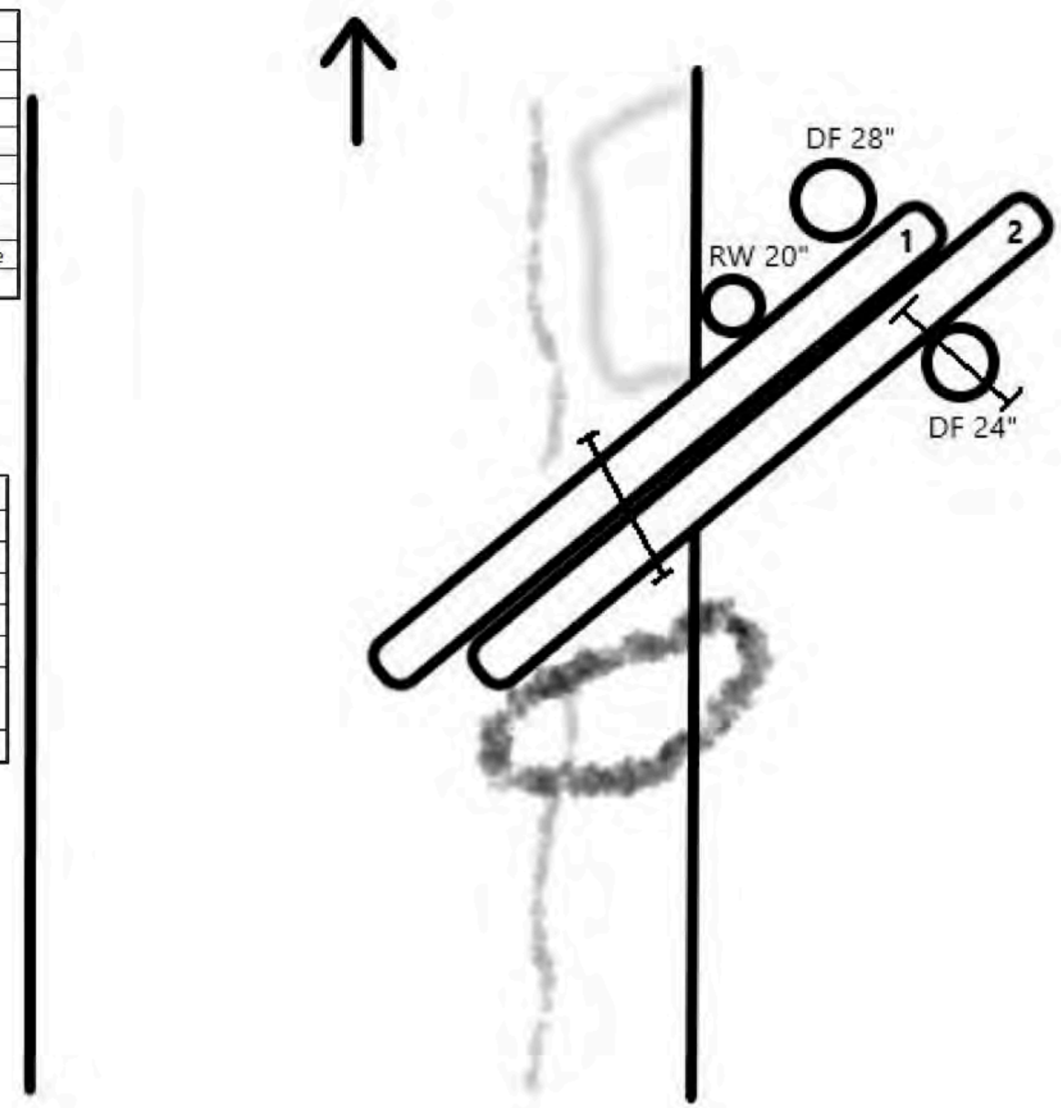
- Increase x-sectional surface area of project wood
- Increase velocity/TKE around obstruction
- Scour pool, create slow water refugia, sort store gravels
- Ability to rack and retain existing instream SWD/MWD/LWD
- Must design and size wood/anchoring appropriate for channel

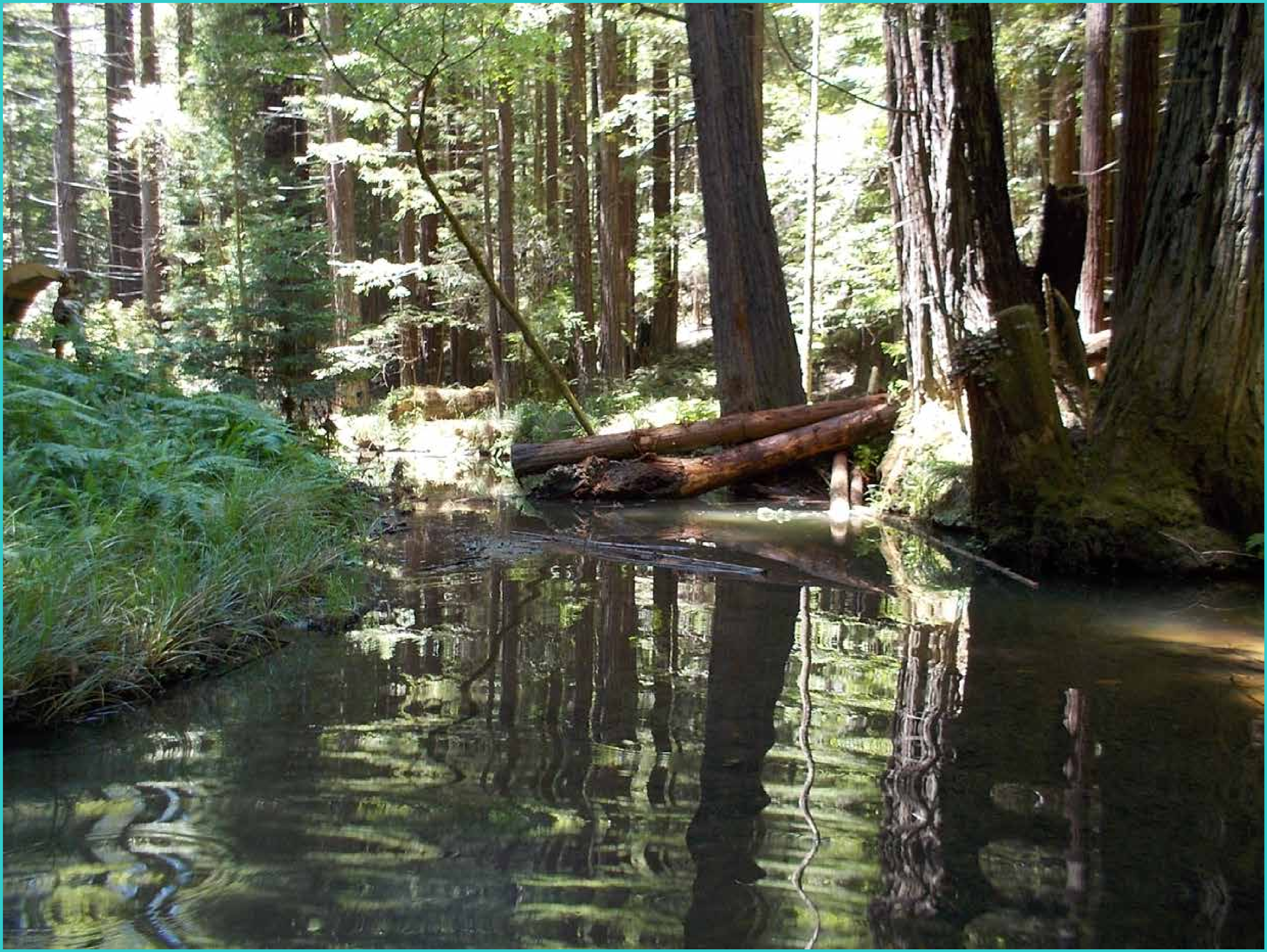
Dynamic Anchoring

- Generally all wood is designed to be retained at structure location
- Wood is ‘wedged’ amongst riparian roughness elements providing the structural anchoring mechanisms
- Dynamic Anchoring can be with or without hardware
- Onsite logistics dictate feasibility

Feature #	00+10
Bankfull (ft)	21
Bankfull height (ft)	2
Length treated (ft)	10
Aq. habitat disturbed (ft)	5
Area w/in bankfull (sq. ft)	50
Existing habitat (depth)	Pool (1') very low shelter
Existing substrate	Gravel, small cobble
Goal of feature	Scour, shelter

# of logs	2
Size of logs	1- 22"< x 33'
	2- 22"< x 33'
# of bolts	2
Wood source	Offsite
Notes	Add SWD





Small Woody Debris (SWD)

- SWD is may be manually added where appropriate
- Direct falling indirectly contributes SWD
- Stobbing of limbs
- High quality material that can be activated during winter flows. May be staggered up bank/channel
- Green SWD removed from wetted channel
- SWD not always desirable

Design appropriate to bankfull width

Some Design Concerns

- Locations without appropriate upslope anchors and lack of suitable onsite material
- Large deep pools with little cover

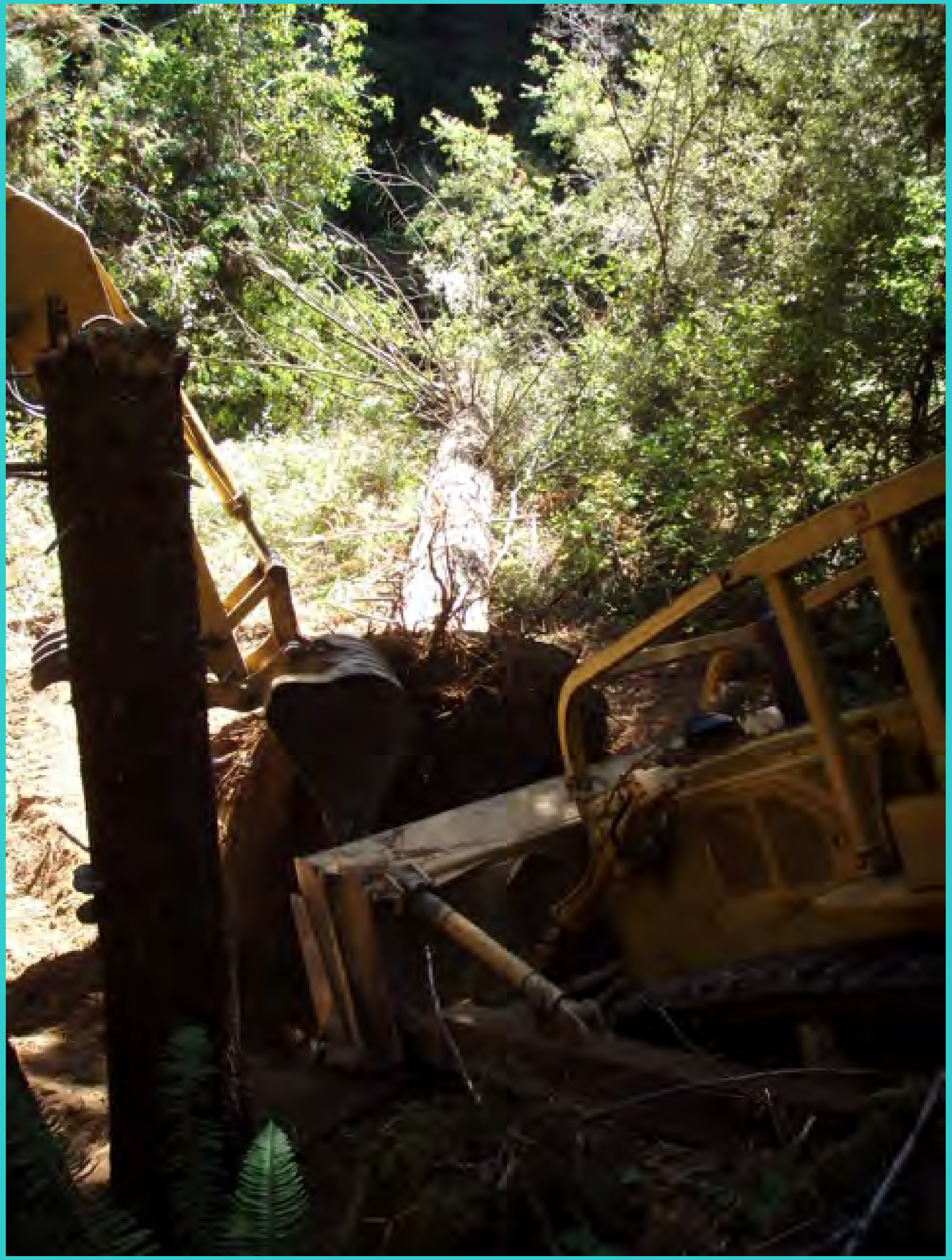
  -Real concern for slowing velocities and contributing to aggradation

  -Promote overhead cover and less LWD surface area into thalweg

  -Difficult to design for ie. less aggressive, passive/deflective structure

Whole Tree Tipping

- 2016 SF Ten Mile
- 7 structures
- 320 Excavator w/D-8
- RW trees need to be singles, not from clumps
- 'Really Big Wood Project'

Lessons Learned

- Successfully falling trees into channel zone is much more difficult then expected
- Need to design for highest flow events, including buoyancy factors and racking capabilities, “Throttle the channel”
- All LWD is not created equal, design important
- Onsite wood is often the best ie. length
- SWD/MWD often difference between good/great structure
- Realistic structure designs for local conditions
- Size wood/anchors appropriately
- Good operators is critical to success

Costs of Engineered vs. Unanchored LWD

Cost Comparison of Engineered vs. Unanchored on SF Ten Mile River

<u>Anchored Project on SF Ten Mile River (2005) (FRGP, CTM):</u>

- 3 mile reach treated
- 40 logs
- 11 sites
- Total cost: $41,000
- $1000 per log
- 13 logs/mi

<u>Accelerated Recruitment Project on SF Ten Mile River (2007-2008) (FRGP, CTM):</u>

- 9.4 mile reach treated
- 309 logs
- 133 sites
- Total cost: $73,000
- $236 per log
- 32 logs/mi

Performance Metrics

- Pre- and post-treatment surveys

  -DFW Stream Habitat Typing Level II w/LWD survey

  -Longitudinal profile
- Tagging/GPS project wood
- Photo points

Survey results by CDFW's Coastal Restoration Monitoring and Evaluation Program on SF Ten Mile, July 2012

- 82% of original pieces of tagged LWD pieces were located.
- 93% tagged LWD are currently considered to be positively functioning.
- 92% sites had minimal movement and/or maintained their original position.
- A significant increase (393%) in large (L>20ft) LWD.
- No significant percent change in maximum pool depth and residual pool depth was seen between 2007 and 2012.

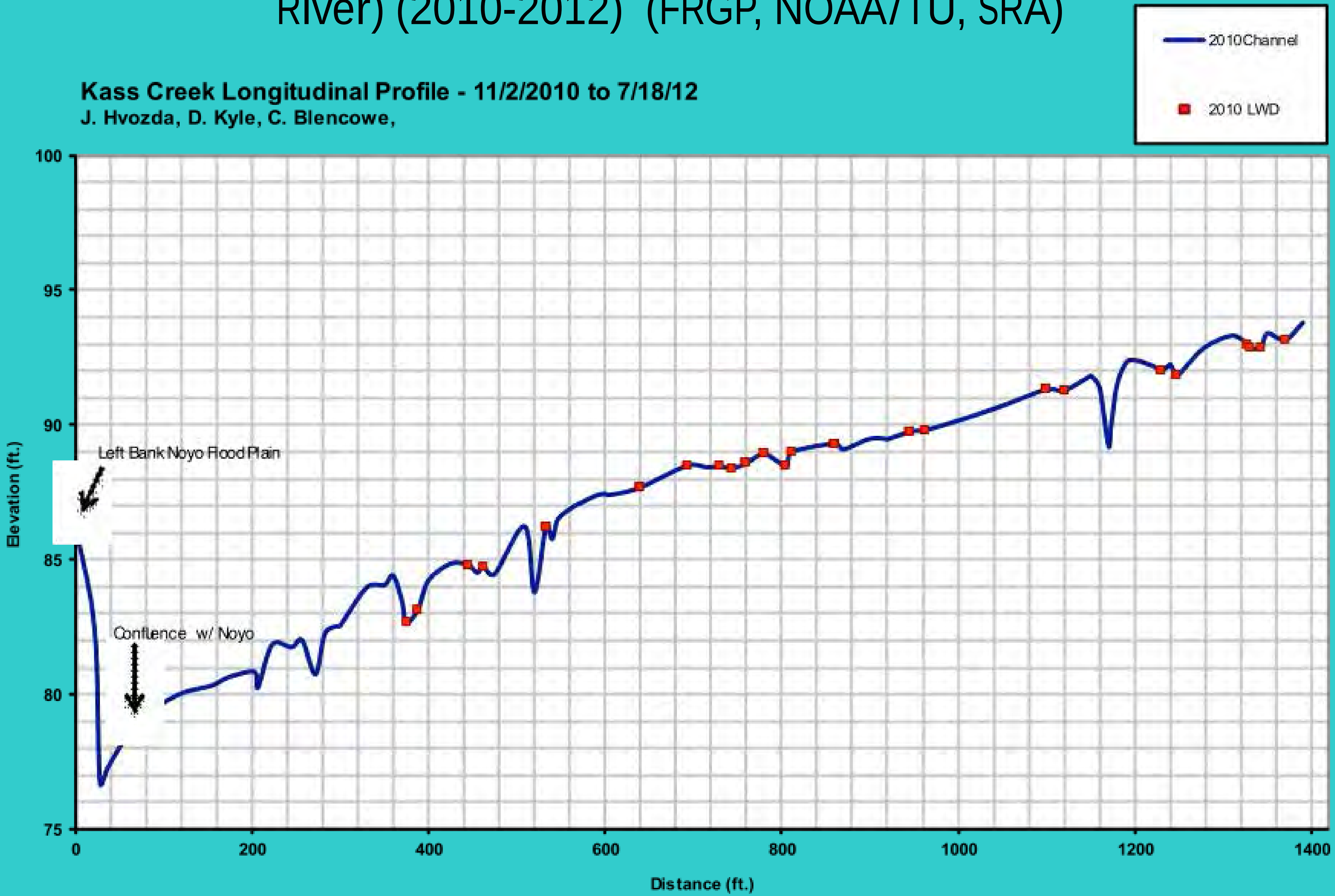
This was a survey of a lower 3.5 mile reach of the 2007 project area by Trevor Lucas et al (2012)

Summary of Percent Change in Key Habitat Variables in Six Mendocino County Streams

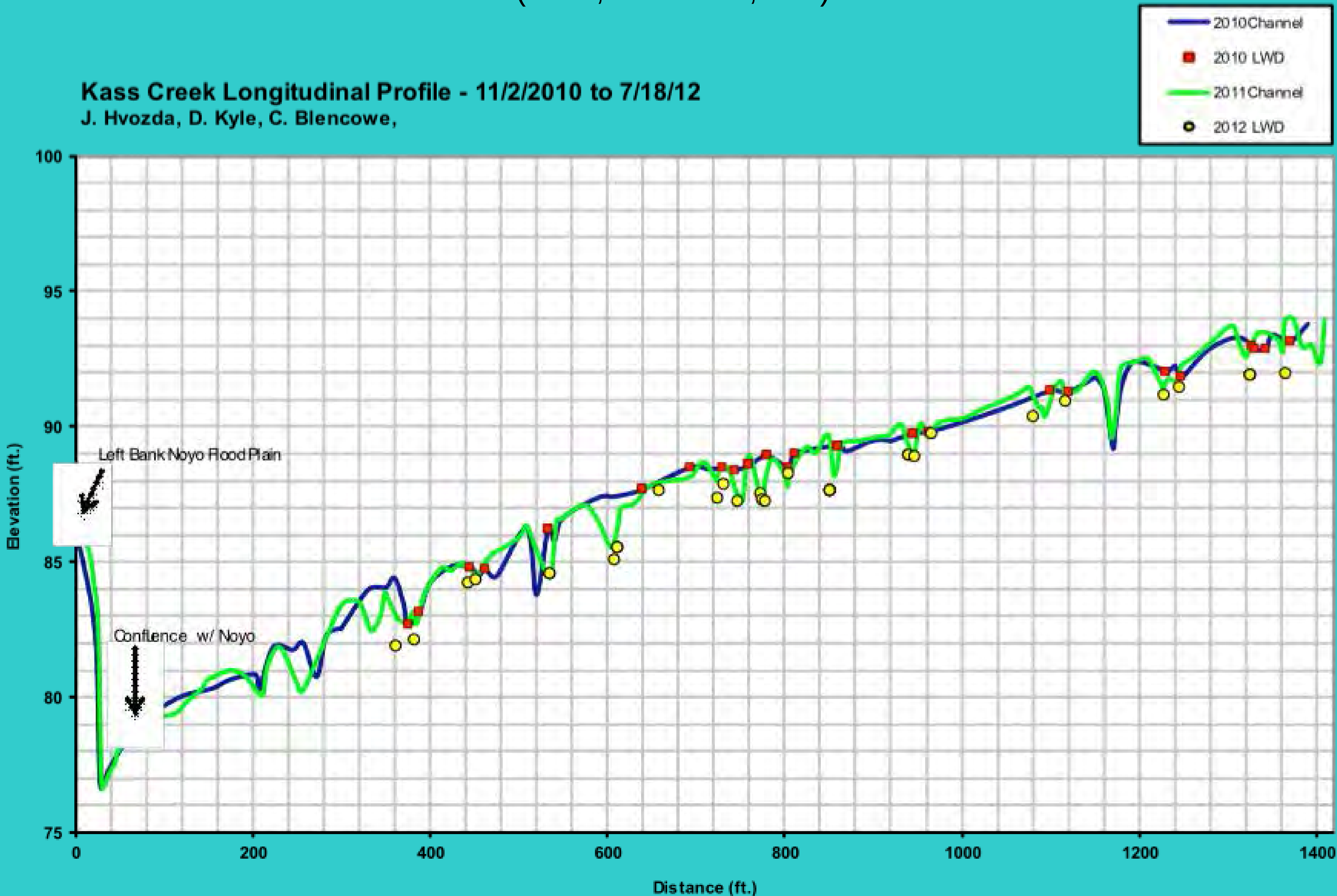
Percent Change in Several Key Variables in Six Mendocino County Streams After Project Implementatio)

	% Pools by Total Length	Total LWD (6'-19')	Total LWD (≥20')	Residual Pool Depths	# of Pools 3.0' - 3.9'	# of Pools ≥ 4.0'	Pool Shelter Rating	% shelter is LW	% shelter is SW
Signal Creek	38.0%	46.0%	113.0%	-4.0%	11.0%	33.0%	5.0%	81.0%	47.0%
SF Big River (Wegner Reach)	25.0%	22.0%	9800.0%	-11.0%	-30.0%	-33.0%	60.0%	1300.0%	2100.0%
LNF Big River	6.0%	10.0%	97.0%	4.0%	14.0%	50.0%	37.0%	12.0%	18.0%
Kass Creek (lower 1400 ft)	24.0%	13.0%	62.0%	0.0%	-100.0%	0.0%	24.0%	49.0%	24.0%
Lower Inman Creek	24.0%	123.0%	327.0%	3.0%	0.0%	100.0%	86.0%	277.0%	587.0%
NF Garcia	10.0%	-7.0%	152.0%	-9.0%	233.0%	0.0%	36.0%	78.0%	76.0%
Mean	21.2%	34.5%	1758.5%	-2.8%	21.3%	25.0%	41.3%	299.5%	475.3%
SD	11.6%	46.7%	3940.6%	6.2%	112.0%	46.8%	28.3%	498.7%	825.6%

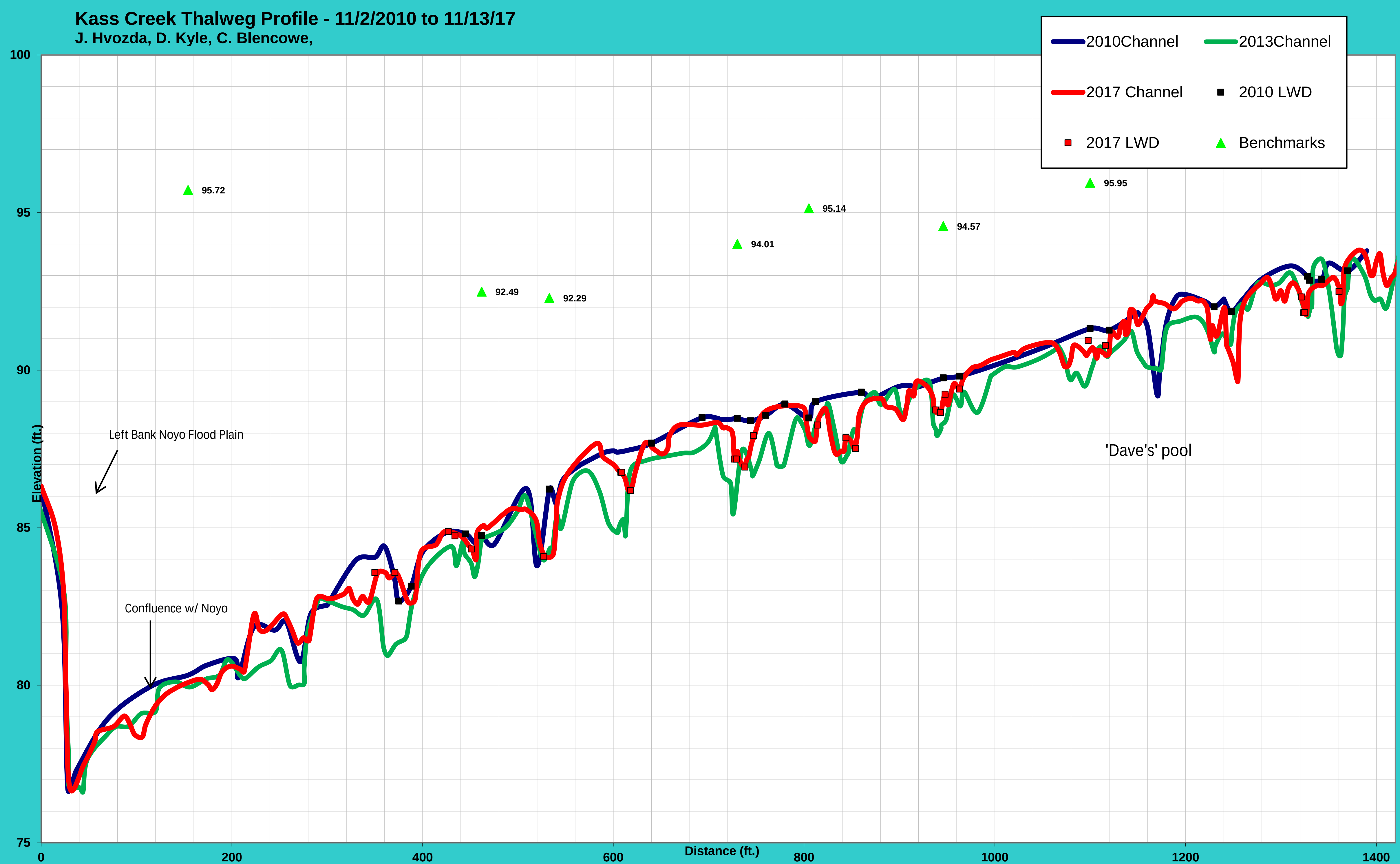
Longitudinal Profile of Lower 1400' Project Reach in Kass Creek (Noyo River) (2010-2012) (FRGP, NOAA/TU, SRA)



Longitudinal Profile of Lower 1400' Project Reach in Kass Creek (Noyo River) (2010-2012) (FRGP, NOAA/TU, SRA)



Longitudinal Profile of Lower 1400' Project Reach in Kass Creek (Noyo River)
2010 and 2013 and 2017
(FRGP, NOAA/TU, SRA)



Big Questions:

- How much wood is good?
- How much wood can we reasonably add to these watersheds without causing problems to the channels and without depleting the still young riparian corridor?
- Retreatment

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- How much wood is good?
- How much wood can we reasonably add to these watersheds without causing problems to the channels and without depleting the still young riparian corridor?
- Does wood actually make more fish? The biological component is missing.

The Pudding Creek Project: a BACI Study

- A partnership between Lyme Timber, CDFW, TNC, TU
- Six years of baseline data on coho life history metrics
- Approximately 80% of the fish bearing habitat will be treated using accelerated recruitment
- Caspar Creek, a similar watershed with a similar monitoring history, will be the control stream
- Changes in biological (e.g., spawner to smolt) and physical indices will be closely monitored for six years after treatment

Limitations/Applicability

- Landowners with large holdings, lots of trees and little risk to infrastructure
- The 18 largest landowners own 81% of the properties in Mendocino County's CCC ESU Coho Core Areas

Limitations/Applicability

- Direct falling best in 20’-30’ bankfull
- Low gradient alluvial streams
- Willing, supportive landowners
- Unique design considerations in entrenched, flashy high volume channels
- Bankfull widths up to +/-50 feet

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Low-Cost Restoration Techniques for Rapidly Increasing Wood Cover in Coastal Coho Salmon Streams

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ARTICLE

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Abstract

Like many rivers and streams in forests of the Pacific Northwest, California north coast rivers and streams have been depleted of downed wood through timber harvest and direct wood removal. Due to the important role of wood in creating and maintaining salmonid habitat, wood augmentation has become a common element of stream restoration. Restoration efforts in North America often focus on building anchored, engineered wood structures at the site scale; however, these projects can fail to meet restoration goals at the watershed scale, do not closely mimic natural wood loading processes or dynamics, and can be expensive to implement. For critically imperiled populations of Coho Salmon *Oncorhynchus kisutch* in California, there is a strong impetus to achieve as much habitat restoration as possible in priority watersheds in the shortest time and with limited resources, so cost-efficient techniques are necessary. In this multi-site project, we investigated unanchored techniques for wood loading to evaluate cost and contribution to salmonid habitat in Mendocino County, California. Over a period of 6 years, 72.4 km of stream were treated with 1,973 pieces of strategically placed wood. We found that unanchored wood loading techniques were much less costly than commonly used anchored techniques, reliably improved habitat, and retained wood at high rates (mean = 92%) in small- to moderate-sized streams, at least over the short term (<6 years). The average cost of design and construction for the unanchored projects was US$259 per log, equivalent to 22% of the cost associated with the anchored wood augmentation methods examined here. Our results suggest that this unanchored wood loading approach has the potential to increase the pace and scale at which wood augmentation projects are implemented in the Pacific Northwest and beyond.

Downed wood plays an essential role in stream morphology and productivity, particularly in salmon-bearing streams of the Pacific Northwest (House and Boehne 1986; Bisson et al. 1987; National Research Council 1996; Abbe et al. 2003a) and northern California (Keller et al. 1981; Lisle 1986; Lassettre and Harris 2001). Wood influences instream erosion and deposition processes by locally altering water velocities and shear stress (Lisle 1986; Abbe and Montgomery 1996). These processes trap sediments, increase bar and other depositional features, provide gravels necessary for salmon spawning, and increase floodplain development and connectivity (Lisle 1986; Bisson et al. 1987; Fetherston et al. 1995). Wood can increase scour in other areas, creating slow-water habitats like pools, backwaters, and side channels, thus providing both oversummer and overwinter

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