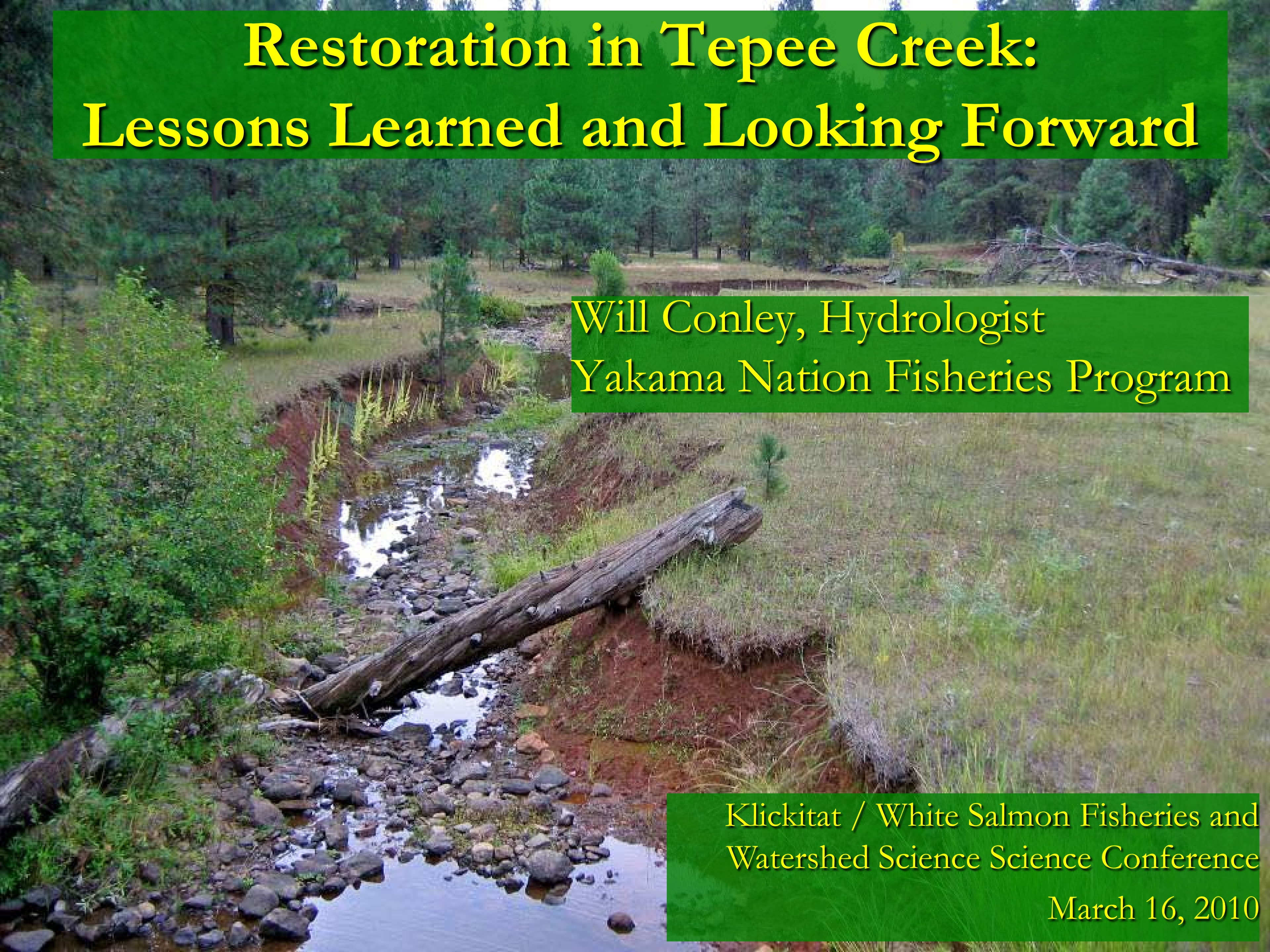
Restoration in Tepee Creek: Lessons Learned and Looking Forward



Will Conley, Hydrologist
Yakama Nation Fisheries Program

Klickitat / White Salmon Fisheries and Watershed Science Science Conference

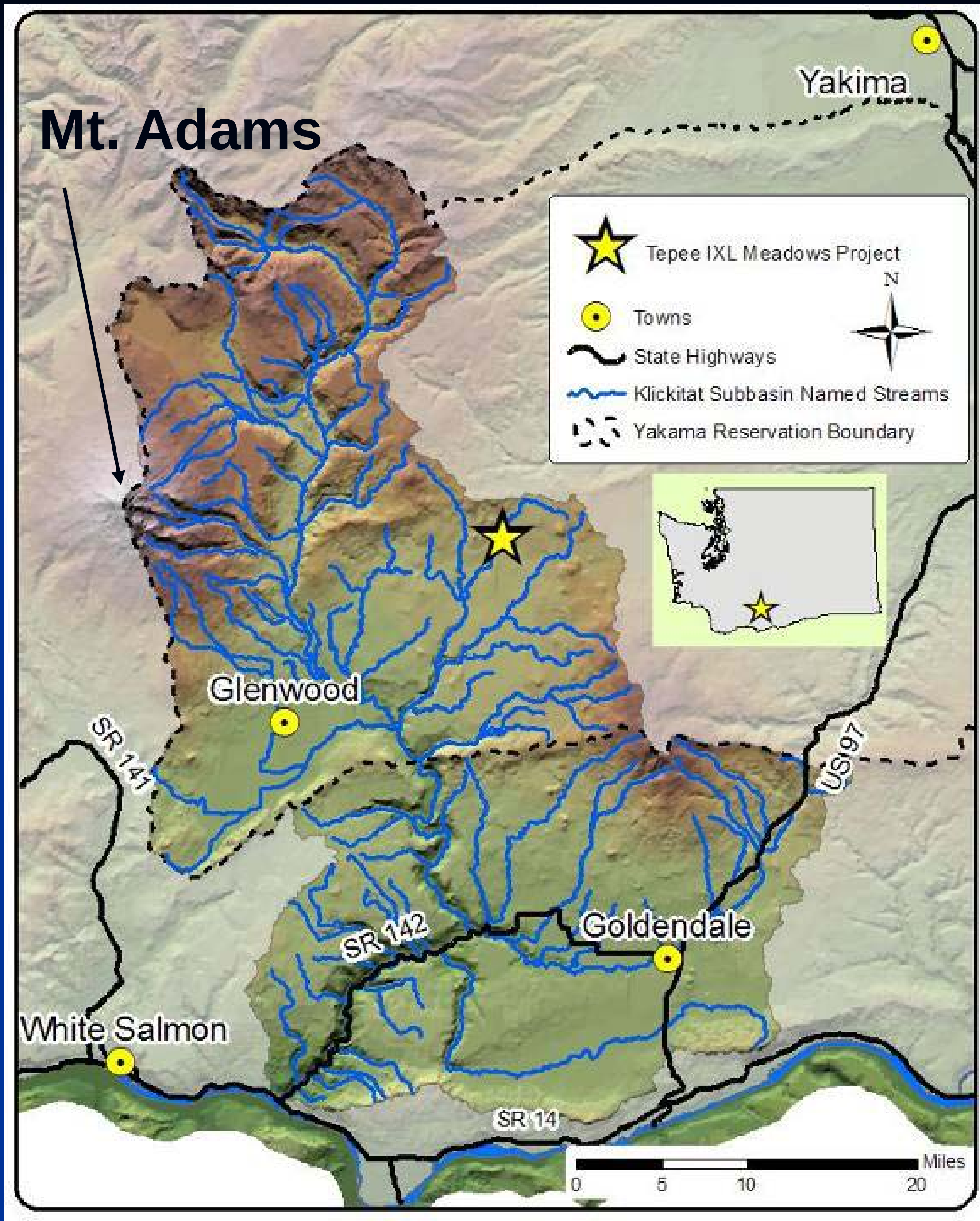
March 16, 2010

Outline

- Background
- Tepee IXL Project (phase 1)
  - Results
  - Insights / lessons Learned
    - Bed Material
    - Average Gradient
    - Materials Salvage
- Tepee Creek Meadows (Phase 2)
  - Sequencing
  - Baseline monitoring results

Location

- Klickitat River tributary
- Columbia R. basin
- south-central Washington State
- east-slope of Cascade Mountains
- 22 miles due east of Mt. Adams
- within Yakama Nation Reservation



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Setting

- Forested watershed (3000-4000')
- Basal geology is Grande Ronde basalt (CRB group)
- Hard parent materials and low to moderate relief = very limited bedload supply
- Contributing drainage area of 8.4 square-miles
- Project reach is at 2965' elevation
- Cohesive soils / banks (Aquandic Haploxeralfs)
- Prevailing soil texture is clay loam

Problem

- Project reach dried-up in 4 out of 5 years preceding project implementation
- Limited steelhead (ESA- “threatened”) **rearing (limiting)** and spawning habitat
- Fish stranding in ephemeral pools
- Field indicators and hydraulic modeling indicated that project reach was incised 3 to 4 feet, mostly within historic planform

Goals

- Raise water table / floodplain storage
- Enhance in-channel habitat conditions for rearing steelhead
- Restore suitability of valley bottom for medicinal and traditional food plants

Project Team

- Will Conley – YN Fisheries Program

  - Project Management - Design

  - Construction Oversight

- Mike McAlister, PE - Interfluve, Inc

  - Design - Construction Oversight

- Mike Brunfelt - Interfluve, Inc

  - Design - Construction Oversight

Sequencing

Implemented over two field seasons:

- Fall 2006
  - All riffles roughed-in
  - Downstream grade control completed
  - All LWD and rock material delivered to site
  - Roughly half of the LWD jams completed
  - Temporary erosion control measures implemented
- Maximum discharge over winter 2006/2007 = 143 cfs
- July 2007
  - Final grading on pools and riffles
  - LWD jams and floodplain LWD completed
  - Revegetation and weed control completed
  - Fence construction completed
  - Access routes rehabilitated

Implementation

- A 140' coarsened riffle (0.03 ft/ft) was constructed at the downstream end of the reach for grade-control
- Ninety-five feet of new channel constructed
- Reconnected 135' of historic channel
- Imported gravel to raise bed elevation (~3') and reconstruct pool/riffle sequences along 1850'
- Overall reach lengthened to 1990'
- 28 LWD jams constructed along channel margins
- Numerous floodplain LWD placements constructed
- Removed 2 culverts and related fill from an abandoned cross-valley road alignment

Typical Riffle Fill and LWD: Under Construction

Typical Riffle Fill: Before & After

STA 6+35

Elevation of constructed bank toe / channel invert

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STA 10+60

"Immature" cross-section constructed (2007) to minimize bed shear and allow development of inset channel

Vegetation encroachment after one growing season

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STA 12+25

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Ineffective areas intentionally left unfilled

STA 20+90

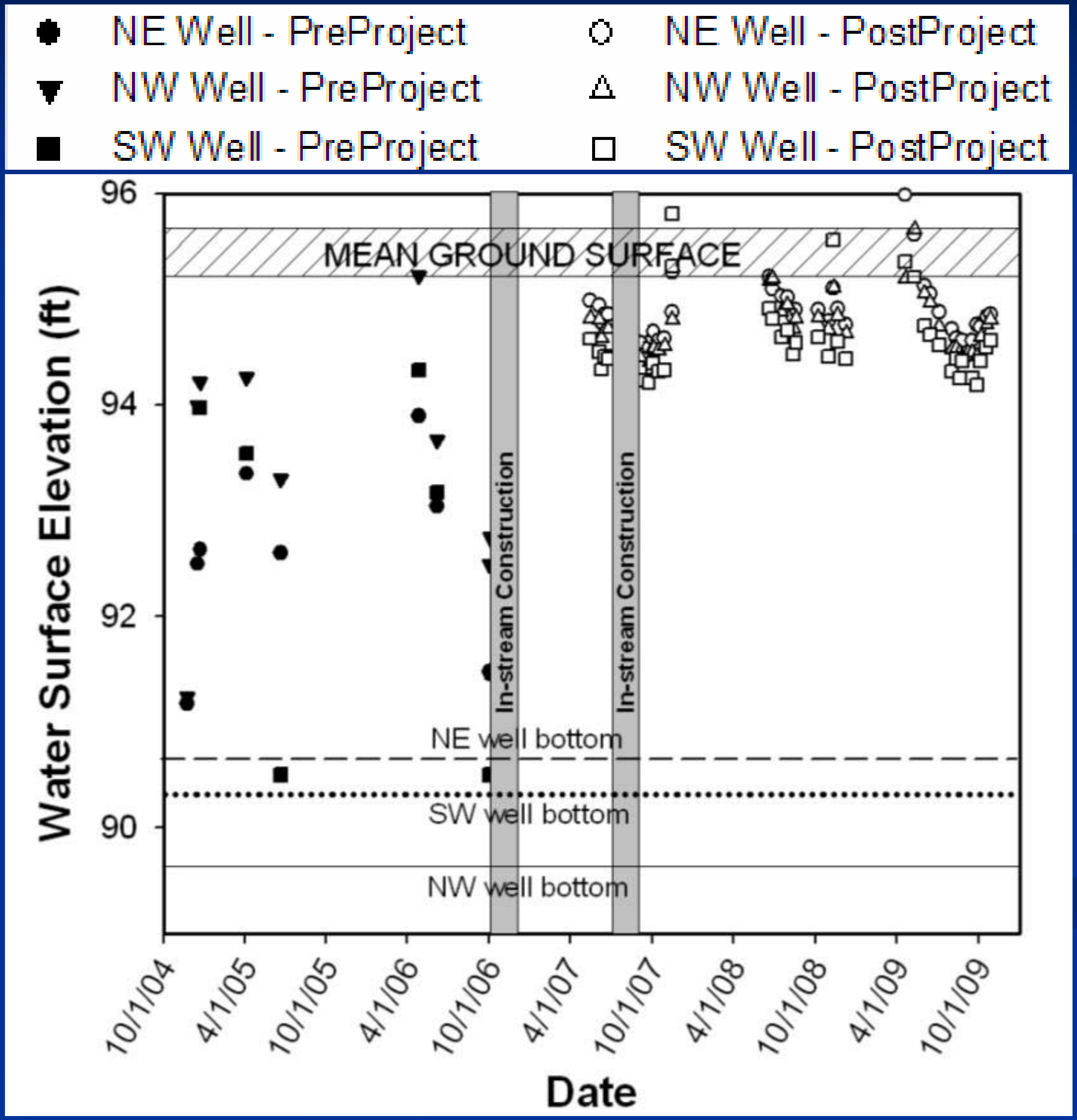
(IXL Road Crossing – upstream end of project reach)

Culvert outlets backwatered to improve fish passage

Groundwater

Post-project:

- 2' – 4' increase in summer/fall water table
- Less variability between and amongst wells



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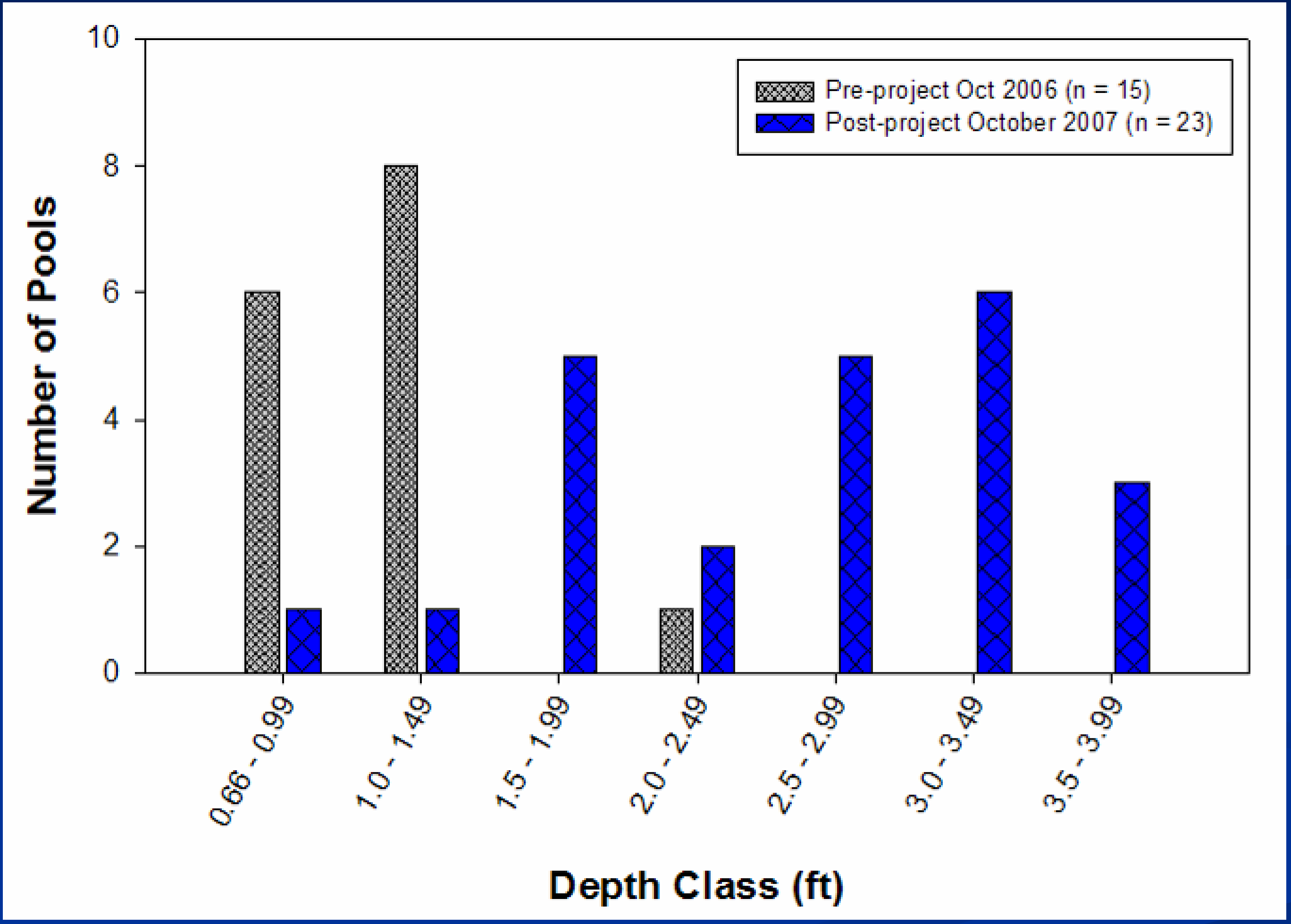
Residual Pool Depths



Note: because some pools were under-filled during construction, the median value for residual depths under equilibrium conditions is anticipated to be 2.0' - 2.49'

Steelhead Spawning

Year	Total Redds in Tepee Creek (redds/mi)	Redds in TepeeIXL Reach (redds/mi)	Redds in Tepee Cr outside of IXL reach (redds/mi)
2004	12 (1.5)	n/a	n/a
2005	0	n/a	n/a
2006	0	n/a	n/a
Project Initiation			
2007	3 (0.4)	2 (5)	1 (0.1)
2008	2 (0.2)	0 (0)	2 (0.3)
2009	12 (1.5)	4 (10)	8 (1.0)

Results Summary

- Flow Duration: 23 perennial pools maintained all 3 years since construction
- Groundwater: 2 - 4’ increase in summer water table
- High Flow Access: at bankfull or lower flows to four side channels totaling 835 lineal feet
- Pools: increased from 15 to 23 (65%); greater depths & cover
- Wetlands: ~3100 ft^2 of emergent wetland created
- Riparian Vegetation: Rapid recovery, particularly of salvaged plant materials
- Spawning: five steelhead redds observed
- Rearing: 2x – 3x increase in juvenile *O. mykiss* abundance
- Macroinvertebrates: Rapid colonization by multiple taxa of caddisflies and mayflies

Bed Material: Pre-Project

colluvial armor; clasts >40mm
mostly sub-angular

bi-modal distribution;
very high fines content

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Bed Material: Design

- Size distribution should balance:
  - stability (Q_2 = ~150 cfs)
  - porosity (Q_{base} = ~10 gpm)

Gradation Table
Imported Gravel

Percent Smaller Than	Diameter (in)
100	4.0
84	1.6
50	0.7
16	0.2

$D_{84} / D_{100} = 0.4$

$D_{84} / D_{16} = 8.0$

$D_{84} / D_{50} = 2.3$

- Consider:
  - Ambient passage conditions
  - Temperature vs dissolved oxygen trade-offs
    - D.O. recovers faster than temperature
    - Erred on side of too porous, hence lower potential for adverse temperature and stability effects

Bed Material: Sourcing

Crushed vs. Alluvium:

- Watershed setting
  - Headwater stream (~8 mi^2 drainage area)
  - Very limited bedload supply is a function of hard basal geology (Grand Ronde basalt) and low relief
  - Bed particles >40 mm are mostly sub-angular
  - Bed particles <40 mm are sub-rounded to rounded and move at flows < Q_{AA}
- What are the project goals?
  - Maintaining vertical elevation of controls (riffle crests) is paramount to success
  - improving spawning habitat NOT a primary goal
- Also consider:
  - Ethics of becoming party to floodplain gravel mining
  - Burning fossil fuels to haul longer distance

Bed Material: Q Through Riffles

Threshold for wetting

10/30/08
Surface flow at control
~ 0.56 cfs**

11/4/08
Top-to-bottom surface flow
~ 1.90 cfs**

* STA 13+20 is one of four controls that has a “plug” of native soil in the subgrade

** adult passage and spawning throughout project is comparable to untreated reaches (median spawning flow = 12.6 cfs)

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Bed Material: Q Through Riffles
(cont'd)

Q < 0.5 cfs

- No subgrade "plug" in either control
- Both stations have comparable cross-sectional fill areas
- STA 2+70 constructed under wetter ambient conditions than 15+80 (i.e. more intrusion of native fines into fill during construction)

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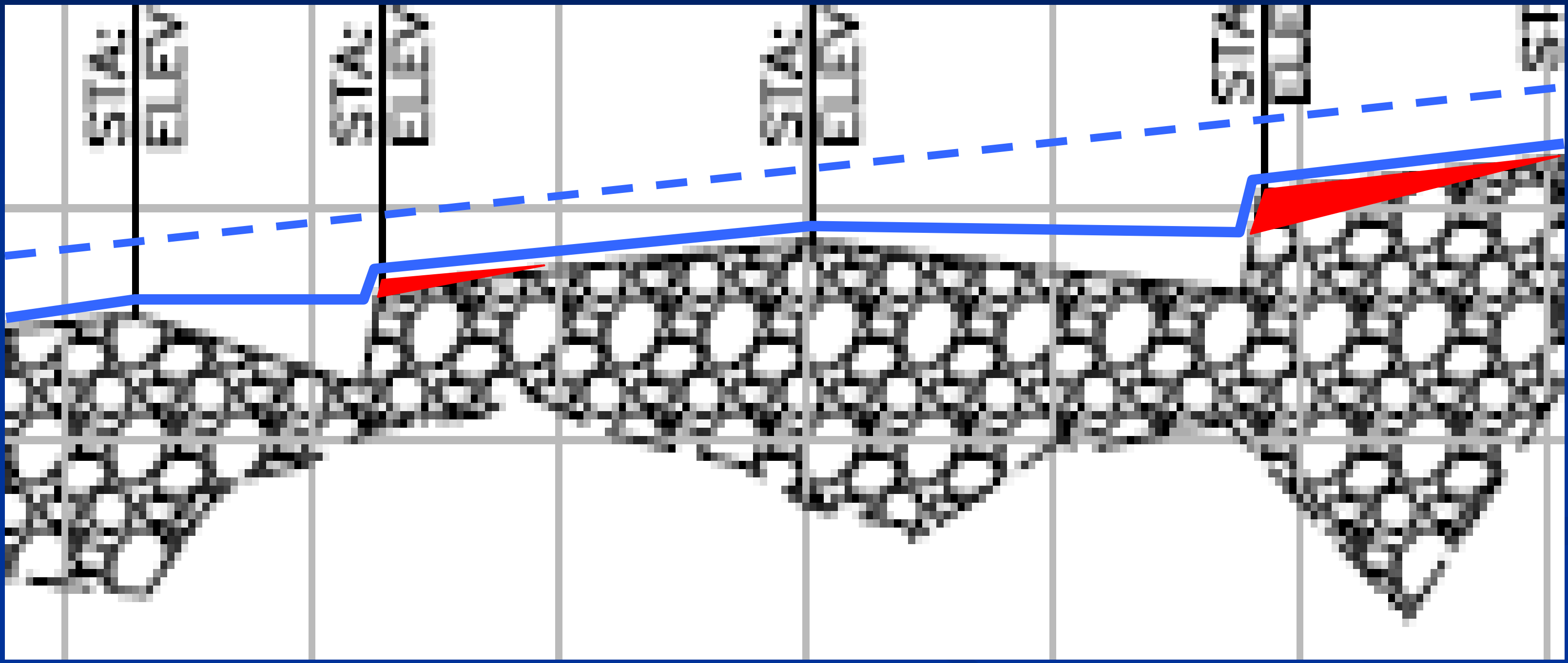
Bed Material: Observations

- Soil plugs in subgrade of riffle crests:
  - Do increase residual pool depths
  - Are as-yet untested in live-bed conditions
- Riffle porosity inversely correlated with:
  - Amount of tracking by equipment
  - Ambient moisture conditions at time of construction
- Fish passage through constructed riffles
  - Is comparable to ambient conditions
- Macroinvertebrate response very positive and rapid
- Steelhead and resident trout spawning observed
- Dissolved Oxygen
  - Appears to be an issue where known groundwater inputs occur and subsurface flow through riffles

The Thing About Average Gradient…



- Medium to high flows: OK because energy line and bed slope are more or less parallel
- Low flows: energy line is stepped which (in the absence of further treatment) causes headcutting of riffle toes

Implementing Average Gradient

Mitigate by one or a combination of:

- Skew thalweg to centerline
- Harden / coarsen riffle toe
- Transition slope into head of pool
- Extend riffle downstream into pool
- Add a log drop (only done in one place)

Native Material Salvage

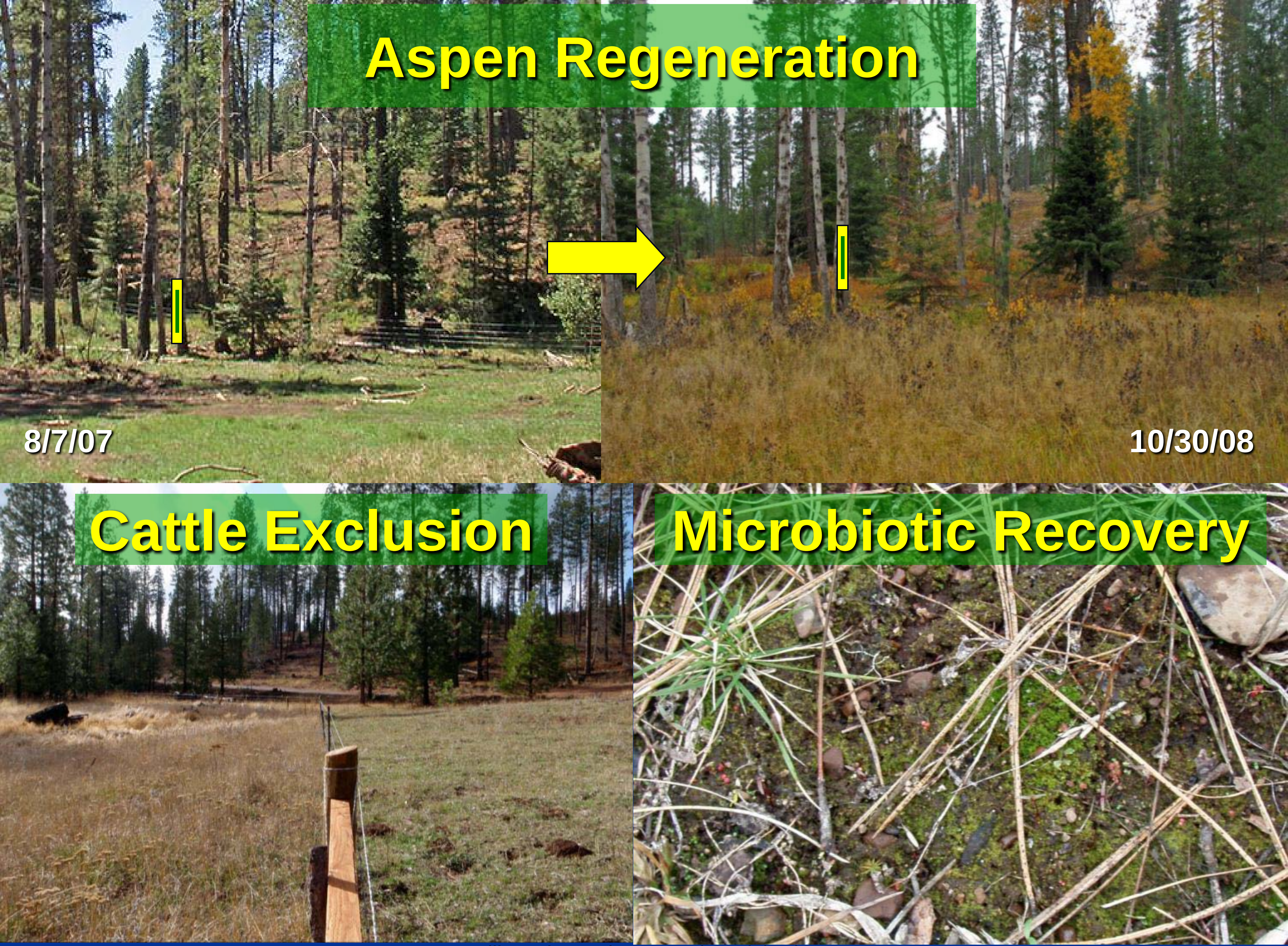
Vegetation - VERY effective

Gravels - mostly window-dressing (in Tepee Creek)

Native Material Salvage (cont'd)

STA 14+80

Salvaged sod and shrubs used along bank



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Tepee – Phase 2

- 7850’ reach immediately downstream of IXL reach
- Monitoring (2003-2009) indicates importance to steelhead (ESA “Threatened”)
- Approximately 2/3 of reach dries-up every year
- Design 2009-2010
- Baseline monitoring 2009-2010
- Construction 2010-2011

Existing Conditions

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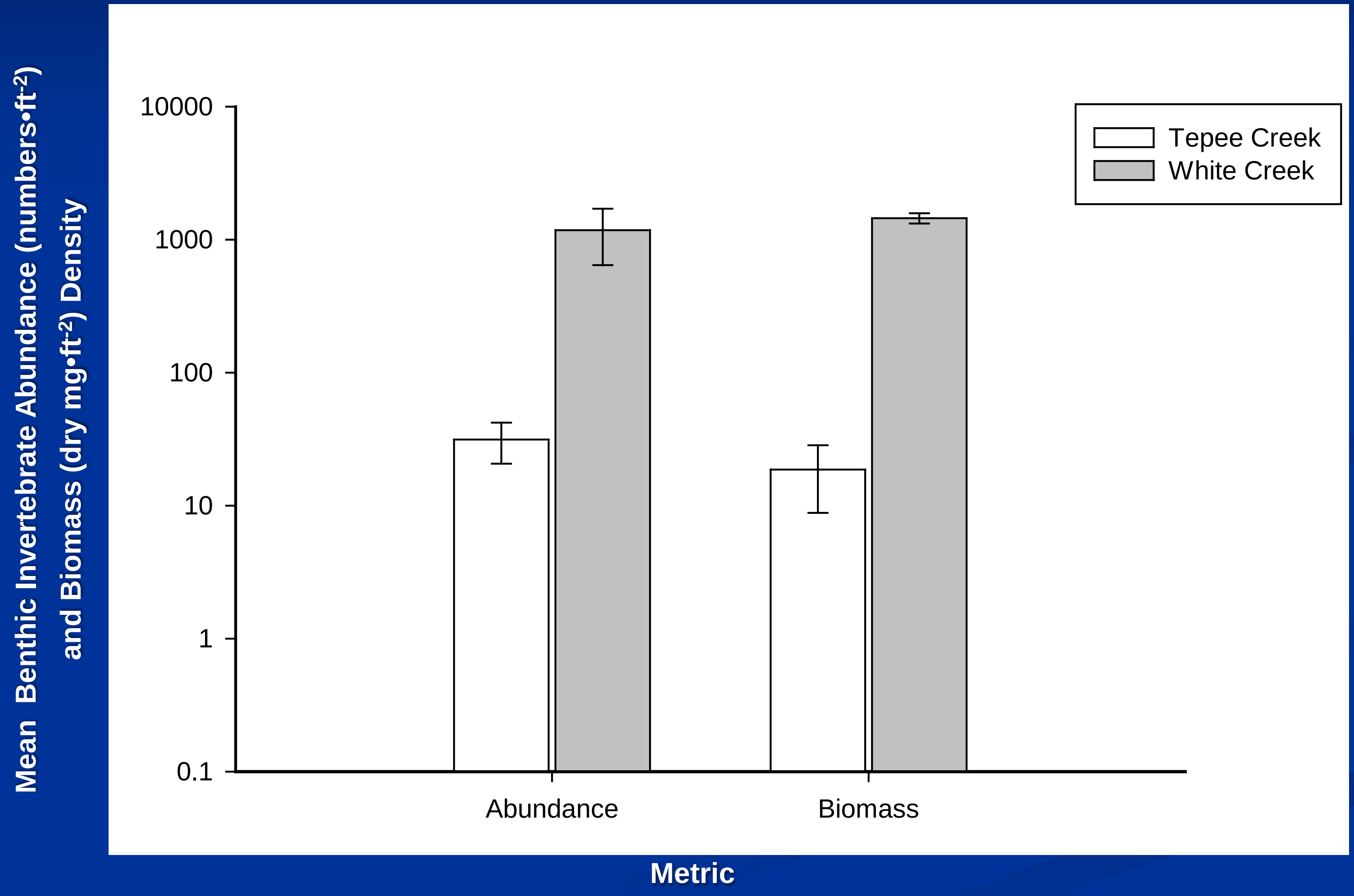
Existing Conditions (cont'd)

Tepee 2 – Monitoring*

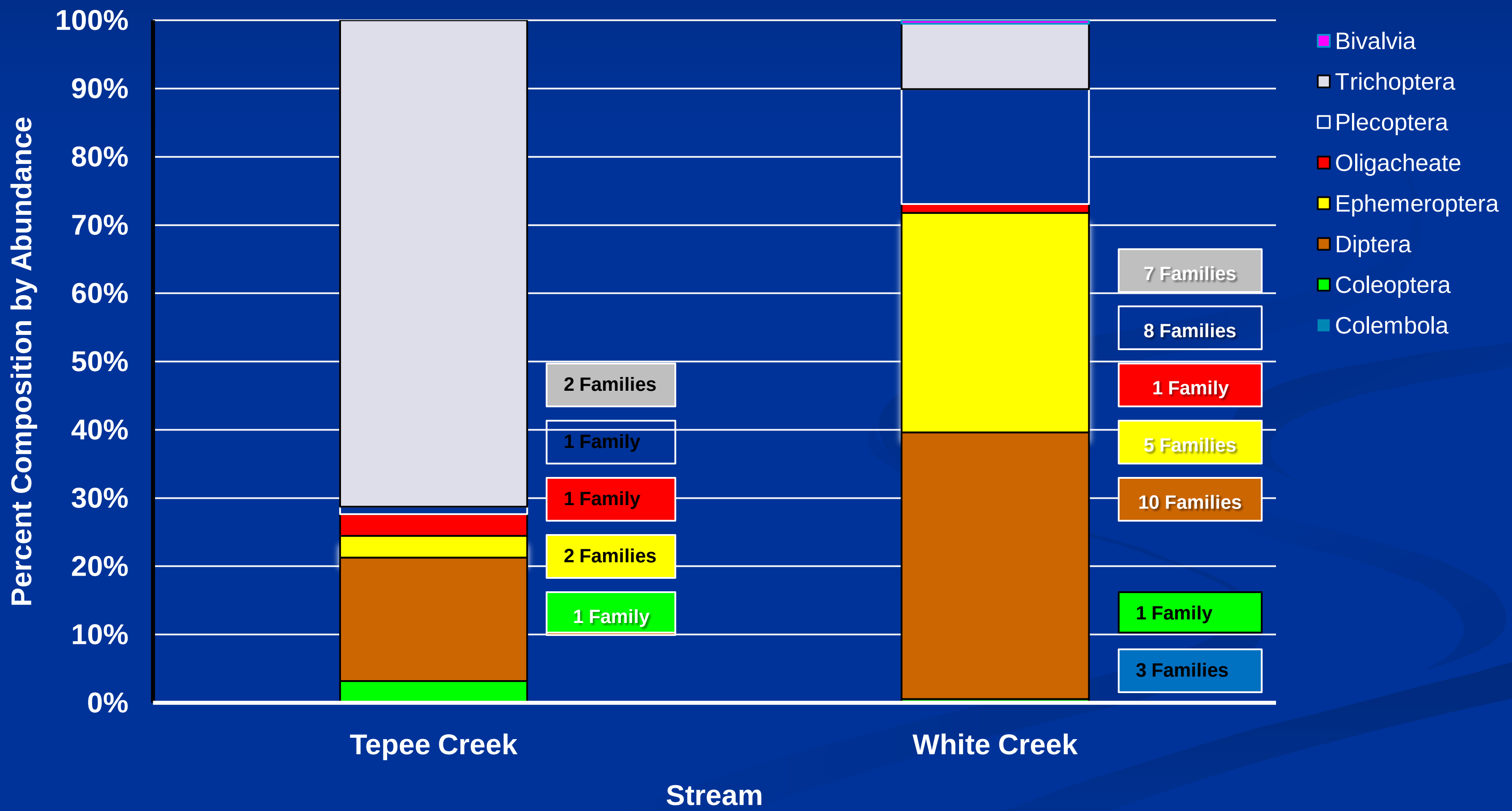
- **Secondary Production**
  - Benthic – Spring, Summer, and Fall
  - Utilization (gastric lavage) - Summer and Fall
  - Drift - Summer and Fall
  - Aerial/Terrestrial - Summer and Fall
- **Salmonids**
  - Adults (spawner and redd counts) - Spring
  - Juveniles/Residents – Summer and Fall
    - Mark-recapture for condition (length & weight)
    - Abundance
    - Migration and survival
- **Physical habitat**
  - **Pools, riffles, glides**
  - **LWD**
- **Shallow groundwater – year-round**
- **Surface water**
  - **upstream and downstream gages - year-round**
  - **wetted channel continuity – early fall**
- **Vegetation/Ground Cover**
  - **Canopy and ground cover**
  - **Species composition (point-based)**

*conducted cooperatively with YN's Klickitat Monitoring & Evaluation Project

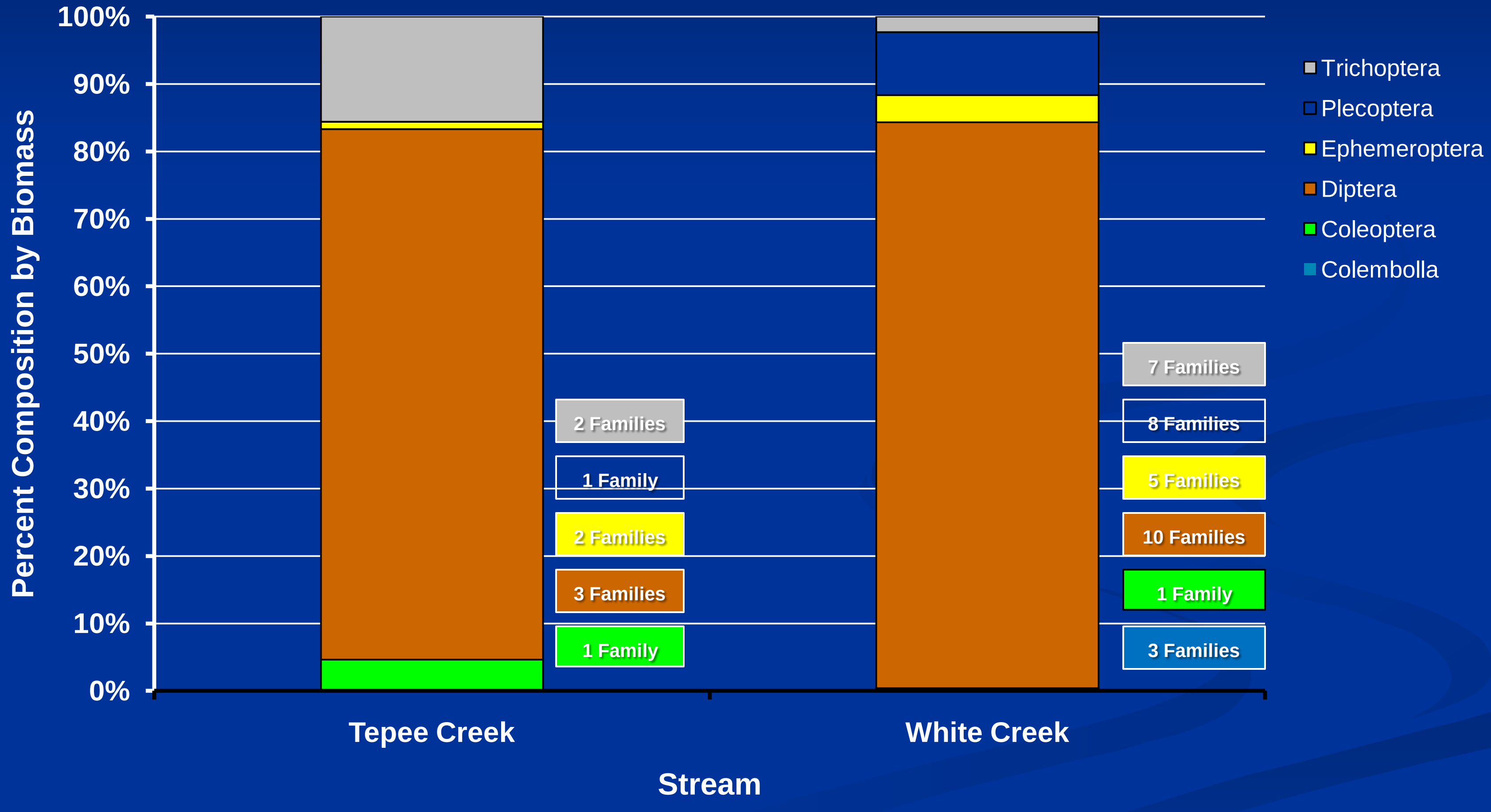
Fall 2009 Mean Benthic Invertebrate Abundance and Biomass Density in Tepee Creek (Phase 2) Treatment and White Creek Control Sections



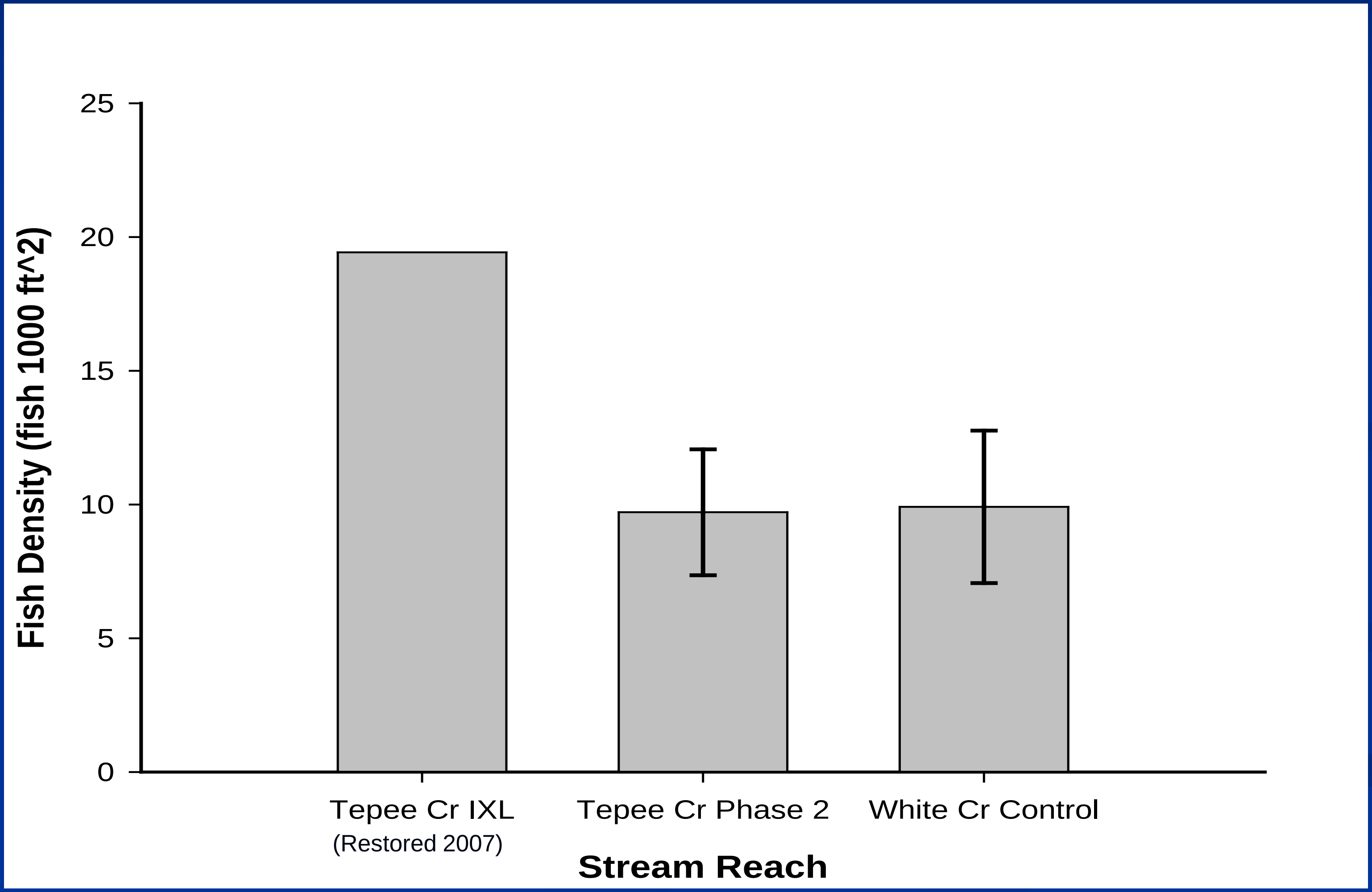
Fall 2009 Benthic Invertebrate Relative Abundance Composition by Order in Tepee Creek (Phase 2) Treatment and White Creek Control Sections



Fall 2009 Benthic Invertebrate Biomass Composition by Order in Tepee Creek Treatment and White Creek Control Sections



Summer 2009 Single-Pass Electroshocking Relative Fish Abundance in IXL Tepee (n=1), Phase II Tepee Treatment Sections(n=4), and White Creek Control Sections (n=4)



Acknowledgements

IXL Project:

- WA State Salmon Recovery Funding Board
  - materials and construction $188,192
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  - materials, planning, design, & oversight $139,092
- The Yakama Nation (in-kind)
  - LWD $ 40,650
- Ralph Kiona, Watershed Technician

Phase 2 Baseline Monitoring

- Nicolas Romero, Fisheries Biologist
- David Lindley, Habitat Biologist

For More Information

http://www.ykfp.org/klickitat/KWEP_TepeeIXL.htm

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