

# Effectiveness Monitoring at Multiple Temporal and Spatial Scales to Quantify Biotic and Abiotic Responses to Stream Enhancement



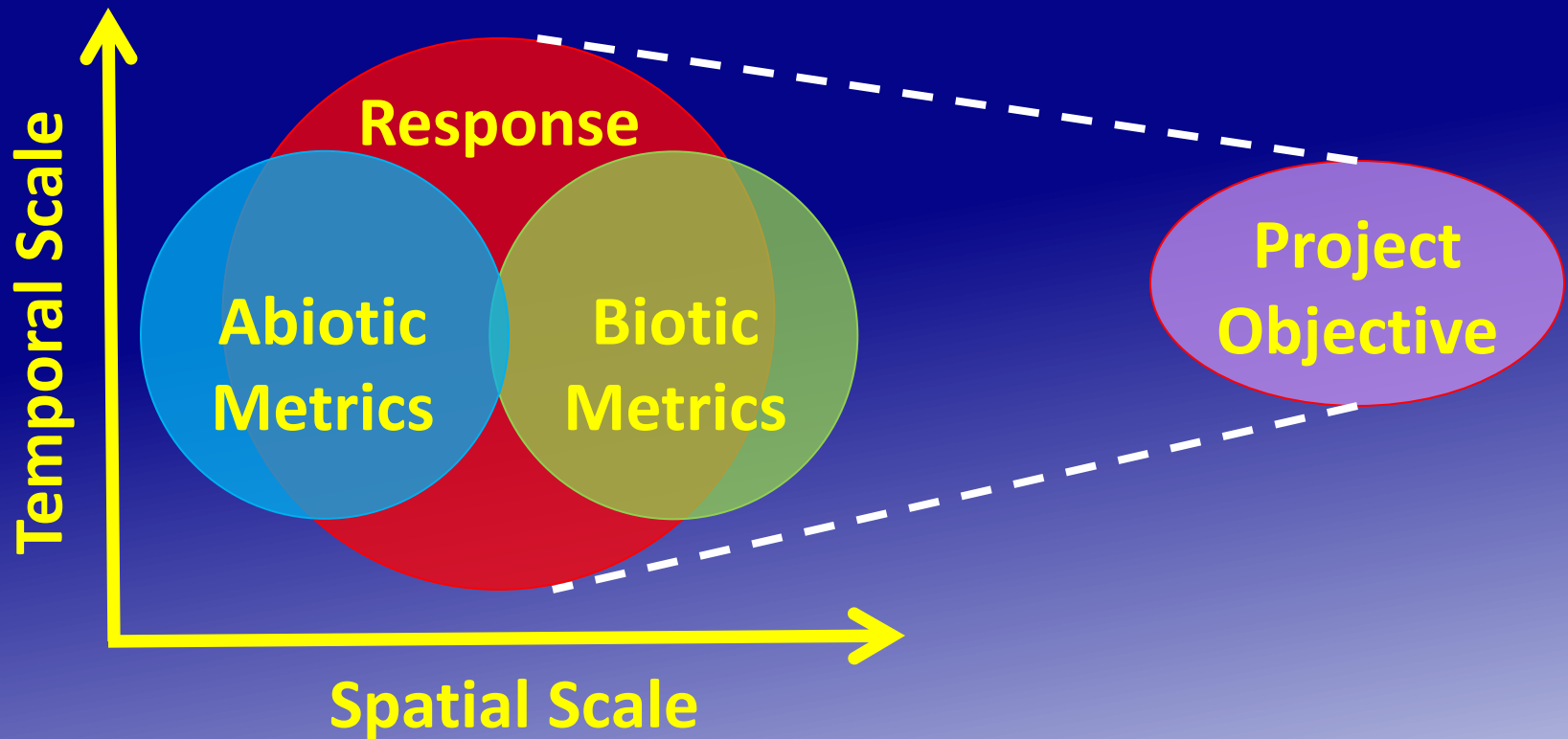
Nicolas Romero, David Lindley, and Will Conley  
Yakama Nation Fisheries Program



# Objectives

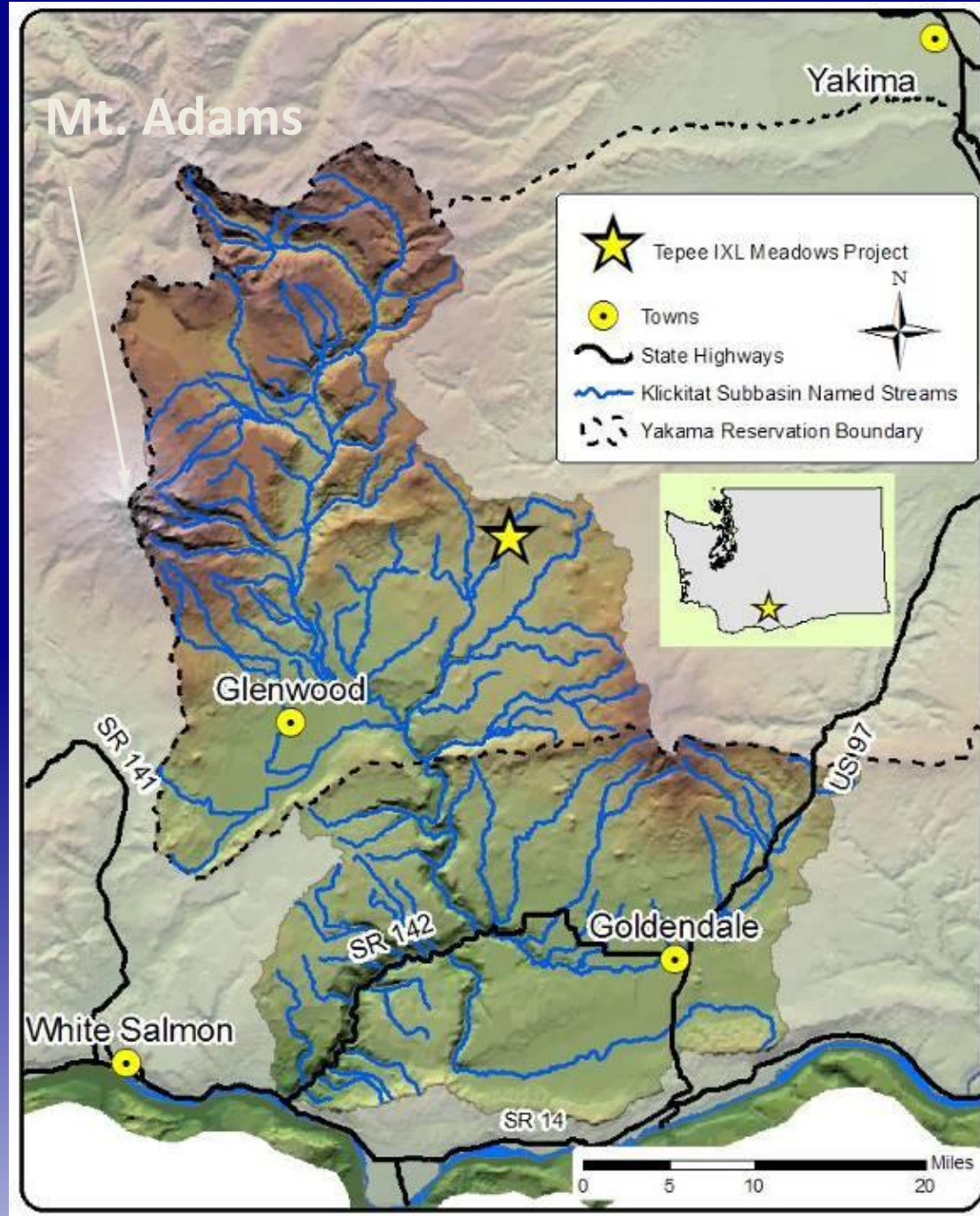
- Present our approach to effectiveness monitoring through two project examples
  - Tepee Ck IXL Meadows Stream Enhancement Project
  - Tepee Ck Phase 2 Stream Enhancement Project

# Effectiveness Monitoring Conceptual Framework



# Tepee CK IXL 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



# Tepee Ck IXL Problem

**Incised Channel**



**Decreased Flow Duration**



**Fish Stranding**

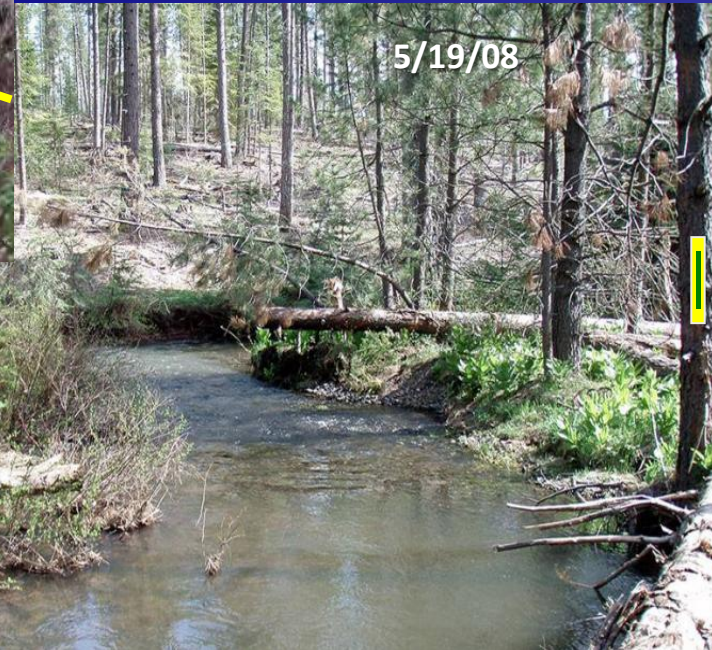


# Tepee Ck IXL Objectives

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

# Tepee Ck IXL Implementation (Fall 2006 and Spring 2007)

## Imported Gravel to Raise Bed Elevation



# Tepee Ck IXL Implementation

(Fall 2006 and Spring 2007)

## Culvert Outlets Backwatered to Improve Fish Passage





# Tepee Ck IXL Implementation

(Fall 2006 and Spring 2007)

## Additional Highlights

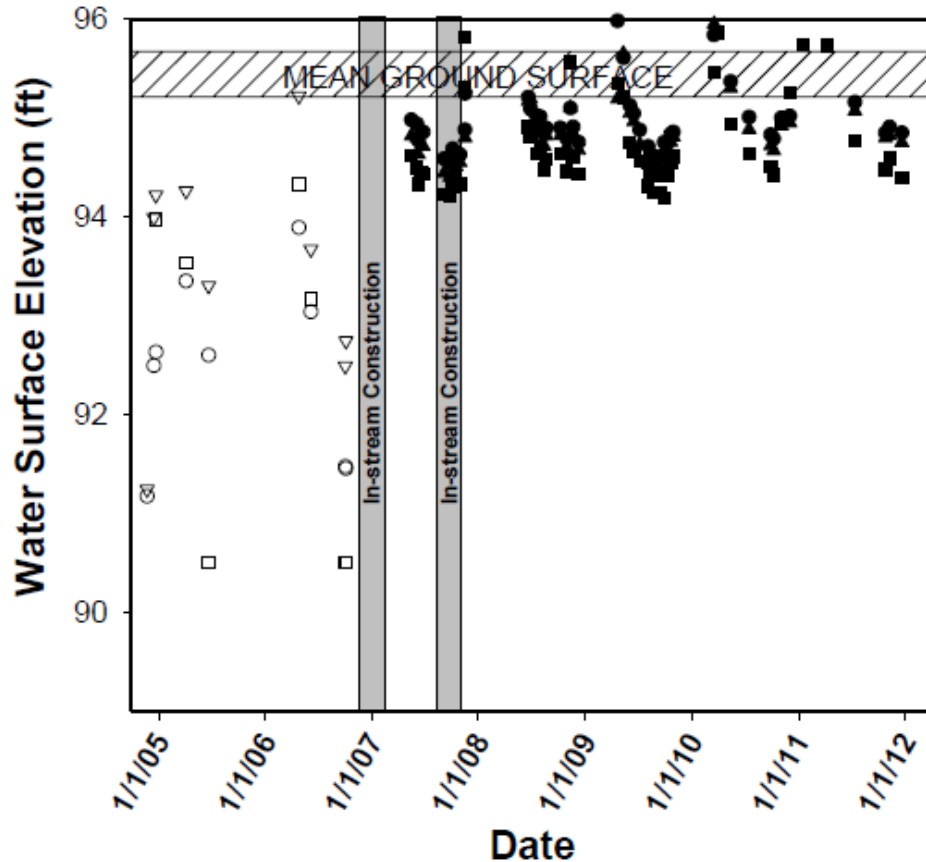
### 28 LWD Jams Constructed



- Ninety-five feet of new channel constructed
- Reconnected 135' of historic channel
- Overall reach lengthened to 1990'
- Numerous floodplain LWD placements constructed
- Built cattle enclosure around perimeter of project site

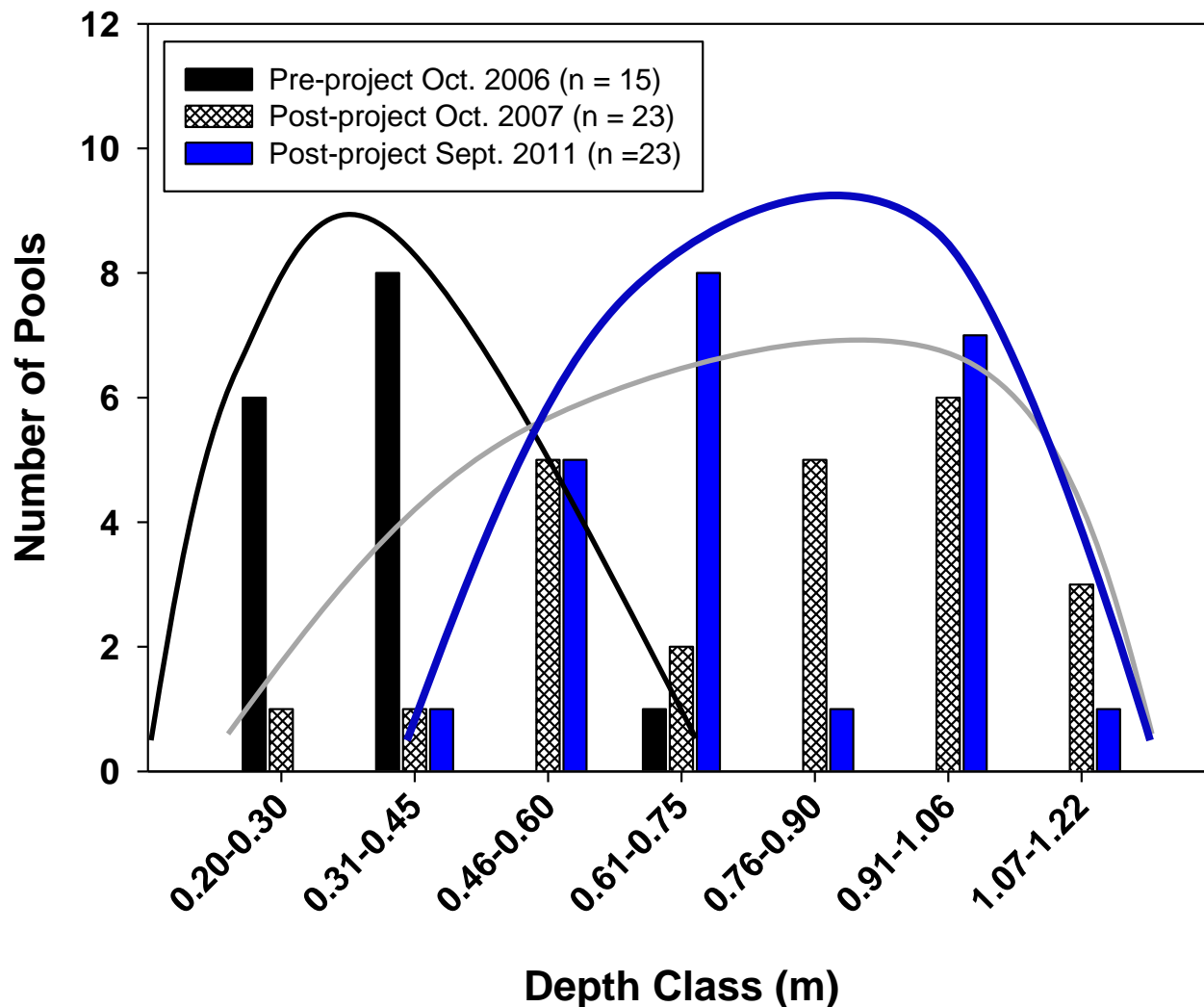
# Groundwater Monitoring – Tepee Ck IXL (Project Site Spatial Scale)

Tepee Creek / IXL Meadows Restoration Project:  
Pre- and Post-Restoration Groundwater Elevations



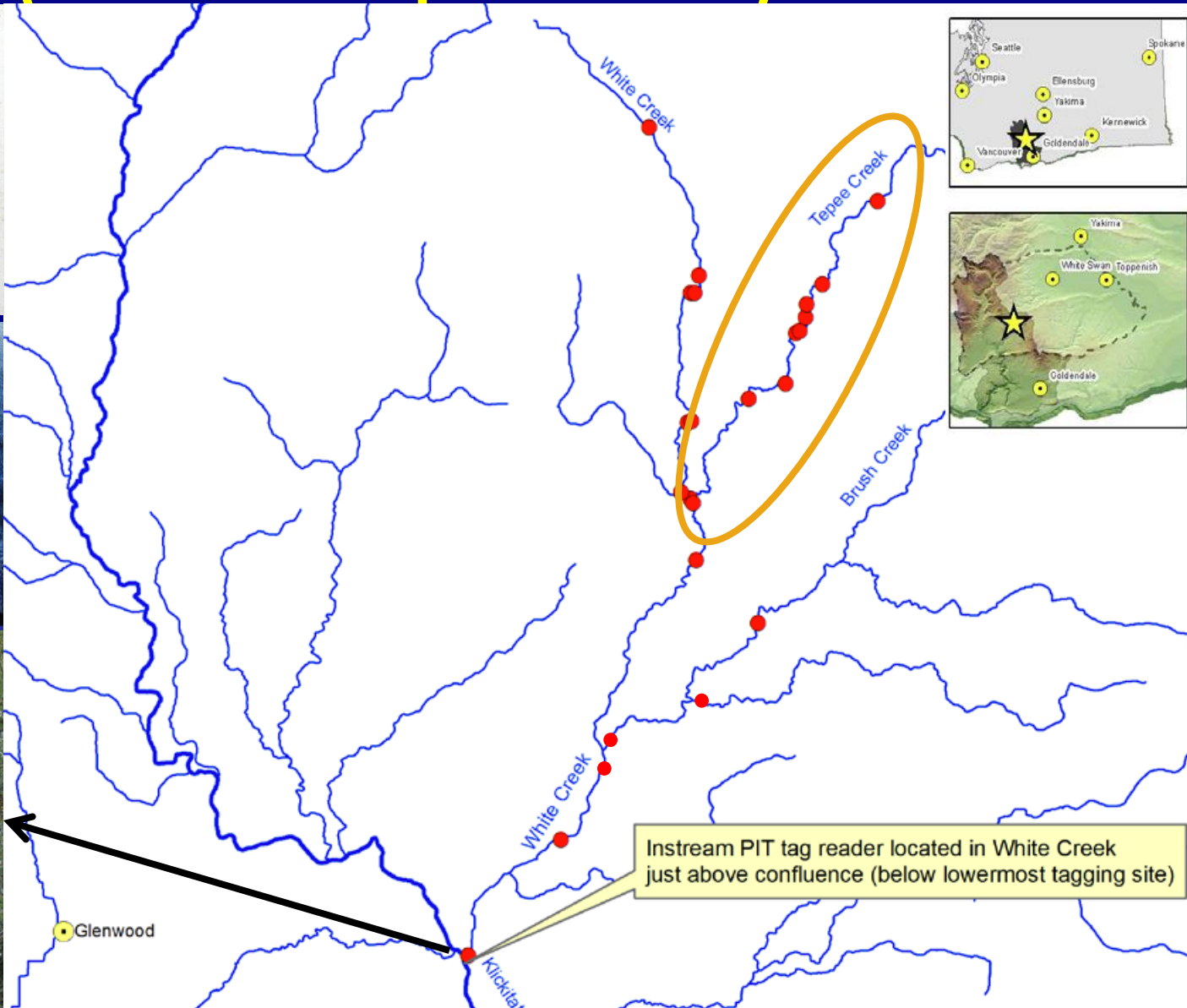
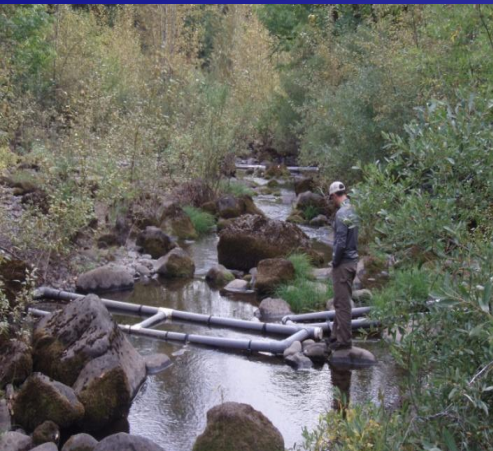
Elevated Water Table  
2-4 ft rise and less  
variation within and  
among wells

# Tepee Ck IXL Residual Pool Depths (Project Site Spatial Scale)



- Pools increased from 15 in 2006 to 23 in 2007 and 2011
- Residual pool depths shifted from shallow to deeper
- Residual pool depths maintained post-project

# White Creek PIT Tag Study (Watershed Spatial Scale)

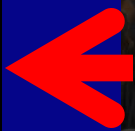
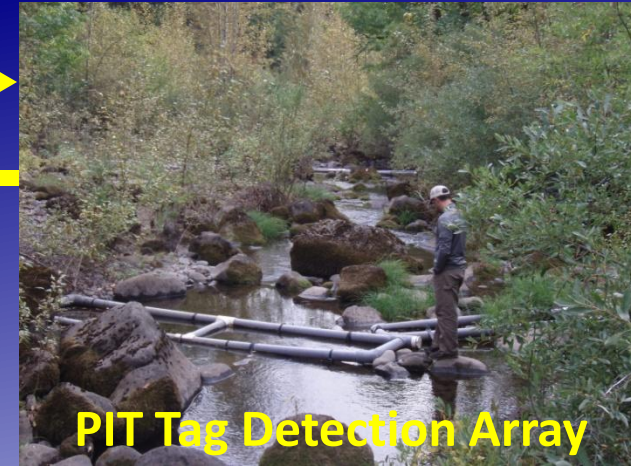


# PIT Tag Study – Methods



## Data Output

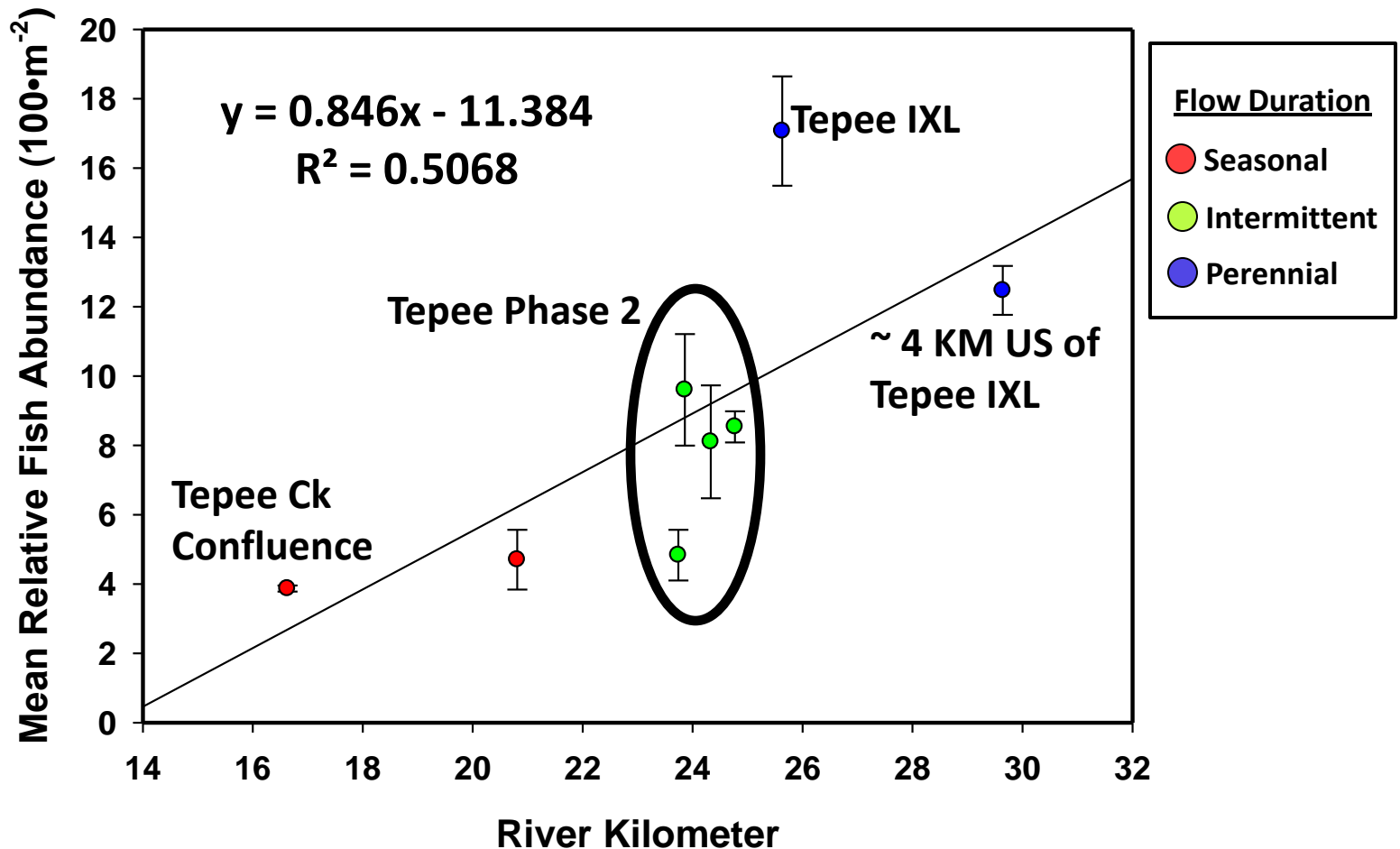
| 01 05/12/10 10:11:42 3D9.1C2CBC4456 FF 02  
| 01 05/12/10 10:17:32 3D9.1C2CBC4456 FF 04  
| 01 05/12/10 10:19:30 3D9.1C2CBC4456 FF 06



# Tepee Ck PIT Tag Study – Results

## (Tributary Spatial Scale)

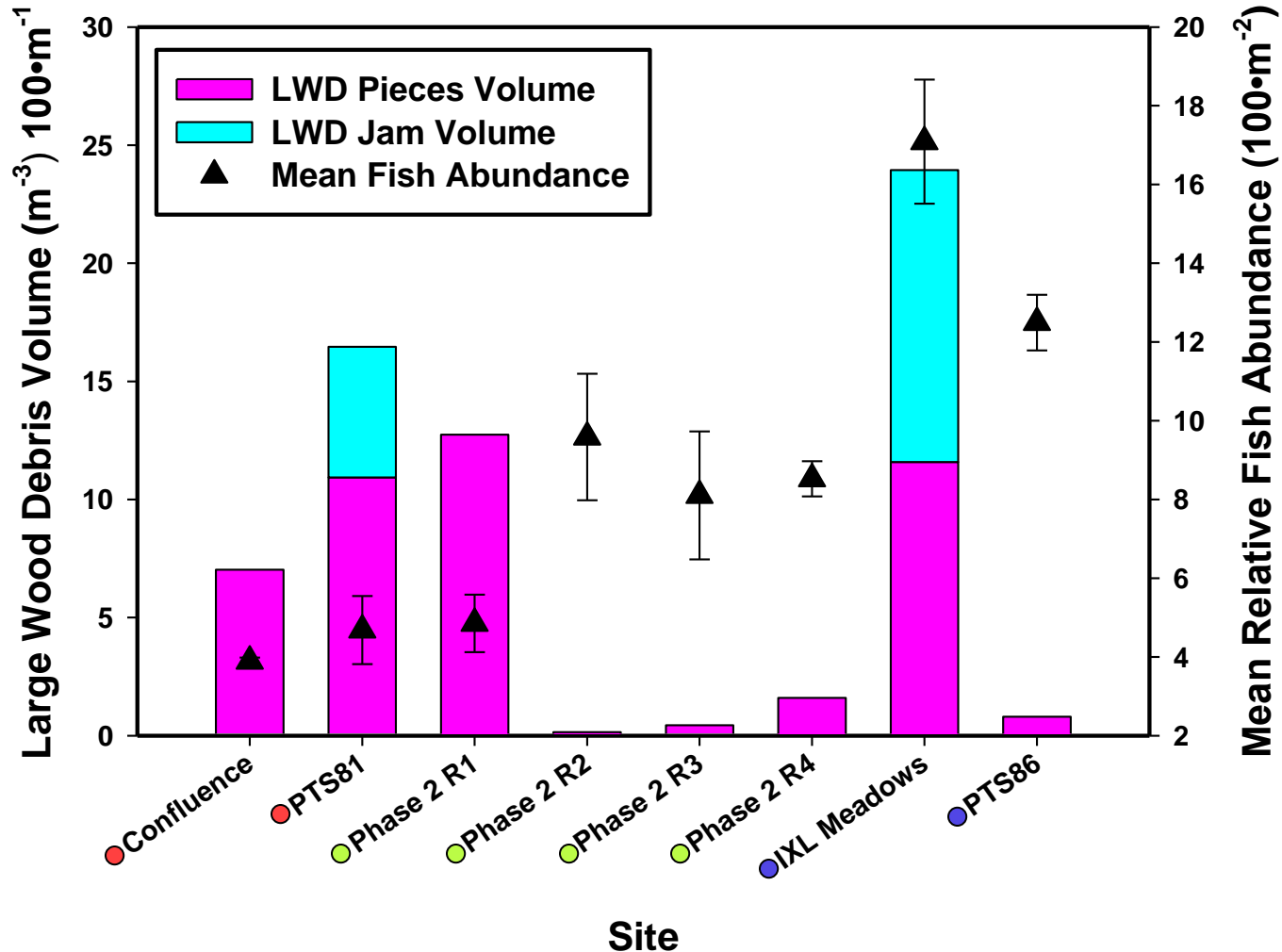
Mean Relative Fish Abundance by Site and Distance from Klickitat River for 2009-2011 Tagging Groups



# Tepee Ck PIT Tag Study – Results

## (Tributary Spatial Scale)

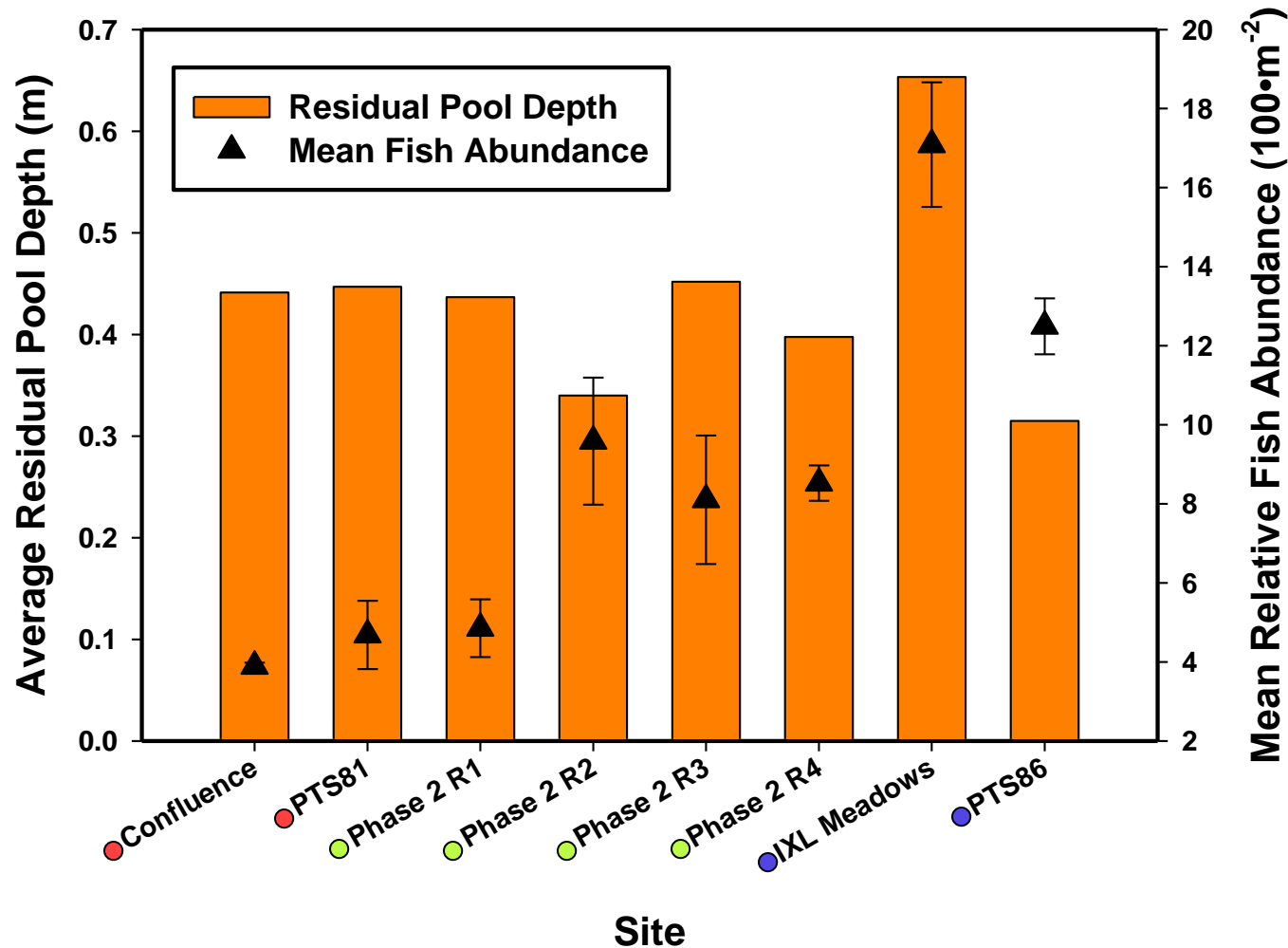
Relationship Between Wood Volume and Fish Abundance



# Tepee Ck PIT Tag Study – Results

## (Tributary Spatial Scale)

Relationship Between Residual Pool Depth and Fish Abundance

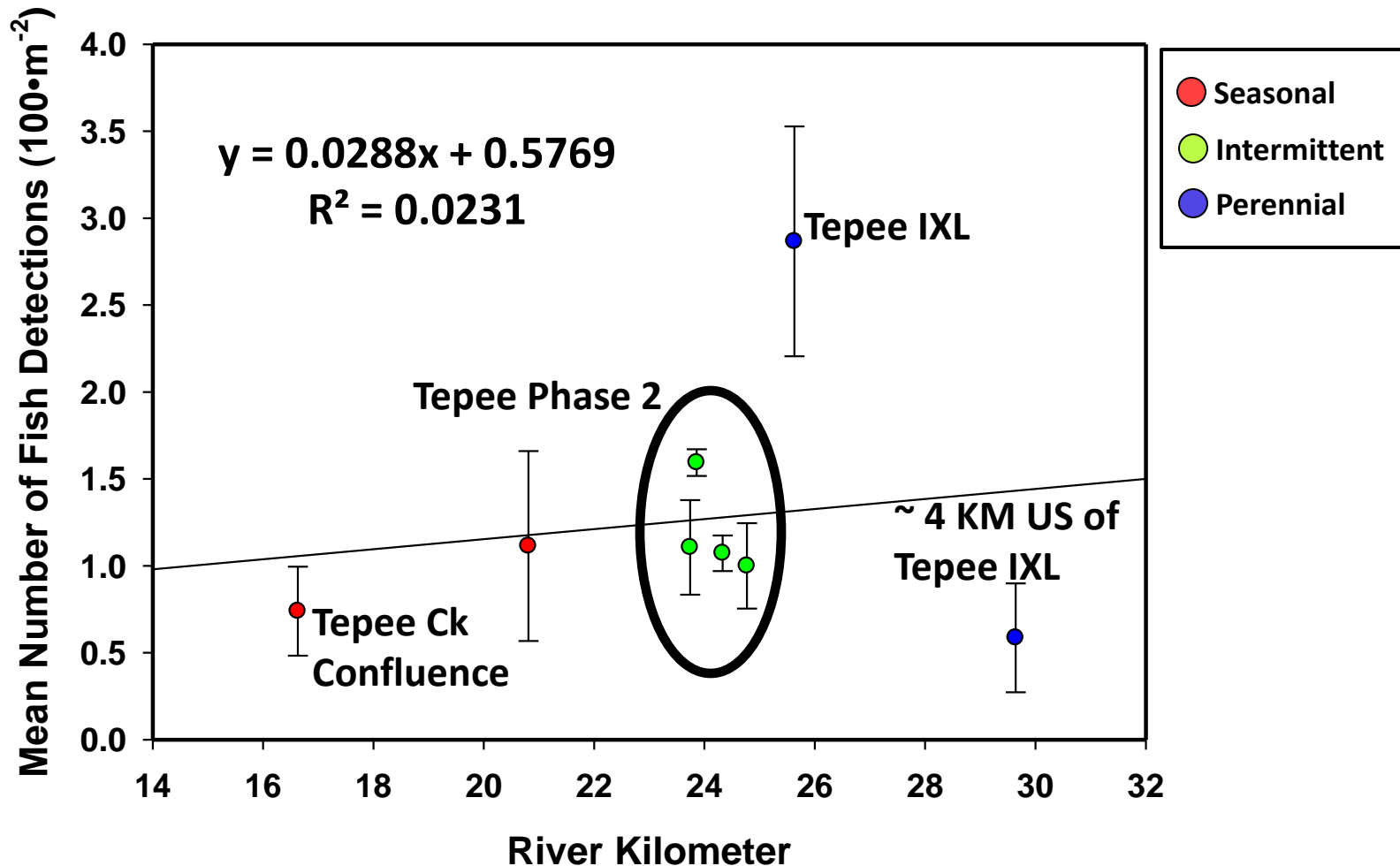




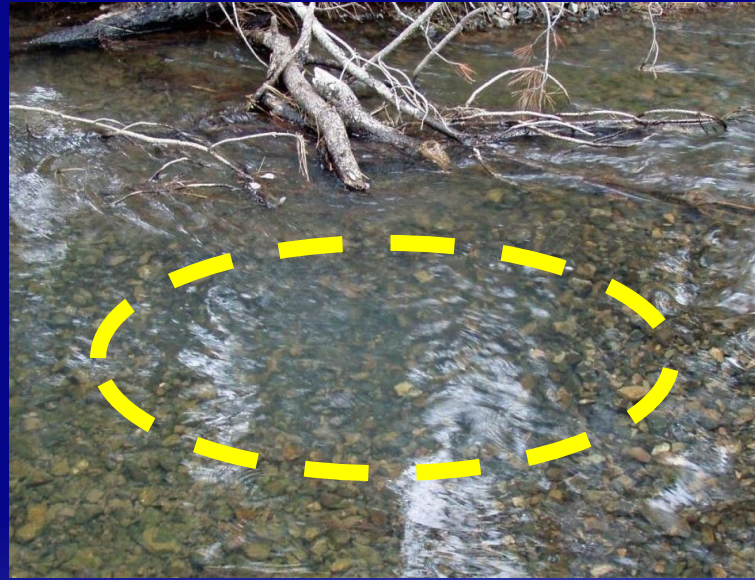
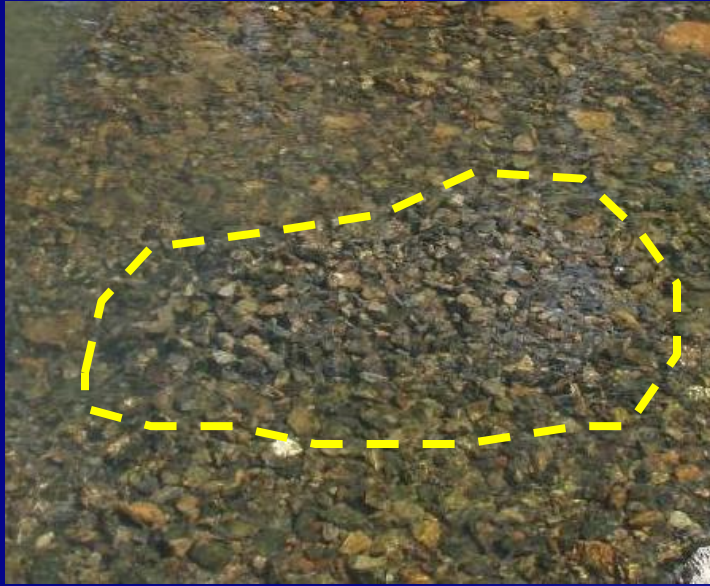
# Tepee Ck PIT Tag Study – Tag Analysis

## (Tributary Spatial Scale)

Mean Number of Fish Detections at the White Creek PIT Tag Array (RK 0.1) by Site and Distance to the Klickitat River for 2010 and 2011 Migration Years



# Tepee Ck Steelhead Spawning Surveys (Tributary Spatial Scale)

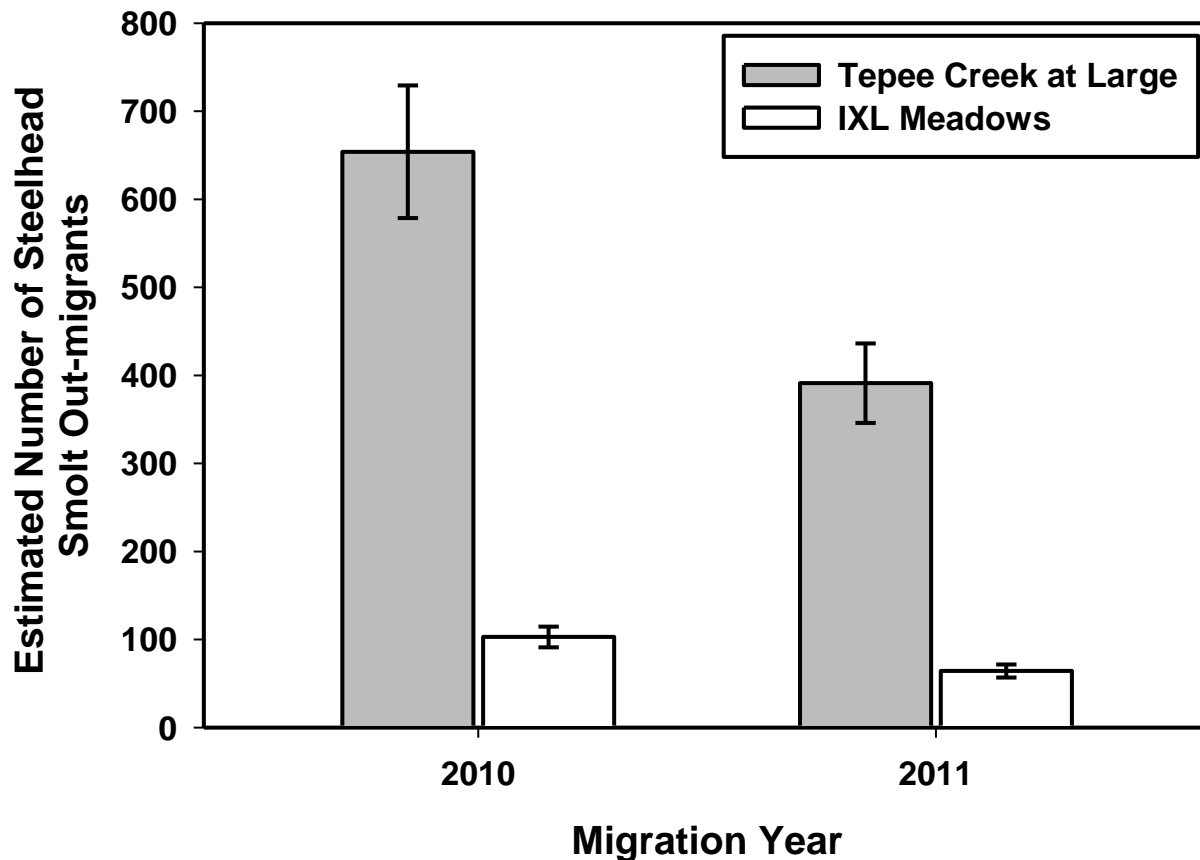


Year	Redds/KM in Tepee IXL Reach (0.64 km)	Redds/KM Tepee Cr outside of IXL Reach (13.0 km)
2007	3.1	0.08
2008	0	0.15
2009	6.3	0.62
2010	4.7	0.62
2011	1.6	0.62

# Tepee Ck PIT Tag Study – Results

## (Tributary Spatial Scale)

Estimated Number of Steelhead Smolt Out-migrants from Tepee Creek by Migration Year



- IXL Meadows = 5% Anadromous Habitat

- IXL Meadows contributed 13.6% of total out-migrants in 2010 Migration Year

- IXL Meadows contributed 14.1% of total out-migrants in 2011 Migration Year

# Food Web Study - Tepee Ck Phase 2

## Study Design

### BACI (before-after-control-impact)

#### Temporal Scales

Intra-Annual  
Sampling (Spring,  
Summer, Fall)

Inter-Annual  
Sampling (six year  
study)

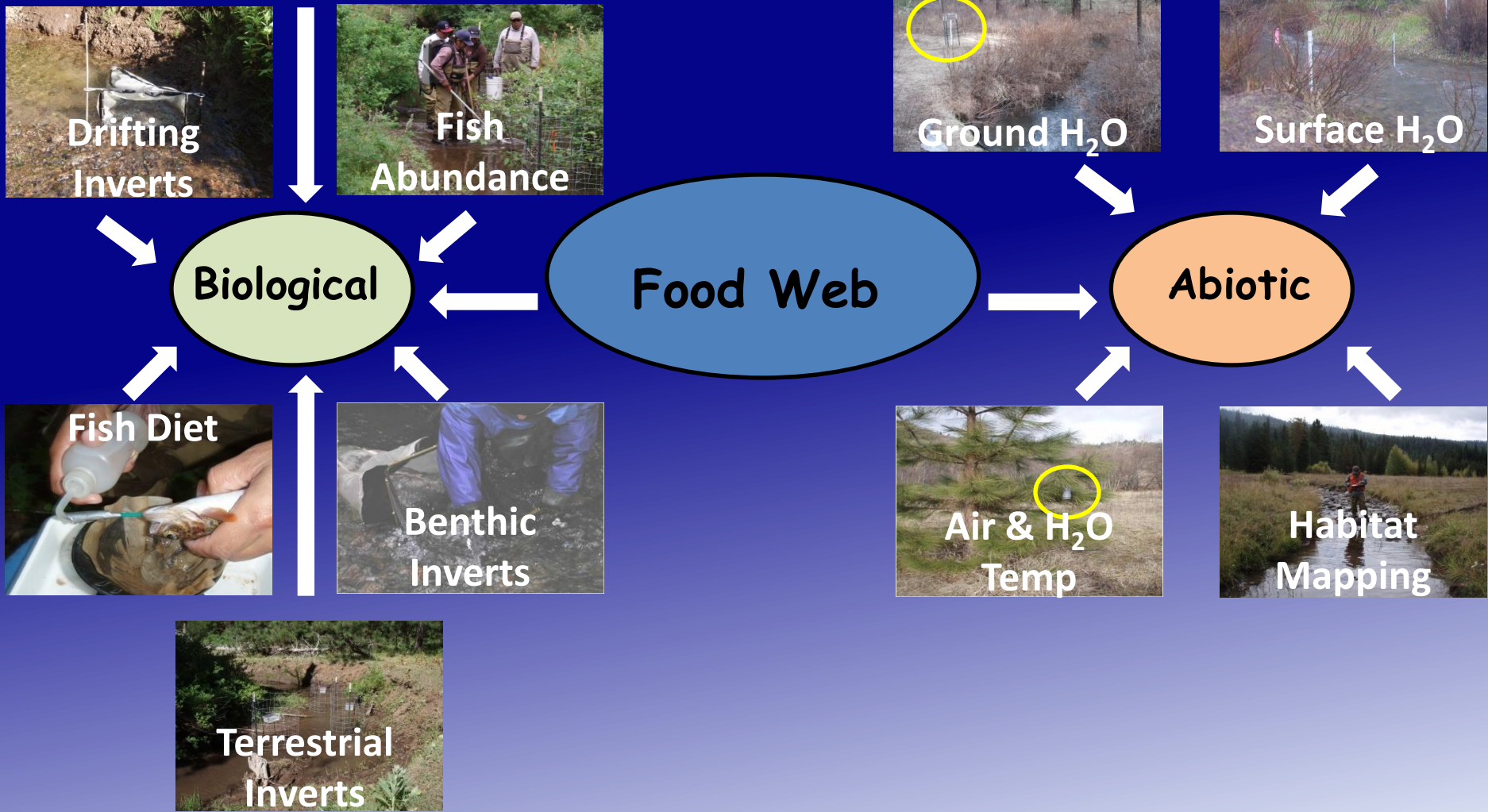
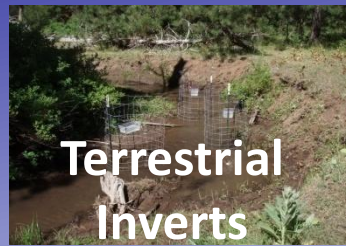
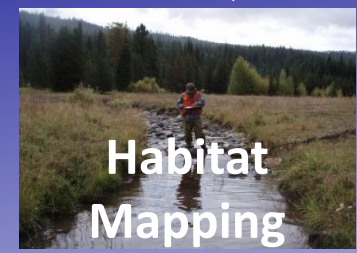
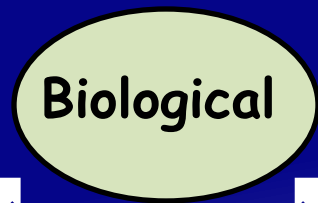
- 2 yr pre-treatment (Fall 2009-Fall 2011)
- 1 yr treatment (2012)
- 3 yr post-treatment (Spring 2013-Fall 2015)

#### Spatial Scales

Stream  
(Treatment = Tepee Ck  
Control = White Ck)

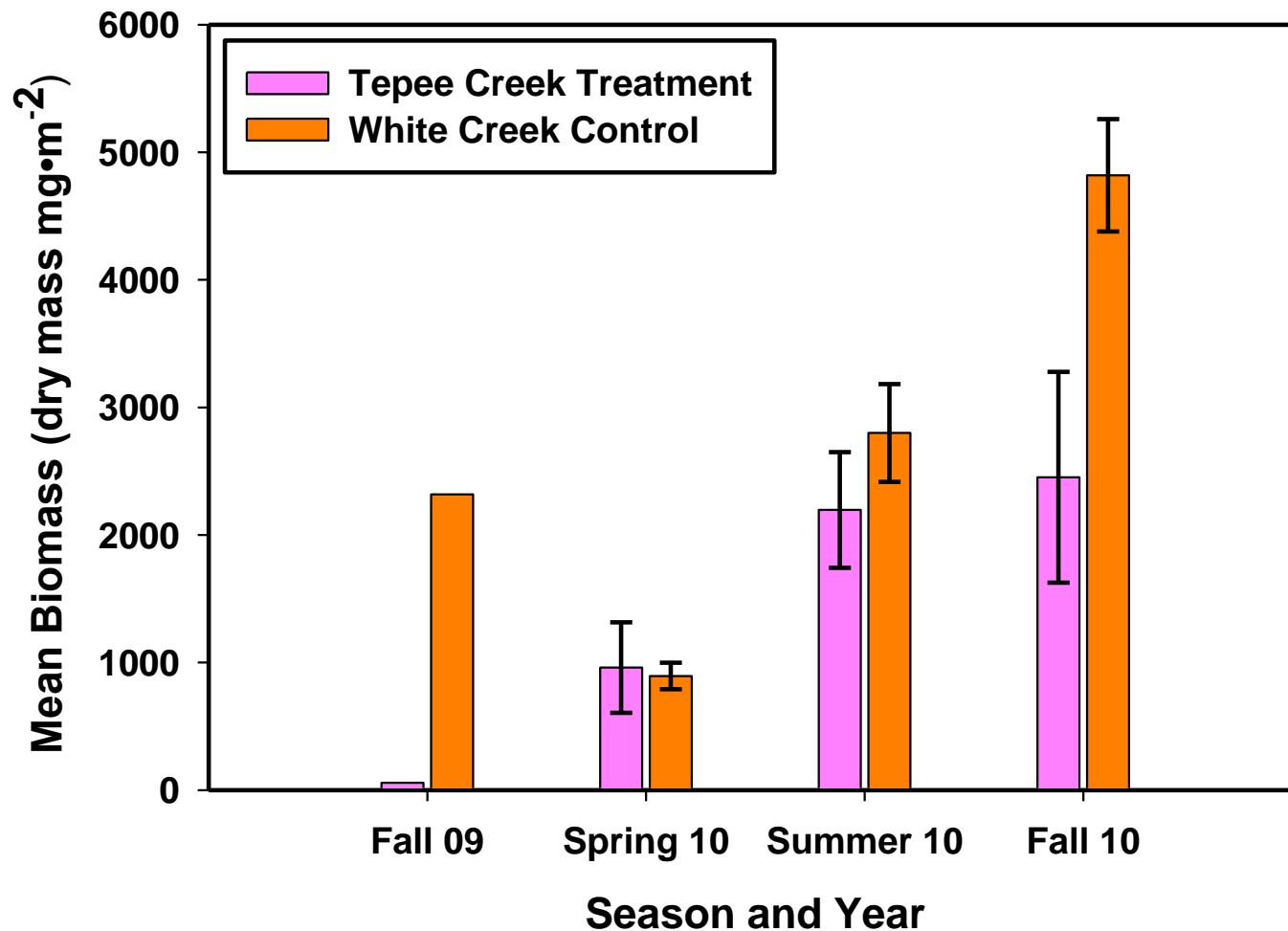
Sample Sections  
(Treatment = 4 sites  
Control = 4 sites)

# Food Web Study - Tepee Ck Phase 2



# Food Web Study – Pre-treatment Preliminary Results

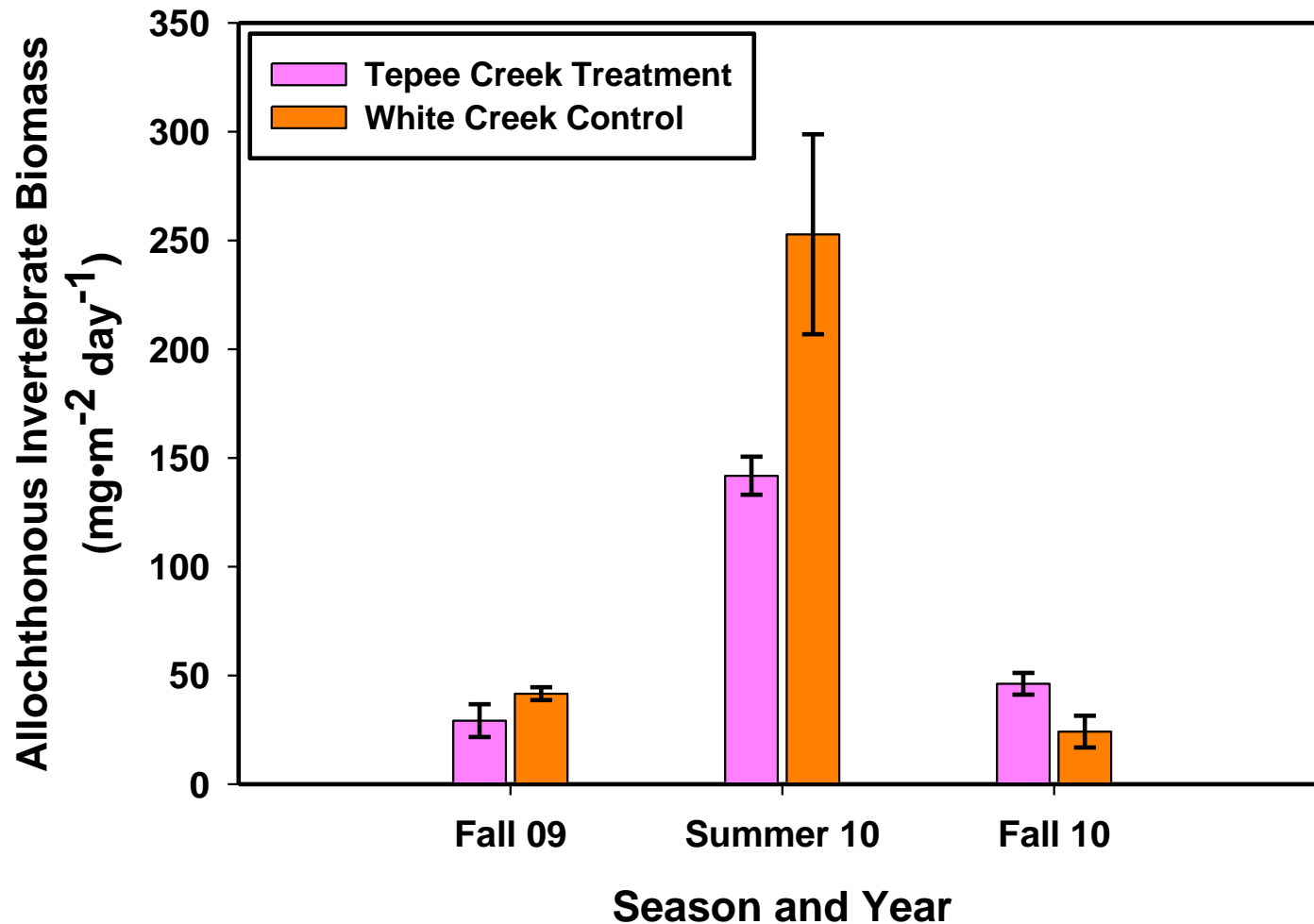
Mean Benthic Invertebrate Biomass in Treatment and Control Sites



# Food Web Study – Pre-treatment

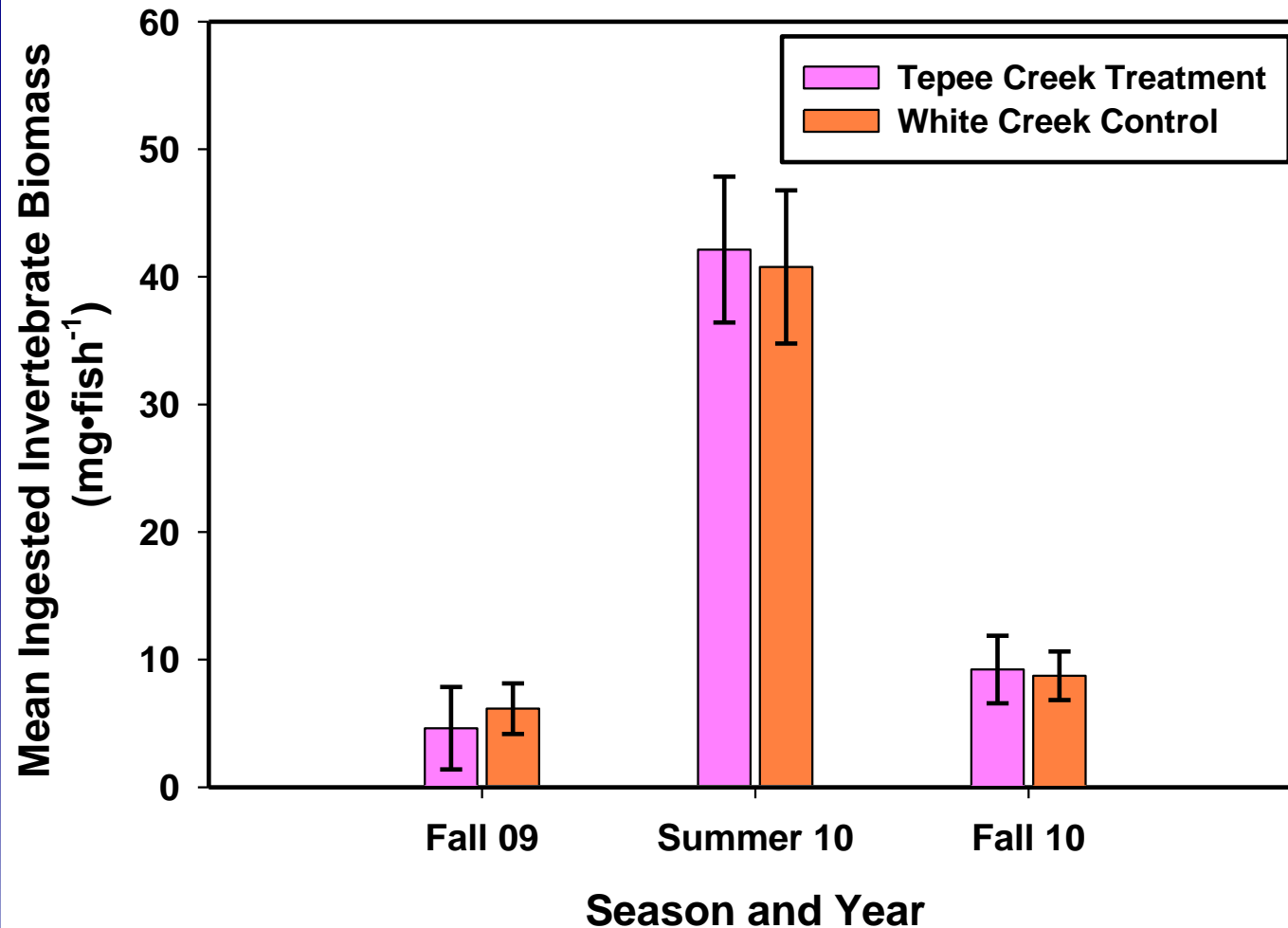
## Preliminary Results

Mean Allochthonous Invertebrate Biomass in Treatment and Control Sites



# Food Web Study – Pre-treatment Preliminary Results

Mean Invertebrate Biomass Ingested in  
Treatment and Control Sites

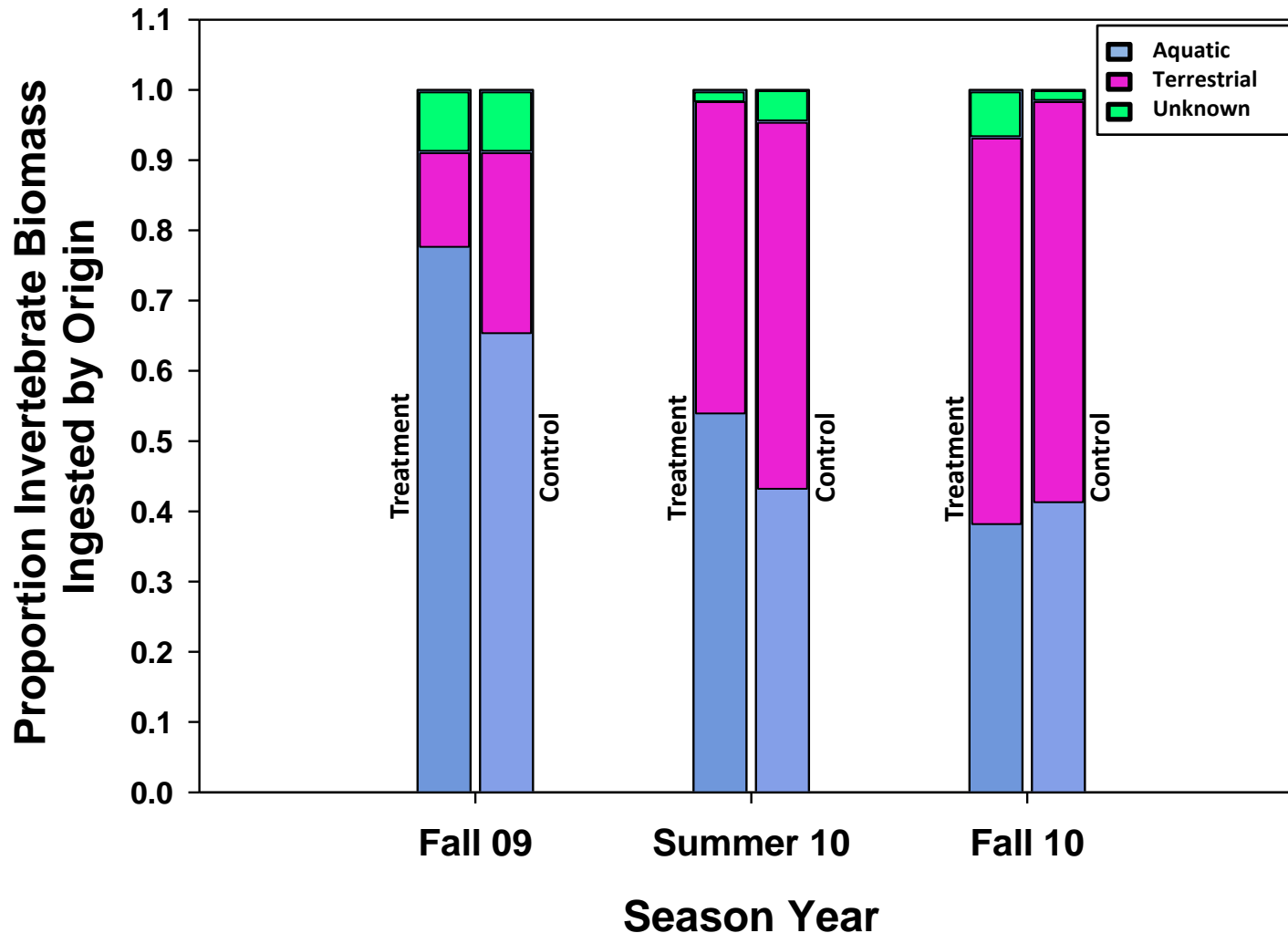




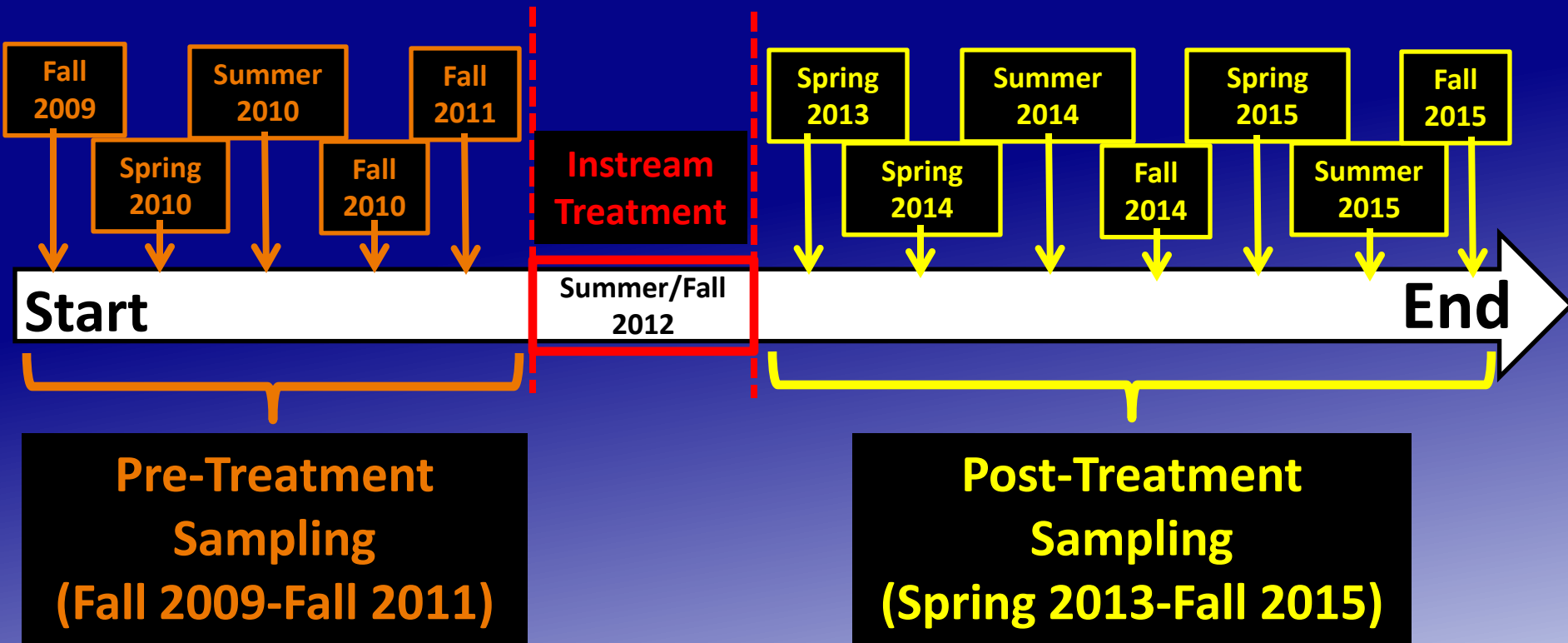
# Food Web Study – Pre-treatment

## Preliminary Results

### Composition of Invertebrate Biomass Ingested in Treatment and Control Sites



# Food Web Study – Timeline



# Conclusions

- By incorporating a monitoring design that spans multiple spatial and temporal scales in Tepee Creek we were able to:
  - Quantified that stated IXL Meadows Project objectives were met
  - Quantified unstated biological responses in Tepee Creek IXL
  - Quantified that intra-annual sampling is a necessary sampling grain to capture variation in invertebrate prey availability and fish diet in Tepee Creek Phase 2.

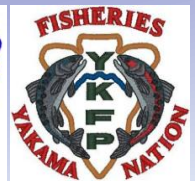
# Acknowledgements

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- USGS (United States Geological Survey)
- Yakama Nation

- **Contributing Personnel:**

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# Questions?

