Wind River IMW:

Steelhead Responses to Dam Removal and Habitat Restoration

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Klickitat and White Salmon Rivers (Columbia Gorge) Fisheries and Watershed Science Conference

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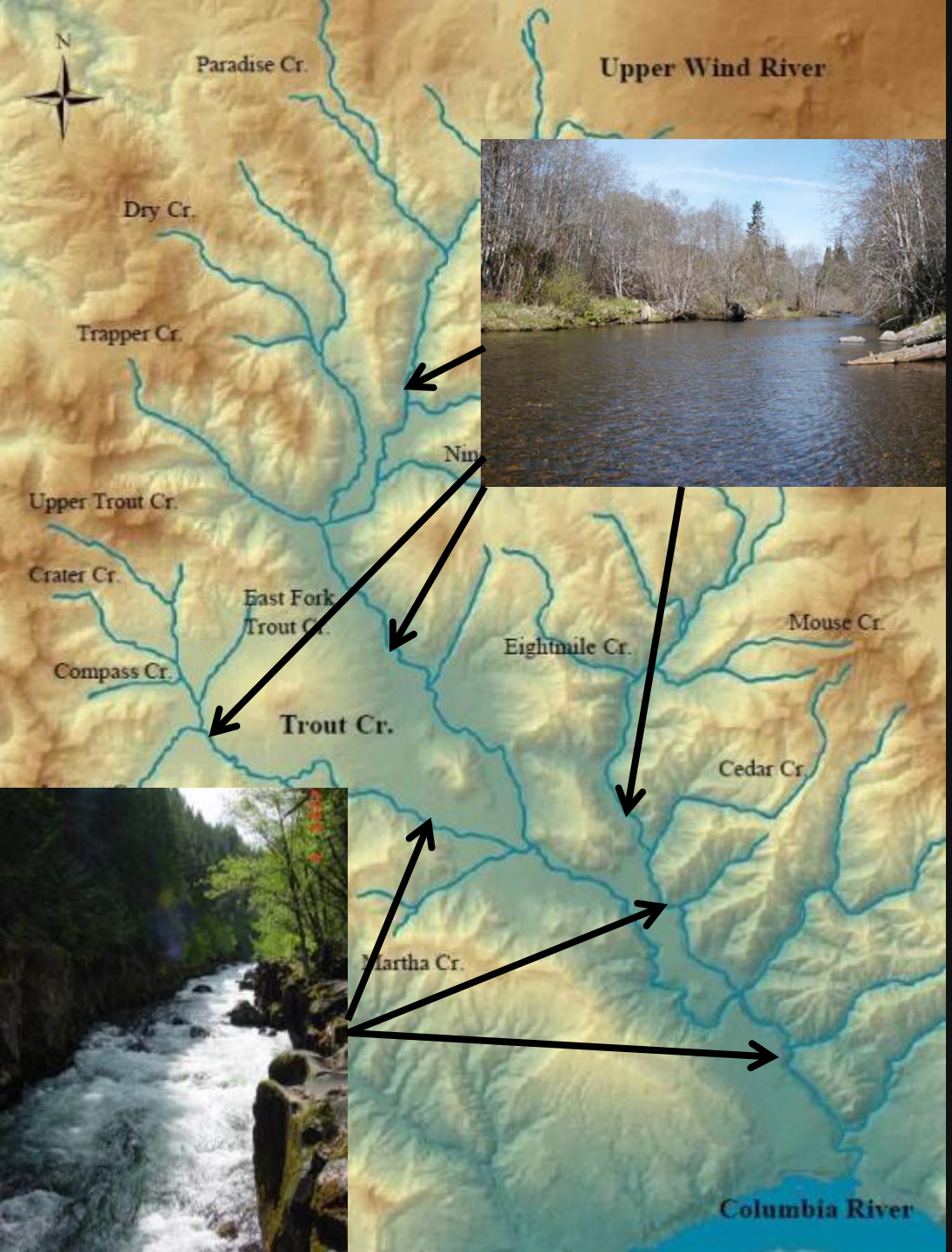
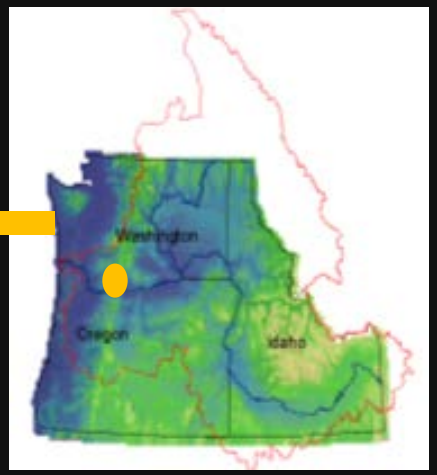
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

USGS

Talk Outline

- Wind River Ecological History
- Hemlock Dam Removal Study Design
- Data Collection Methods
- Preliminary Results and Power Analysis
- Conclusions





Basin:

Drainage area: 580 km^2

Elevations from 30-1200 m

Rain dominated hydrograph

Monthly Mean Discharge 5.7-60 cms

Land Ownership & Use:

77% USFS multi-purpose

23% timber, rural residential

Location:

Columbia River rkm 250

~15 km Bonneville Dam

Anadromous fish:

Summer Steelhead

(Hatchery Spring Chinook)

Shipherd Falls (rkm 3)

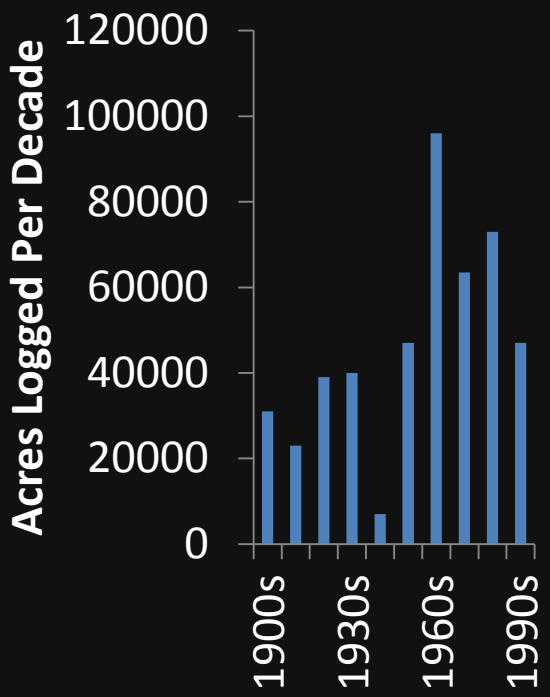
Barrier to salmon

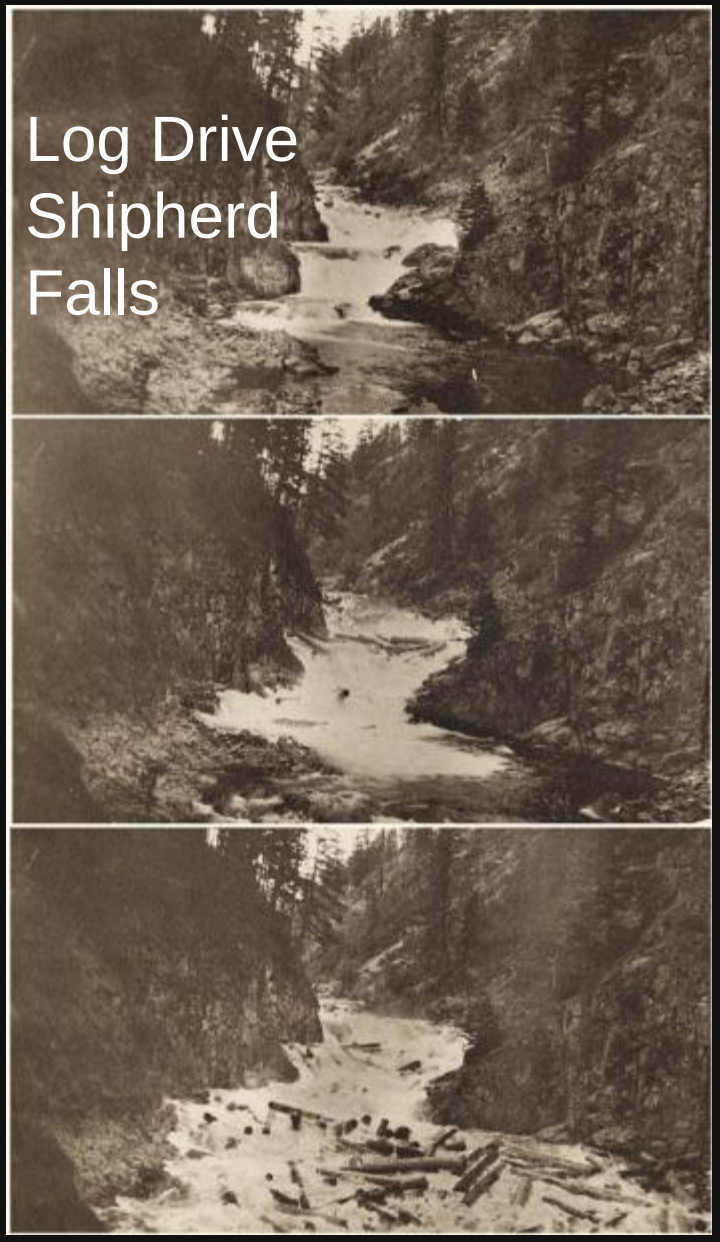
Wild steelhead refuge (pHOS 1%)

Fish Habitat in the Wind: Logging

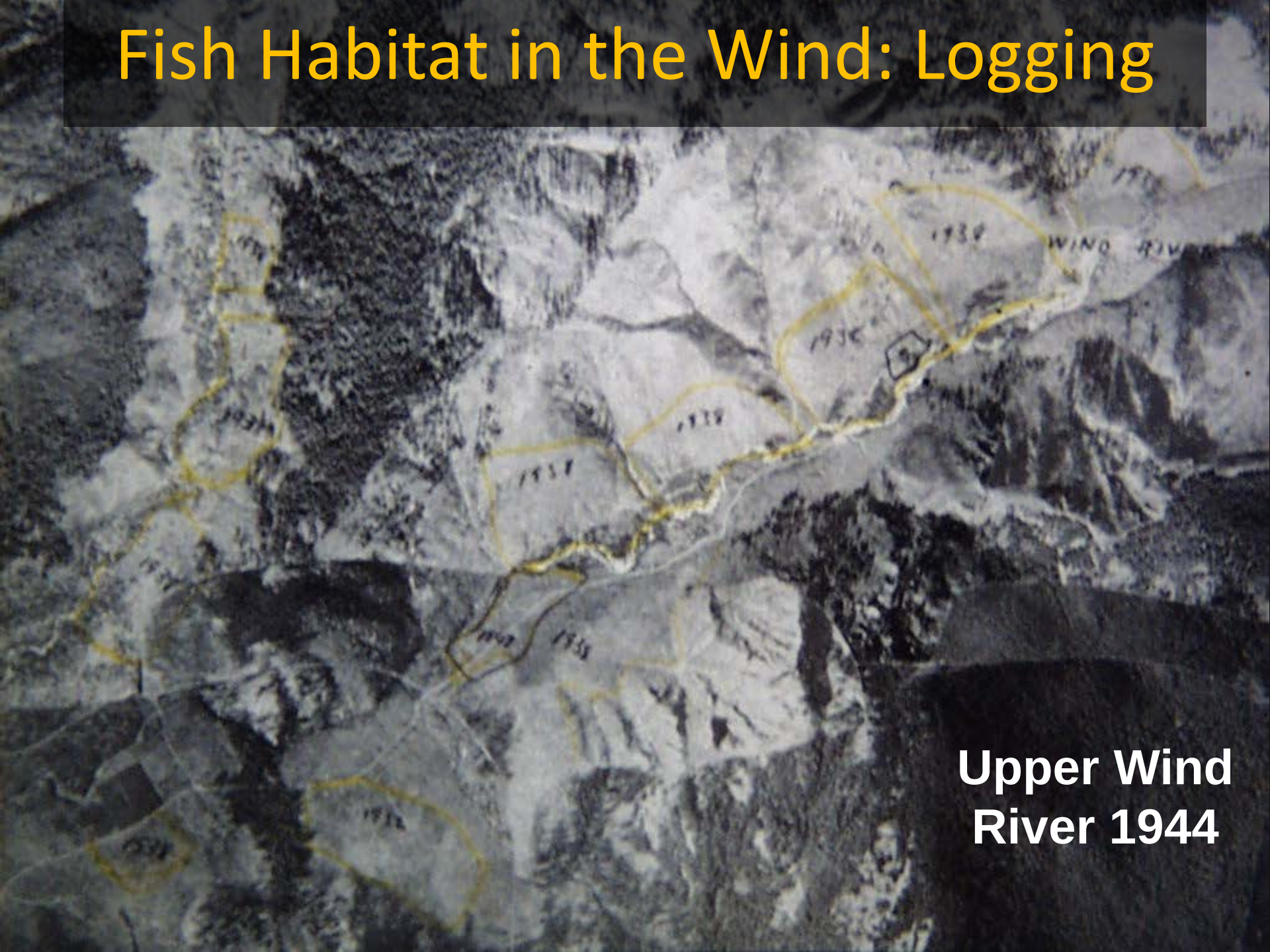
Railroad Logging
(begins ~ 1890)

Splash Dams





Fish Habitat in the Wind: Logging



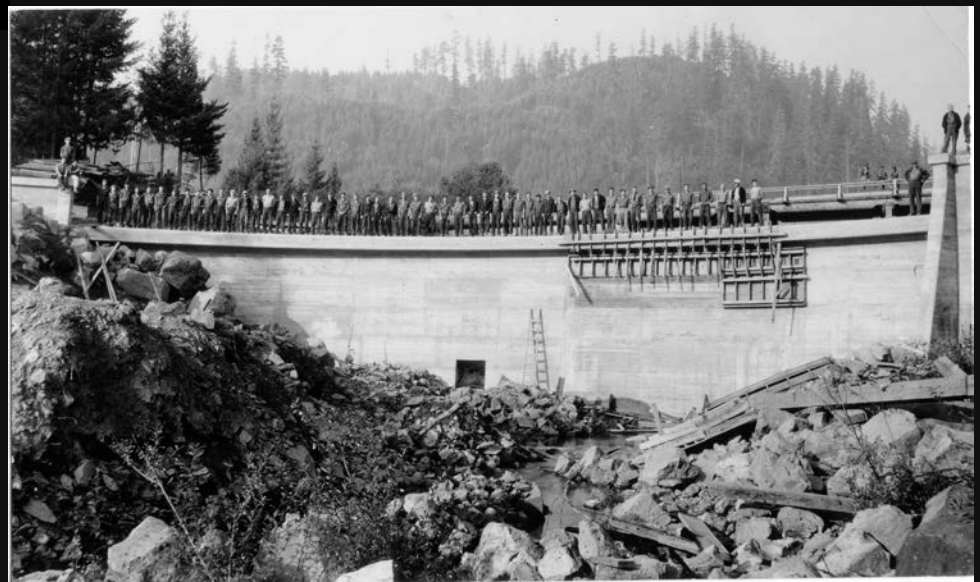
Upper Wind River 1944

Fish Habitat in the Wind: Dams

Splash Dam at the Hemlock Site—1902

Dam completion—1935

- 26 feet high; 183 feet long
- Originally constructed for hydropower
- Retrofitted for irrigation in 1958
- ***Had low-moderate functioning fish ladder***



1980-1990's Changes

- Northwest Forest Plan (1994)
  - Wind Tier 1 Key watershed
- Cessation of logging
- Focus on restoration
  - Ongoing in-stream work in Trout Creek
  - Mining reach restored in Upper Wind
  - Hemlock Dam planning begins

1980-1990's Fish Monitoring Begins

- Fly fishing club starts snorkel surveys (1988-1989)
- Steelhead abundance noted to be very low (1990's)
- Steelhead listed (1998)
- Hatchery Steelhead Plants terminated (1997)
- Current Wind IMW monitoring initiated (1992-2000)
  - Adults and smolts at basin and sub-basin scales

Hemlock Dam Removal (2009)

- Total dam removal cost estimated at $2.7 million
- Goal: Increase viability, productivity of Wind River steelhead.
- Objectives:
  - Improve passage for adult and juvenile steelhead passage
  - Reduce peak stream temperatures in lower Trout Creek.
  - Restore substrate transport in lower Trout Creek
  - Increase habitat complexity in lower Trout Creek

Hemlock Dam (2009)

Hemlock Dam (2010)

In-stream Work in Trout Creek

Year	Major Habitat Accomplishment	Metrics	Cost
2005	Upper Trout Creek Instream Restoration	1,300 logs placed in 2 miles of stream 17,000 native plants	$120,000
2006	Upper Trout Creek Riparian Thinning	250 sites thinned to release conifers	$150,000
2007	Upper Trout Creek Instream Restoration by helicopter	1,000 whole trees one river mile 35 acres invasive plant removal	$130,000
2009	Hemlock Dam Removal	Hemlock Dam Removed 2,900 native plants in reservoir footprint	$2,700,000
2012	Martha Creek Dam Removal (Trout Cr. Trib)	Removed dam (7' x 40') from Martha Creek	$50,000

*Some restoration occurred outside the treatment basin (road decommisioning, culvert removal in non fish bearing, planting)

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Trout Creek BACI and BA design

- Steelhead response to dam removal and instream work in Trout Creek sub-basin (30 sq. mi)
  - Passage improvement at Hemlock
  - Improved habitat in upper Trout Creek

- Use existing basin/subbasin design
  - Treatment: Trout Creek
  - Control(s):
    - Adults: Wind R. minus Trout Creek; (subbasins)
    - Juveniles: Upper Wind, Panther Creek

- Cannot test for changes due to improved habitat quality downstream of dam site

Testable Hypotheses

1. Ho: No change in abundance of: (BACI)
   a. Smolts
   b. Adults
   c. Parr (index)

2. Ho: No change in Parr : Smolt ratio in smolt traps (BACI)

3. Ho: No change in survival (BACI)
   a. Smolts migrating downstream
   b. Trout Creek vs. UW adults migrating upstream
   c. Kelts migrating downstream

4. Ho: No change in percentage of repeat spawners. (BACI)

5. Ho: No change in Productivity/Capacity of Trt Crk. (BA)

Timing of First Potential Responses

Metric	2000-2009	2010	2011	2012	2013	2014	2015
Adult Abundance							
Parr Abundance (index)							
Smolt Abundance							
Smolts per Spawner							
Parr : Smolt Ratio							
Adult to Adult Recruits							

Pre-Treatment Data

Post-Treatment Data in Hand

Future Post-Treatment Data

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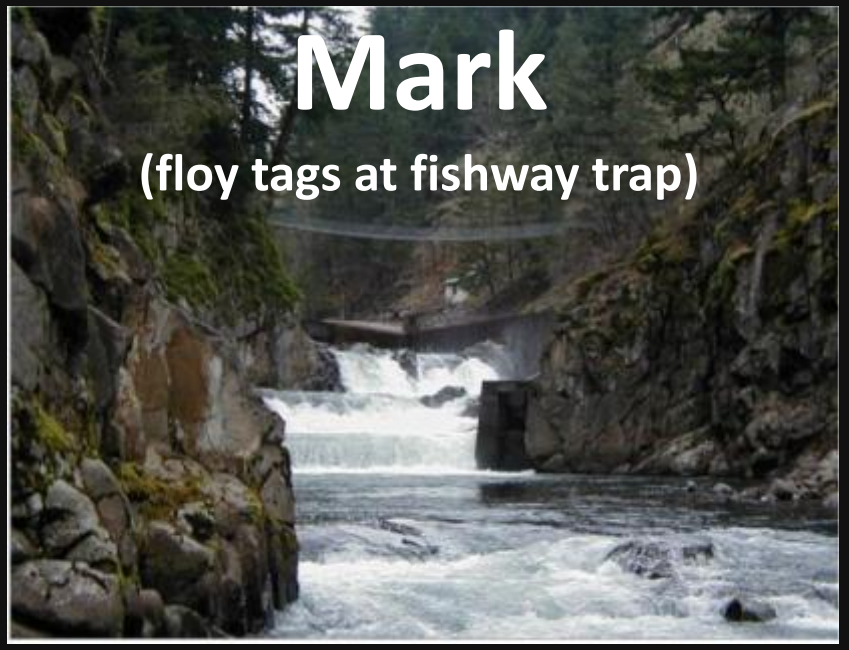
Wind River IMW Data Collection

- **Fish data**
- Water temperature and water quality(~40 loggers throughout watershed; USGS, UCD, USFS)
- Benthic invert production (YIN index sites)
- Stream flow (two mainstem, historic tributary gauges)
- Habitat monitoring (USFS project-scale; CHaMP proposed for future)
- National Environmental Observatory Network (NEON) in development for Wind R. (air quality, temp, etc.)

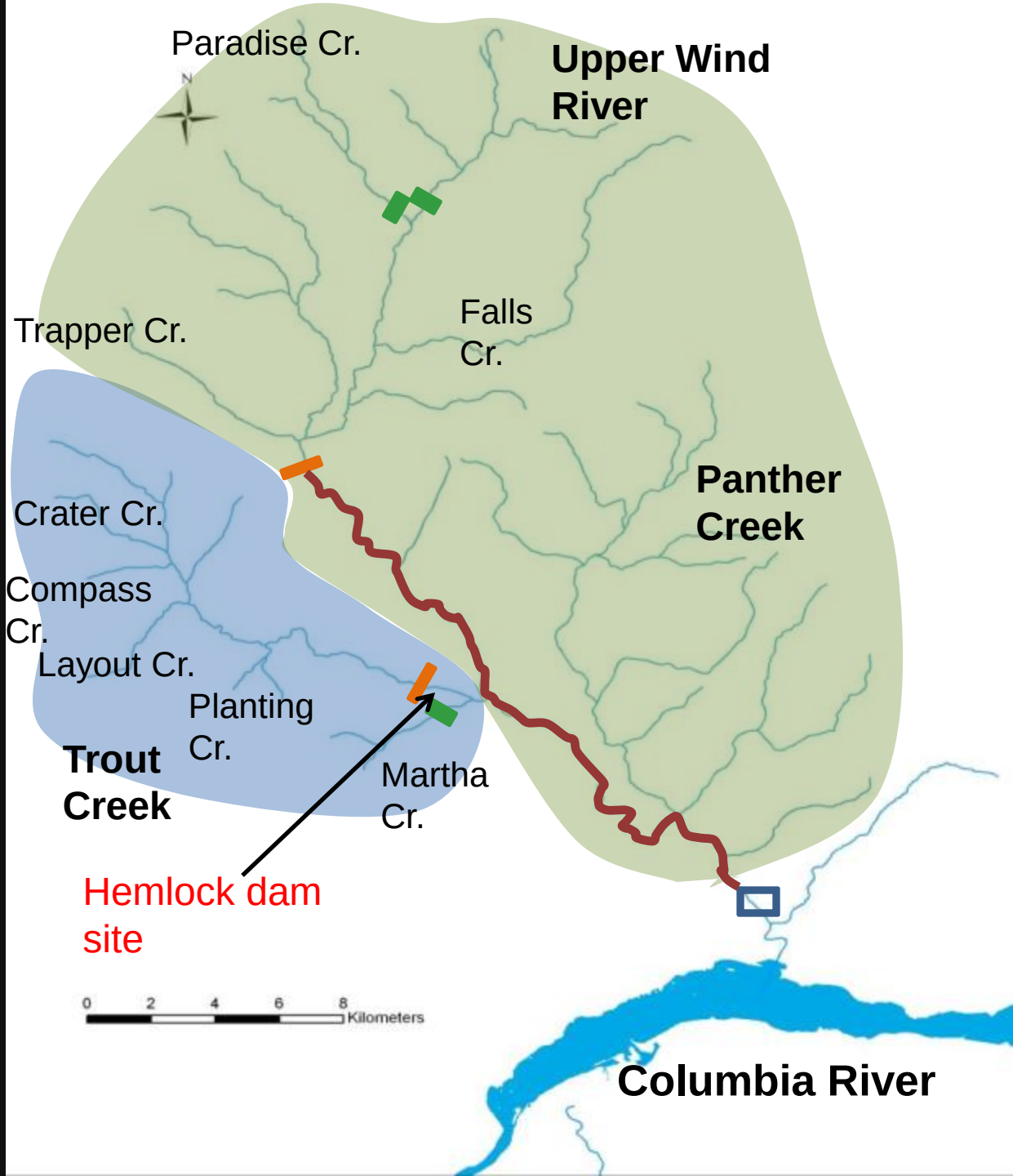
Adult Monitoring

- Abundance
  - Wind River
    - mark-resight (2000-pres.)
  - Trout Creek
    - Hemlock Dam census (1992-2009)
    - PIT tag detection efficiency and mark-resight (2010-pres.)
- Bio-Samples
  - Scales, length, sex, origin, & tags (PIT and Floy)



Adult Data Sites

- PIT Tag Array (MUX)
- Tributary PIT Array (Allflex)
- Shipherd falls Adult trap
- Snorkel resight reach
- Control Basin
- Treatment Basin



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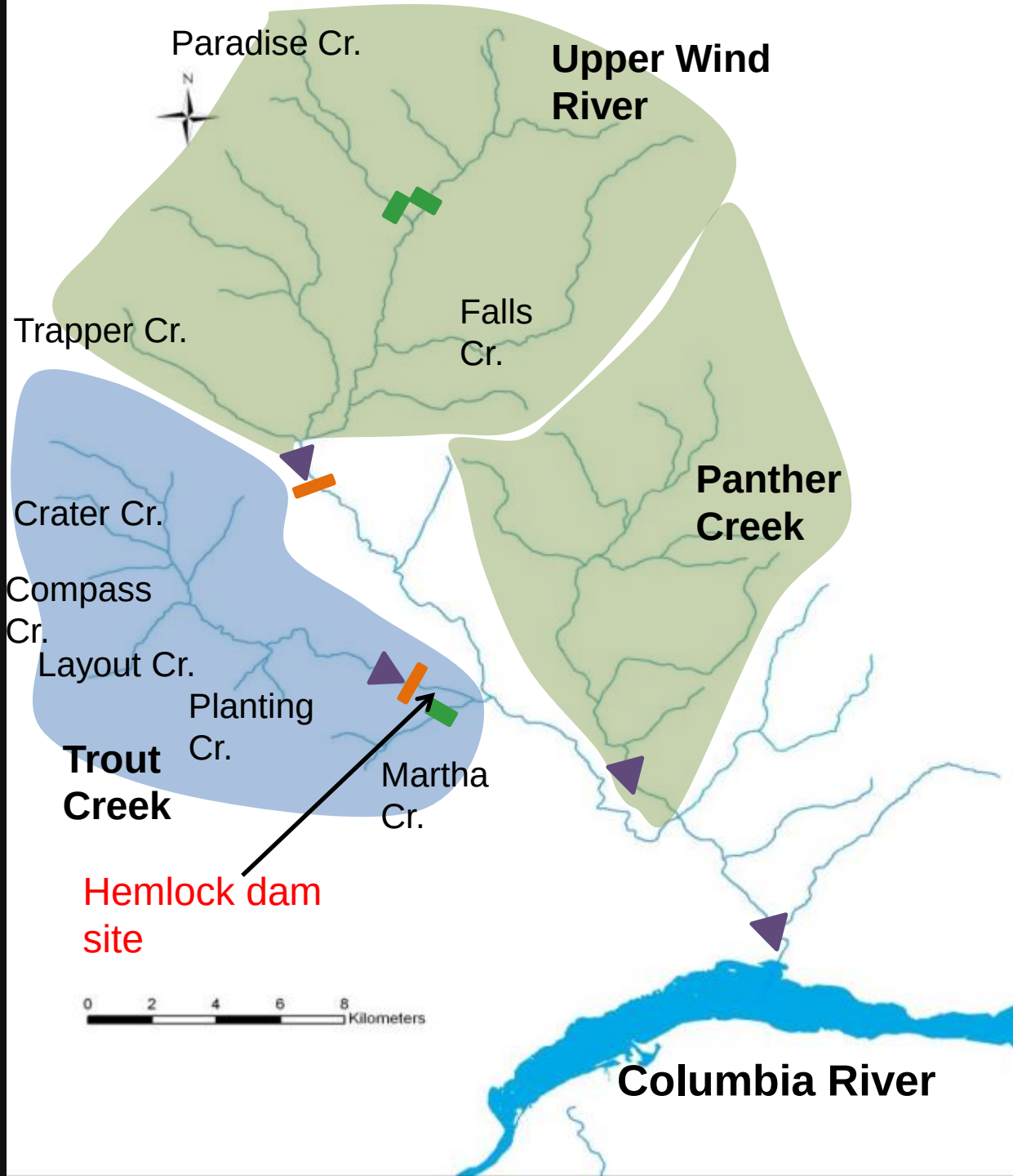
Juvenile Monitoring

- Data (4 smolt traps)
  - All start between 1992- and 1998
  - Smolt abundance
  - Parr abundance (index)
  - Bio-Samples
    - Lengths, scales, PIT tags

Juvenile Data Sites

- PIT Tag Array (MUX)
- Tributary PIT Array (Allflex)
- Smolt trap
- Control Basin
- Treatment Basin



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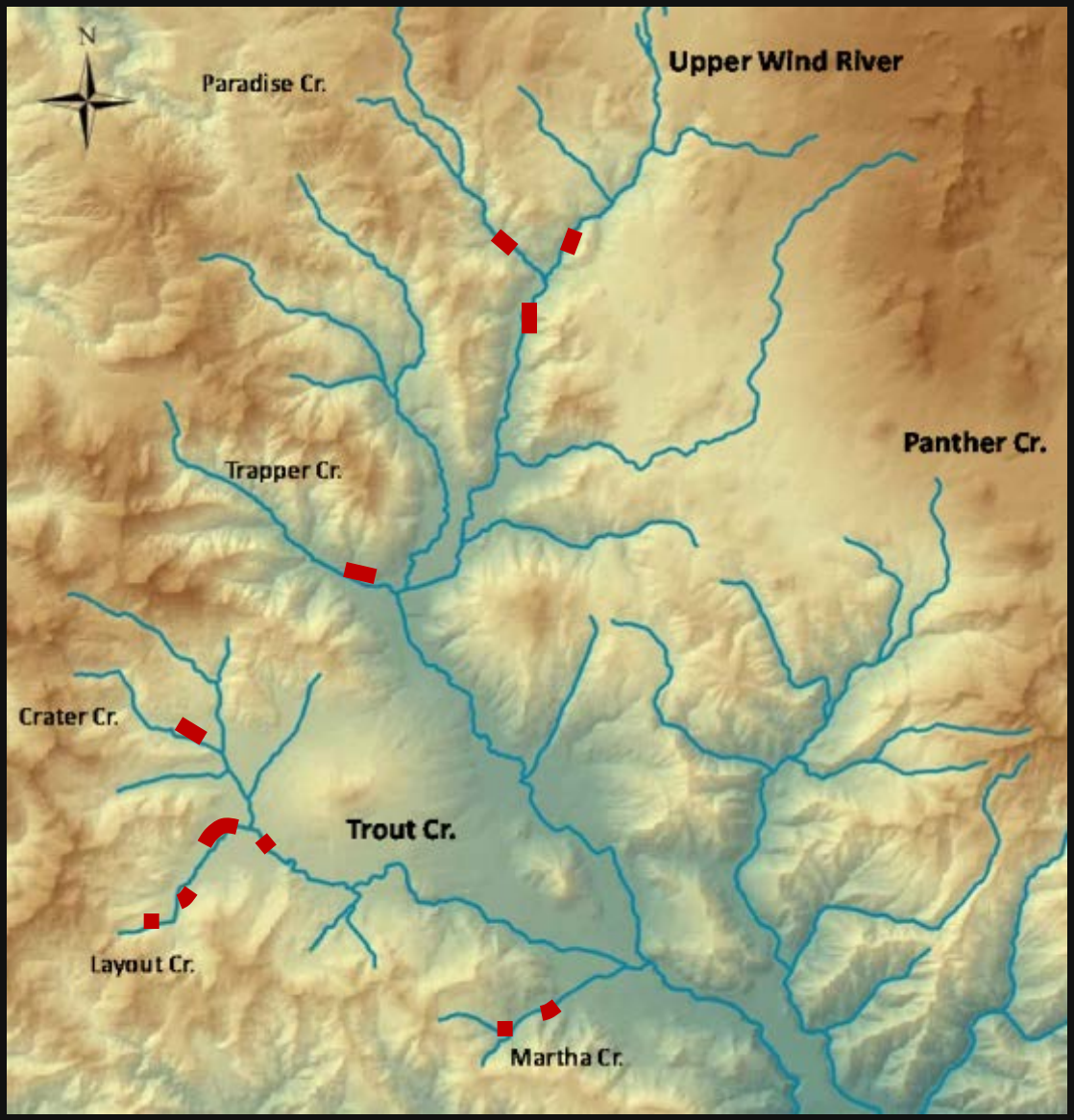
PIT Tagging and instream arrays

- MR Smolt and Parr estimates
- Adult abundance in TC post treatment
- Life history information
- SAR Wind to Wind, Wind to BON, BON to BON
- Loss to fisheries, avian predators

Steelhead Parr Lifehistory: USGS Parr PIT-Tagging Areas (2011 and 2012)



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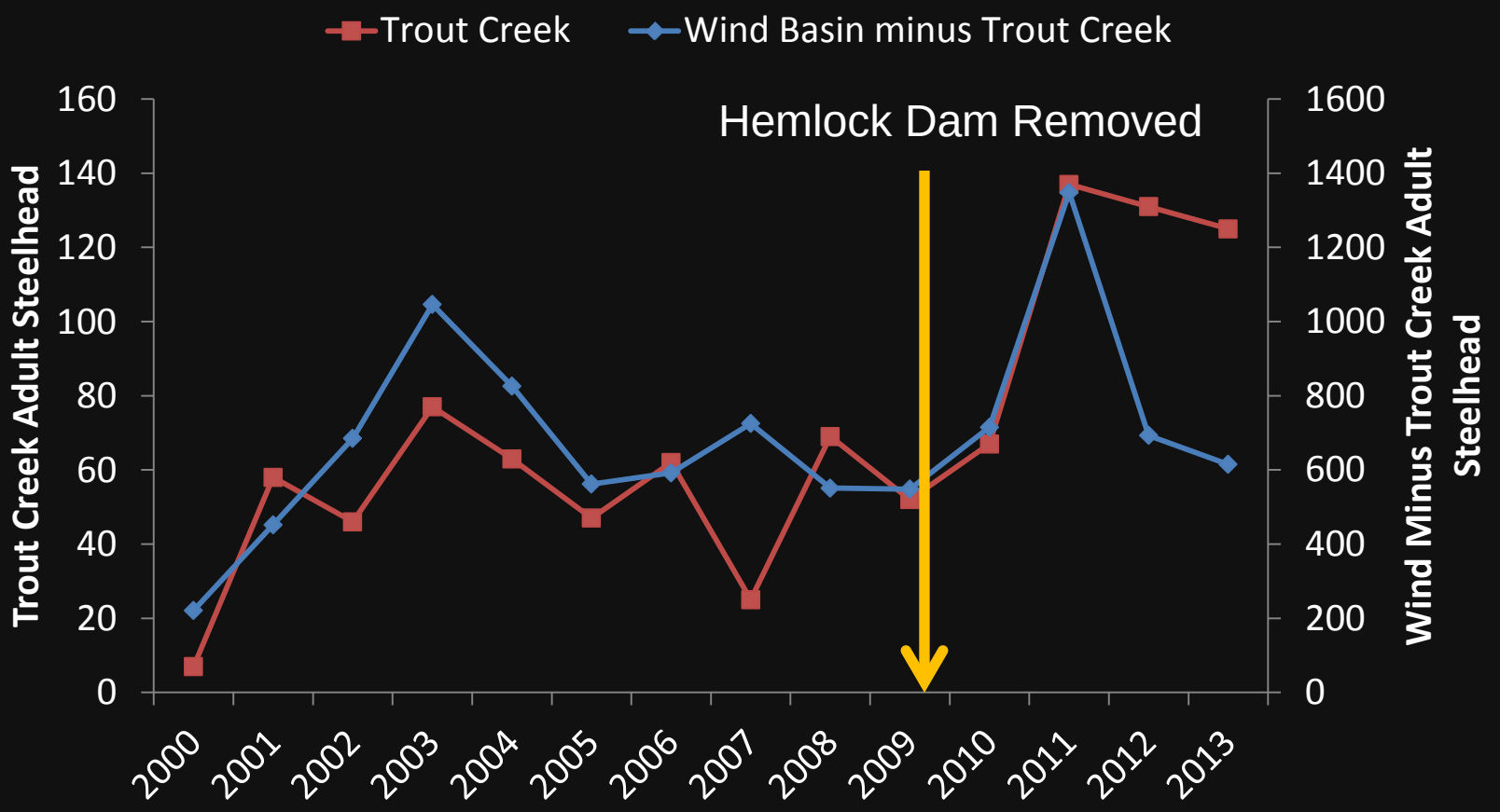
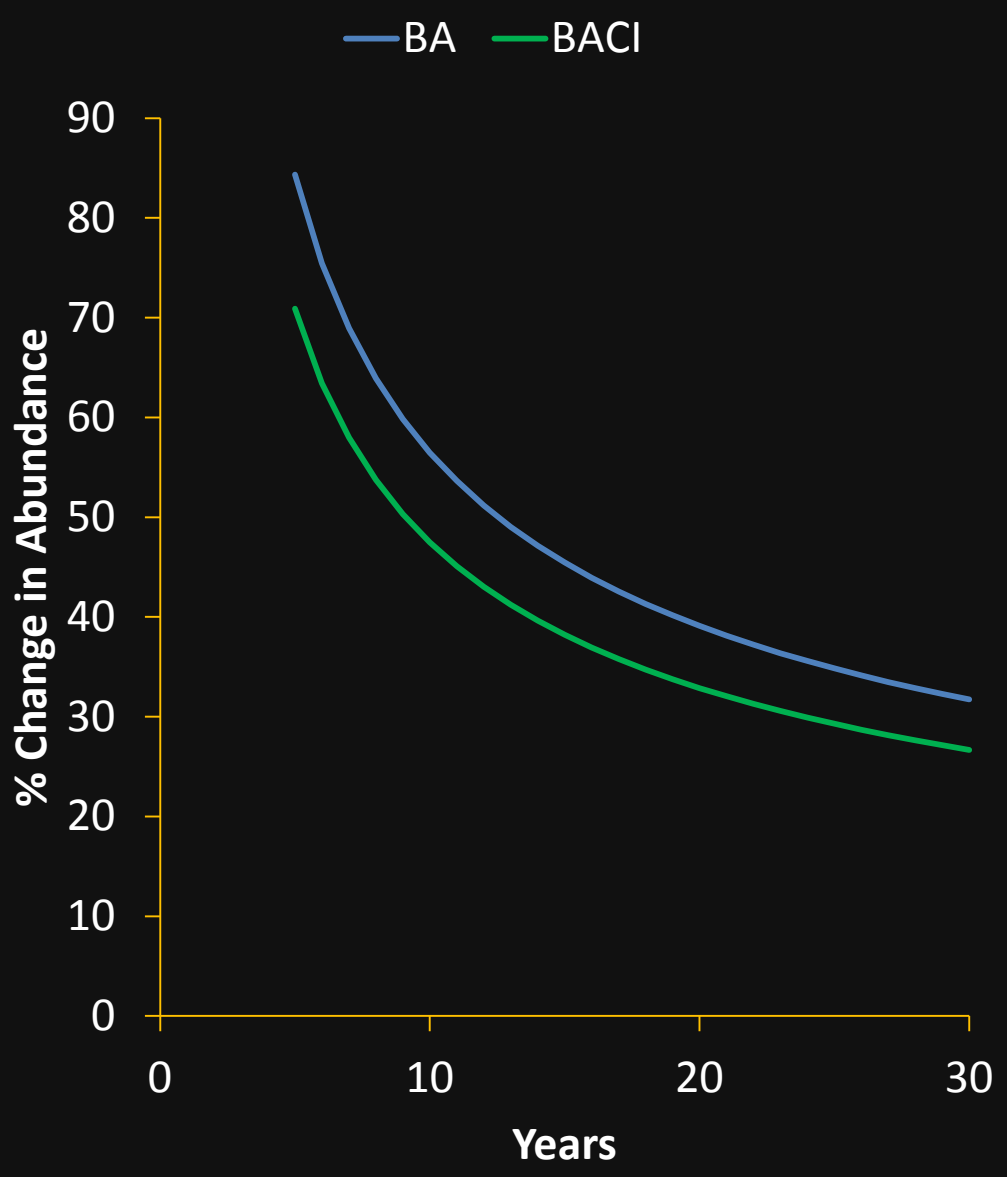
Results: Adults

- Trout Creek abundance increased following dam removal…
- …but so did the Wind
- Some indication Trout Creek abundance remains higher BUT methods an issue
- Good correspondence between treatment and control (R^2 =0.69) –good BACI



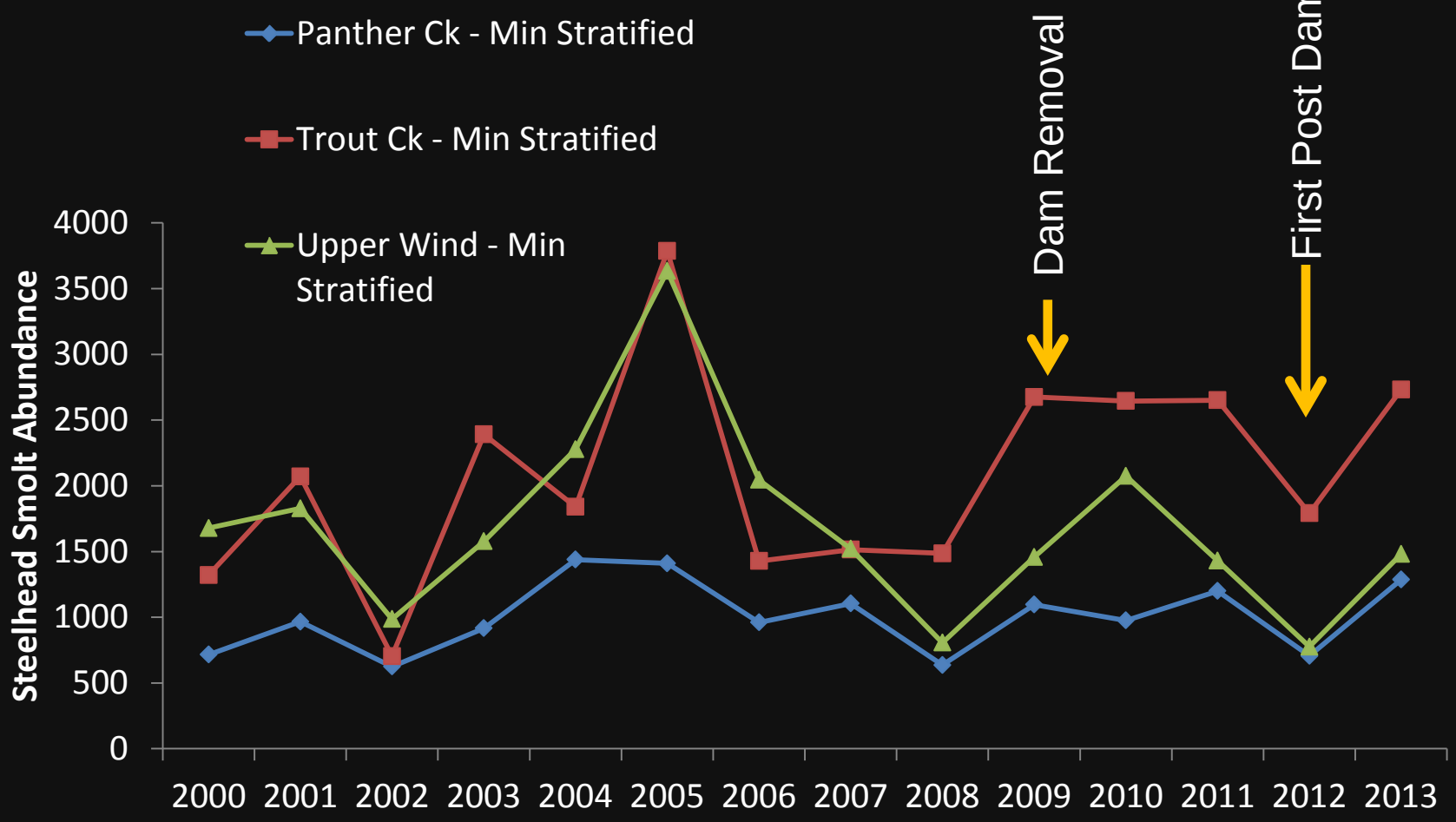
Adults t-test & Power BA vs. BACI

- t-test, $\alpha = 0.10$, $\beta = 0.90$
- BA design effect size decreases from 43 to 16 adults
- BACI effect size decreases from 36 to 13 adults.
- Greater change for BA than BACI because BACI removes some variance through control



Results: Smolts

- Reasonable correspondence between TC and UW (R^2 =0.49)
- Unexplained decrease in UW smolts immediately prior to dam removal
- No obvious jump in first year of post treatment data

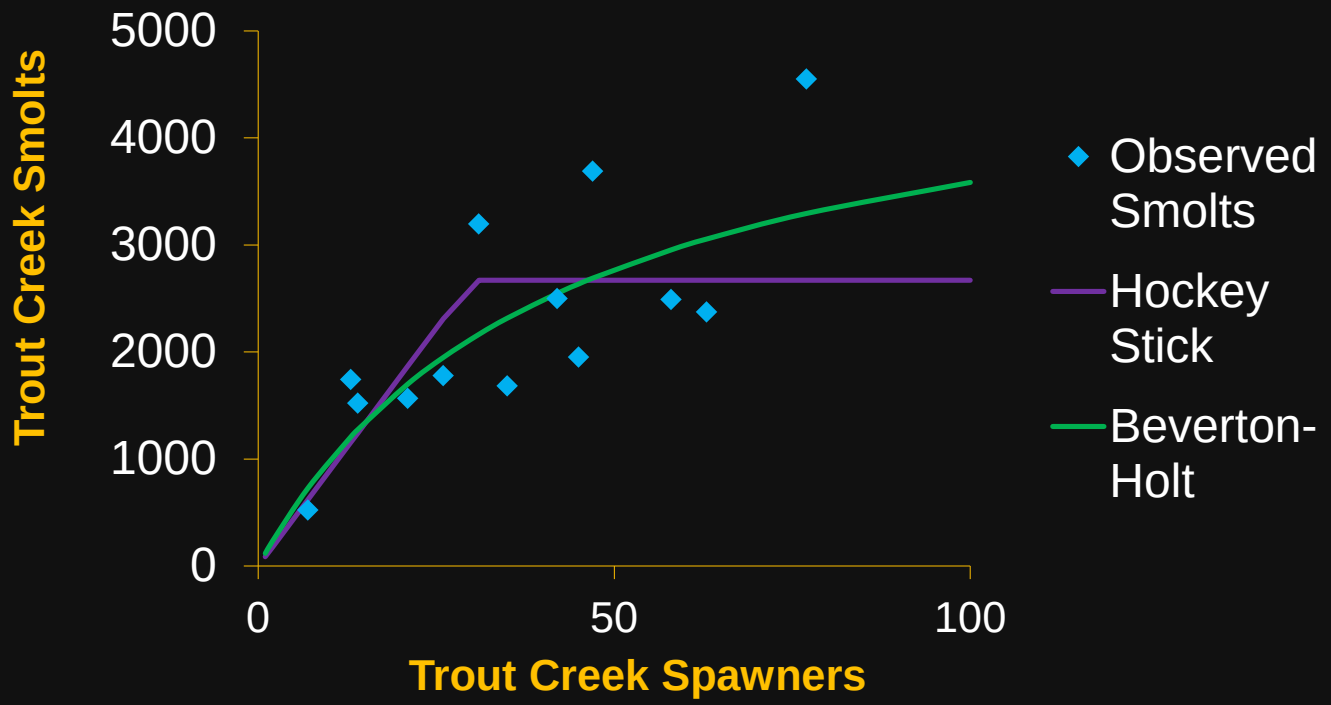


Power: Smolts

- Ho: No change T-C difference in smolt production before and after dam removal
- Before T-C difference: mean = 43 smolts, sd= 394 (8 years)
- After T-C difference of mean = 431 smolts (24% effect size) for 8 yrs would yield significant results
- t-test, $\alpha = 0.10$, $\beta = 0.80$, and equal variance

Power: Productivity/Capacity

- Ho: no change in productivity/capacity (BA analysis from Bradford et al. 2005)
- Models & alpha values influence detectable differences
- 50% change in smolt P/C over a 12 year period detectable with HS model but only partially with BH model (α = 0.20)



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Summary

- Too early to measure response of steelhead to effects of Hemlock Dam removal + Restoration

- Different from other dam removals
  - Prior access not completely blocked

- Long pretreatment datasets allow better study
  - Pretreatment data are variable (freshwater and marine)
  - Identification of good controls (Upper Wind vs. Panther)
  - Help identify monitoring timeframe necessary

Summary Cont.

- Power analysis
  - Value of controls (BA vs. BACI)
  - BA is problematic due to variable conditions
  - Need for longterm monitoring to detect modest sized effects
  - Change in abundance at sub-basin and basin scale harder to detect than project-scale change in density
- Wind restoration control subbasin issues
  - Restoration plans vs. Research
  - Some restoration may be OK in ‘control’ areas
  - Need to consider Effect Size, Timescale
- Adult abundance issues
  - Confounding of treatment and change In TC abundance methods
  - Violations to “I.I.D.” assumptions for PIT array intrinsic efficiency
    - New PIT array will address this in 2014

Acknowledgements

- WDFW
  - Dan Rawding—study design, analytical framework, slides
  - Charlie Cochran—data collection and database management
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- USGS
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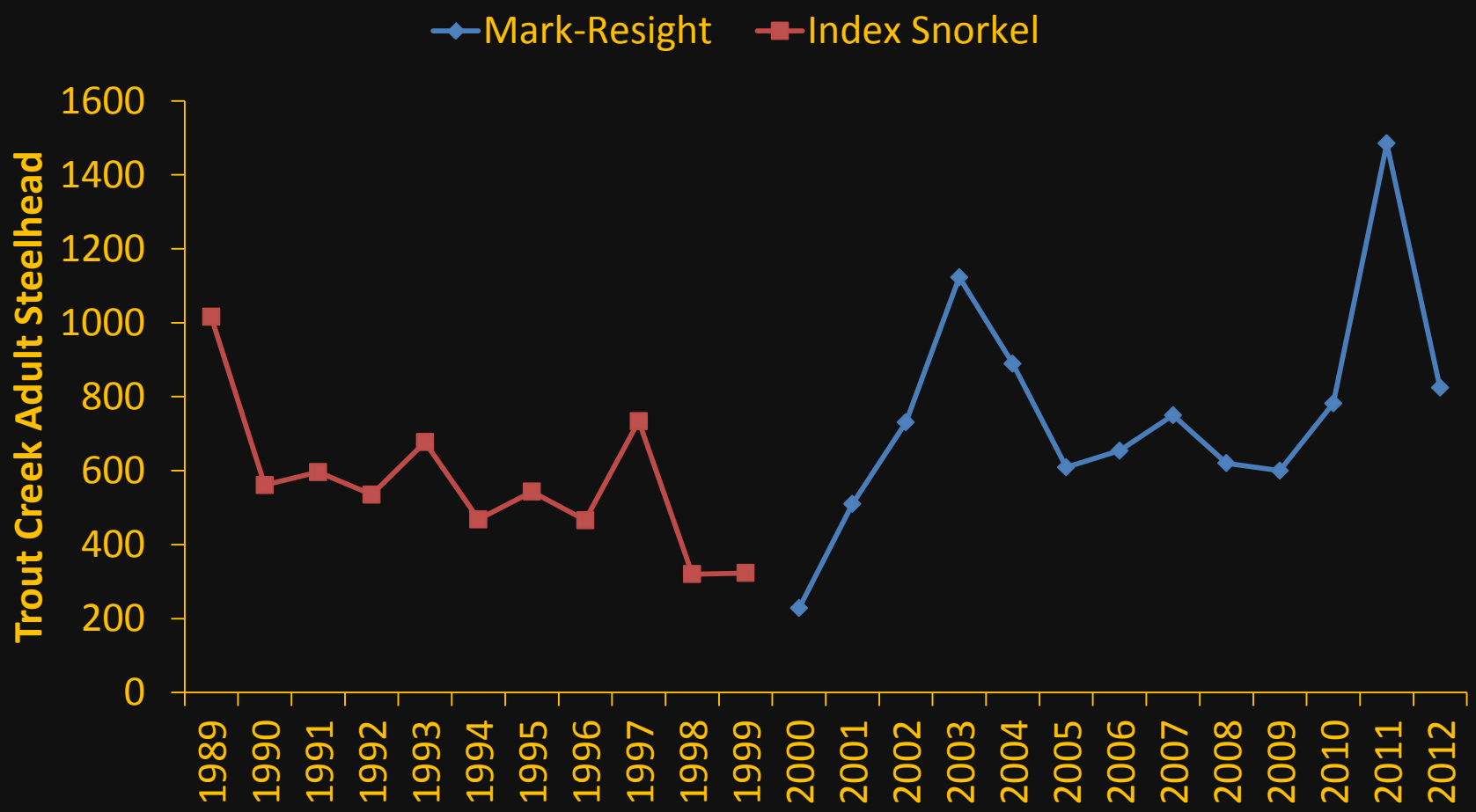
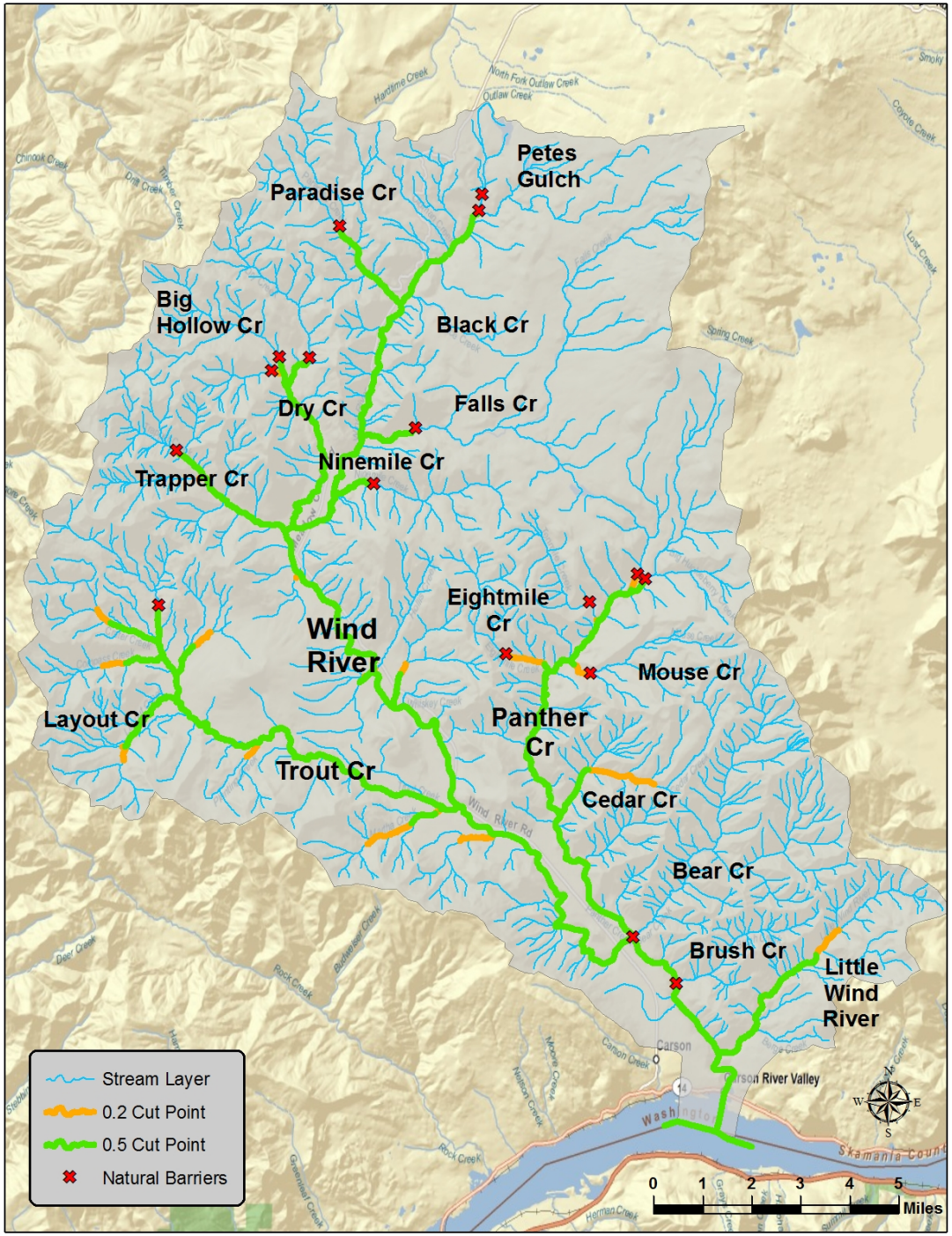
  - Bengt Coffin –photos and information on dam removal and restoration
- Bonneville Power Administration
  - Project Funding
  - Mary Todd Haight—project administration
- Wind River Watershed partners UCD, USFS, USFWS, USGS, & YN.

Questions?

Extra Slides

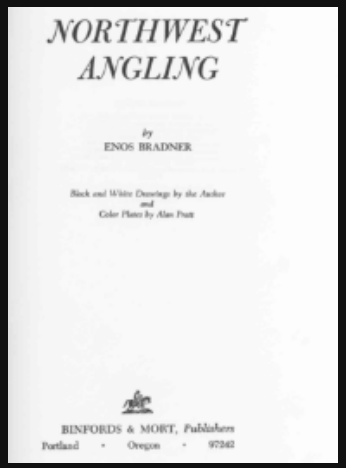
Wind River Steelhead Timeseries





Wind Steelhead Modeled Spatial Distribution

Fishing in the Wind



"The Wind holds one of the best runs of summer-run steelhead in the State of Washington."

Bradner (1950), Bradner (1973)

Before_After (BA) Designs

- Compare data from multiple years collected from before and after dam removal for a difference typically with ANOVA, T-test, mix
  - Has temporal replication but lacks spatial replication.
  - Difference in the impact area is **attributed** to the actions but may be due to fish response to natural variations or cycles (marine survival, water temperatures, flooding, etc) or other activities.
  - Cannot disentangle response from natural variation and cycles in the impact area.

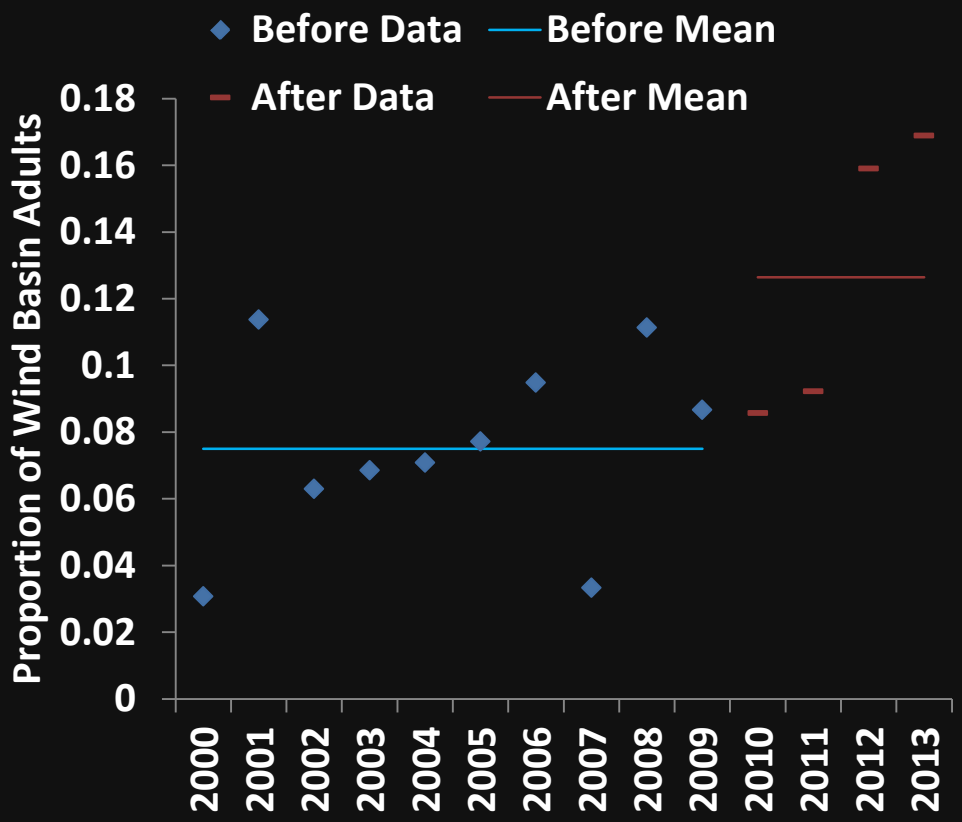
Before_After_Control_Impact (BACI) Design

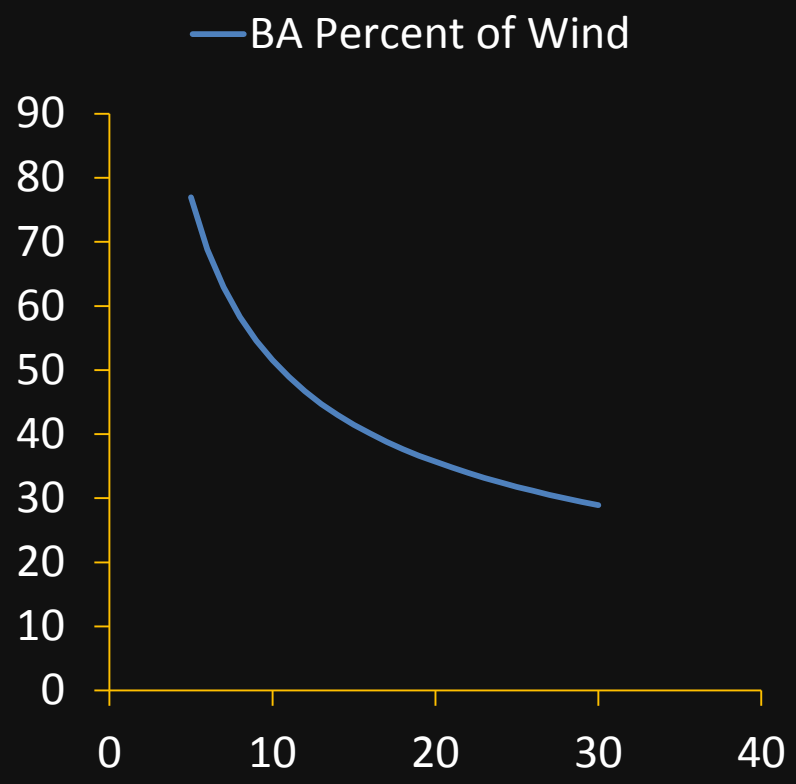
- Measurements are taken at both the treatment (impact) and control site before and after the action and typically analyzed with ANOVA or T-test.
  - $D_{ik} = X_iC_j - X_iI_k = \mu + \eta_i + \varepsilon_{ik}$, μ=mean difference between control and impact, η_i = change in difference control and impact, and ε_{ik}= error associated with the differences.
  - To account for the problem with natural variation in the B_A design the impact area is paired to control area.
  - Has temporal replication but lacks spatial replication due to single control. The solution is to add another control site.

Preliminary results

- Post Dam Removal (2009) Data
  - Adults 2010-2012 spawn years
  - Smolts 2012 (only 2 year olds)
  - Parr index 2011-2012
- New method for Trout Creek adults since trap census not available
- Trout Creek smolt age is 2.25, so smolts produced by 2010 spawners started emigrating in Spring 2012

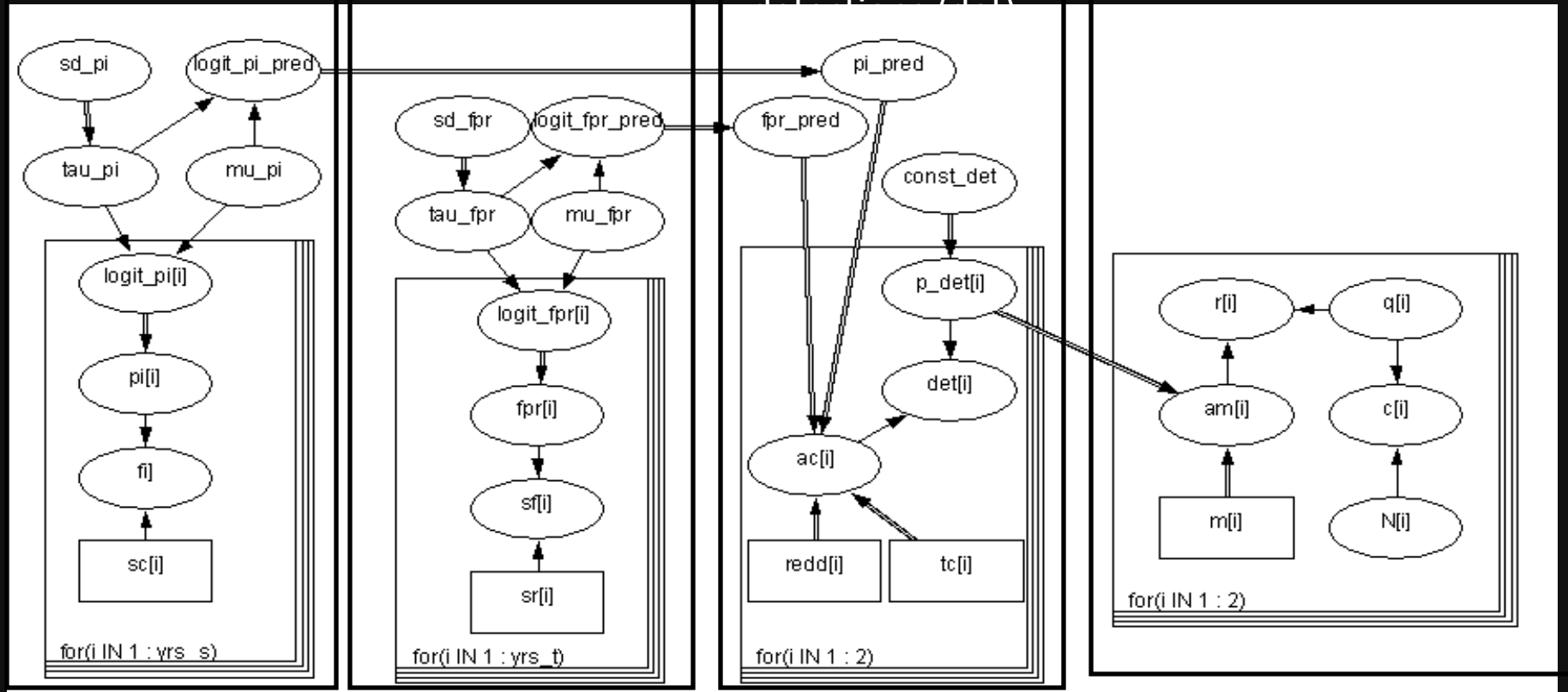
Power: Adult % of Basin





Trout Cr. Esc. Estimate using a DAG, 2010 & 11

1992-2008	1977-1984	2008-2009	2010-2011
Estimate % females(pi) from females (f) & count (sc) from Trout Cr. trap w/ hierarchical model.	Estimate females per redd (fpr) from Snow Cr. redds (sr), females (sf) w/ hierarchical model.	Estimate prob. of detection (p_det) from Trout Cr dam count (tc), adult count(ac) above detector,and	All fish at Shipherd Falls are Floy & PIT tagged. Adjusted marks (am) = Floy & PIT tags/prob of detection (m) / (p_det). Petersen mark-resight estimator (N =c *am / r),



Trout Creek Results

Probability of Detection
p_det = 0.604
95% CI = 0.512-0.692

Trout Cr. Abundance
N[2010] = 57
95% CI = 34-227

N[2011] = 137
95% CI = 77-280

Recommendations
If more precise estimates are desired either improve detection efficiency w/additional interrogators, snorkel efficiency w/additional surveys, or both.