Wind River steelhead: an example of significant iteroparity in the Columbia River Hydrosystem

Thomas Buehrens[1]

Dan Rawding[2]

Charlie Cochran[1]

[1]WDFW, Science Division, Fish Ecology and Life Cycle Monitoring Unit

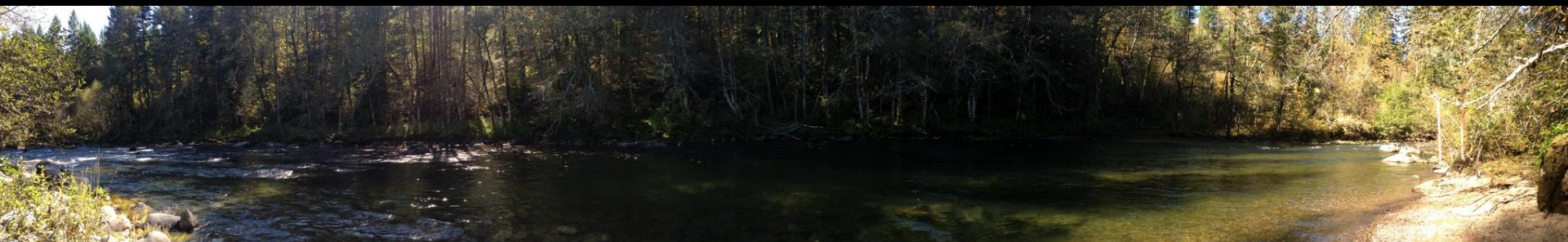
[2]WDFW, Science Division

2014 PSMFC Steelhead Management Meeting

3/19/2014

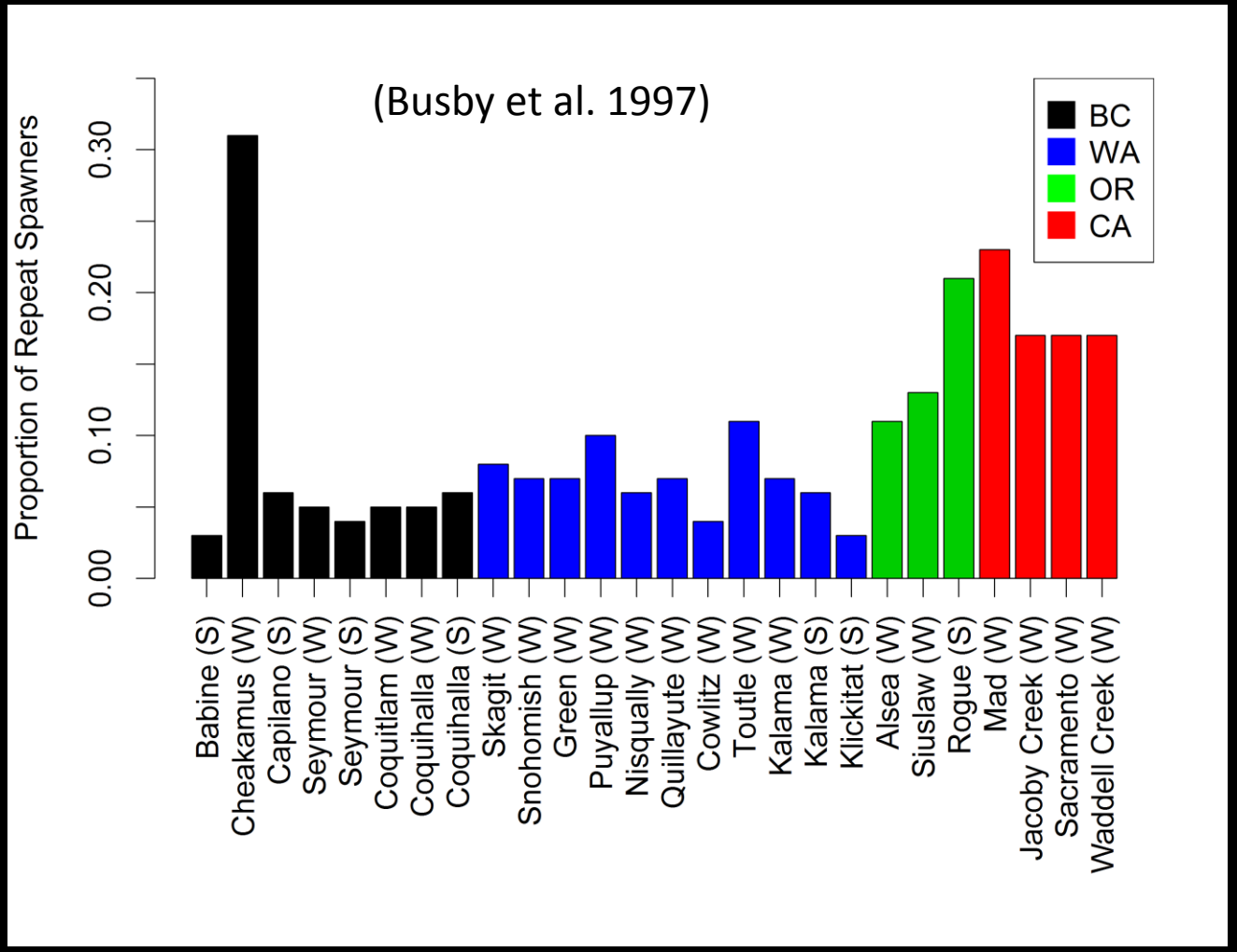
Talk Outline

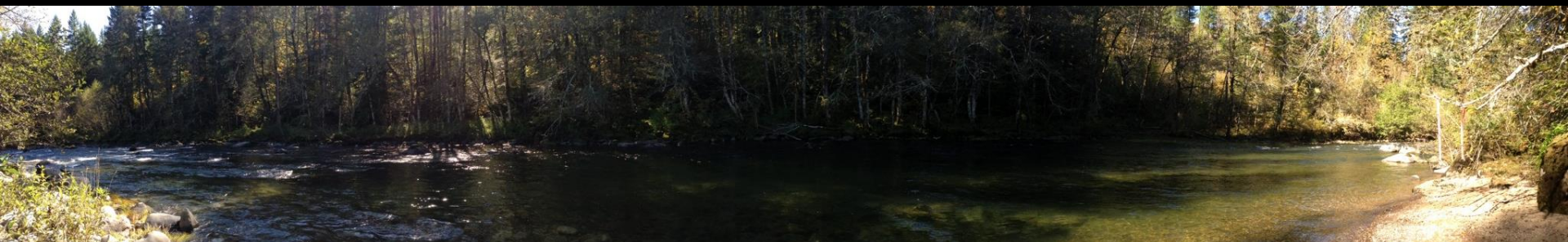
- Background on steelhead iteroparity
- Wind River data collection methods
- Rates of iteroparity
- Factors influencing iteroparity
- Implications of iteroparity



Background on Iteroparity

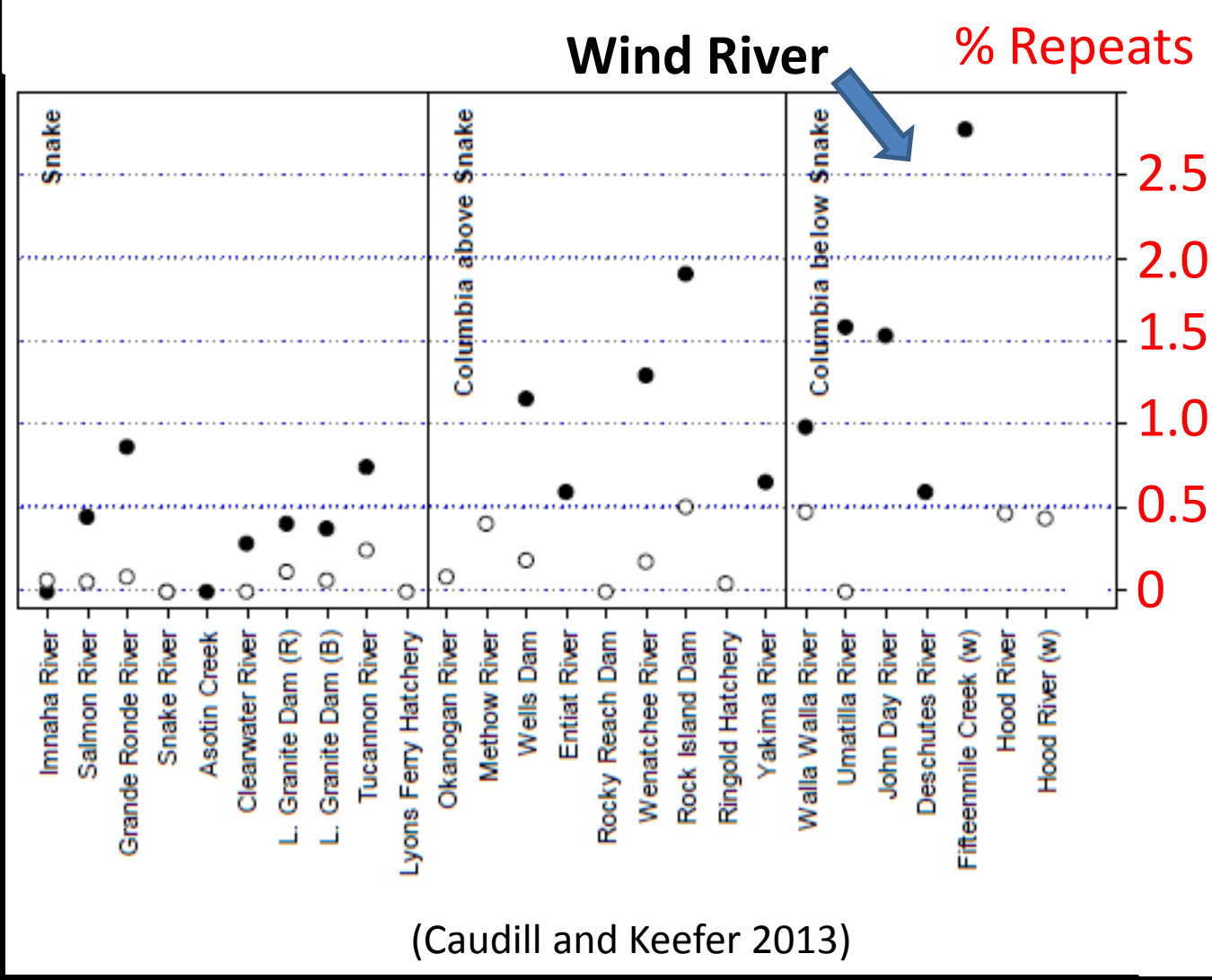
- Variable across range
- Maybe higher N & S
- Generally 5-20%
- Benefits:
  - Multiple spawning events
  - Larger size



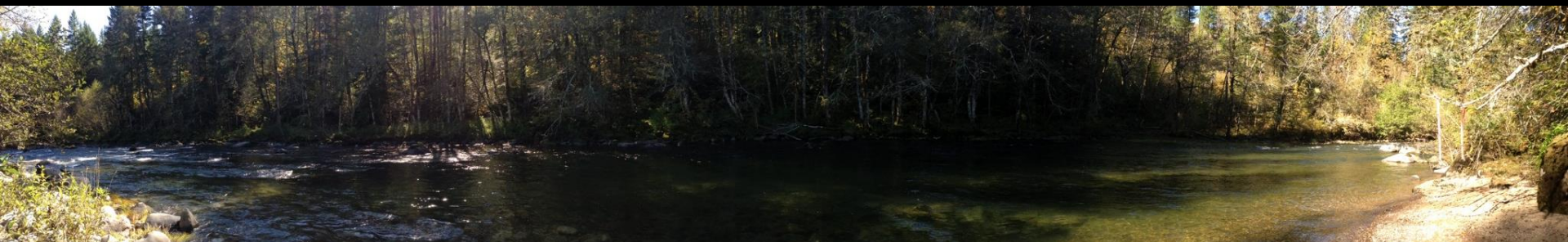


Background on Iteroparity

- Repeat Spawner Rates VERY low in Columbia River Hydrosystem

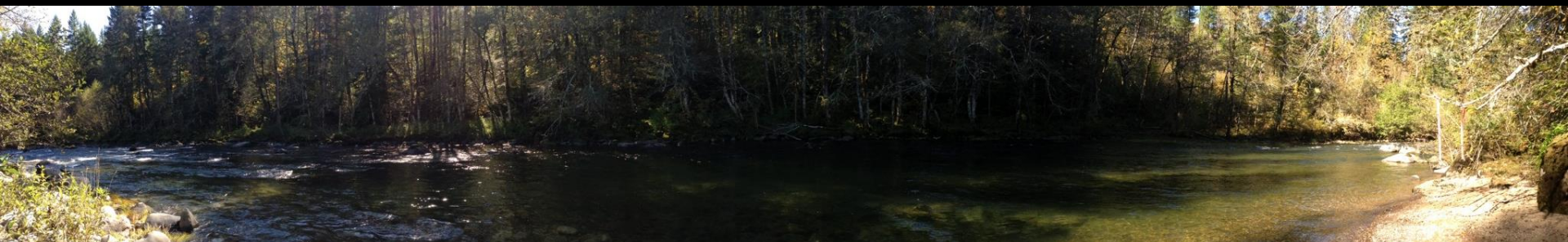


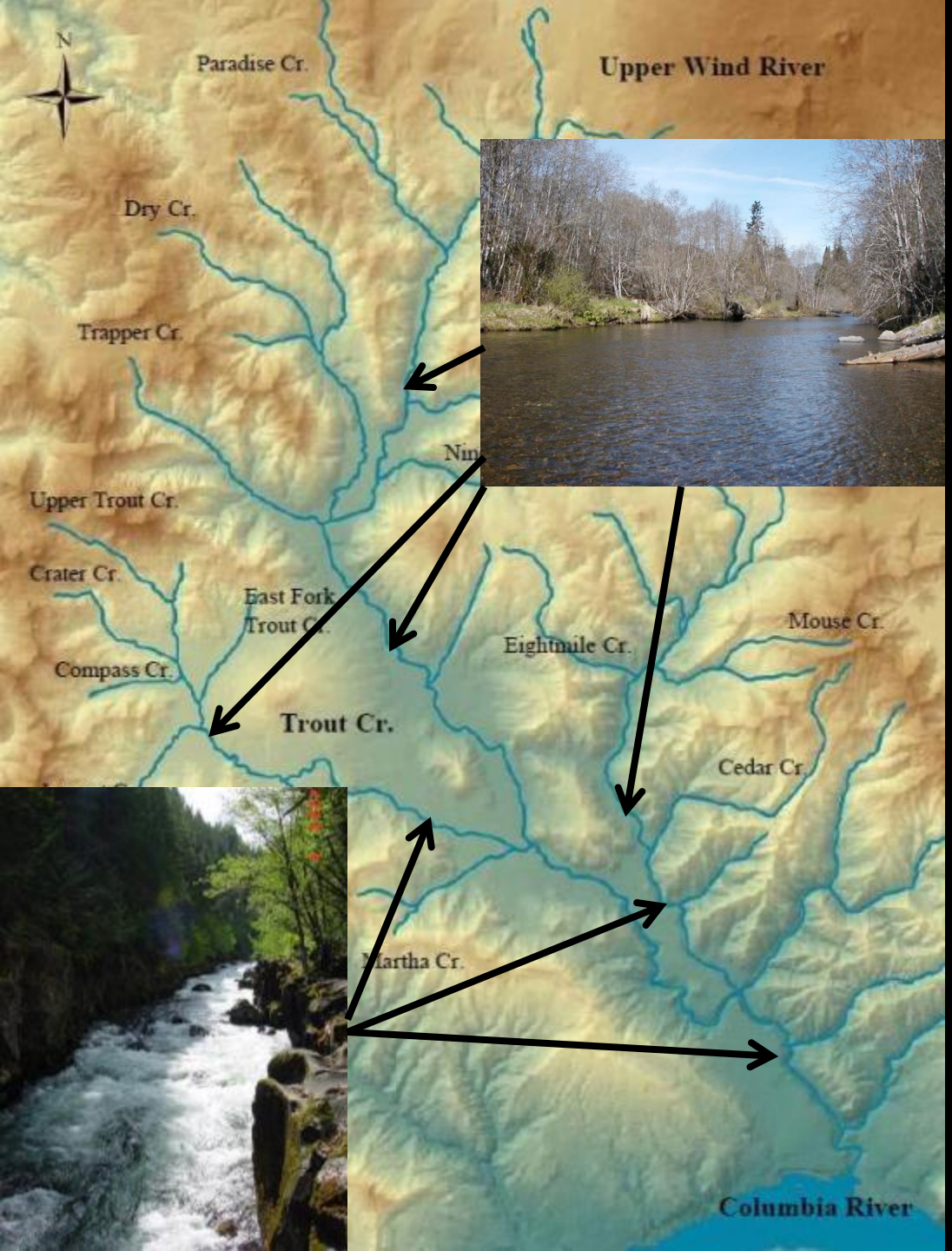
(Caudill and Keefer 2013)

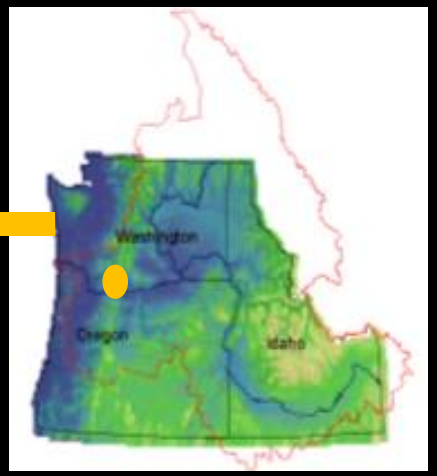


Talk Outline

- Background on steelhead iteroparity
- Wind River data collection methods







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

10 km > Bonneville Dam

Anadromous fish:

Summer Steelhead

(Hatchery Spring Chinook)

Shipherd Falls (rkm 3)

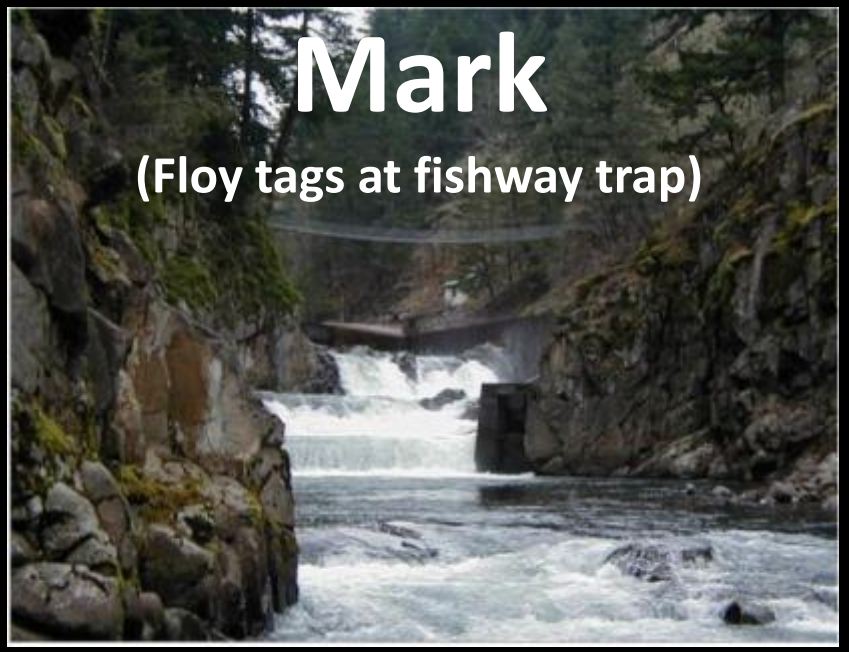
Barrier to salmon

Wild steelhead refuge (pHOS 1%)

Adult Monitoring

- Abundance
  - Floy tag adults at Shipherd Falls fish ladder
  - Snorkel to count tagged and untagged adults (2000-pres.)

- Bio-Samples
  - Scales, length, sex, origin
  - Tags
    - Floy – since 2000
    - PIT – since 2007

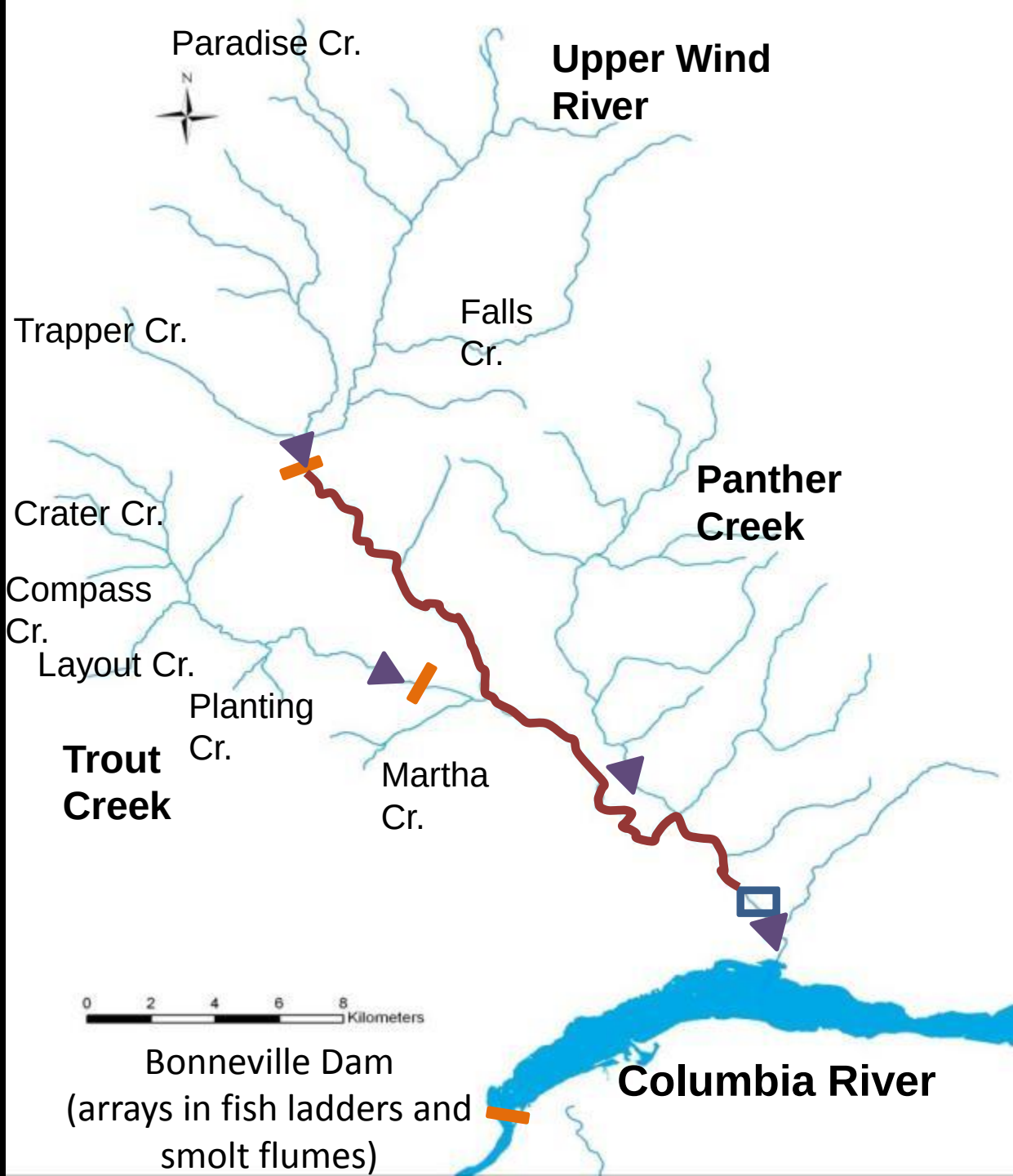


Juvenile Monitoring

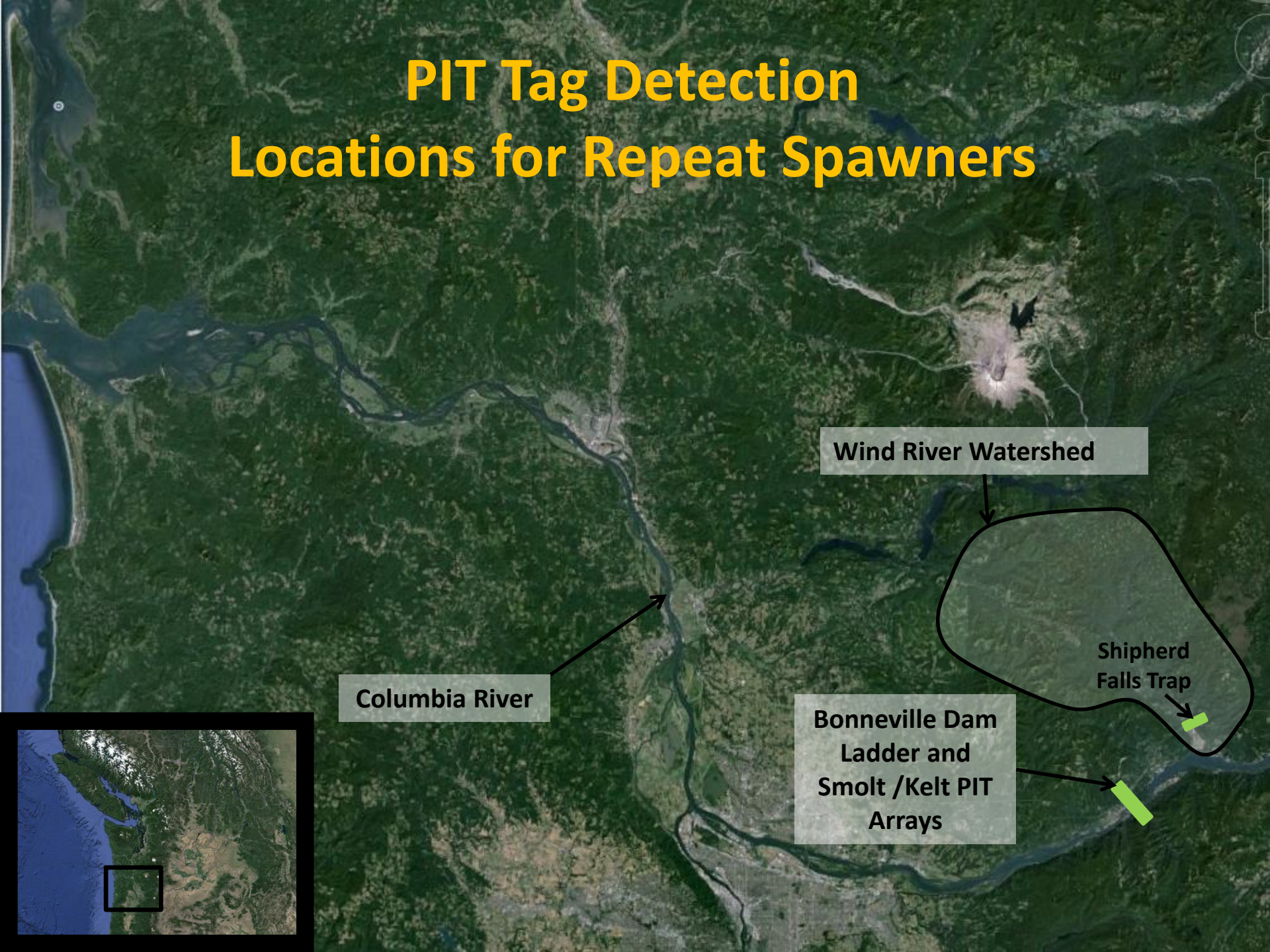
- 4 smolt traps
  - All start between 1992- and 1998
  - Smolt abundance
  - Parr abundance (index)
  - Bio-Samples
    - Lengths
    - Scales
    - PIT tags
      - partial since 2003
      - all smolts since 2005

Data Sites

- PIT Tag Array (MUX)
- Shipherd Falls Adult trap
- Snorkel re-sight reach
- Smolt trap

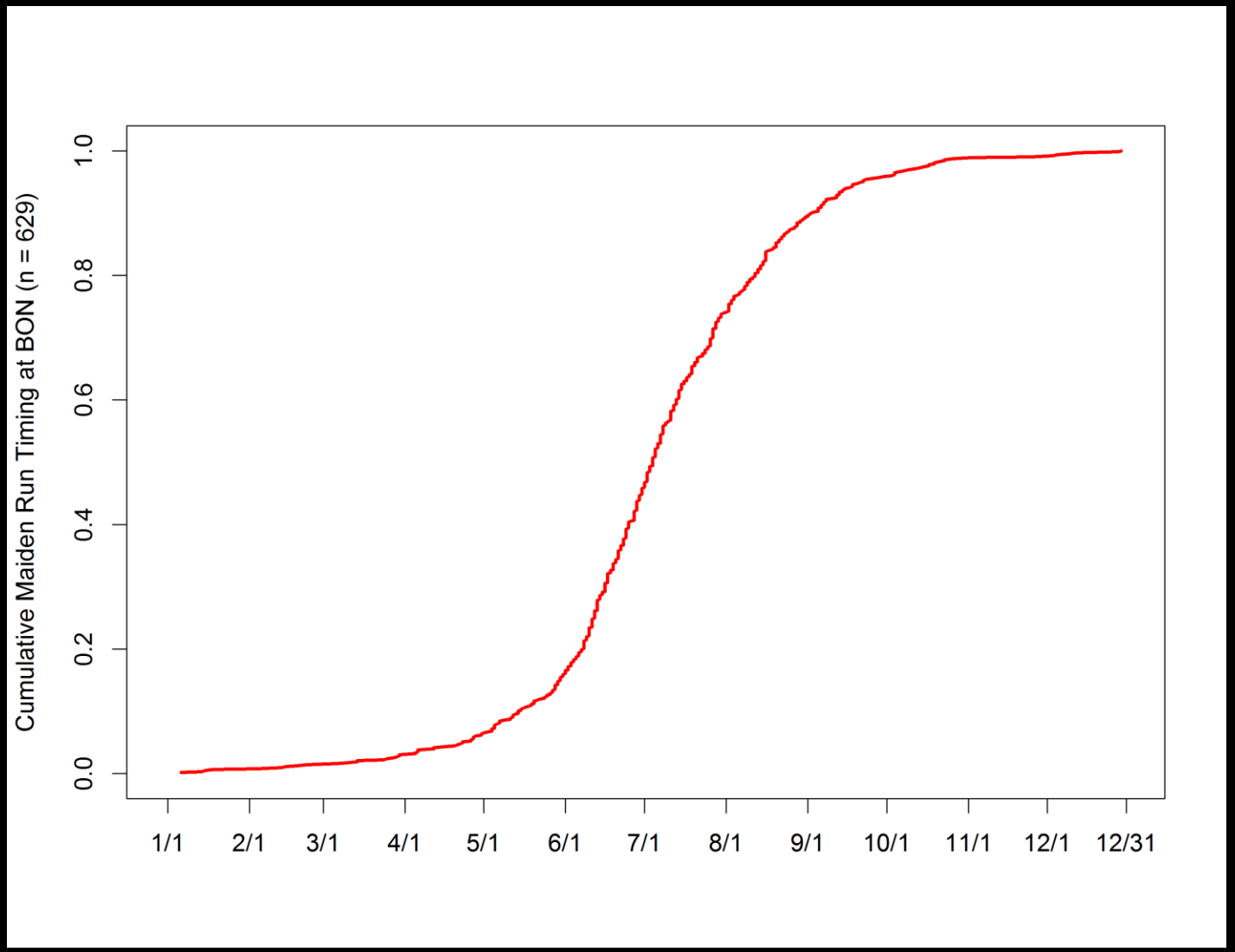


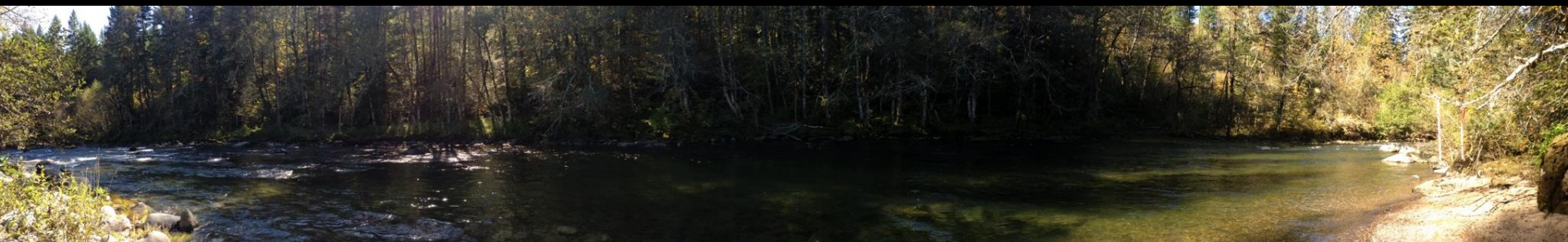
PIT Tag Detection Locations for Repeat Spawners



Wind River Steelhead

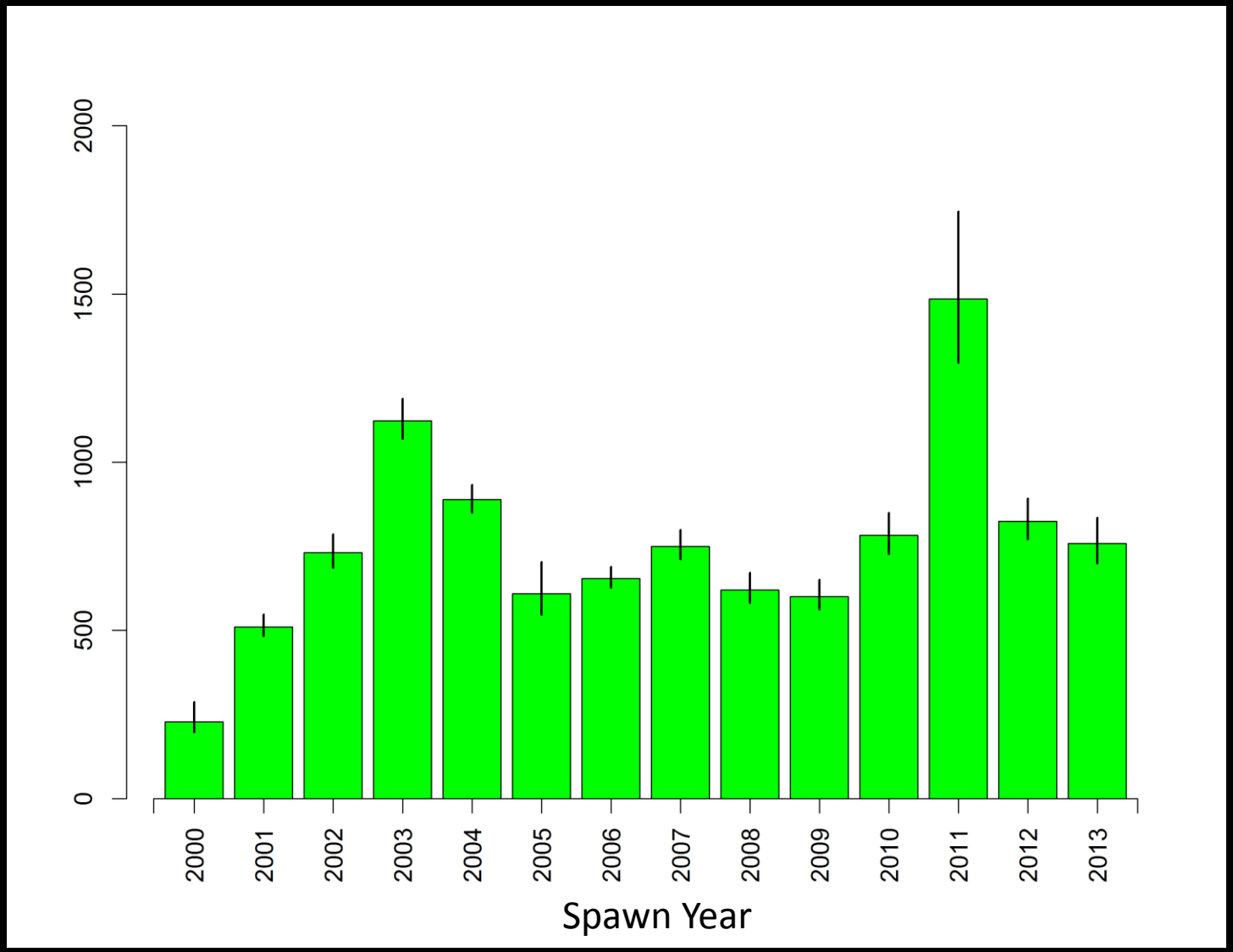
Dominated by summer runs; May-October passage at BON

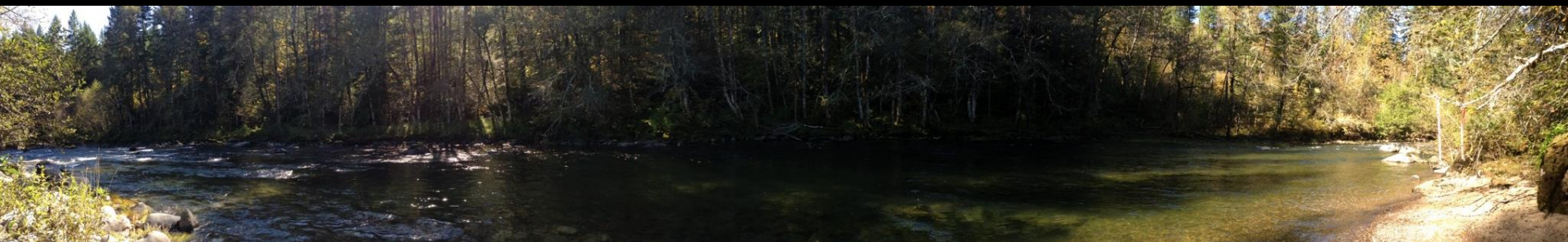




Wind River Steelhead

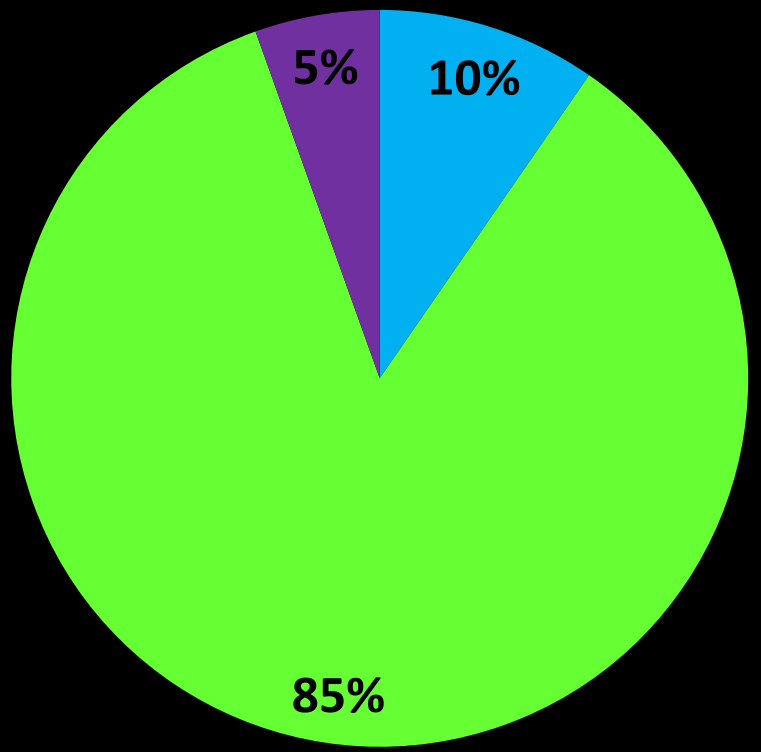
Abundance ranges from 200-1500 adults by spawn year

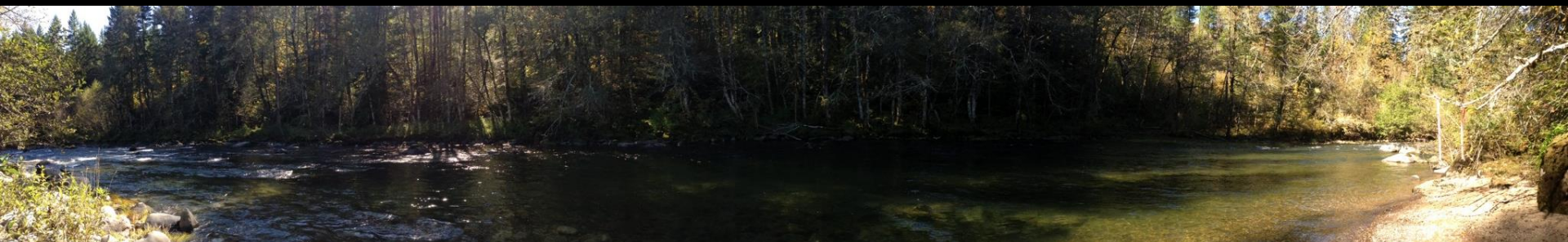




Wind River Steelhead

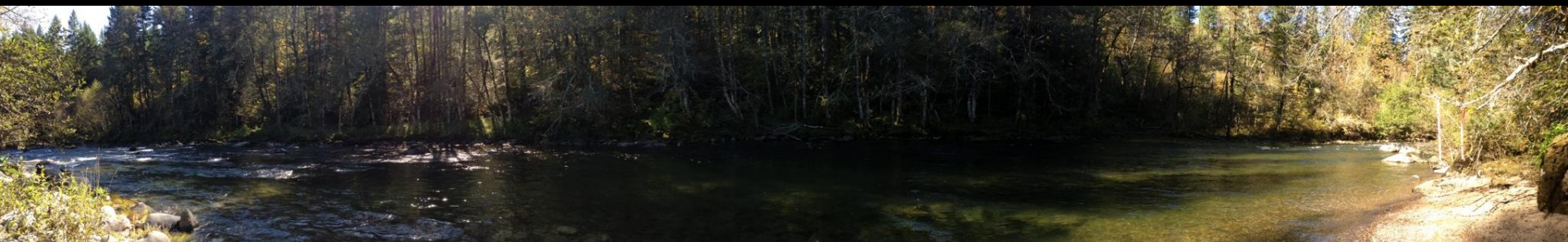
Ocean Age of Maiden Spawners dominated by 2-salts





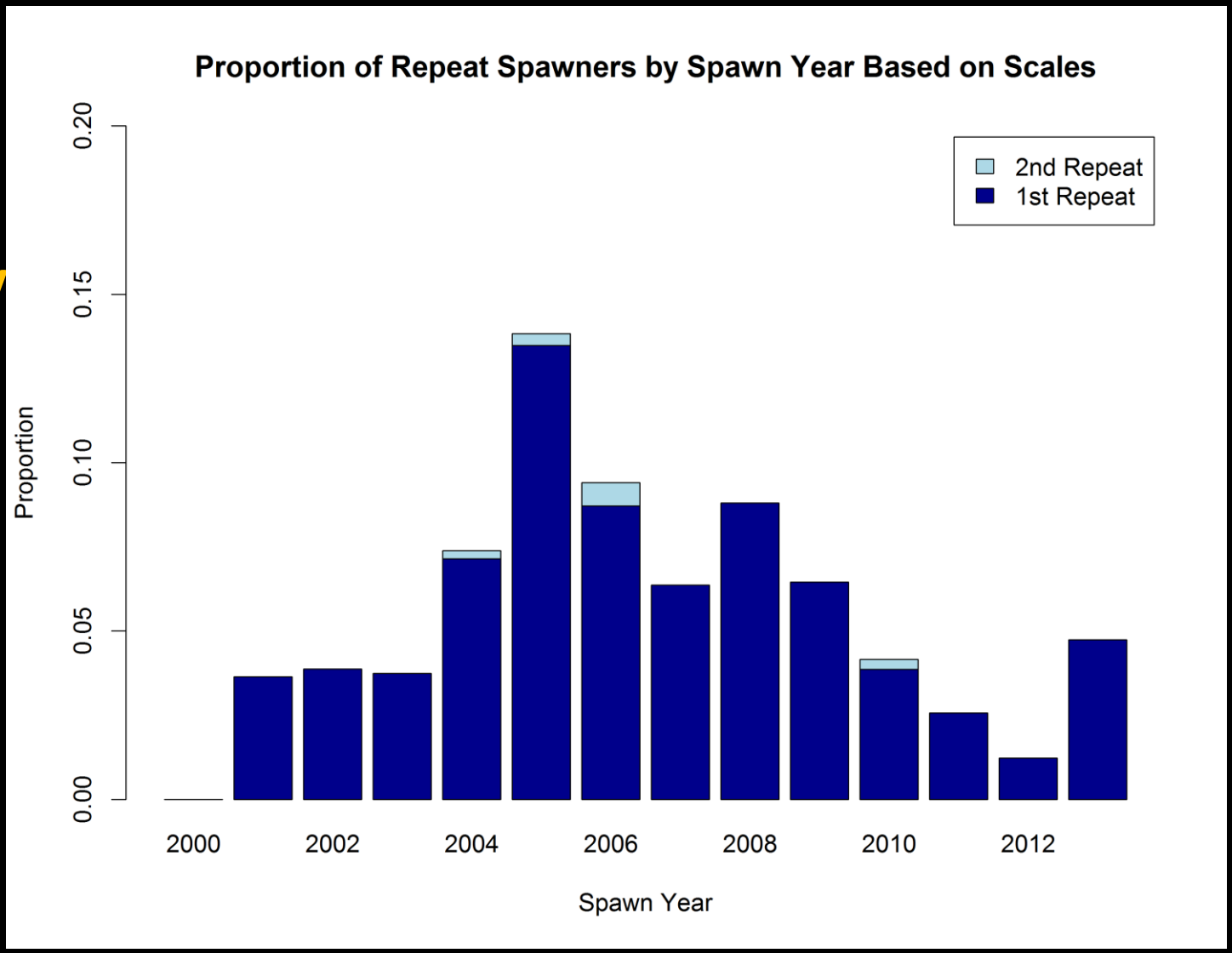
Talk Outline

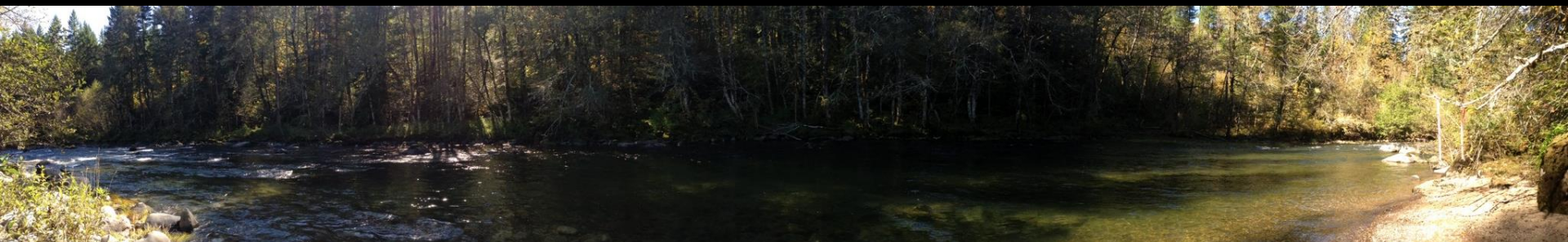
- Background on steelhead iteroparity
- Wind River data collection methods
- Rates of iteroparity



Results: Rates of Iteroparity

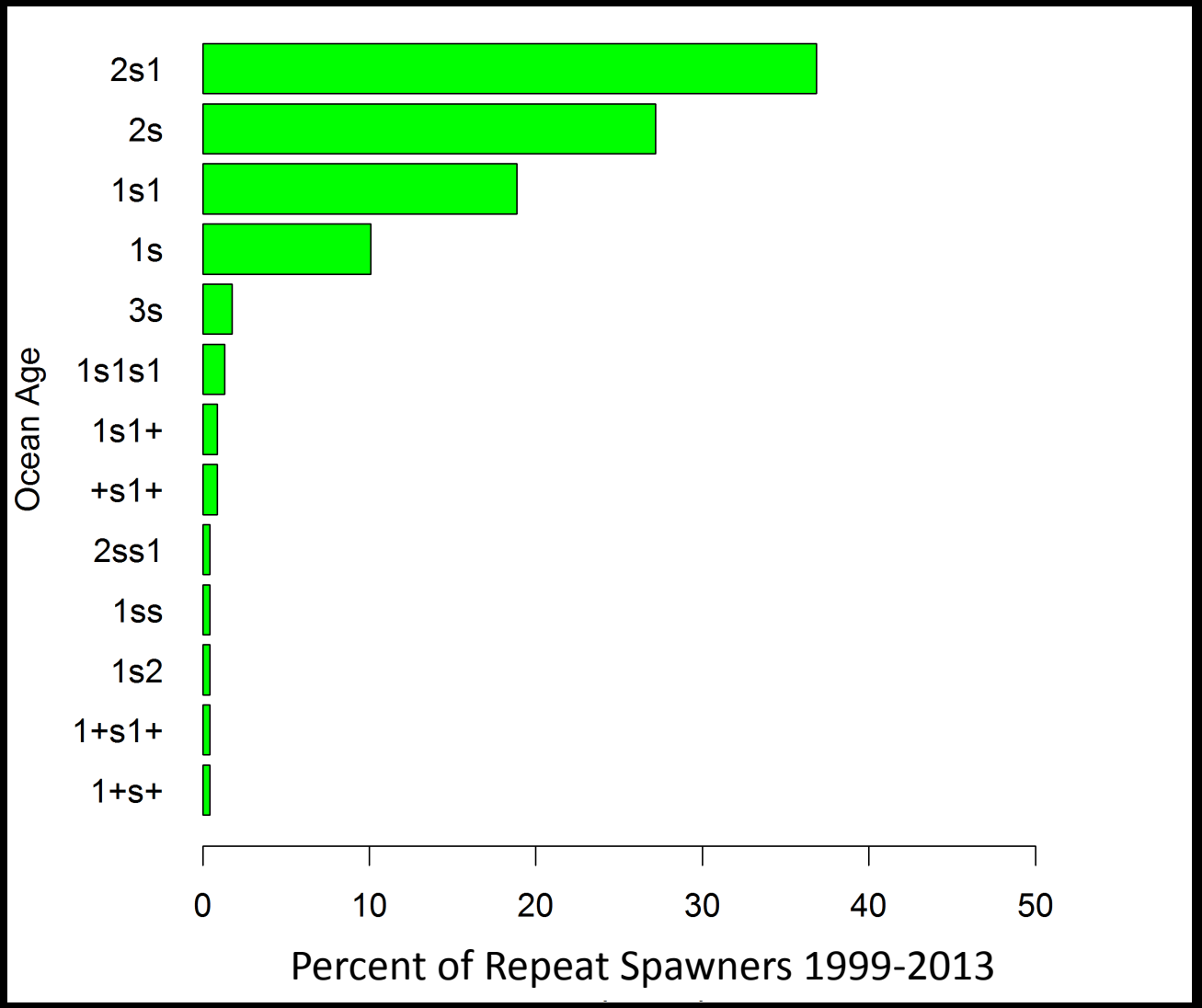
Repeat spawners varied from 1.2 % to 13.5% of the run by spawn year

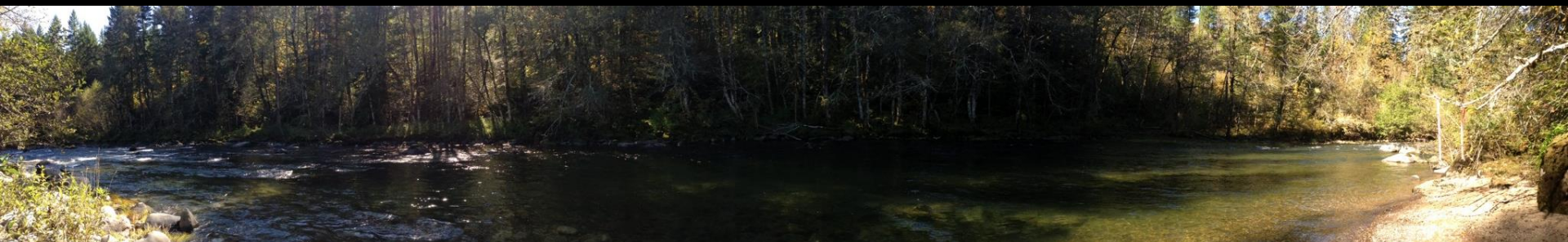




Results: Rates of Iteroparity

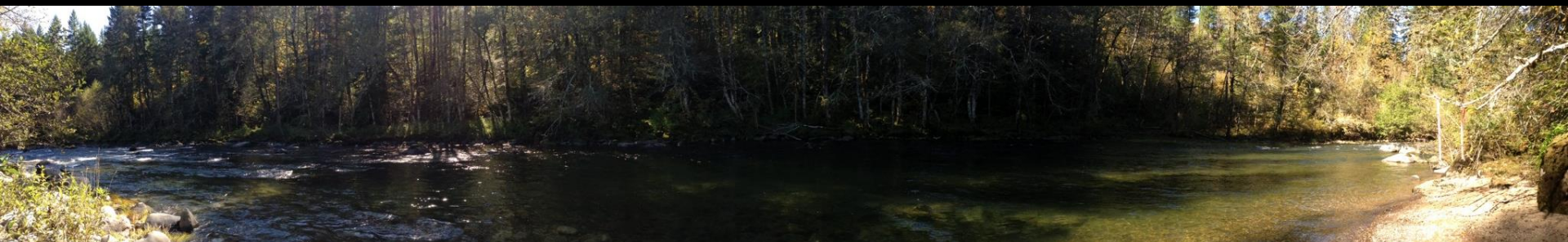
- Skip repeat 2 salt summers most common
- Annual repeat 2 salt summers second most common
- One salts of same categories next





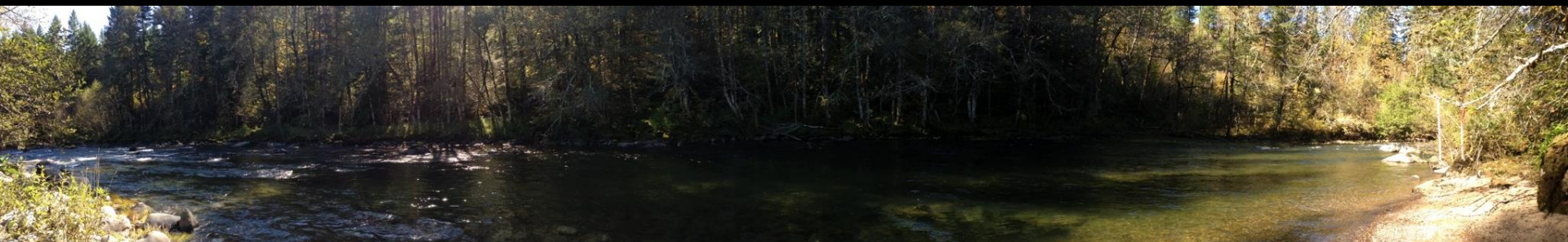
Talk Outline

- Background on steelhead iteroparity
- Wind River data collection methods
- Rates of iteroparity
- Factors influencing iteroparity



Analysis of iteroparity

- Factors affecting iteroparity
  - *Ho*: no difference in probability of an individual repeat spawning
- Differences between maiden and repeat spawners
  - *Ho*: no difference in repeat and maiden timing at BON
  - *Ho*: no difference in length between maiden and repeats

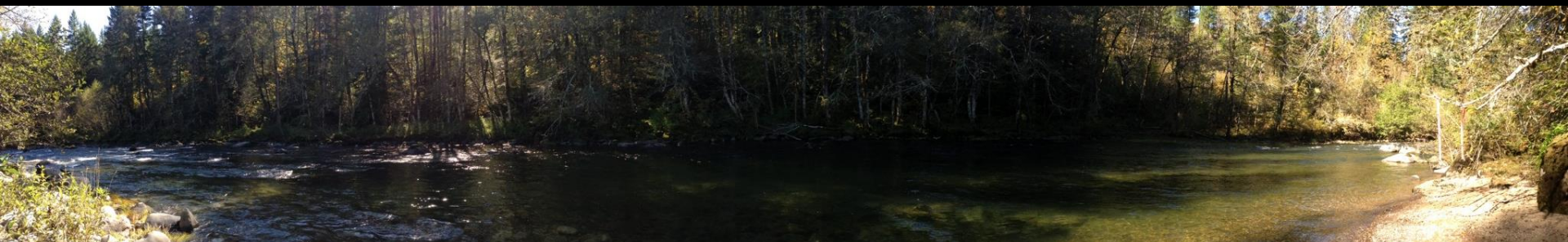


Factors affecting iteroparity

Ho: No difference in probability of a maiden spawner repeat spawning by:

- GLM models—binomial response, with logit link function
- All subsets up to 3 variables tested (no interactions)
- Model selection with AIC
- Also ran model with year subset to include SAR

Variable	Continuous or Factor
Sex	F
Length	C
Run type (winter or summer)	F
Years since smolting at spawn	F
Days before spawning (common date)	C
Spawn Year	F
Tag Month	F
Previous Spawn History	F
SAR during kelt year	C

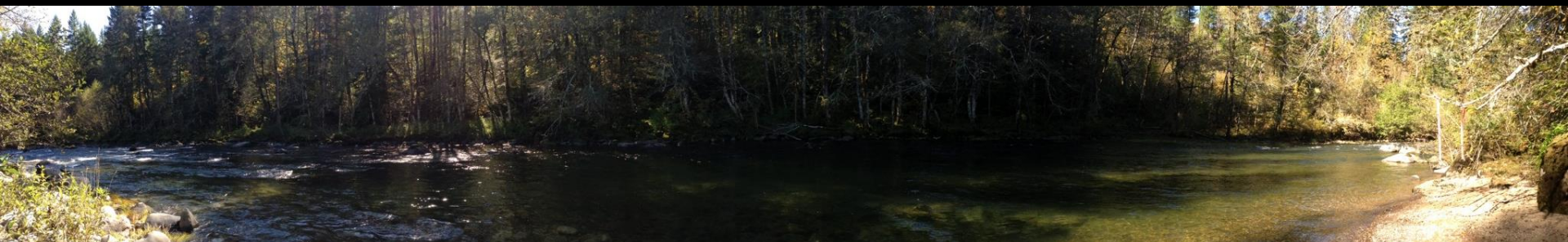


Results: Factors affecting iteroparity

Ho: No difference in probability of a maiden spawner repeat spawning by:

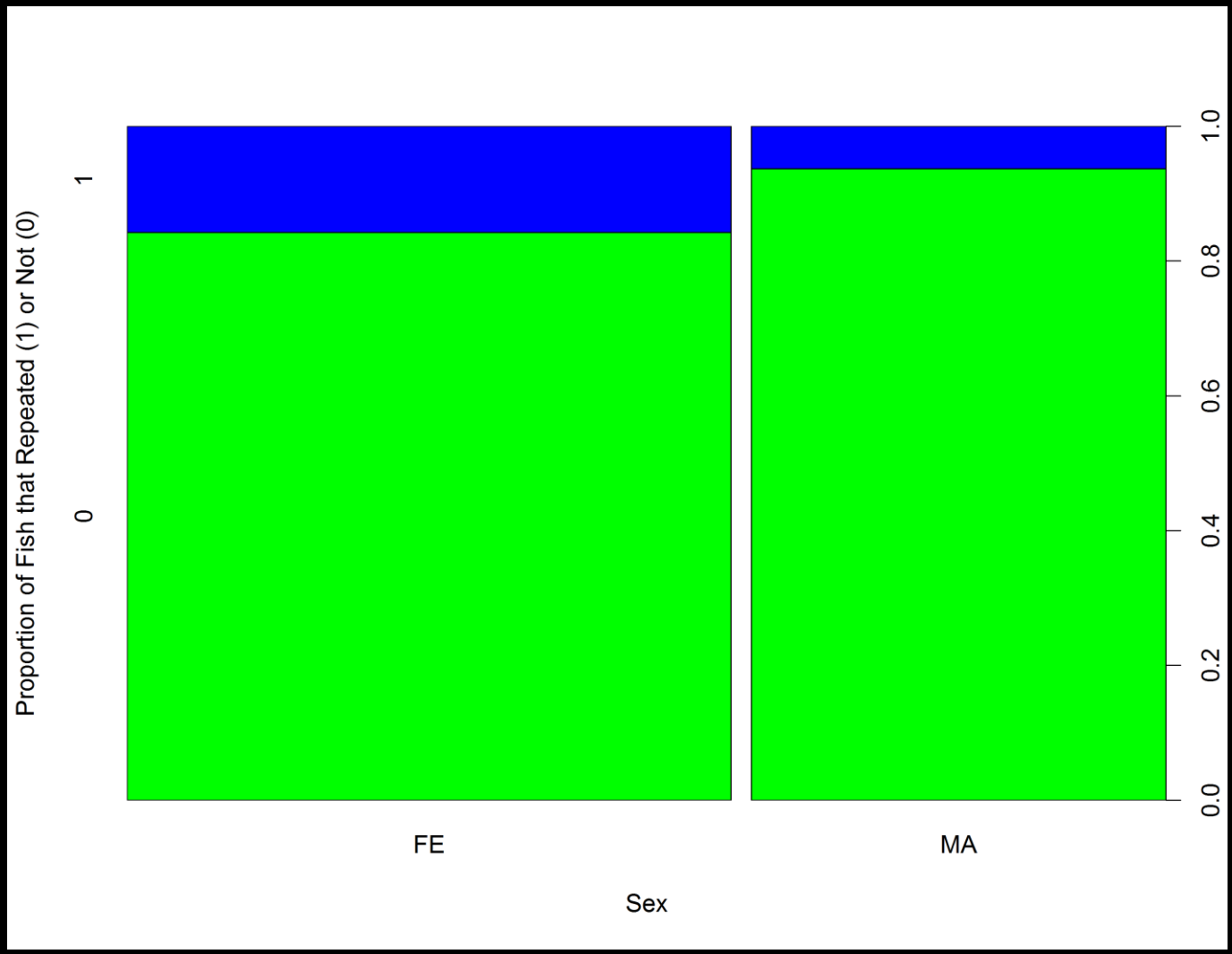
- Two models with delta AIC < 4)
  - One included Salt Age, one had Length, which were highly correlated
- Low explanatory power (R^2 = 0.065)

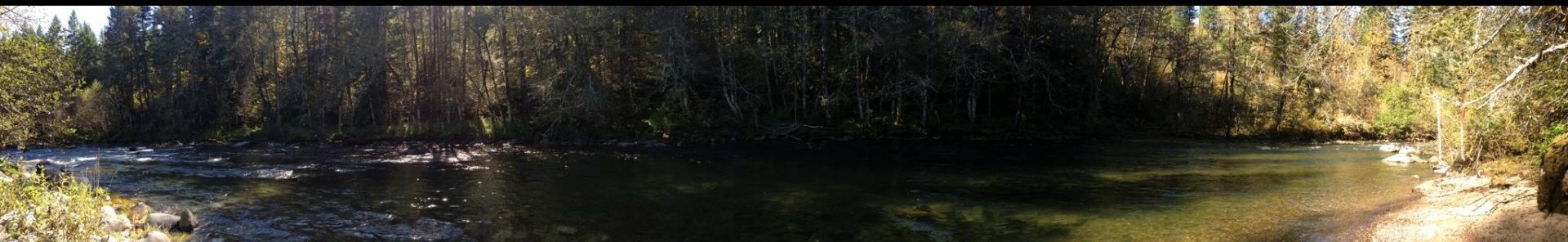
Variable	Continuous or Factor	Effect on repeat spawning
Sex	**F**	**females more likely**
Length	**C**	**shorter fish more likely**
Run type (winter or summer)	F	smaller fish more likely
Years since smolting at spawn	**F**	**oldest fish less likely**
Days before spawning (common date)	**C**	**earlier arrivers more likely**
Spawn Year	F	NS
Tag Month	F	NS
Previous Spawn History	F	NOT APPLICABLE
SAR during kelt year	C	NS



Results: Factors affecting iteroparity

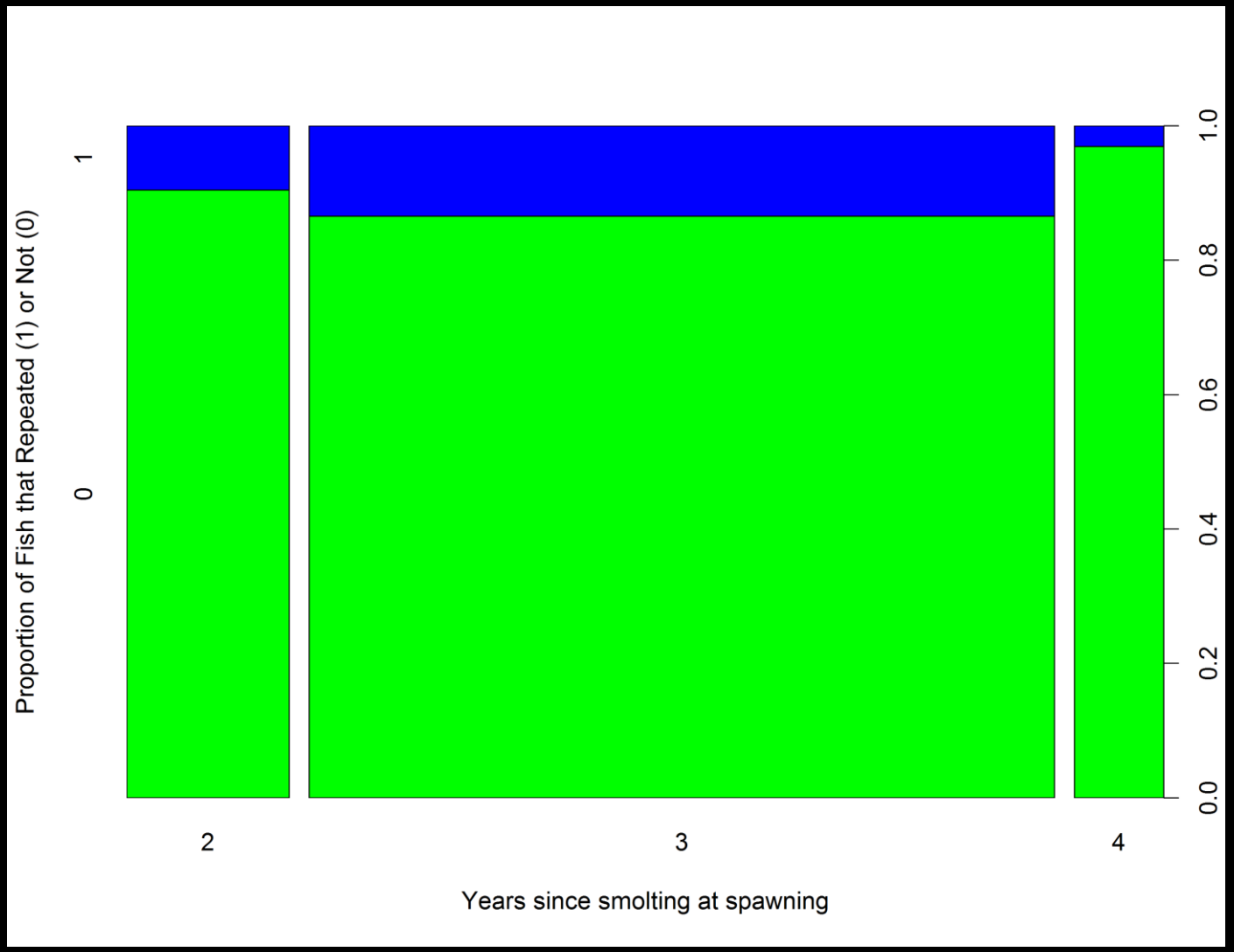
Females more likely to repeat spawn (n = 1093)

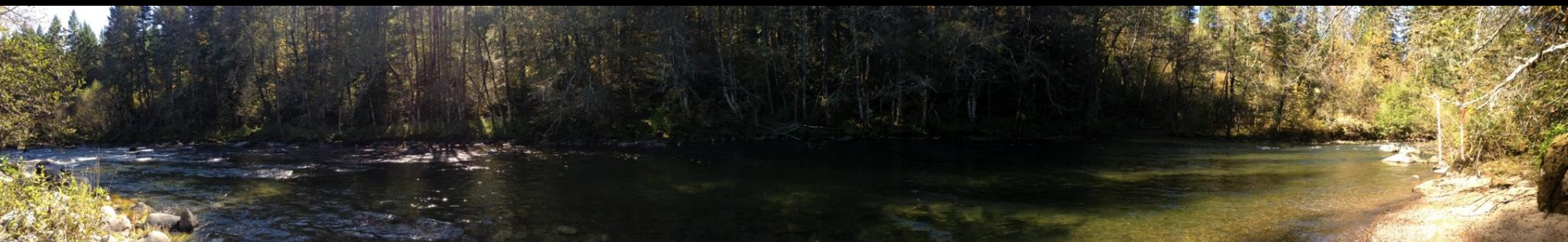




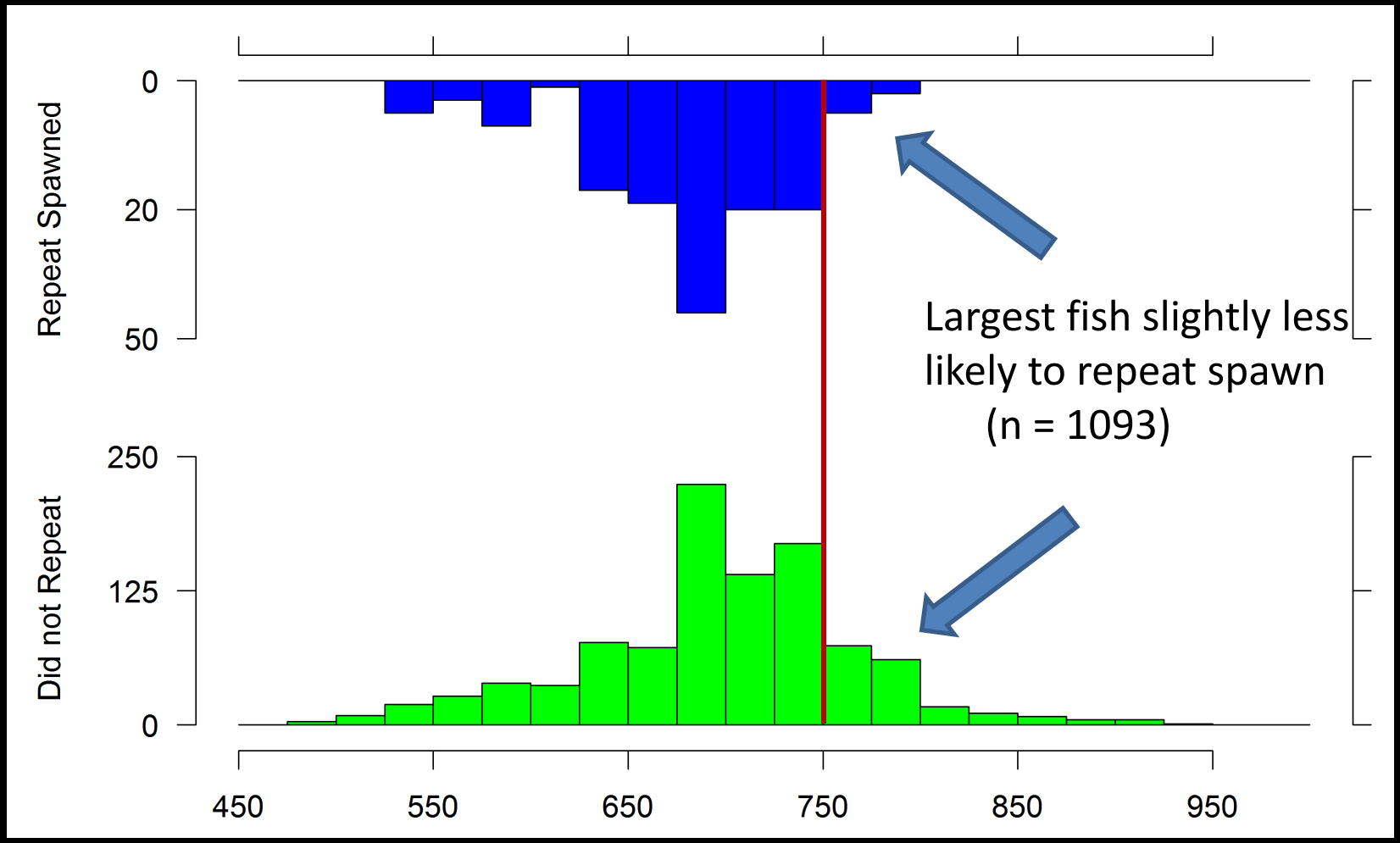
Results: Factors affecting iteroparity

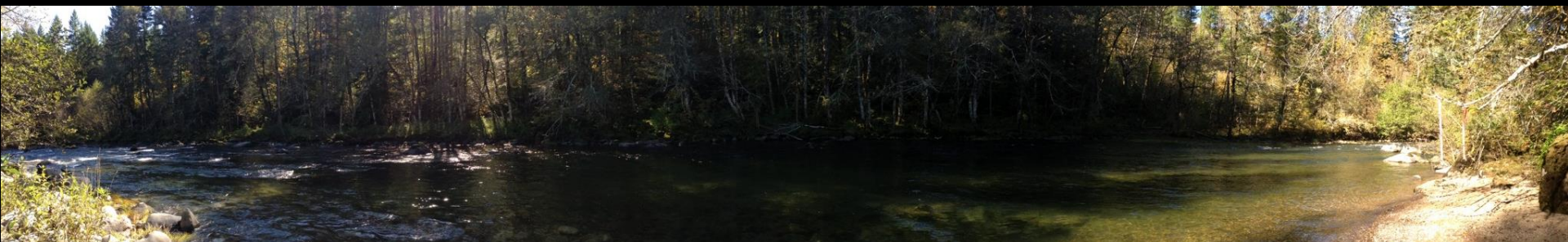
Oldest fish less likely to repeat spawn
(n = 1093)





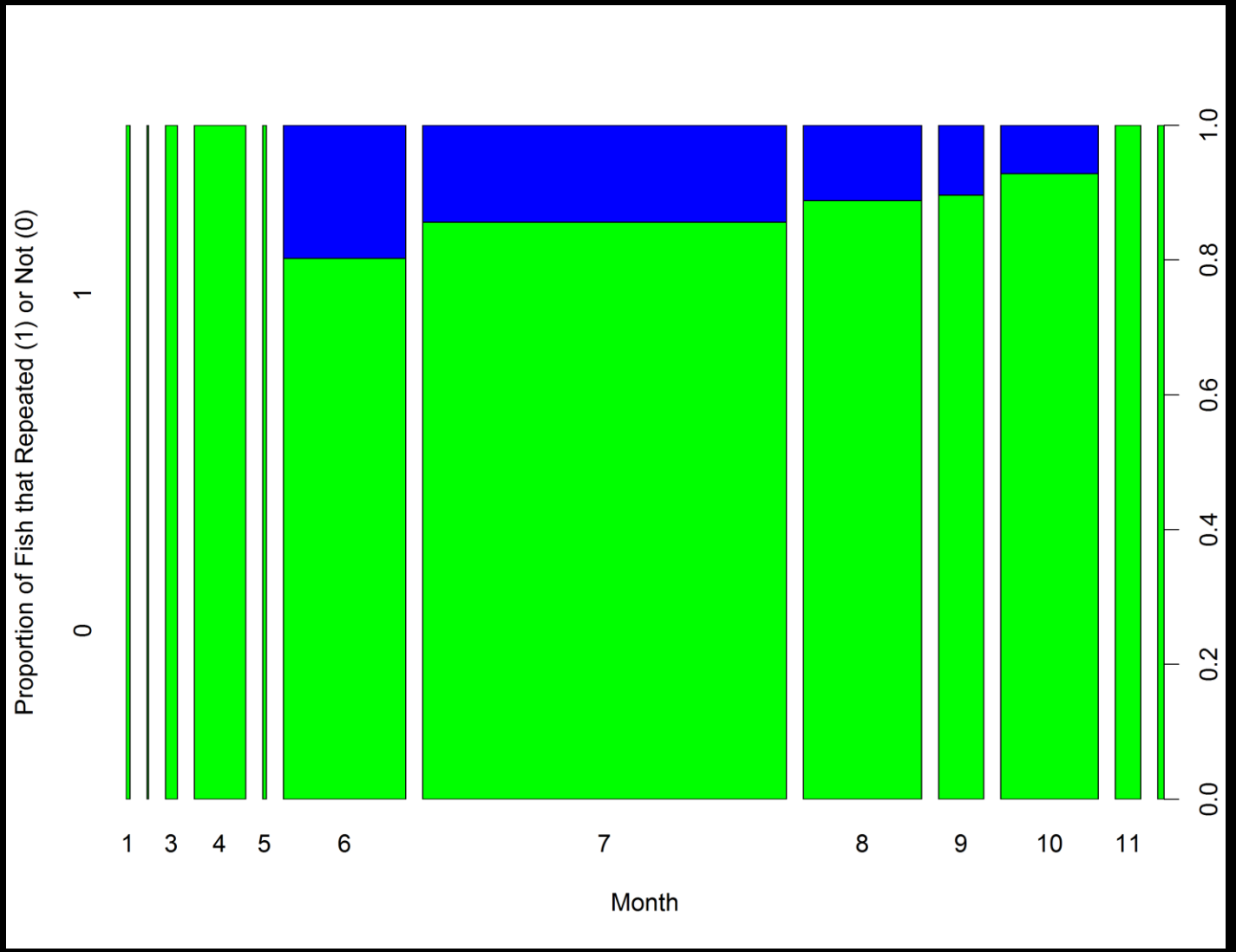
Results: Factors affecting iteroparity

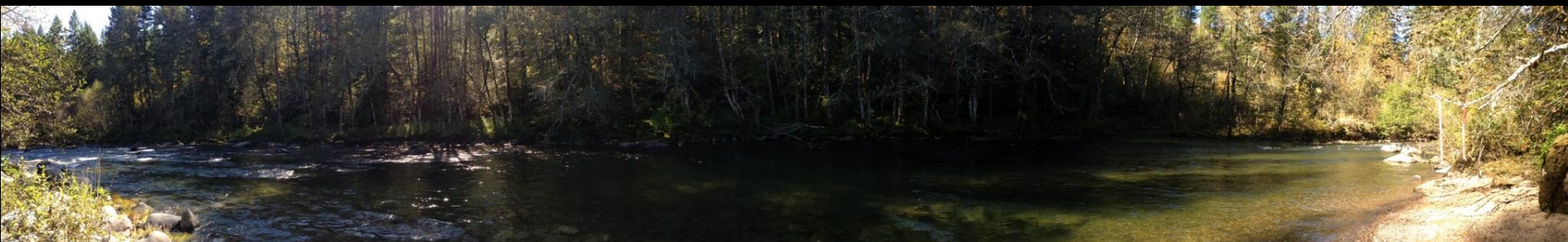




Results: Factors affecting iteroparity

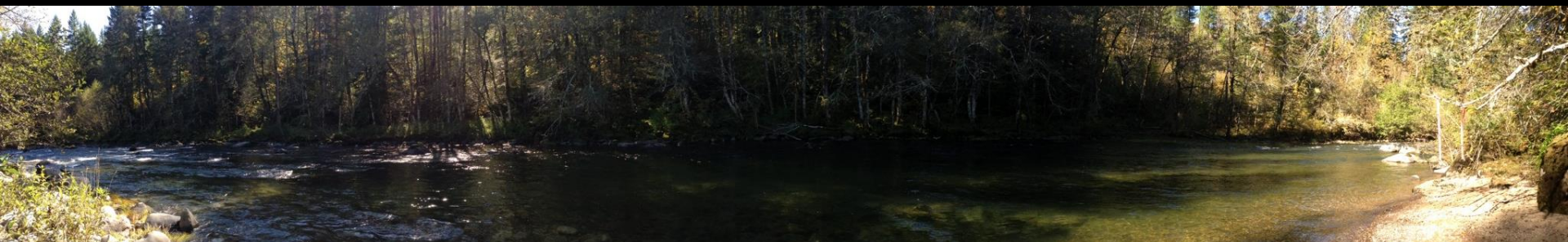
- Few fish tagged in winter but none repeated to BON
- Declining proportion of summers repeat by month





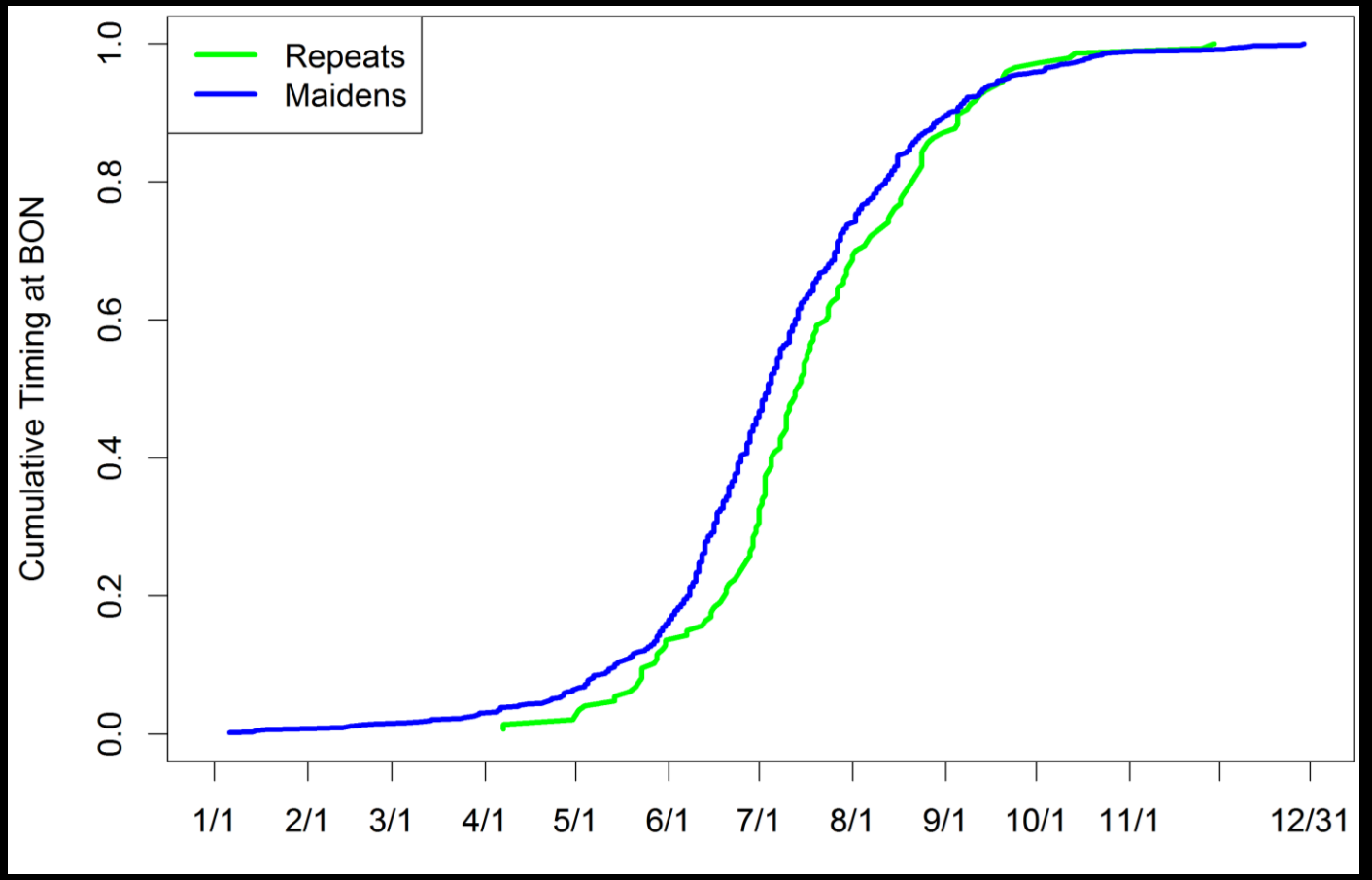
Analysis of iteroparity

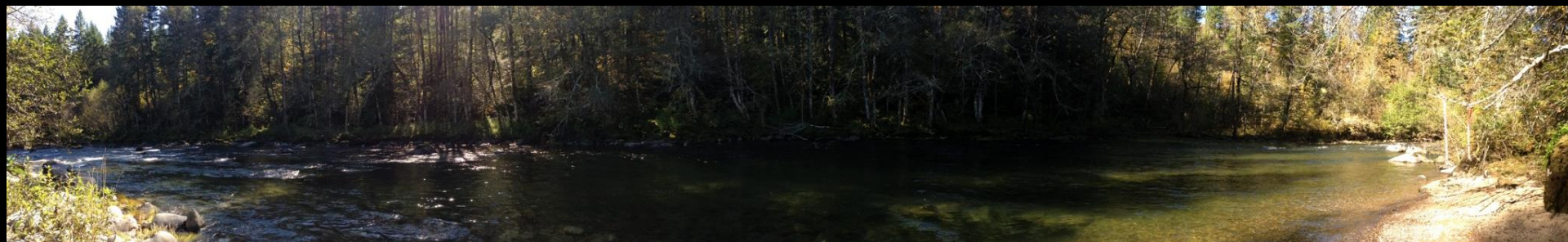
- *Ho*: no difference in probability of an individual repeat spawning
- *Ho*: no difference in repeat and maiden timing at BON



Results: Timing

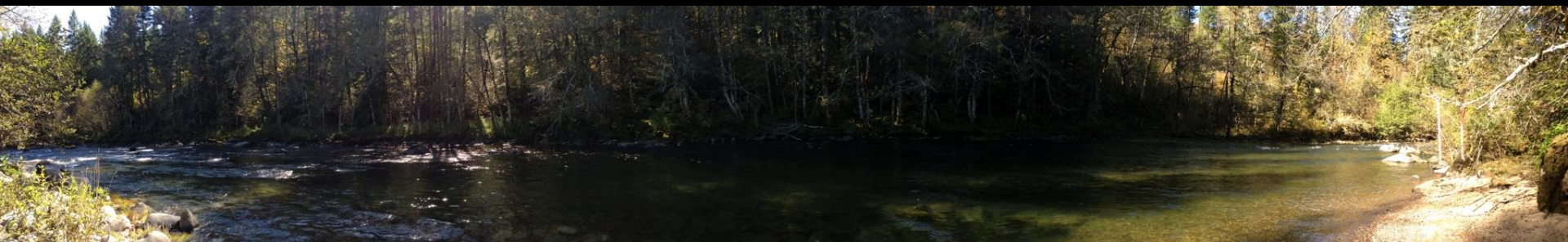
- Repeats slightly later at BON
- Limited sample size
- Possible bias: maidens tagged as smolts, repeats tagged at Shipherd Falls





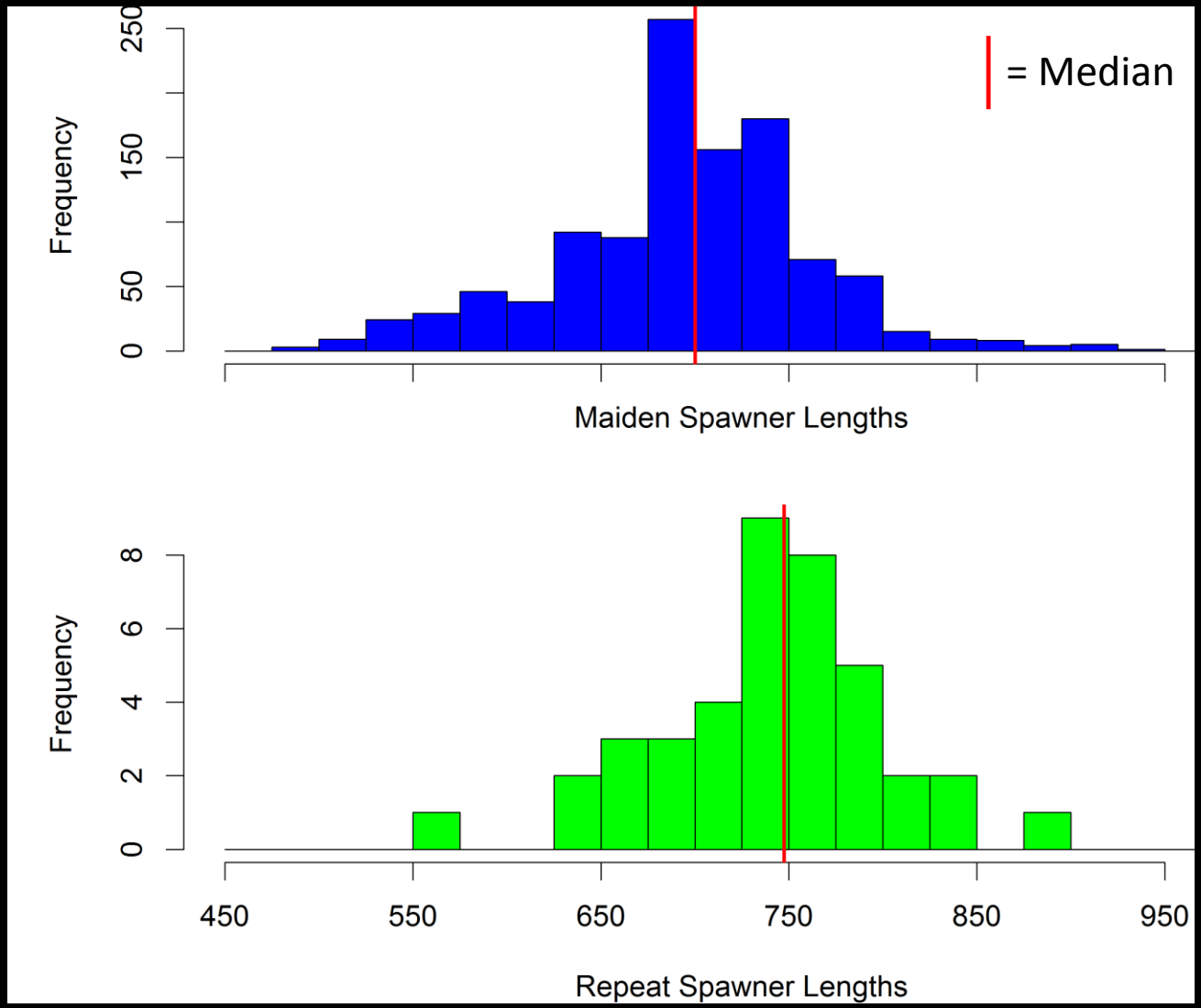
Analysis of iteroparity

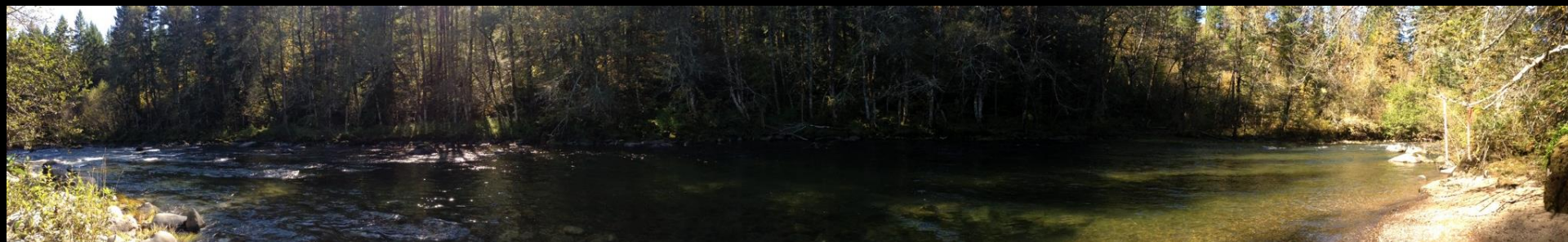
- *Ho*: no difference in probability of an individual repeat spawning
- *Ho*: no difference in repeat and maiden timing at BON
- *Ho*: no difference in length between maiden and repeats



Results: Lengths

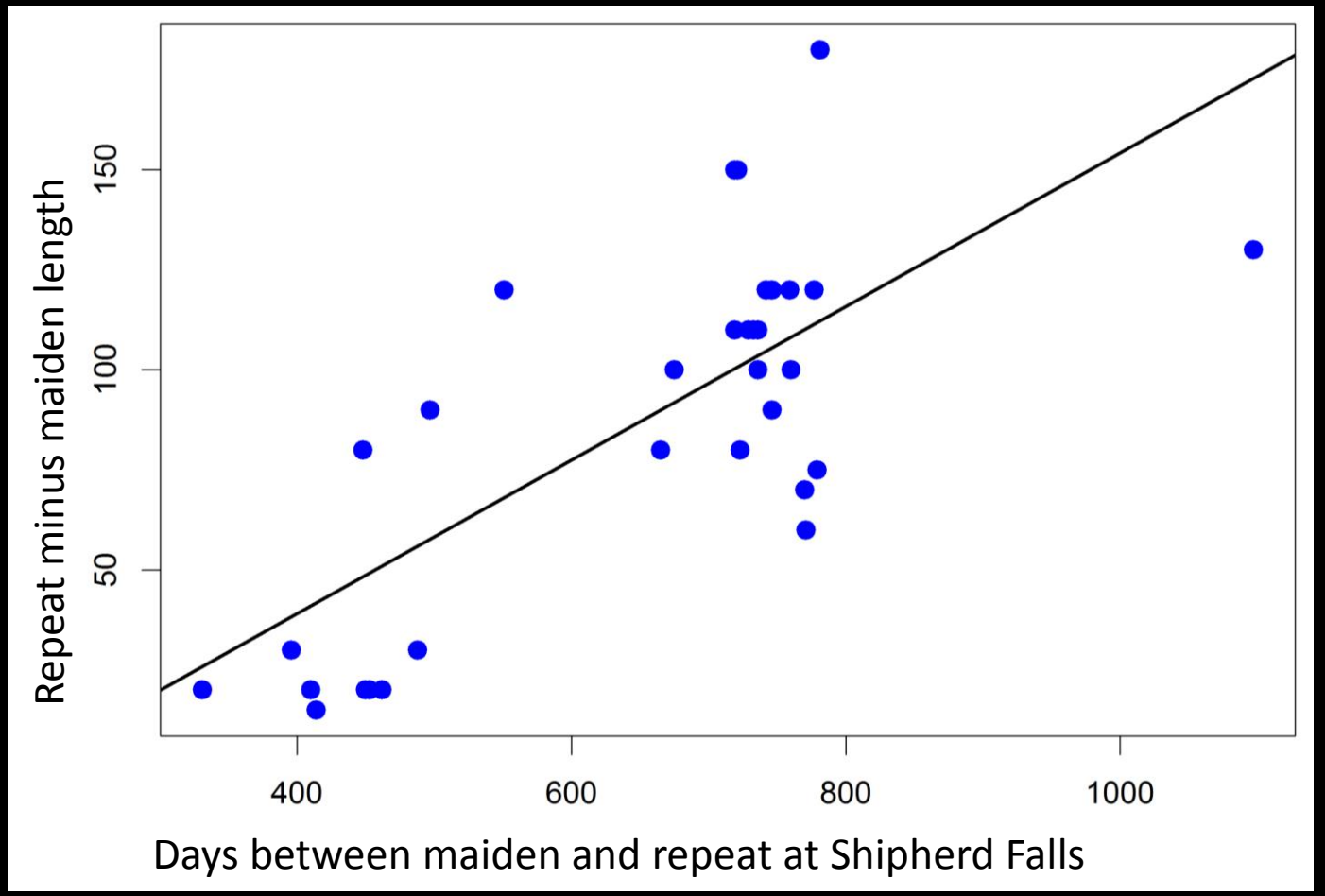
- Median length 48 mm larger for repeat spawners
- KS test p << 0.001

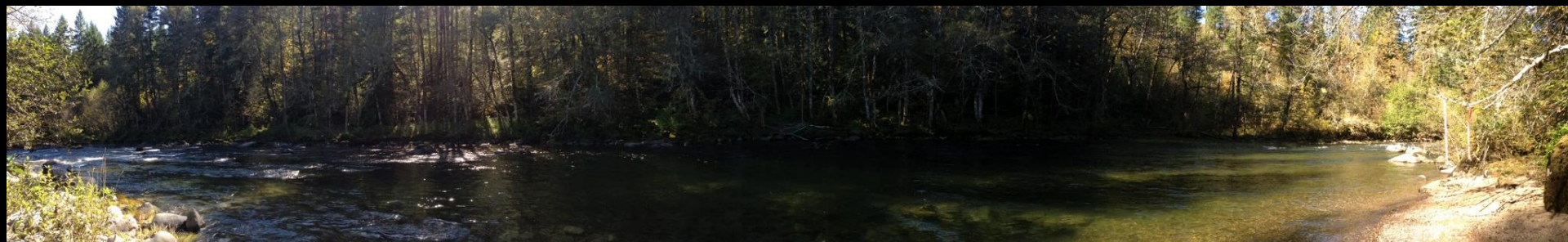




Results: Lengths

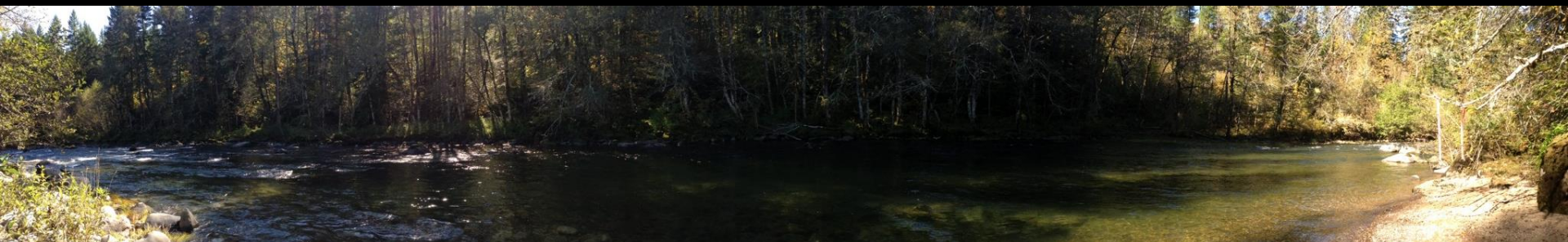
- Repeat spawners grew before repeating
- Length growth correlated with days between spawning





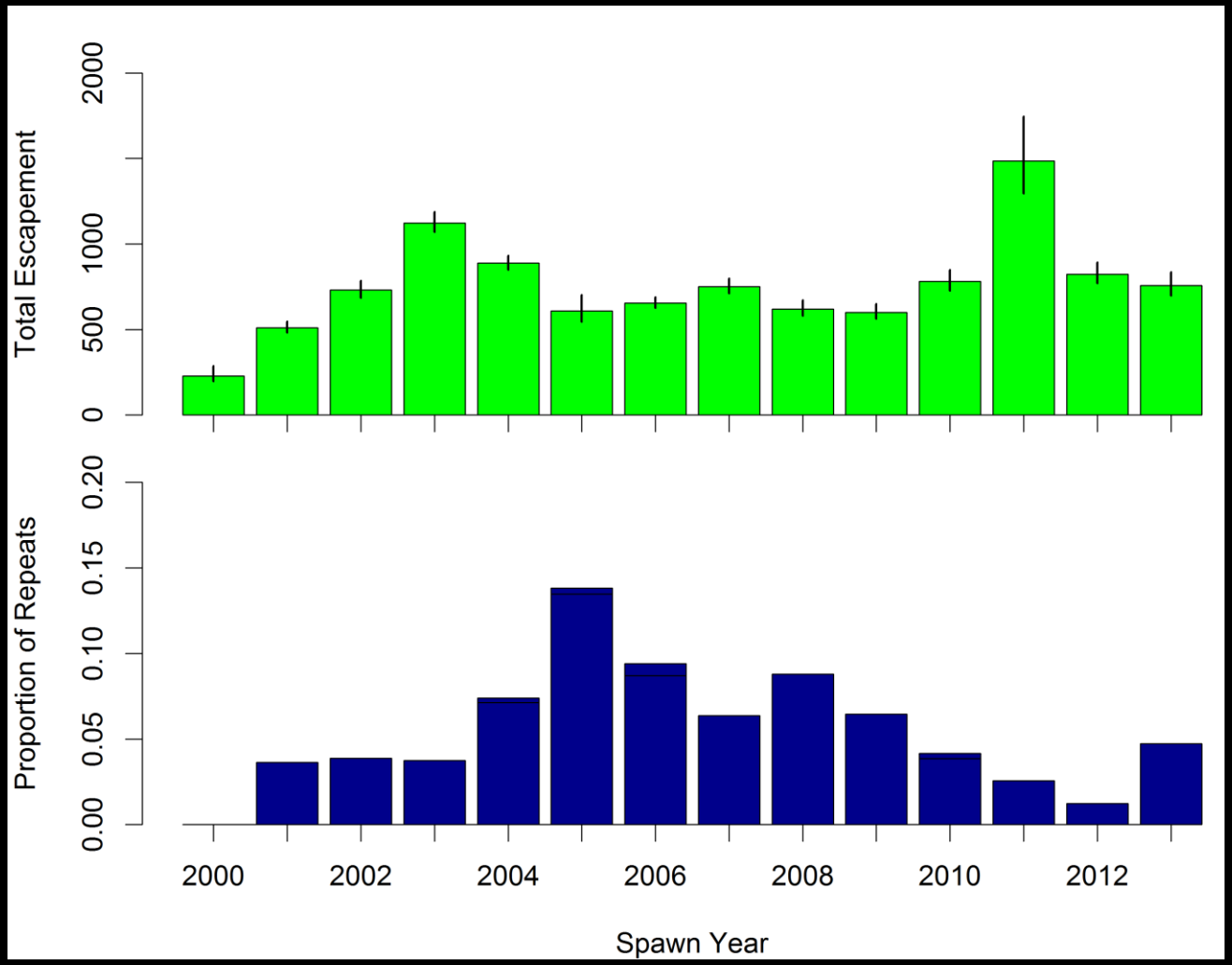
Talk Outline

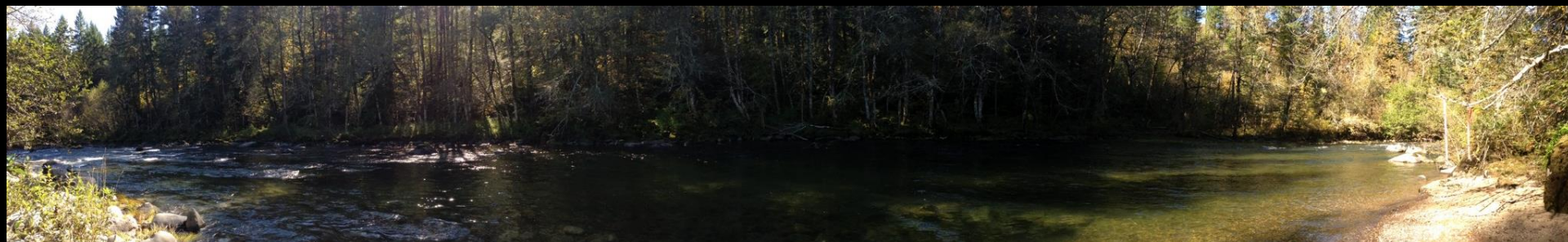
- Background on steelhead iteroparity
- Wind River data collection methods
- Rates of iteroparity
- Factors influencing iteroparity
- Implications of iteroparity



Implications of Iteroparity

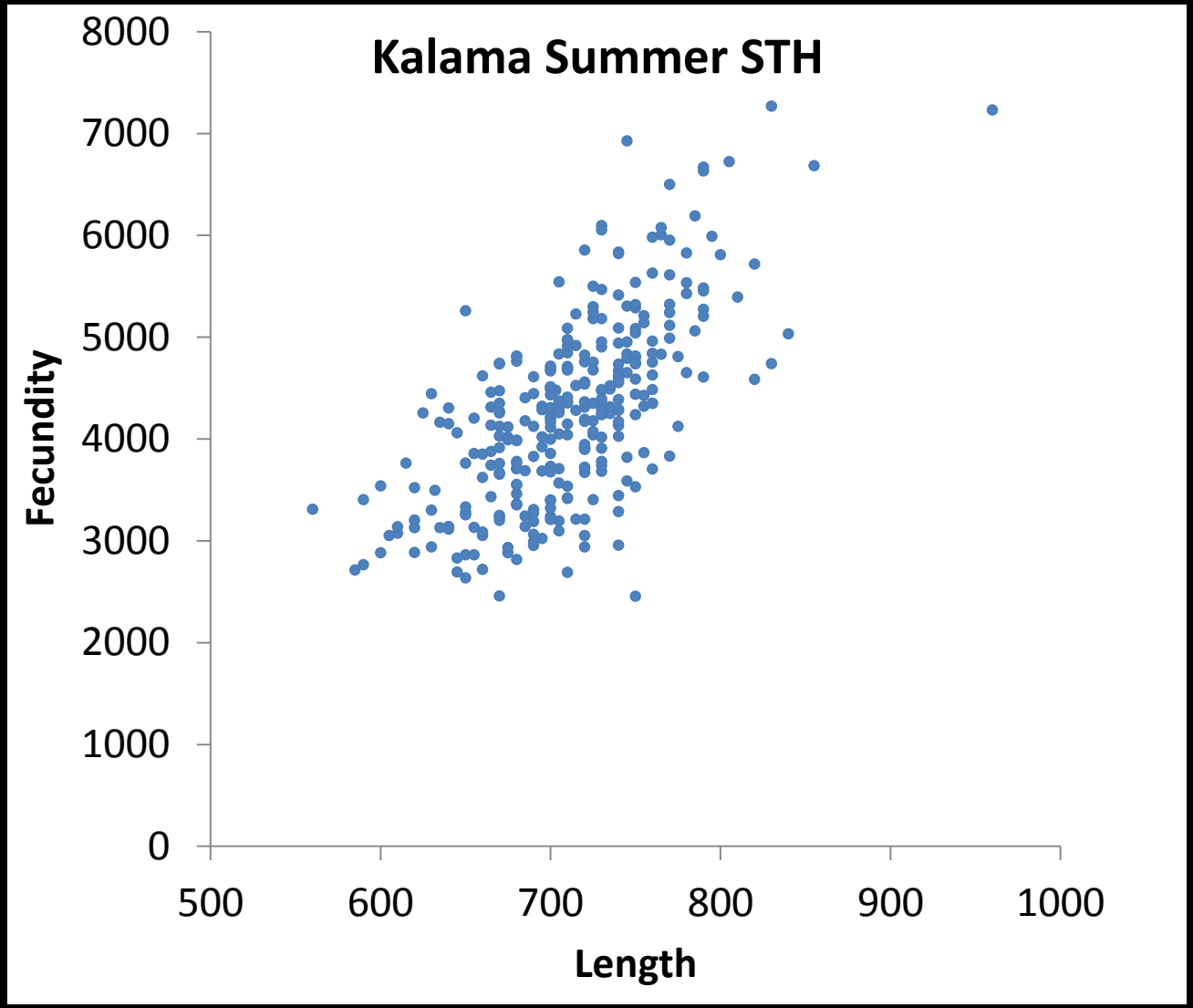
- Increase median abundance by 40 spawners and 6%
- Lower than median abundance years; 9%
- Reduce CV in abundance by 1.6%

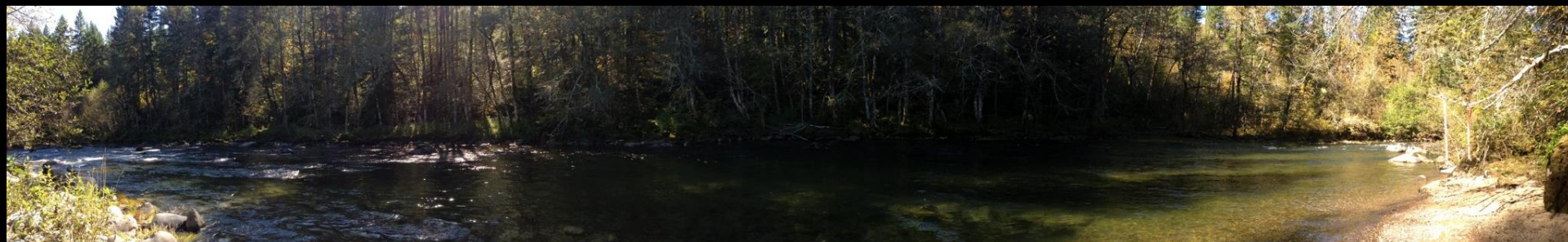




Implications of Iteroparity

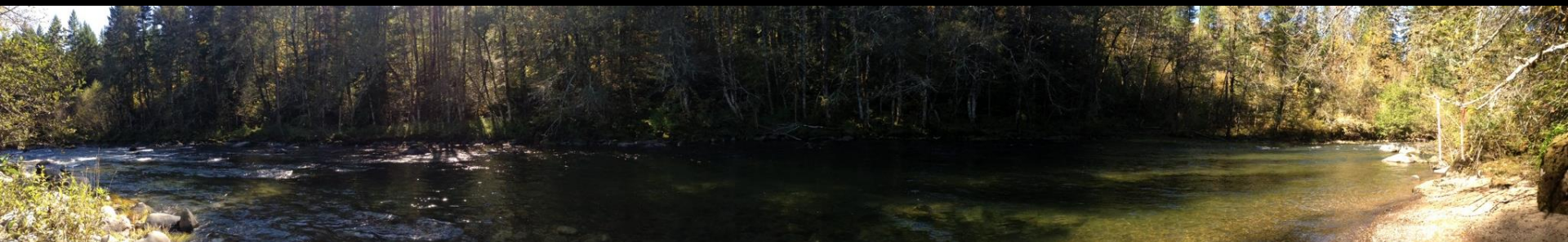
- Higher fecundity associated with greater length





Summary

- Iteroparity in Wind > than observed in Columbia; up to 13.5%
- Probability of repeat spawning for maidens correlated with:
  - Sex (females more likely)
  - Length (smaller more likely)
  - Timing (earlier more likely) !?
  - Age of maidens (oldest less likely)
- Repeat spawners larger, slightly later timed relative to maidens
- Growth of repeats increased with time
- Repeat spawners buffer declines in abundance
- Increasing iteroparity would likely benefit listed Columbia River populations



Acknowledgements

- **WDFW**
  - Wind River technicians
  - Fish Ecology and Life Cycle Monitoring Unit
  - ESA / Anadromous Fish Investigations Unit
- **USGS**
  - Pat Connolly
  - Ian Jezorek
- **Bonneville Power Administration**
  - Project Funding
  - Mary Todd Haight—project administration
- **Wind River Watershed partners UCD, USFS, USGS**

Questions?

Extra Slides

East Sand Island
(ESANIS)
RM 5.5

Jones Beach
RM 47
NOAA Trawl
(TWX)

Columbia
River

Wind River
RM 154.5

Shipherd
Falls
Adult
Trap

Bonneville Dam
(BON)
RM 143.4

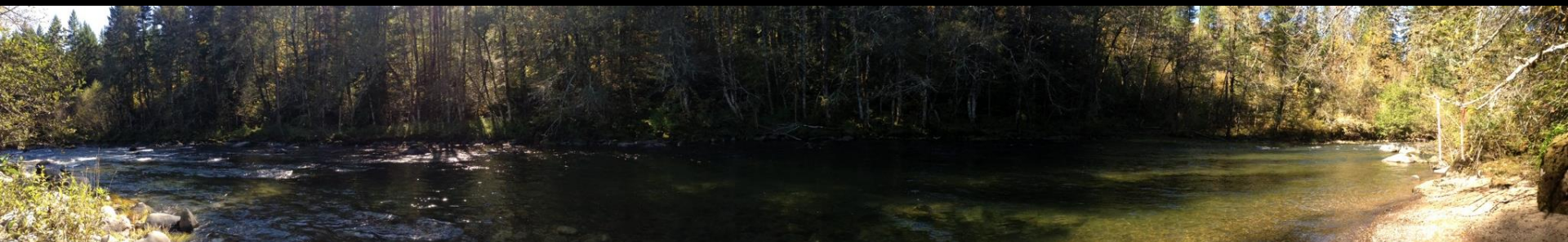
Service Layer Credits: Copyright: ©2013 Esri, DeLorme, NAVTEQ

Results: All Fish

Ho: No difference in probability of an individual repeat spawning by:

- One best model (delta AIC = 4.1)
- Low explanatory power (R^2 = 0.06)

Variable	Continuous or Factor	Effect on repeat spawning
Sex	**F**	**females more likely**
Length	**C**	**shorter fish more likely**
Run type (winter or summer)	F	smaller fish more likely
Years since smolting at spawn	F	NS
Days before spawning (common date)	**C**	**earlier arrivers more likely**
Spawn Year	F	NS
Tag Month	F	NS
Previous Spawn History	F	NS ***but correlated with length**
SAR during kelt year	C	NS



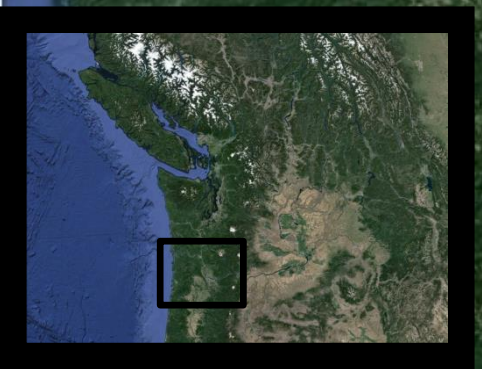
PIT Tag Detection Locations

Wind River Watershed

Upper Wind Array

Trout Creek Array

Shipherd Falls Trap

Columbia River

Bonneville Dam Ladder and Smolt /Kelt Flume Arrays