Monitoring Steelhead Populations: Methods, Challenges, and Opportunities

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Talk Outline

- Monitoring goals
- Adult Methods
- Juvenile Methods
- Uses for Life Cycle Data

Goals for Steelhead Monitoring

- "Viable Salmon Population" (VSP) metrics
  - **Abundance**—Adult & Juvenile
  - **Productivity**
    - Adult to Adult (Population Growth Rate)
    - Adult to Juvenile (Freshwater Survival)
    - Juvenile to Adult (Marine Survival)
  - **Spatial Structure & Diversity**—Distribution, life history, genetic

- Criteria
  - **Unbiased**—Accurate estimates at population scale
  - **Precise**—Quantify uncertainty in our estimates; meet goal (CV <15%)
  - **Prioritized**—Important populations and parameters first

Bias and Precision

Bias and Precision

- Bias (lack of accuracy)
  - Caused by not meeting assumptions of methods
    - Survey area wrong/incomplete
    - Time frame wrong/incomplete
    - Use of data from somewhere else

- Precision
  - Related to sample size
    - % of area/time surveyed
    - % of fish tagged or recaptured

Adult Monitoring Tools

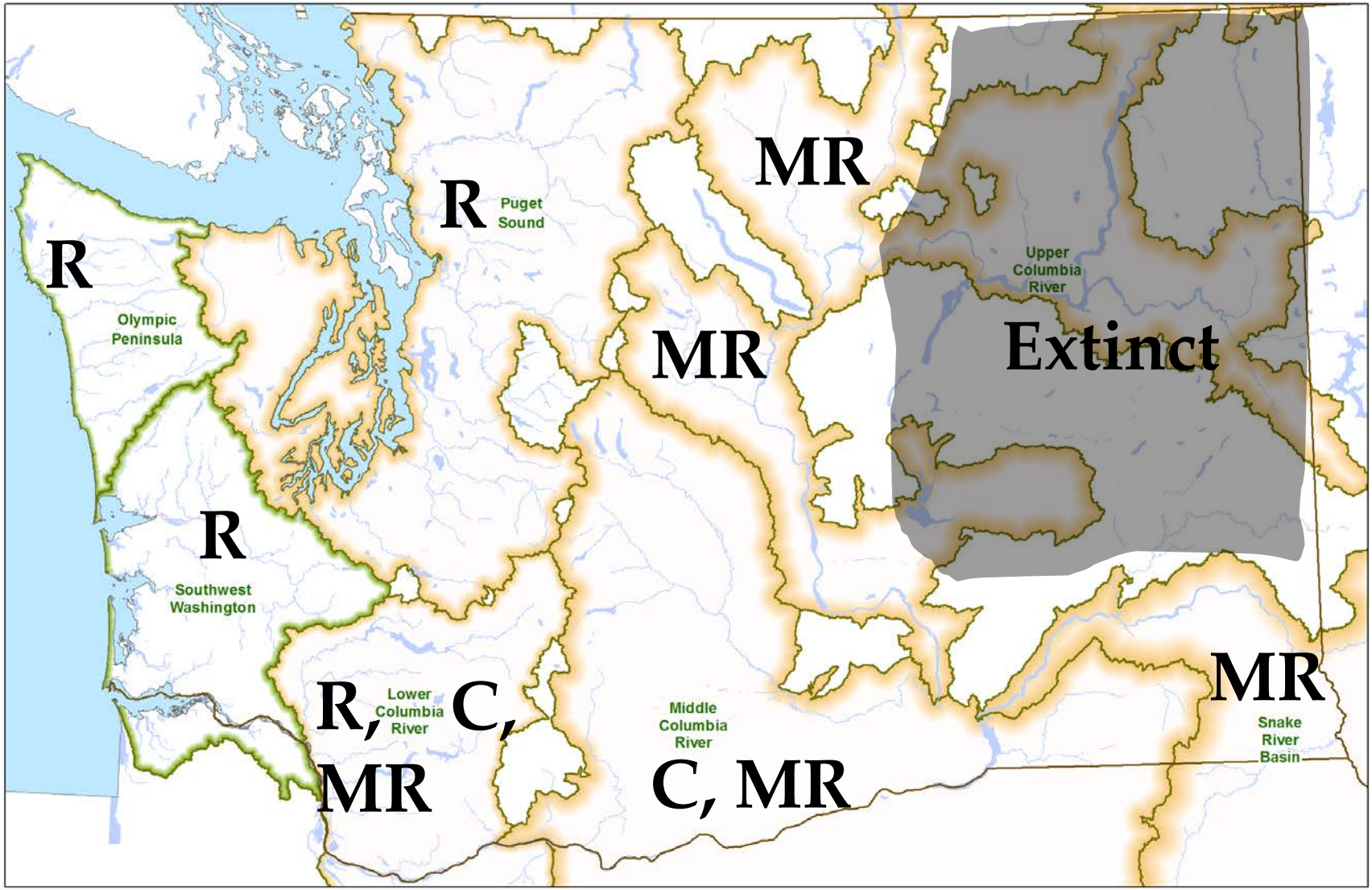
Weirs
&
Dams

Redd Counts

Mark
&
Recapture/
Resight

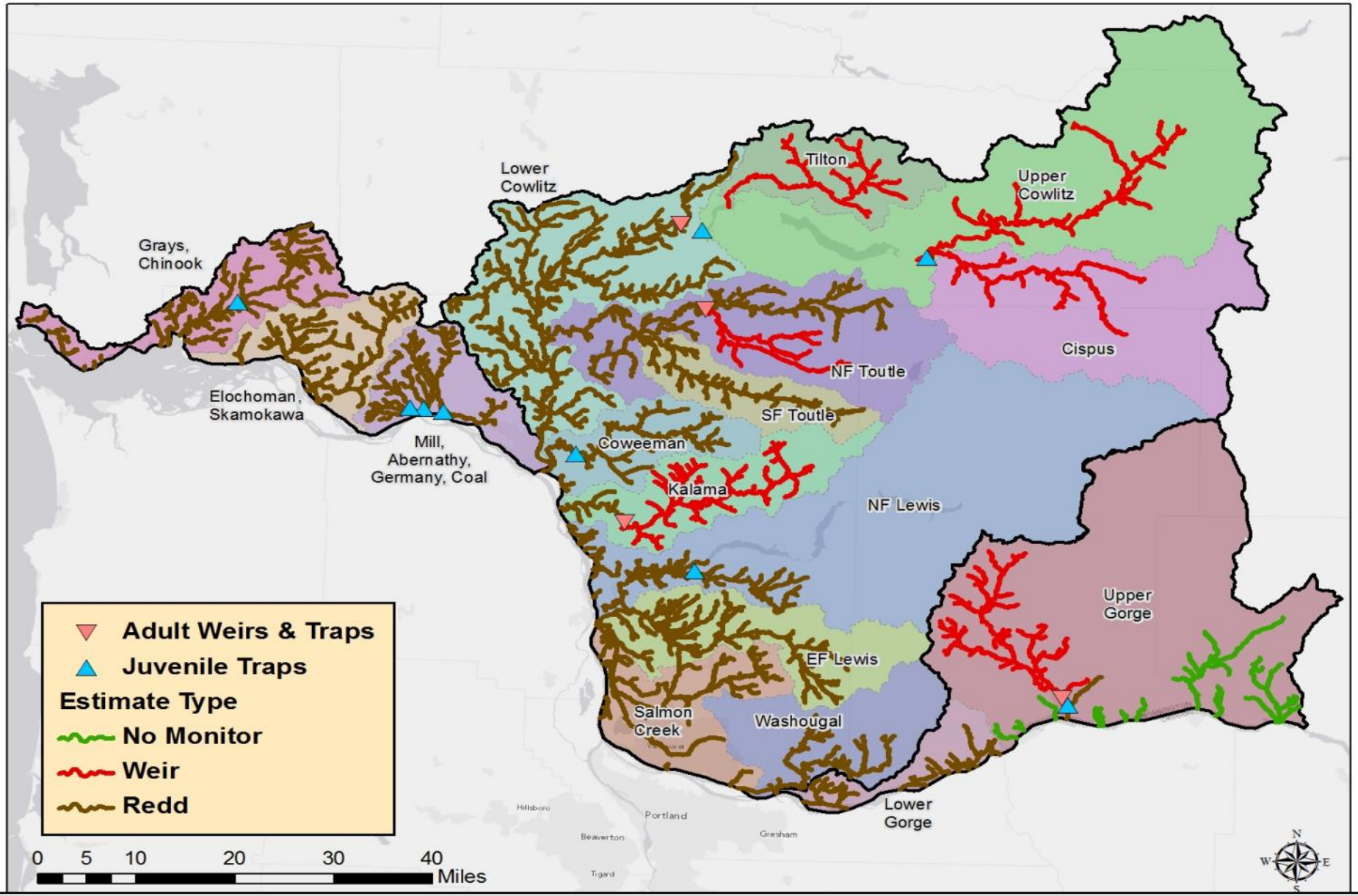
Steelhead Adult Methods

Map by Andy Weiss

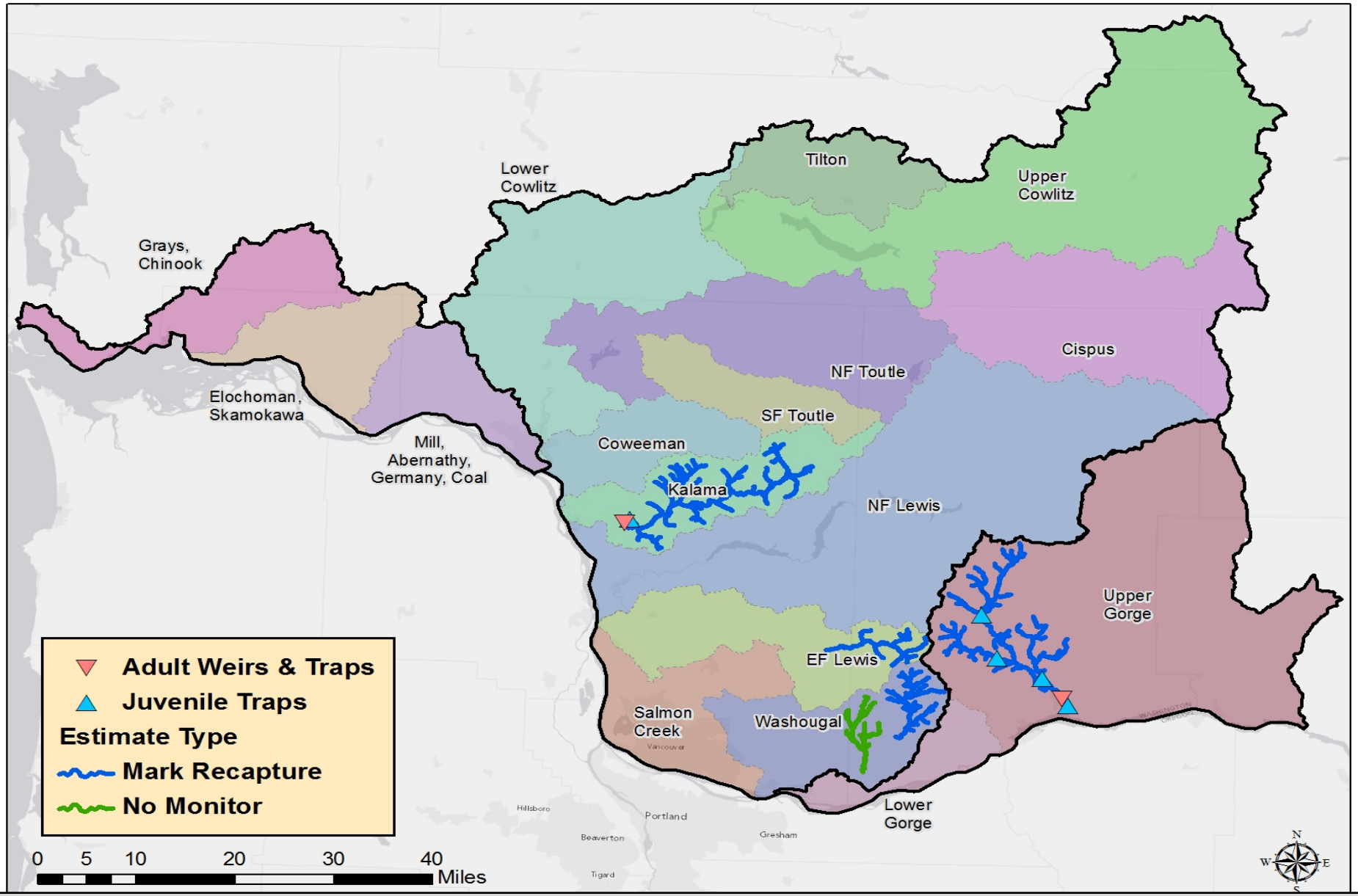


R = Redds C = Census MR = Mark-Resight

Winter Steelhead Monitoring



Summer Steelhead Monitoring

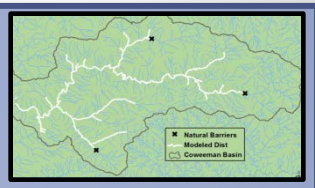


Adult Methods: Census

- Method:
  - A complete count of the species of interest
  - Typically dams & fish ladders
- Challenges:
  - None
- Opportunities:
  - Not really—we aren't planning to build new dams to monitor fish!

Adult Methods: Redds

Identify steelhead distribution(miles of occupied stream)



Count redds in survey areas

Calculate redd density for survey area (redds/mile)

Apply density in survey area to non-surveyed area → total redds

Multiply total redds by 'females per redd' **(0.8)** to get total females

Divide total females by sex ratio **(0.5)** to get total abundance

Data Collected Annually

Data from Snow Creek

Redds: Assumptions *Challenges!*

Space

- Total extent of spawning habitat (miles) is known
- Density of redds in survey reaches same as un-surveyed

Time

- Survey dates encompass all spawning activity
- If peak surveys are used, spawn timing is same as index areas

Observer Efficiency

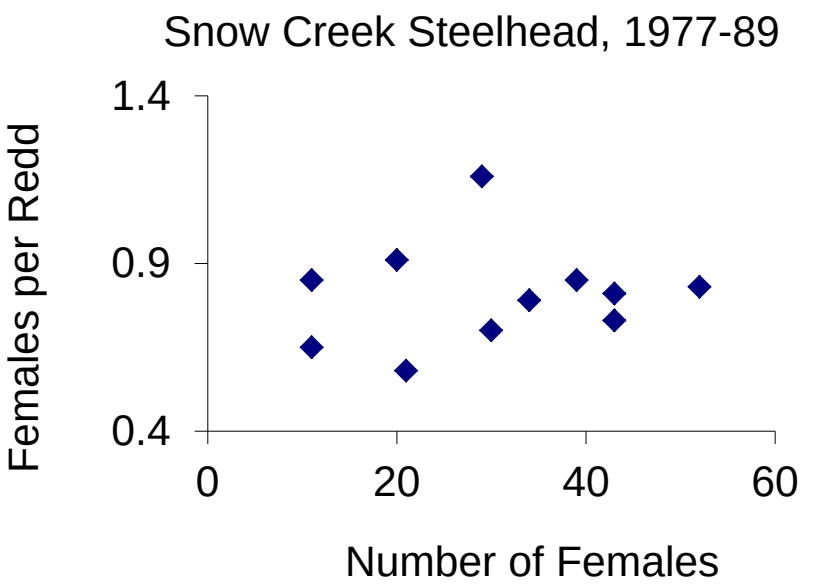
- All redds are visible on survey dates
- All redds in survey reaches are seen

Converting Redds to Fish

- Redds per female→Snow Creek Data
- Sex ratio: 50:50→Snow Creek Data
- Origin: All redds are created by wild fish

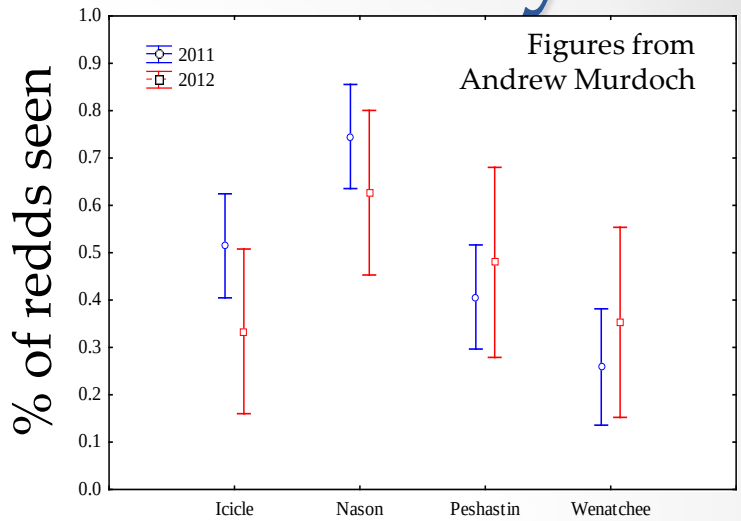
Redds/Female

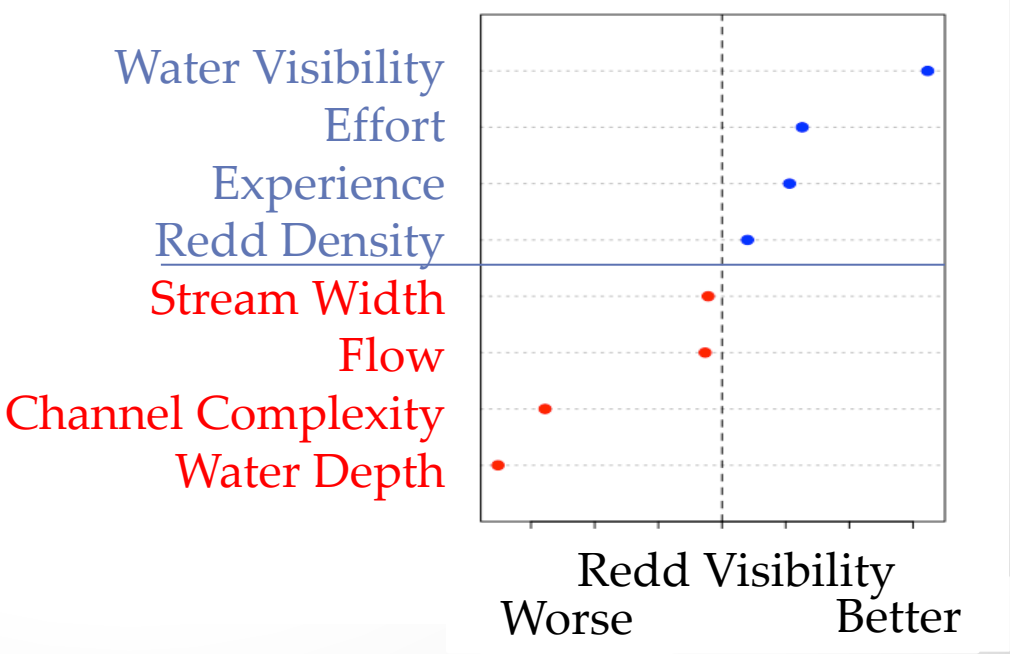
- Females per redd used for all of Western Washington
- Based on redd surveys compared to weir count of females (1977-89)
- Average = **0.804**, but variable! (SD = 0.152, CV = 19%)
- …and the variability is just in one population!
- Means redd-based estimates elsewhere are imprecise and may be biased



Redds: Observer Efficiency

- Study on Methow & Wenatchee to measure observer efficiency for redds
- Observer efficiency is highly variable
- Habitat, environmental, and human factors all influence obs. efficiency
- Our redd-based estimates in W. WA do not account for this
- Could result in severe bias in abundance estimates





Adult Methods: Mark-/Resight

Mark

- Seine, weir or fish ladder
- Tag a portion of run with Floy tags
- Scales for age, genetics

Resight

- Snorkel to count tagged & untagged steelhead

$$\frac{\text{\# Fish originally tagged}}{\text{Proportion of tagged fish counted during snorkel}} = \text{Total Escapement}$$

Mark-Resight: Challenges! Assumptions

1. No fish leave after tagging & before resight event

Ok for summer STH; NOT winters

2. There are no tagging effects
   a) no tag loss
   b) no tag induced mortality

Easy to test; usually condition is met

3. All fish have an equal probability of capture during the first or second event....
   a) ...or marked and unmarked fish completely mix between sampling events.

Hard to test; condition not always met

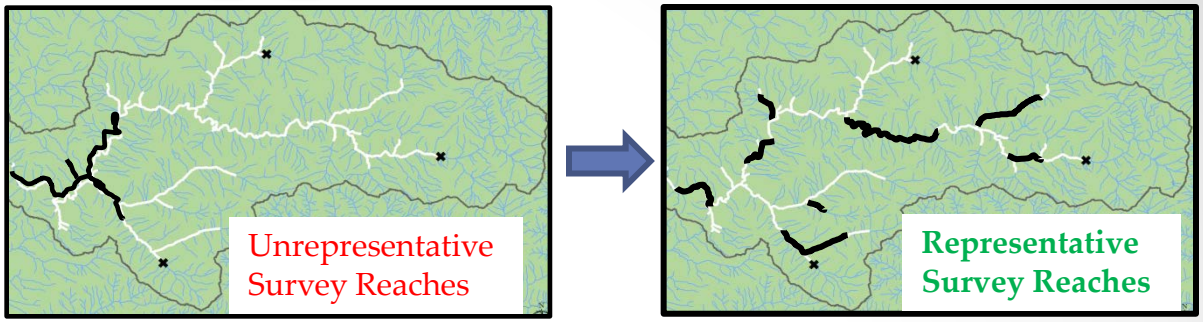
Solution: *Tag throughout run; tag at a location all fish must pass*

Which method?

- Depends!
  - o Existing infrastructure
  - o Watershed/population characteristics
  - o How important a population is
  - o How much $ we have

Adults: Opportunities

1. Ensure representative spatial study designs for redds



2. Develop new set of ***regional*** and ***annual*** sites to estimate females per redd reducing the need to rely on Snow Creek to convert redds to fish
   b) Cowlitz Tributary Weirs
   c) ???

3. Explore use of alternative methods

4. Wherever possible, test for bias and report precision

Juvenile: Methods

- Almost all done with rotary screw traps
- Use mark-recapture methods

Catch juveniles

↓

Mark and release upstream

↓

Recapture to estimate trap efficiency

↓

Expand catch using trap efficiency

$$\frac{\text{Total catch at trap}}{\text{Proportion of tagged smolts recaptured at trap}} = \text{Total Smolts}$$

Juveniles: Challenges

- Assumptions same as adult mark-resight
  - Difficult to ensure screw trap efficiency estimates are unbiased

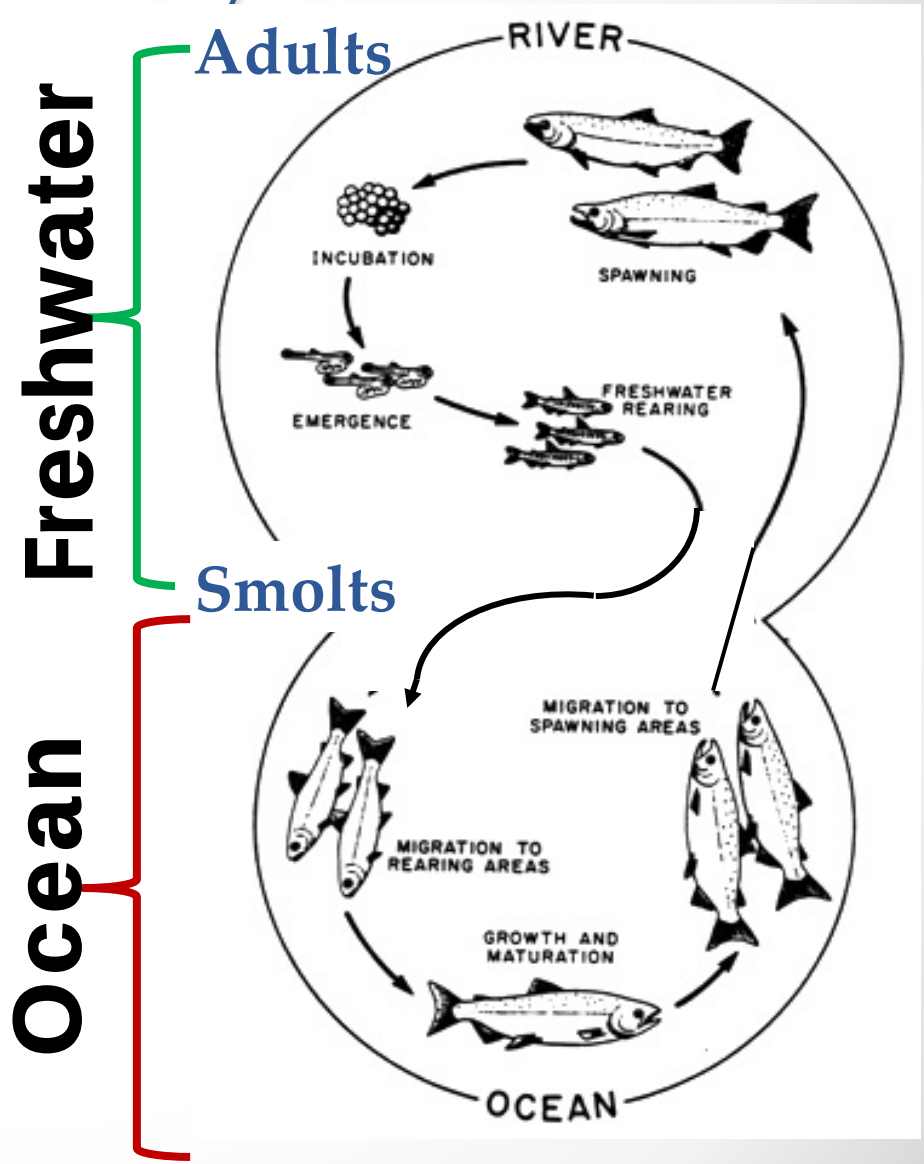
- Difficult to trap with high enough efficiency to make estimates on large rivers

Juveniles: Opportunities

1. Conduct daily trap efficiency trials at all traps
2. Test different release locations
3. Use multiple trap study designs on large rivers
4. Site traps to catch fish!

Uses for Life Cycle Data

- Measuring spawner and smolt abundance for populations lets us partition survival into freshwater and saltwater
- Density-dependence vs. density independence
- Identify limiting life stages and habitats



Uses for Life Cycle Data

- Smolt to adult survival

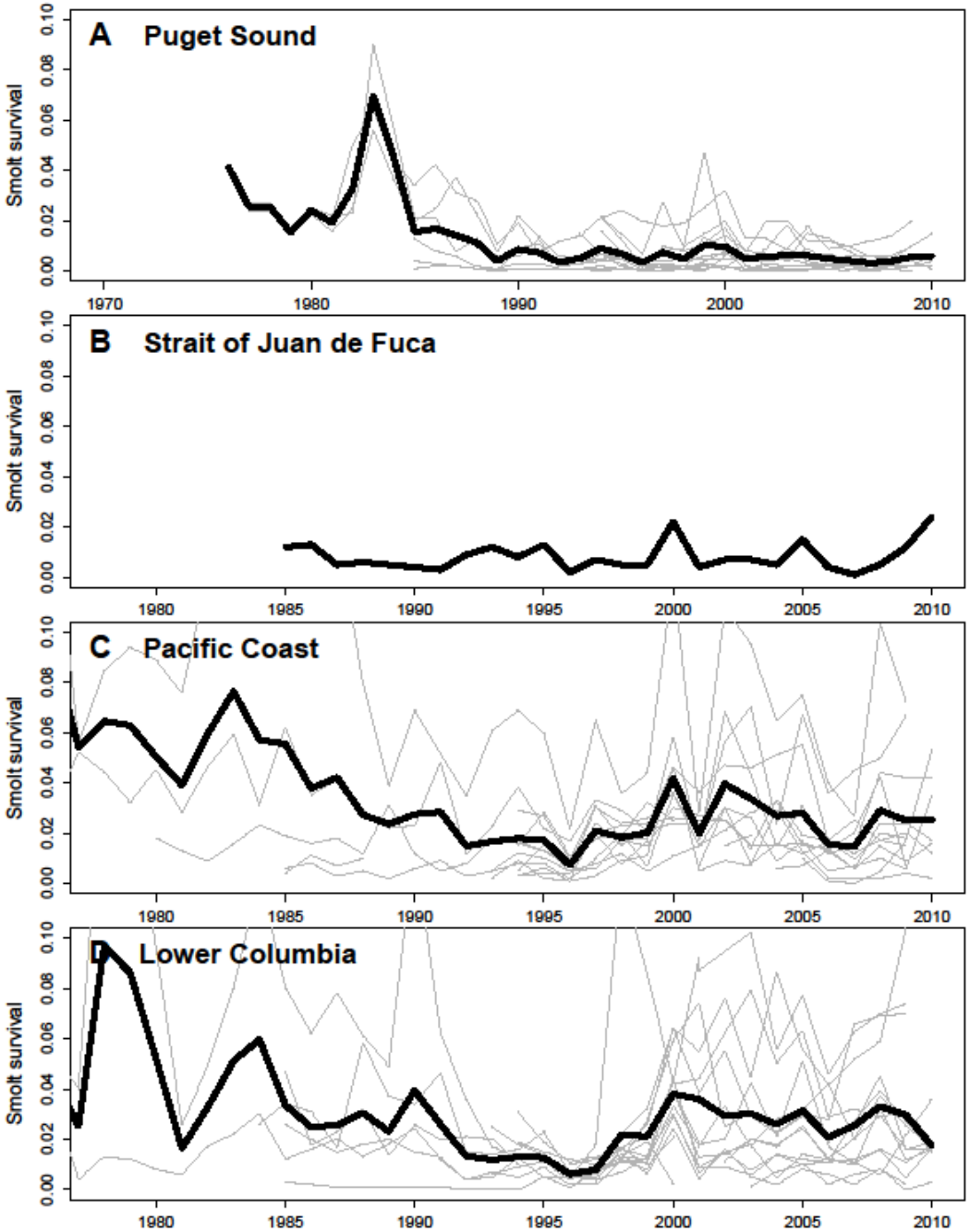
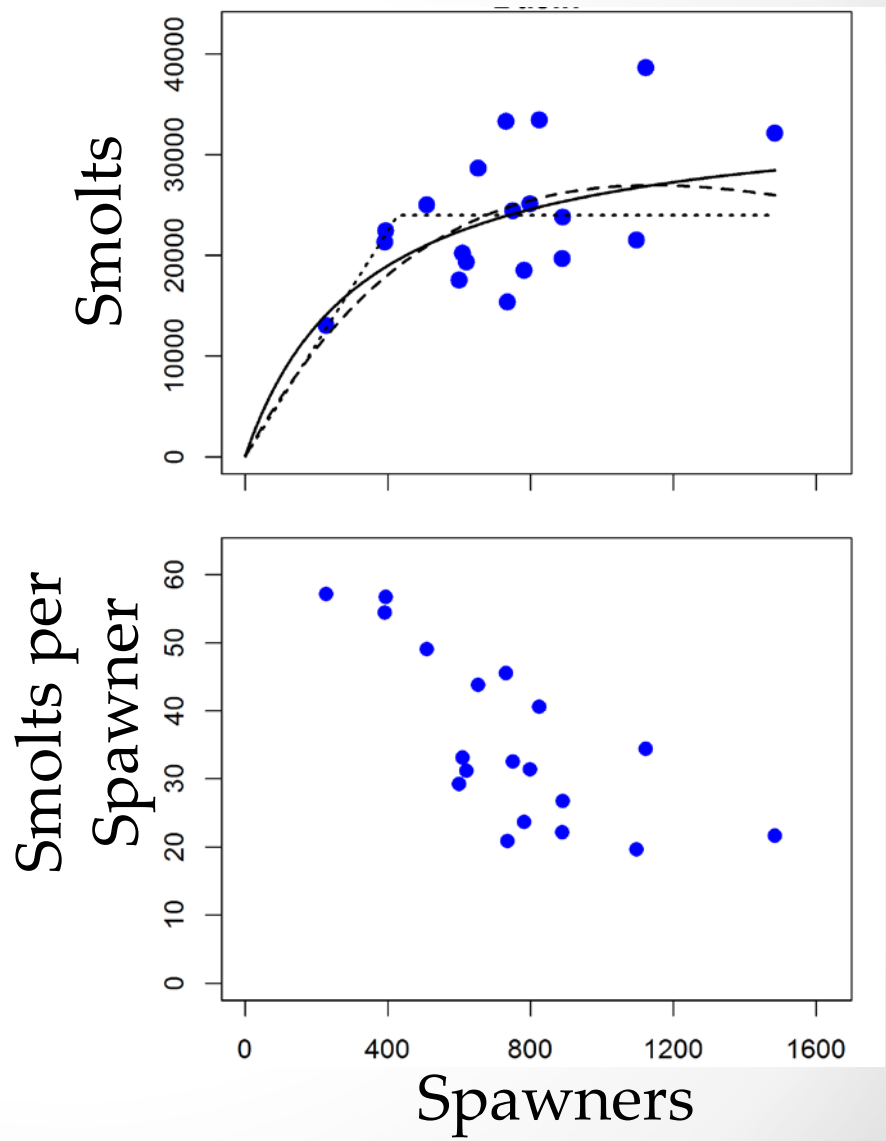


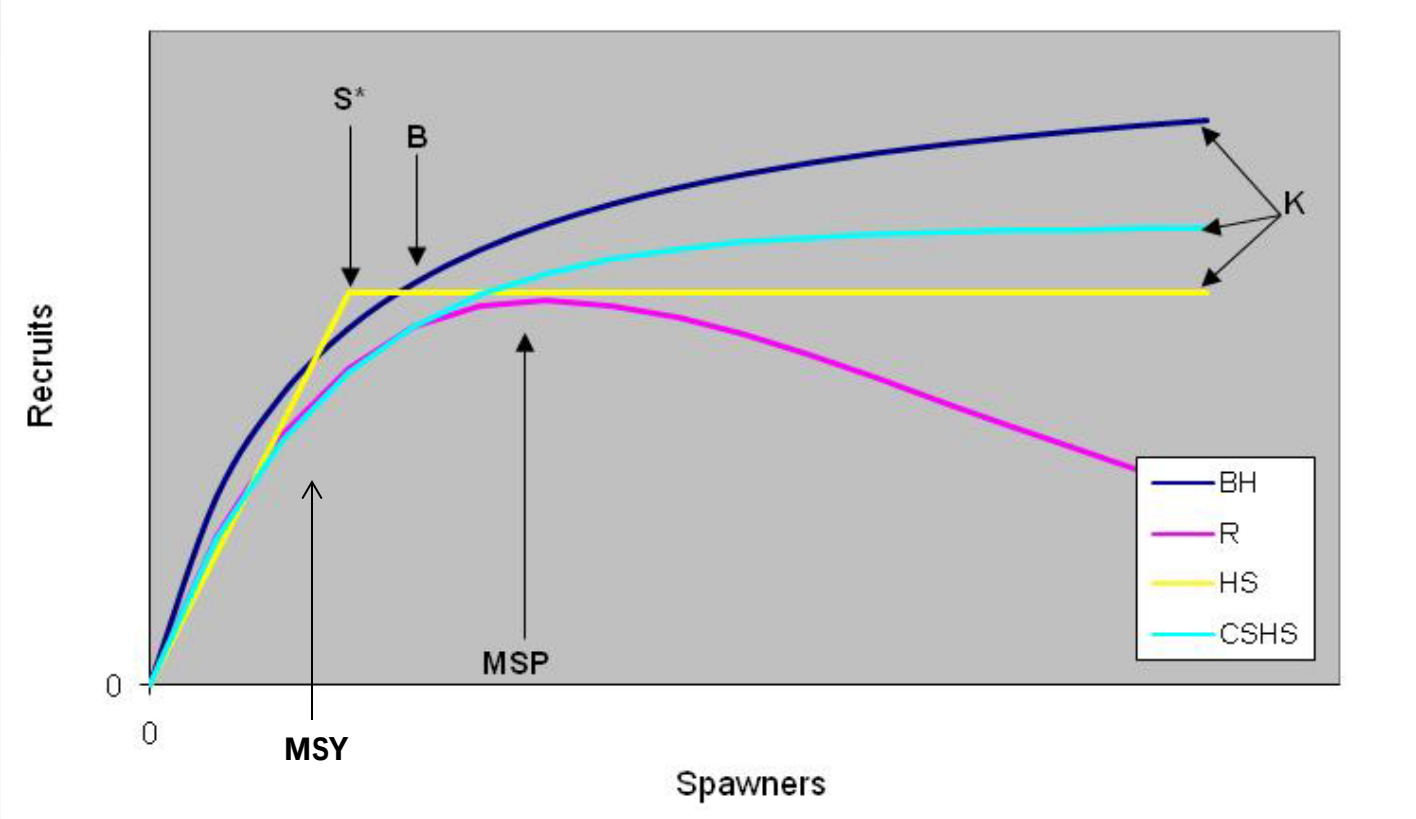
Figure provided by Neala Kendall

Uses for Life Cycle Data

- Spawner to smolt survival
- Can be used to determine need for supplementation (are populations under-seeded?)
- Allows us to estimate "Biological Reference Points"
  - carrying capacity
  - productivity



Biological Reference Points



- BRP are quantitative descriptors of a population
  - B = spawners needed to produce 50% of asymptotic smolt estimate
  - S* = inflection point in curve, spawners needed to seed habitat
  - MSP = spawners needed to produce maximum smolt production
  - K = smolt capacity estimate
  - MSY = spawners needed to produce maximum sustained harvest
  - Productivity = slope of curve at origin; est. of population resiliency.

Biological Reference Points

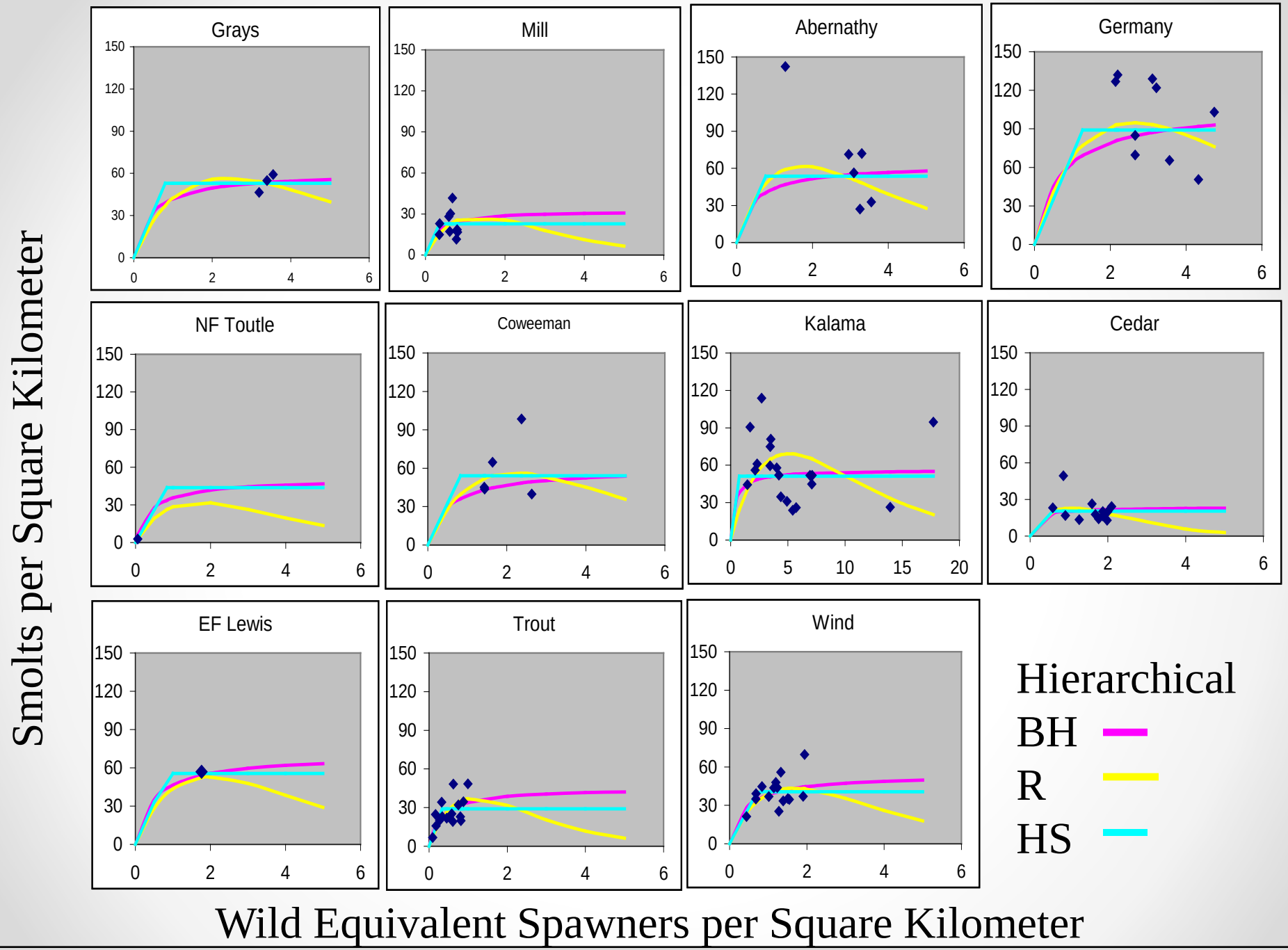
- (BRP) ≠ Escapement Goals or Recovery Goals

- Escapement goals = policy/management choices translated into biological targets (e.g., can be stated in terms of BRPs)
  - Implicit tradeoff between risk and fishery opportunity
  - Should include:
    - Quantitative analysis (estimate BRPs)
    - Risk to persistence
    - Fishery stability or maximization of catch
    - Uncertainty

- Recovery goals = long term target for population after "4-H's" have been addressed

Do we need to re-examine BRPs?

- Historic escapement goals based on habitat model estimates of MSY from 1980's
  - No population data was available
  - Rely on several assumptions we now know are false (e.g., marine survival is constant)
- Recent monitoring data & analysis suggests that historic escapement goals may have inaccurately estimated MSY
  - Due to ESA listing and population declines, directed harvest of wild steelhead was eliminated
  - Non-retention fishery impacts to wild steelhead have been constrained to meet a target of < 10% mortality in LCR tributary fisheries and 2% in the mainstem, rather than managing for escapement goals
  - Without accurate BRPs it is not possible to manage fisheries to provide opportunity while allowing for long term recovery by ensuring stocks are abundant enough to use the existing habitat
  - Opportunity to update BRPs for Washington's coastal steelhead populations using monitoring data collected over the last 30 years!
- Does not affect long term recovery goals


Smolts per Square Kilometer
Grays
Mill
Abernathy
Germany
NF Toutle
Coweeman
Kalama
Cedar
EF Lewis
Trout
Wind
Hierarchical
BH
R
HS
Wild Equivalent Spawners per Square Kilometer

Implications of prelim analysis

- In LCR populations – it appears we have been achieving seeding levels or higher in most years.

- In LCR - **12/95 (only 13%) of spawner points were < S* (full seeding)**

- Reassessment of current Escapement Goals for LCR steelhead populations is likely warranted.

- If LCR steelhead recovery requires improvement in adult abundance, we must:
    - increase habitat capacity
    - increase wild stock productivity by decreasing pHOS
    - hope for improved marine survival

    …because we are seeding the current habitat with adults already

Summary

- Goals of Steelhead Monitoring →VSP parameters
  - Unbiased & Precise
- Adult Monitoring
  - Methods: Census, redds, mark-recapture
  - Challenges: Redd-based estimates rely on many untested assumptions
    - Spatial & temporal designs
    - Conversion of redds to fish
  - Opportunities: Refine untested redd assumptions (weirs, mark-recapture)
- Juvenile Monitoring
  - Methods: Smolt traps; mark-recapture, PIT tags
  - Challenges: Few places with population-scale estimates
  - Opportunities: Improve trapping in large rivers; expand network of sites

Summary

- Uses of Life Cycle Data
  - Partitions freshwater & saltwater portions of life history
  - Smolt to adult, adult to smolt survival
  - Biological Reference Points (BRPs)

- BRPs
  - …are quantitative descriptors of a population
  - (BRP) ≠ Escapement Goals
  - Escapement goals = policy target for population under current conditions s that can be defined in terms of BRPs
  - Historic escapement goals are not based on current data
  - Data are available to update estimates of BRPs and analysis is planned
  - Preliminary analysis suggests most watersheds are fully seeded most years

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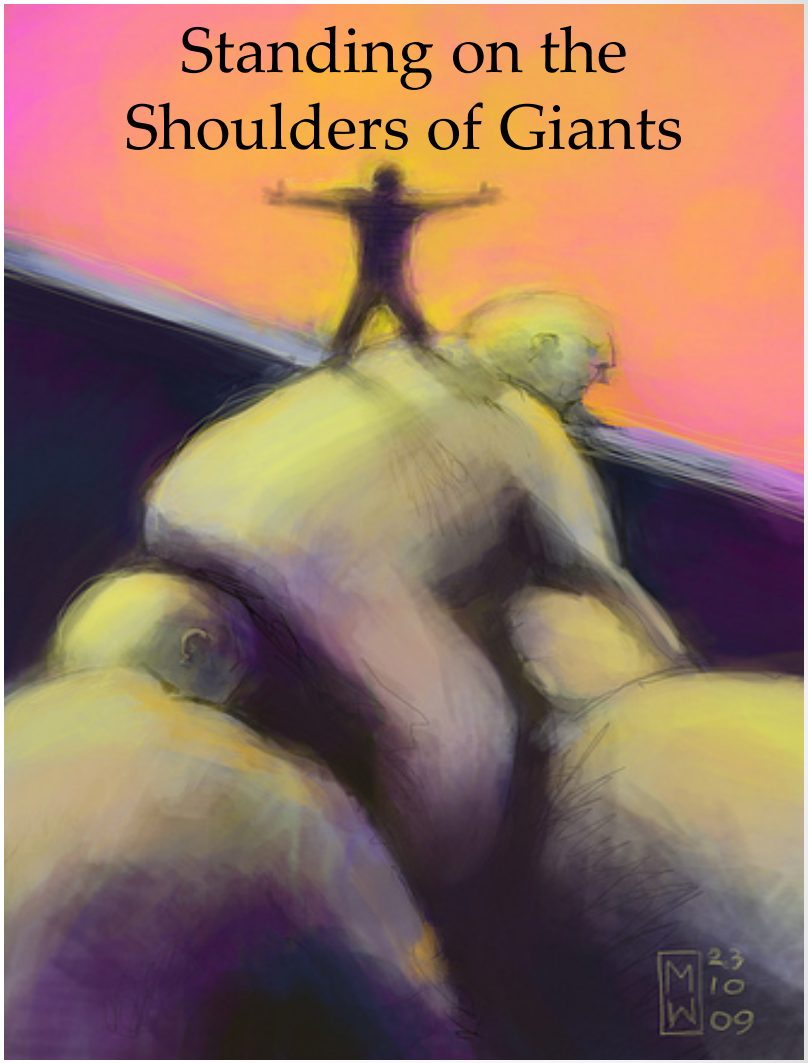

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Questions?