PIT-tag Based Abundance Estimation for Snake River Basin Steelhead Populations

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Coauthors: Ryan Kinzer, Rick Orme, and Kevin See

March Sampling Madness

Why PIT-tag Abundance?

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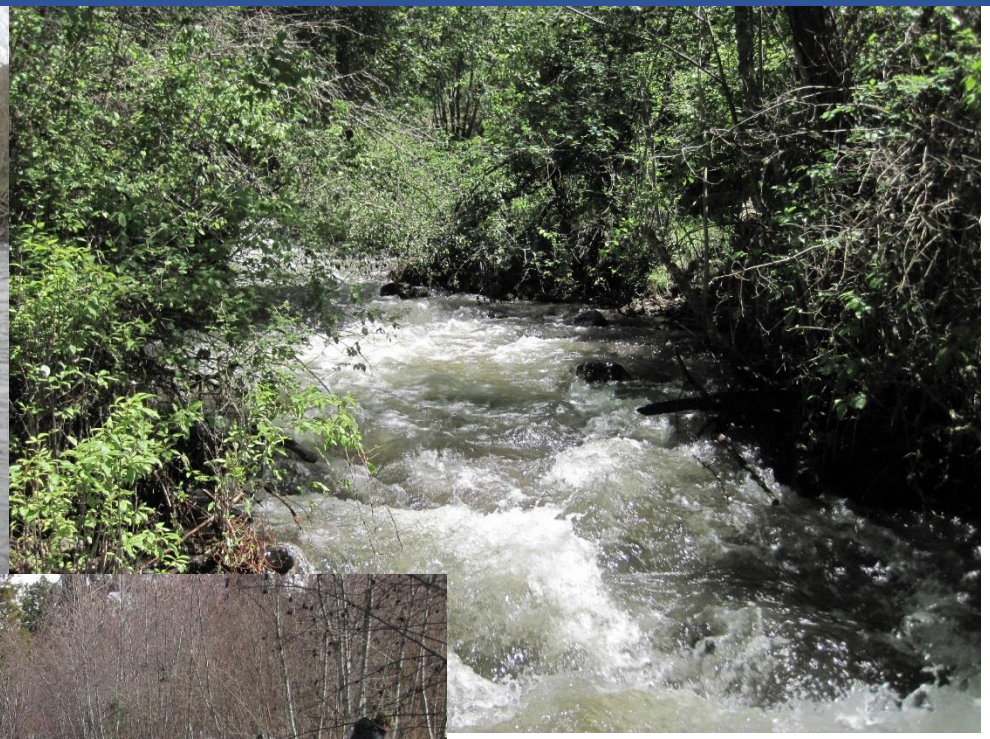
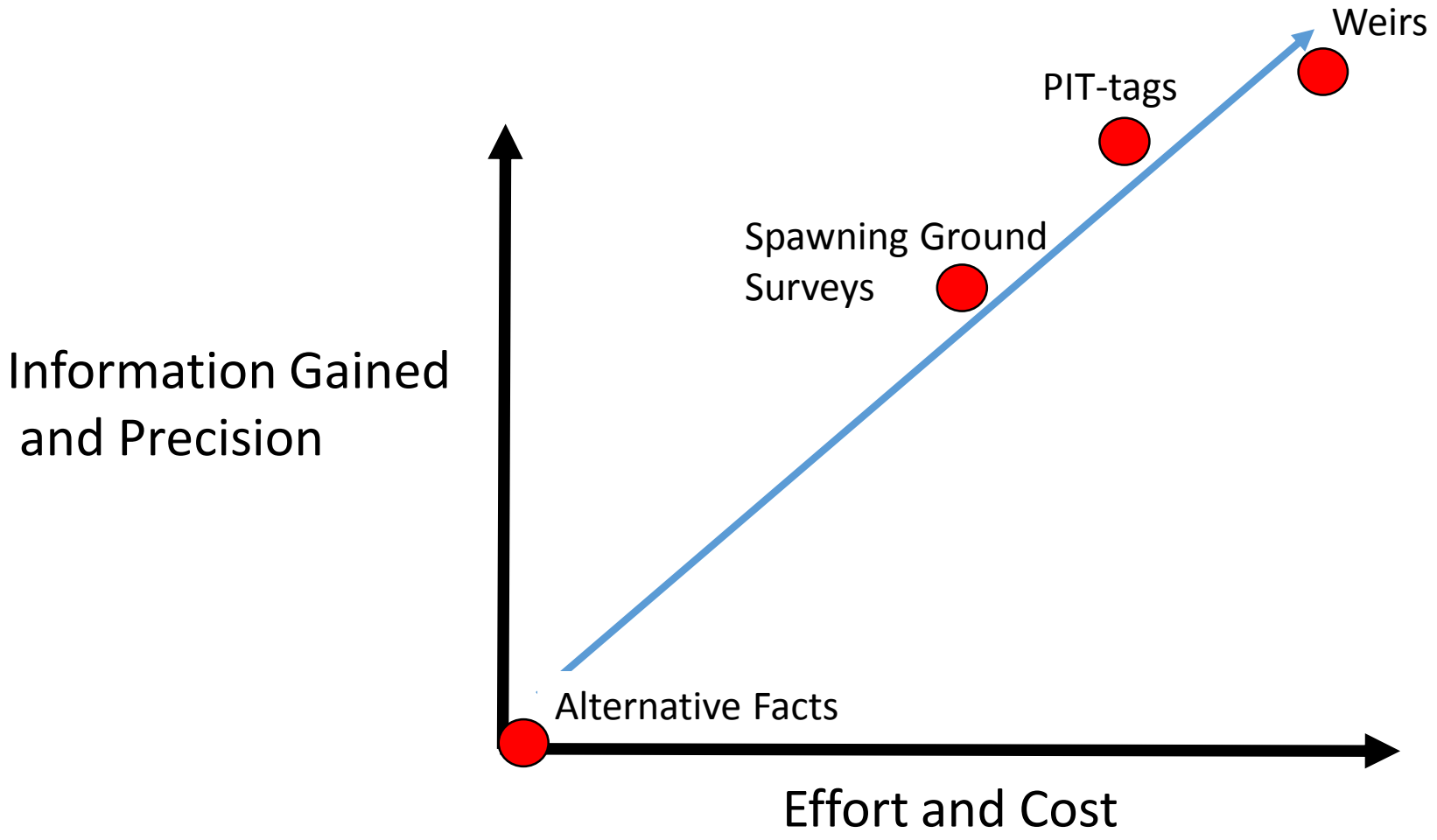
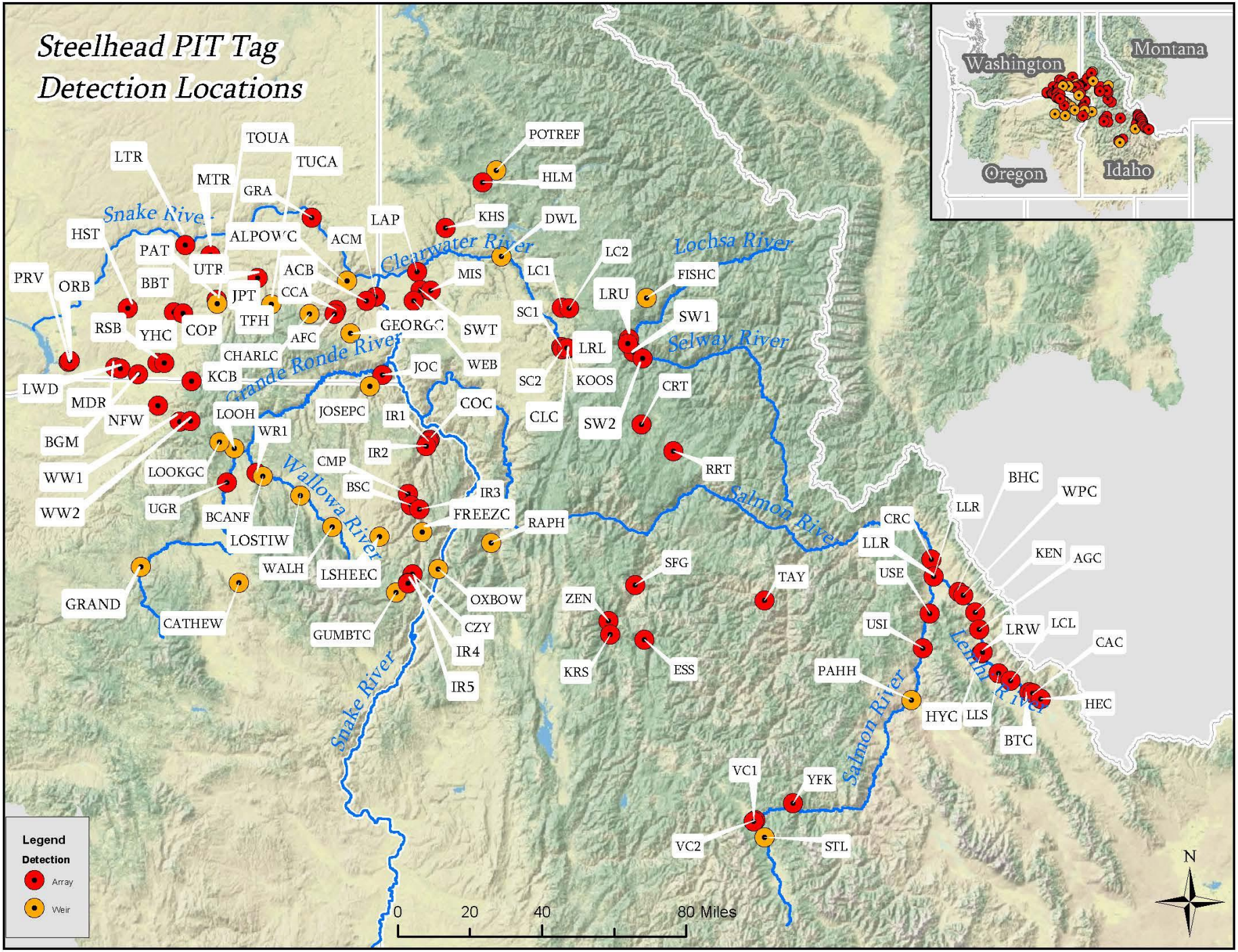


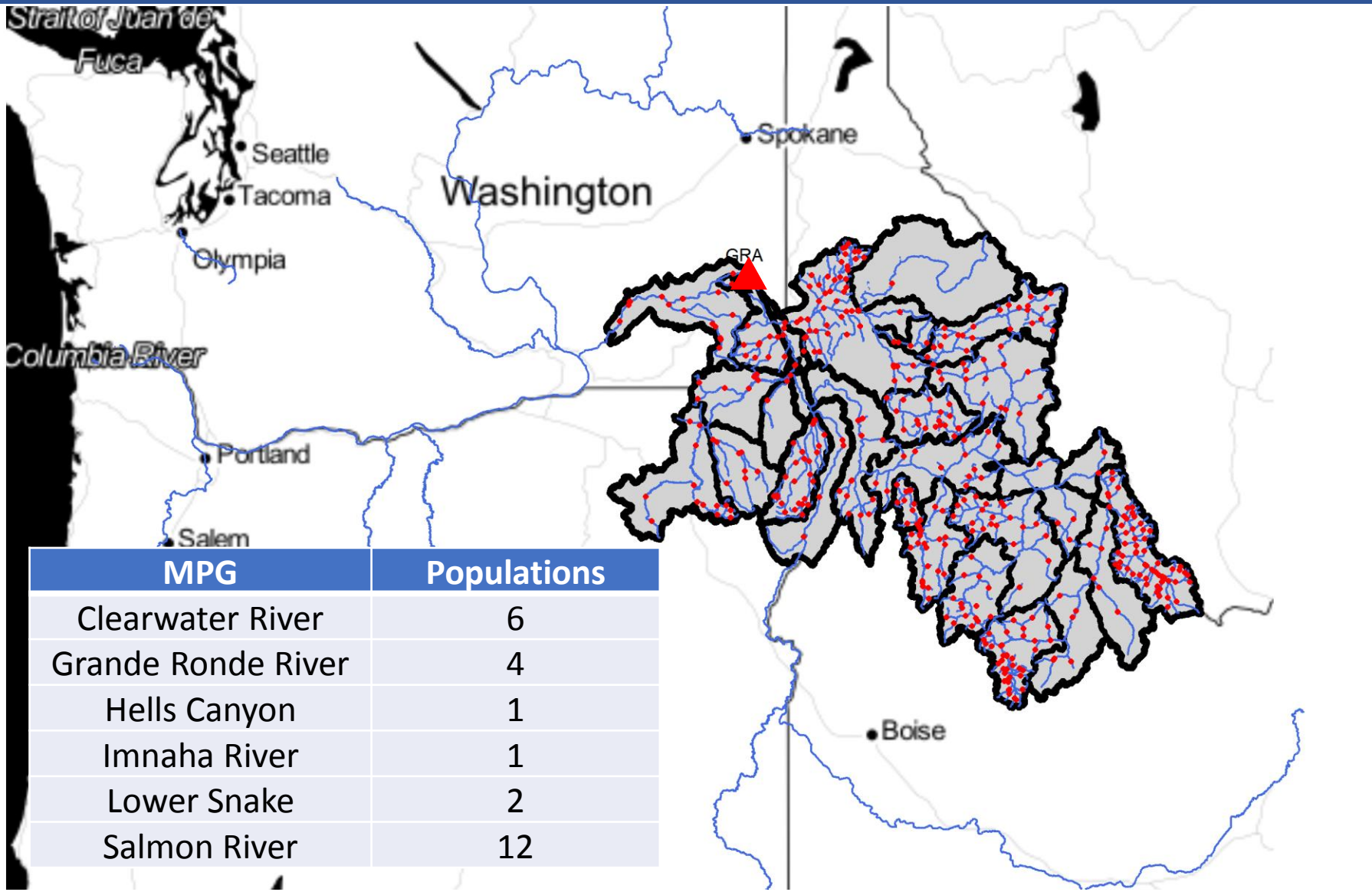
Why PIT-tag Abundance?



PIT-tag Detection Types

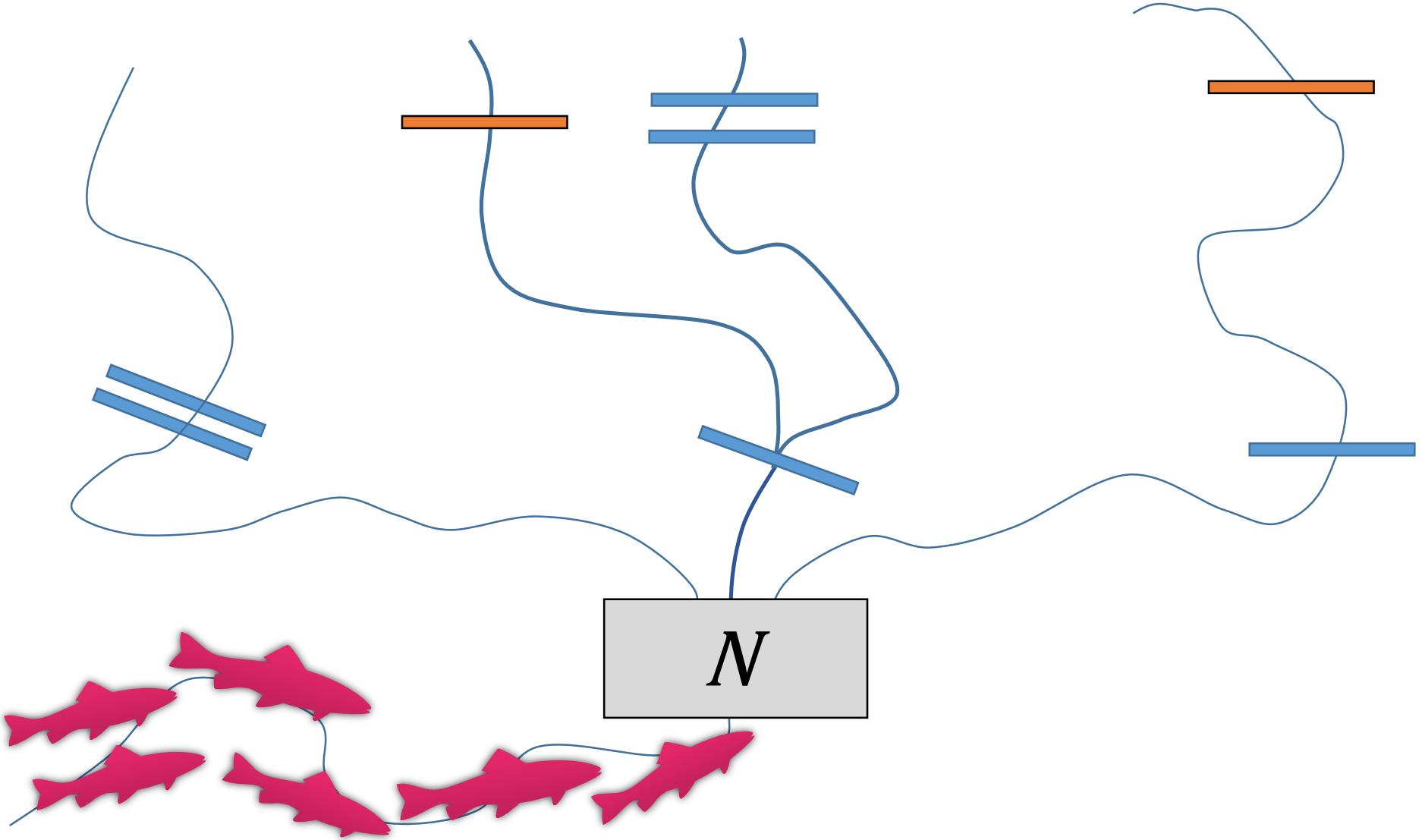

Steelhead PIT Tag
Detection Locations
Washington
Montana
Oregon
Idaho
Snake River
Clearwater River
Lochsa River
Selway River
Grande Ronde River
Wallowa River
Salmon River
Lemhi River
Snake River
Salmon River
TOUA
LTR
TUCA
MTR
GRA
HST
ALPOWC
ACM
LAP
PAT
UTR
ACB
PRV
ORB
BBT
JPT
CCA
RSB
YHC
COP
TFH
AFC
CHARLC
KCB
LWD
MDR
NFW
LOOH
WR1
BGM
WW1
WW2
LOOKGC
UGR
BCANF
LOSTIW
GRAND
CATHEW
WALH
LSHEEC
GUMBTC
CMP
BSC
IR3
FREEZC
OXBOW
CZY
IR4
IR5
IR2
IR1
JOSEPC
JOC
WEB
GEORGC
SWT
MIS
POTREF
HLM
KHS
DWL
LC2
LC1
SC1
LRL
SC2
KOOS
CLC
LRU
FISHC
SW1
SW2
CRT
RRT
RAPH
SFG
ZEN
KRS
ESS
TAY
BHC
WPC
LLR
CRC
KEN
AGC
USE
LRW
LCL
CAC
USI
HEC
PAHH
HYC
LLS
BTC
VC1
YFK
VC2
STL
Legend
Detection
Array
Weir
0
20
40
80 Miles
N

Snake River Basin Steelhead



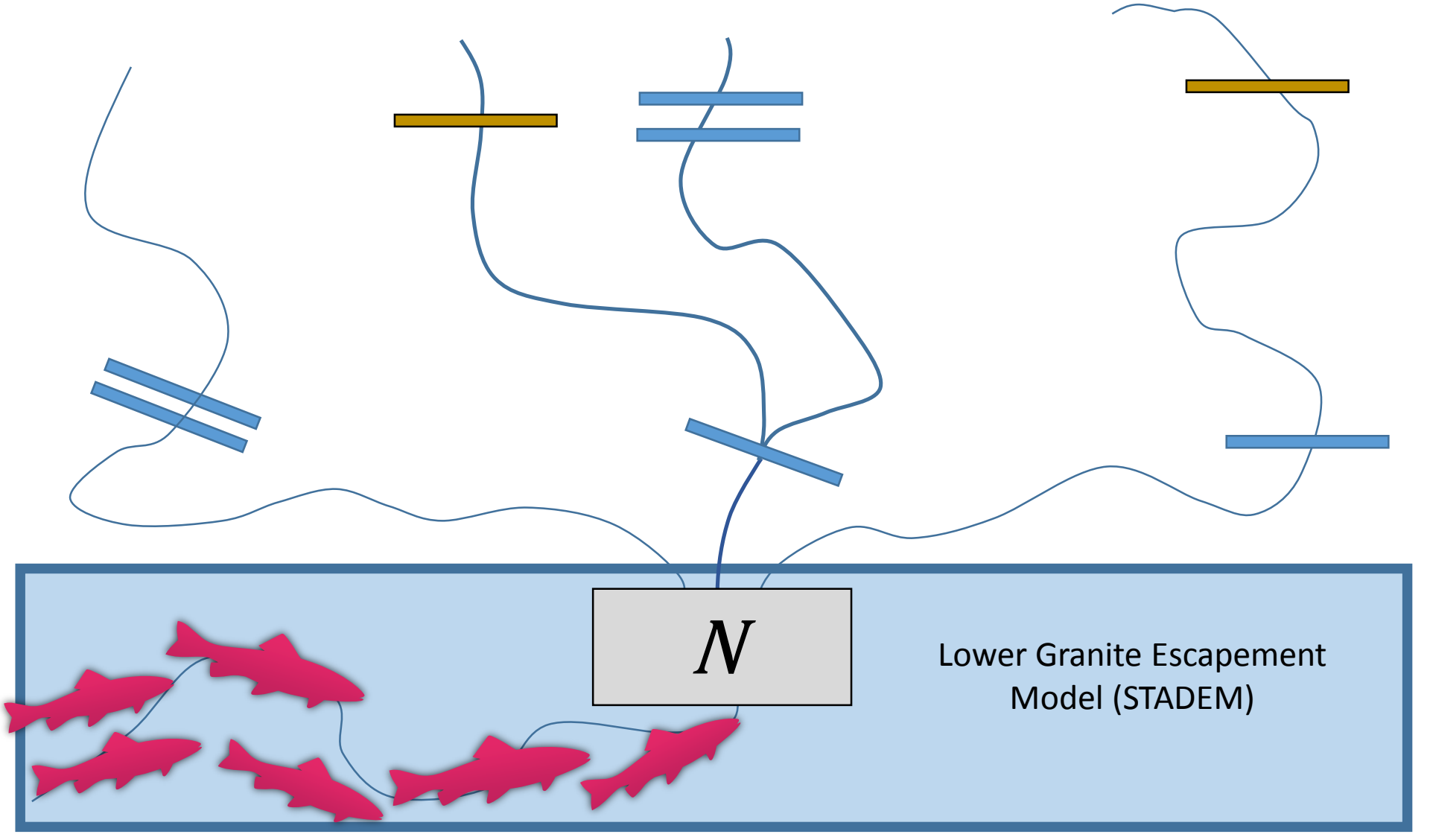
MPG	Populations
Clearwater River	6
Grande Ronde River	4
Hells Canyon	1
Imnaha River	1
Lower Snake	2
Salmon River	12

Estimation Basics

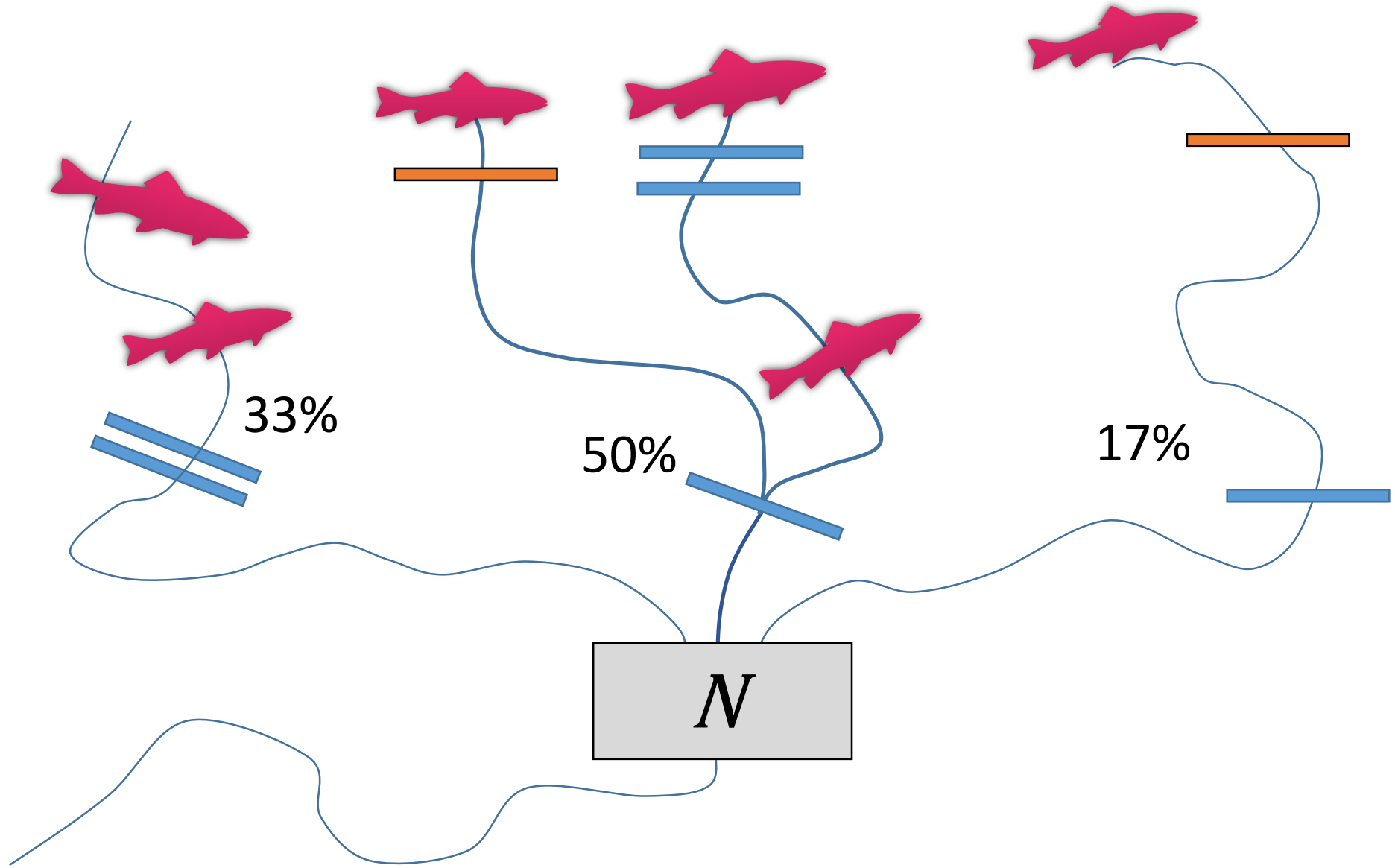


Lower Granite Dam

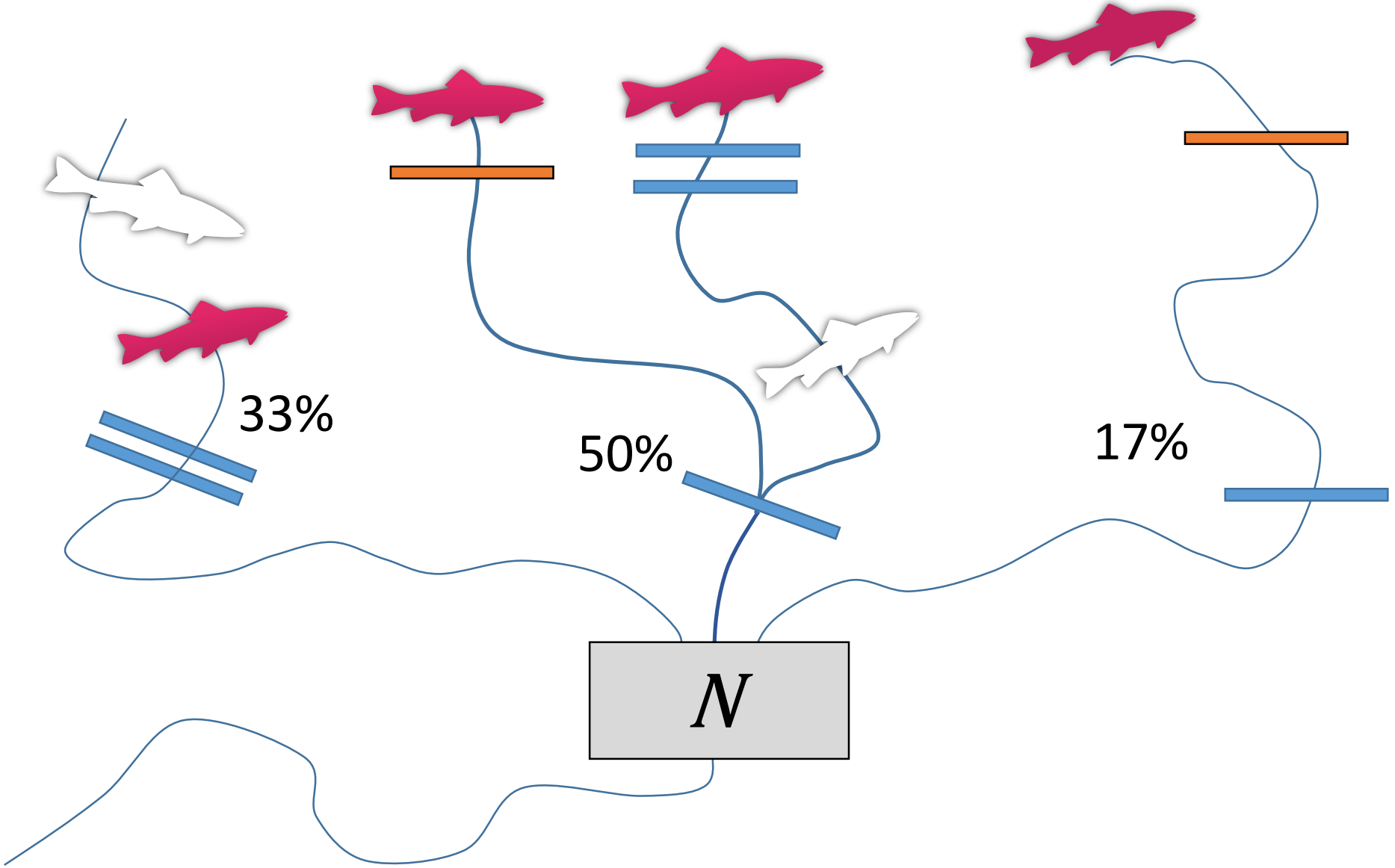
Estimation Basics



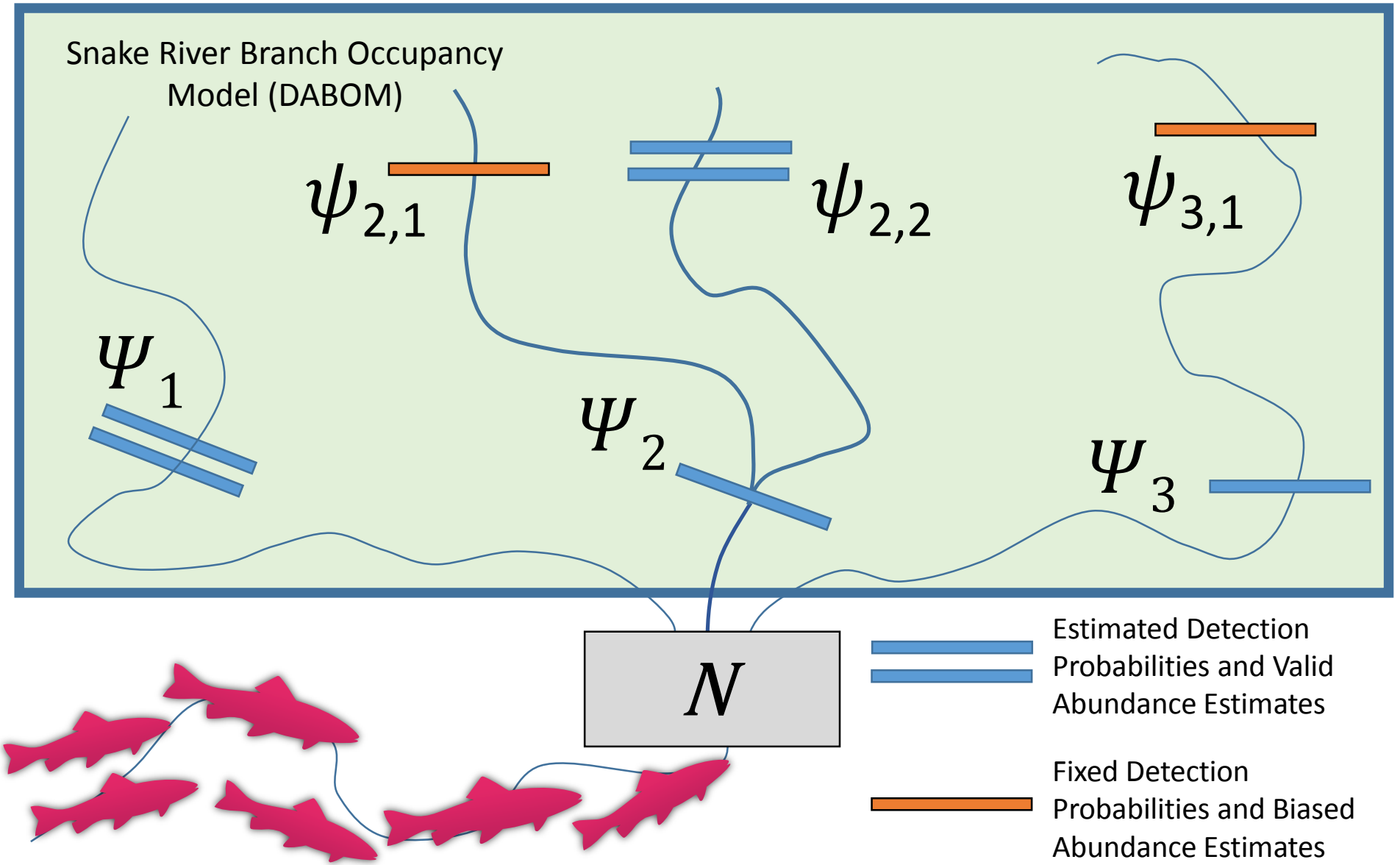
Estimation Basics



Estimation Basics

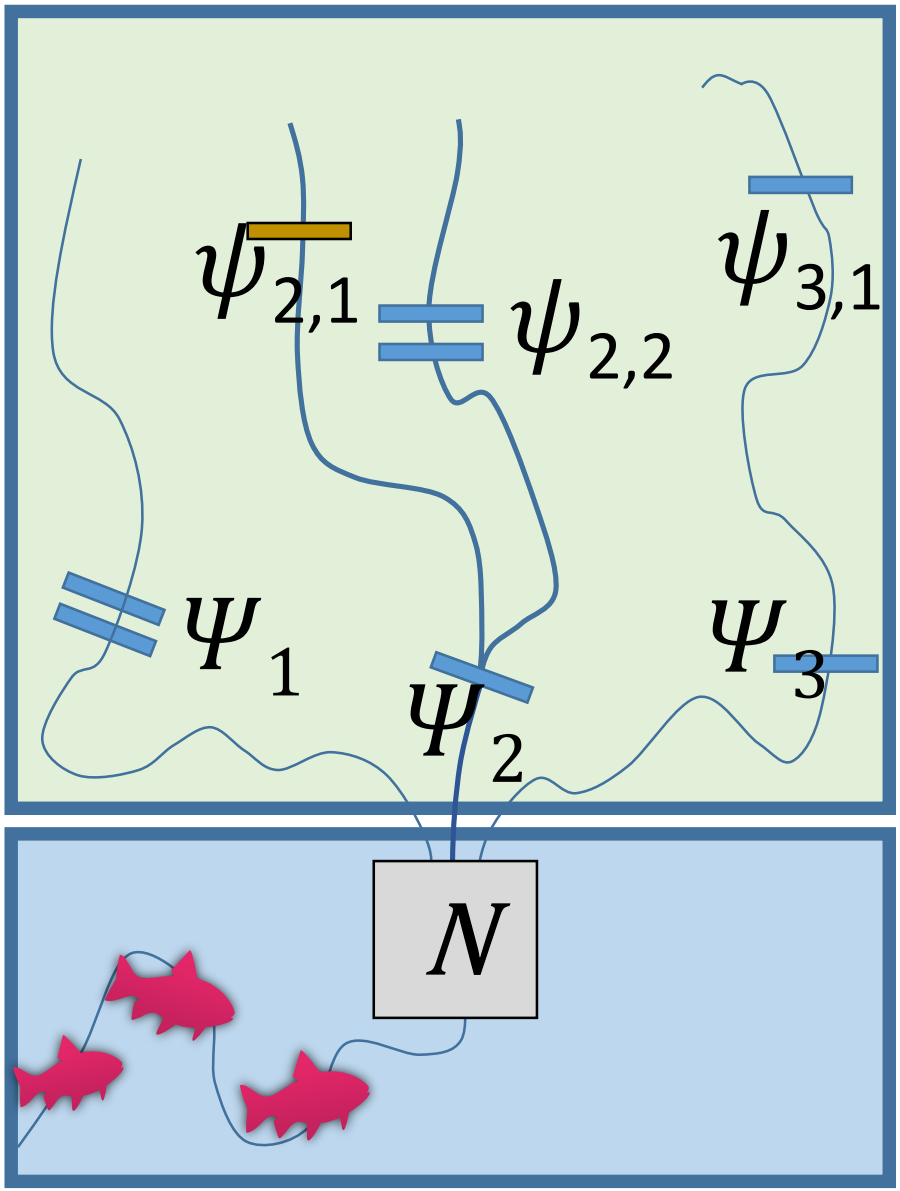


Estimation Basics



Model Details

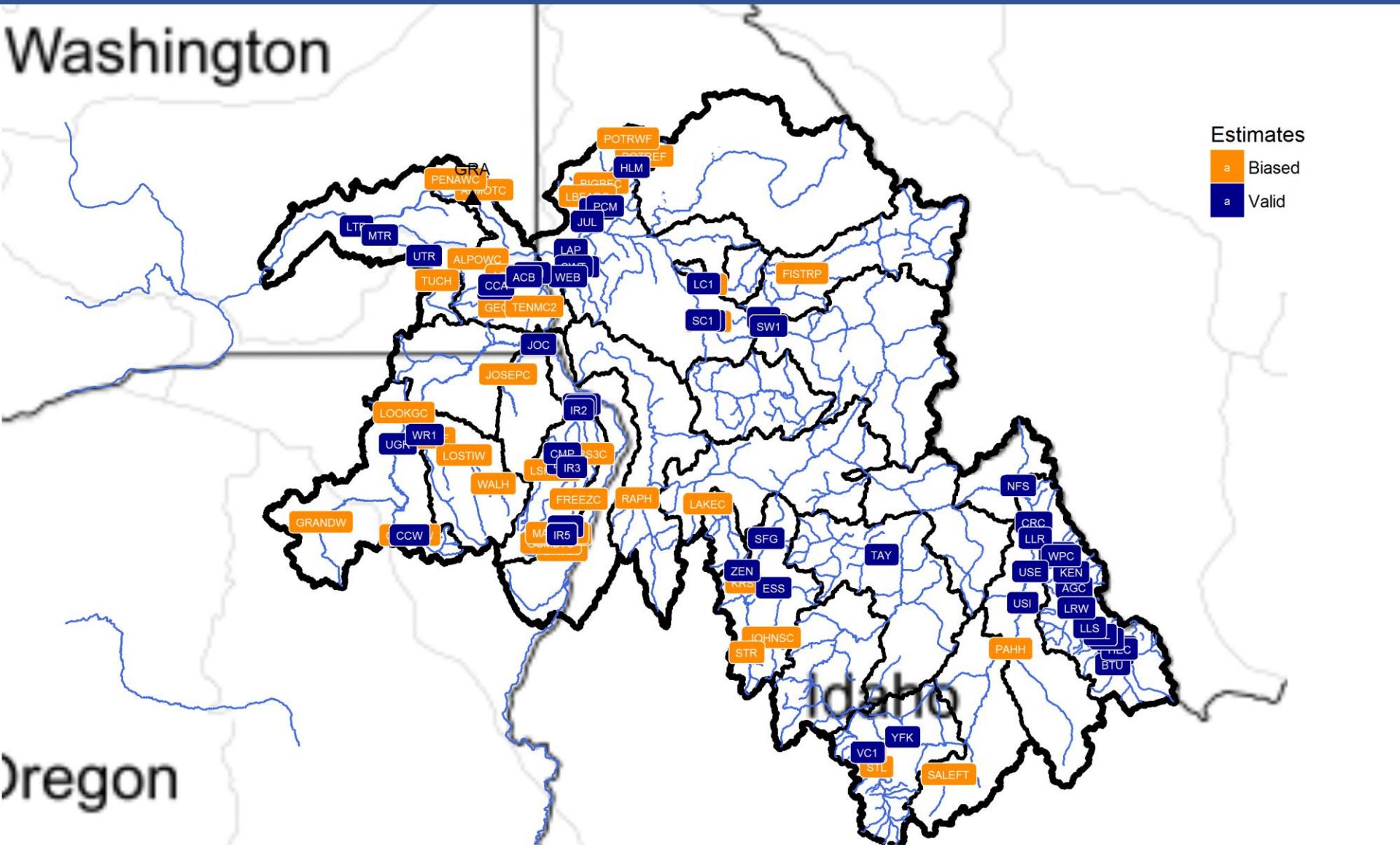
Estimation Basics



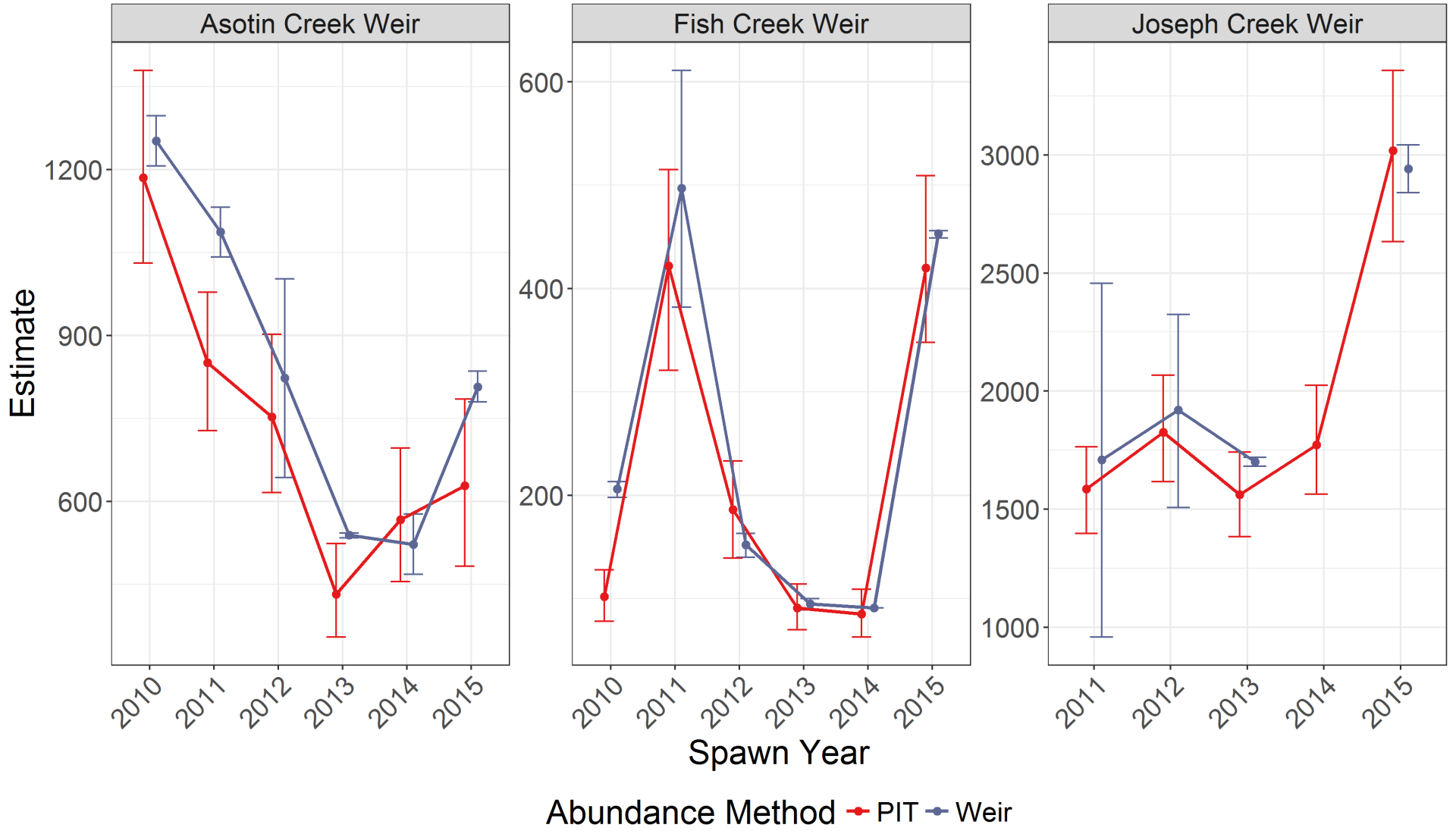
$$N_{Pop1} = N * \Psi_1$$
$$N_{Pop2} = N * \Psi_2$$
$$N_{Pop3} = N * \Psi_3$$

$$N_{Pop2,1} = N * (\Psi_2 * \psi_{2,1})$$
$$N_{Pop2,2} = N * (\Psi_2 * \psi_{2,2})$$
$$N_{Pop3,1} = N * (\Psi_3 * \psi_{3,1})$$

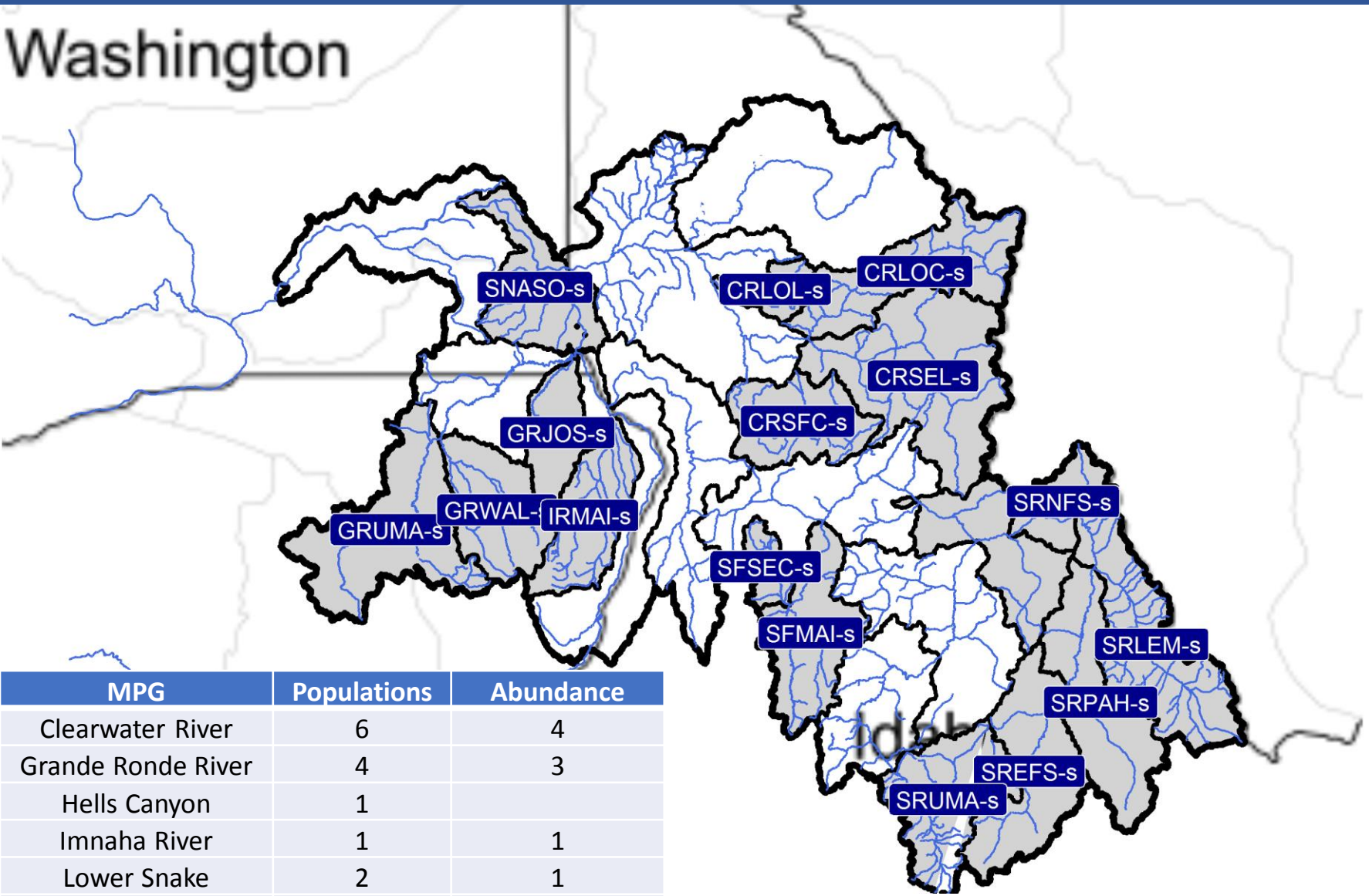
DABOM Sites


Washington
Oregon
Idaho
Estimates
Biased
Valid
POTRWF
HLM
PENAWC
PCM
JUL
MTR
UTR
LAP
ALPOWC
TUCH
ACB
WEB
TENMC2
JOC
JOSEPC
LOOKGC
WR1
LOSTIW
IR2
IR3
WALH
FREEZC
RAPH
LAKEC
GRANDW
CCW
IR5
LC1
SC1
SW1
FISTRP
SFG
ZEN
ESS
TAY
STR
NFS
CRC
LLR
WPC
USE
KEN
AGC
USI
LRW
LLS
BTU
PAHH
YFK
VC1
SALEFT

Tributary

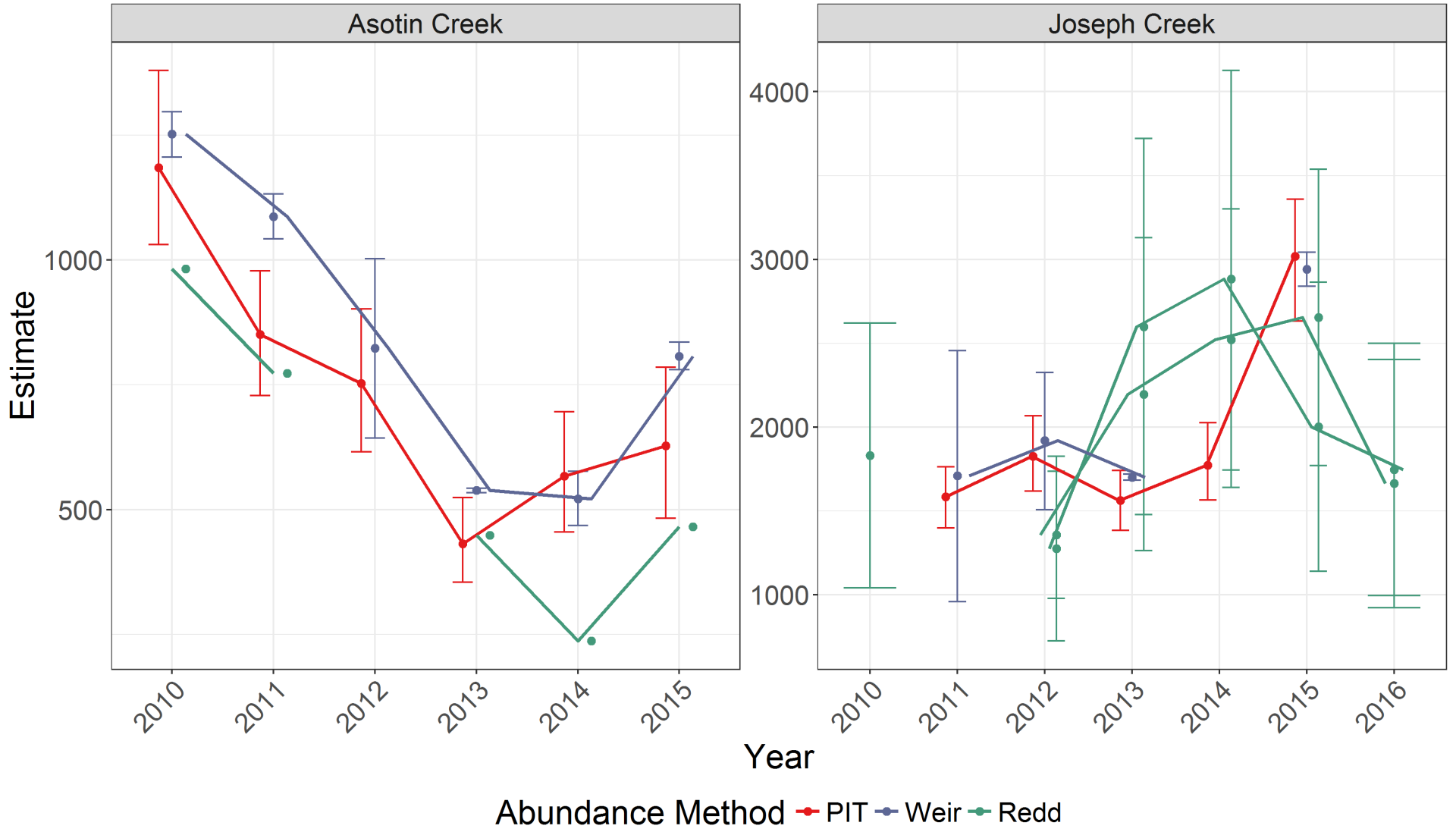

Asotin Creek Weir
Fish Creek Weir
Joseph Creek Weir
Estimate
1200
900
600
600
400
200
3000
2500
2000
1500
1000
2010
2011
2012
2013
2014
2015
Spawn Year
Abundance Method
PIT
Weir

Population Abundance



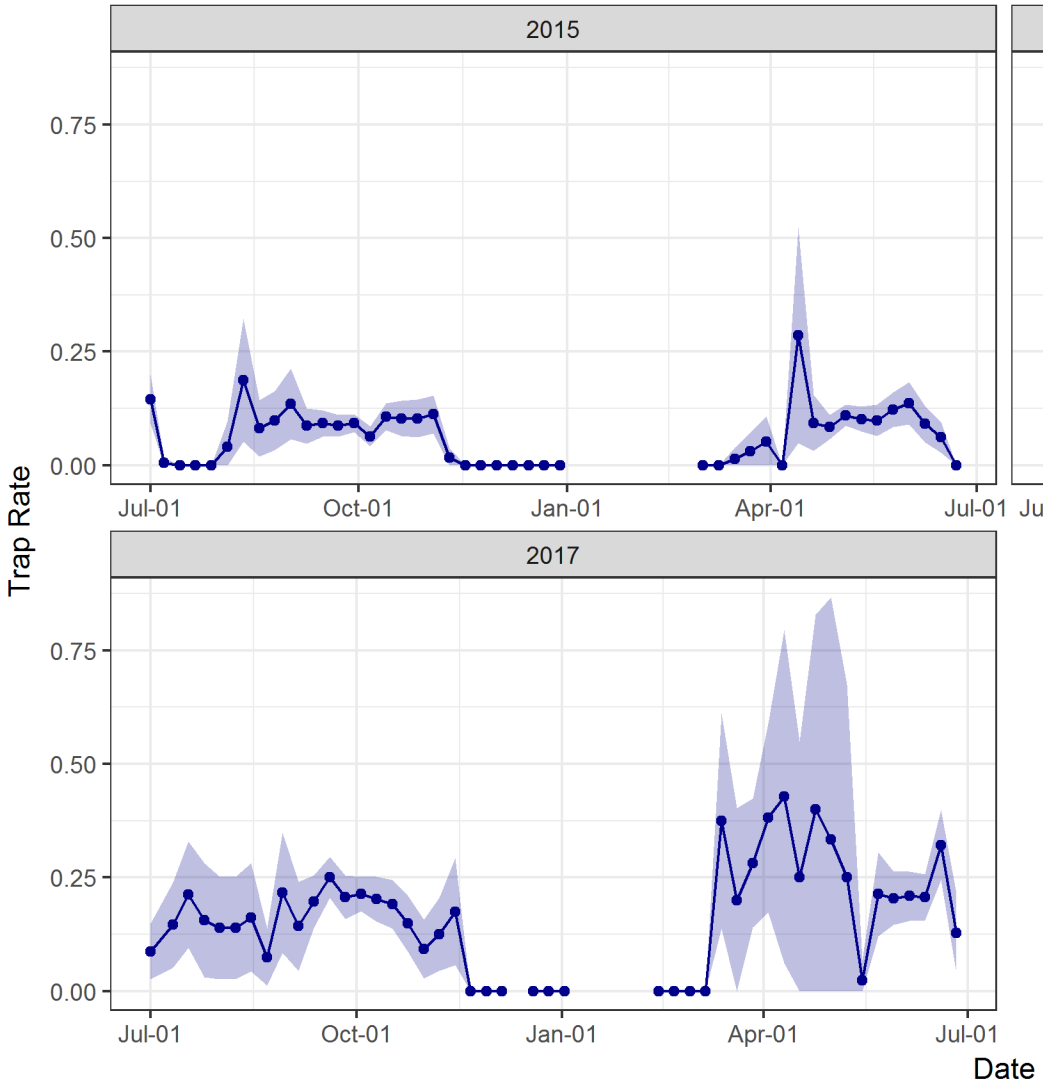
MPG	Populations	Abundance
Clearwater River	6	4
Grande Ronde River	4	3
Hells Canyon	1	
Imnaha River	1	1
Lower Snake	2	1
Salmon River	12	8

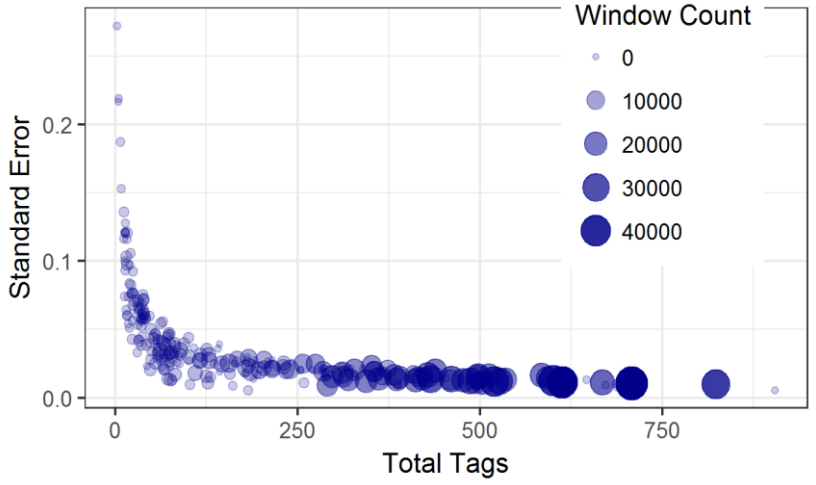
Population


Asotin Creek
Joseph Creek
Estimate
1000
500
4000
3000
2000
1000
2010
2011
2012
2013
2014
2015
2016
Year
Abundance Method
PIT
Weir
Redd

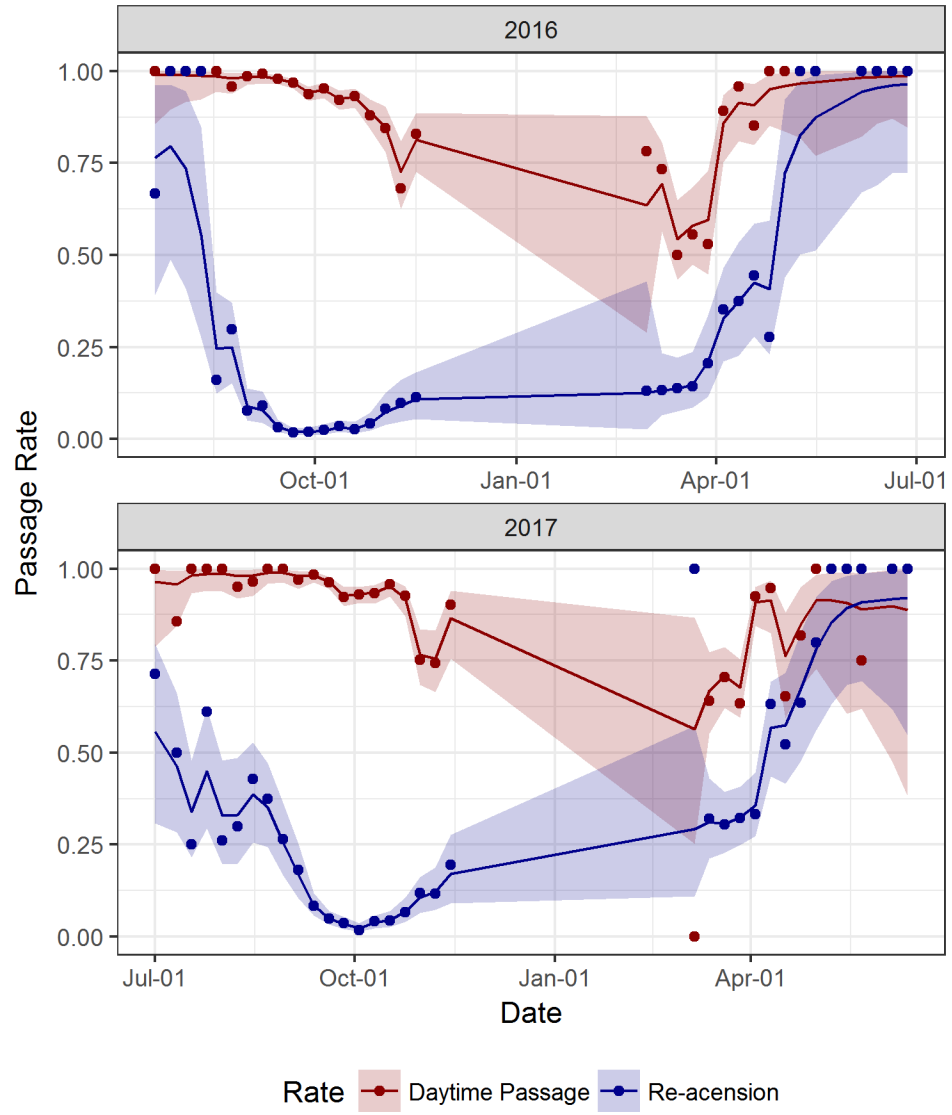
Lower Granite Trap Rates

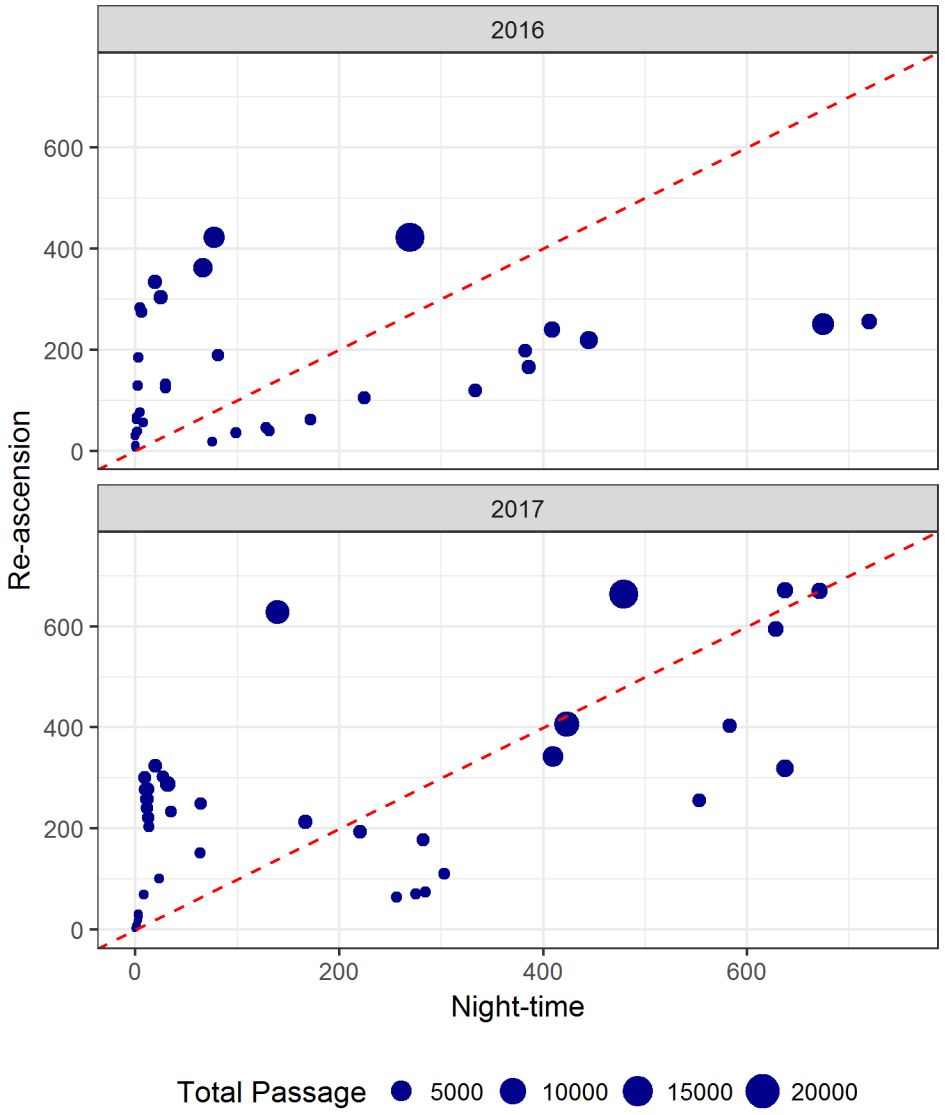
Weekly trap rate estimated from all previously tagged fish ascending the ladder



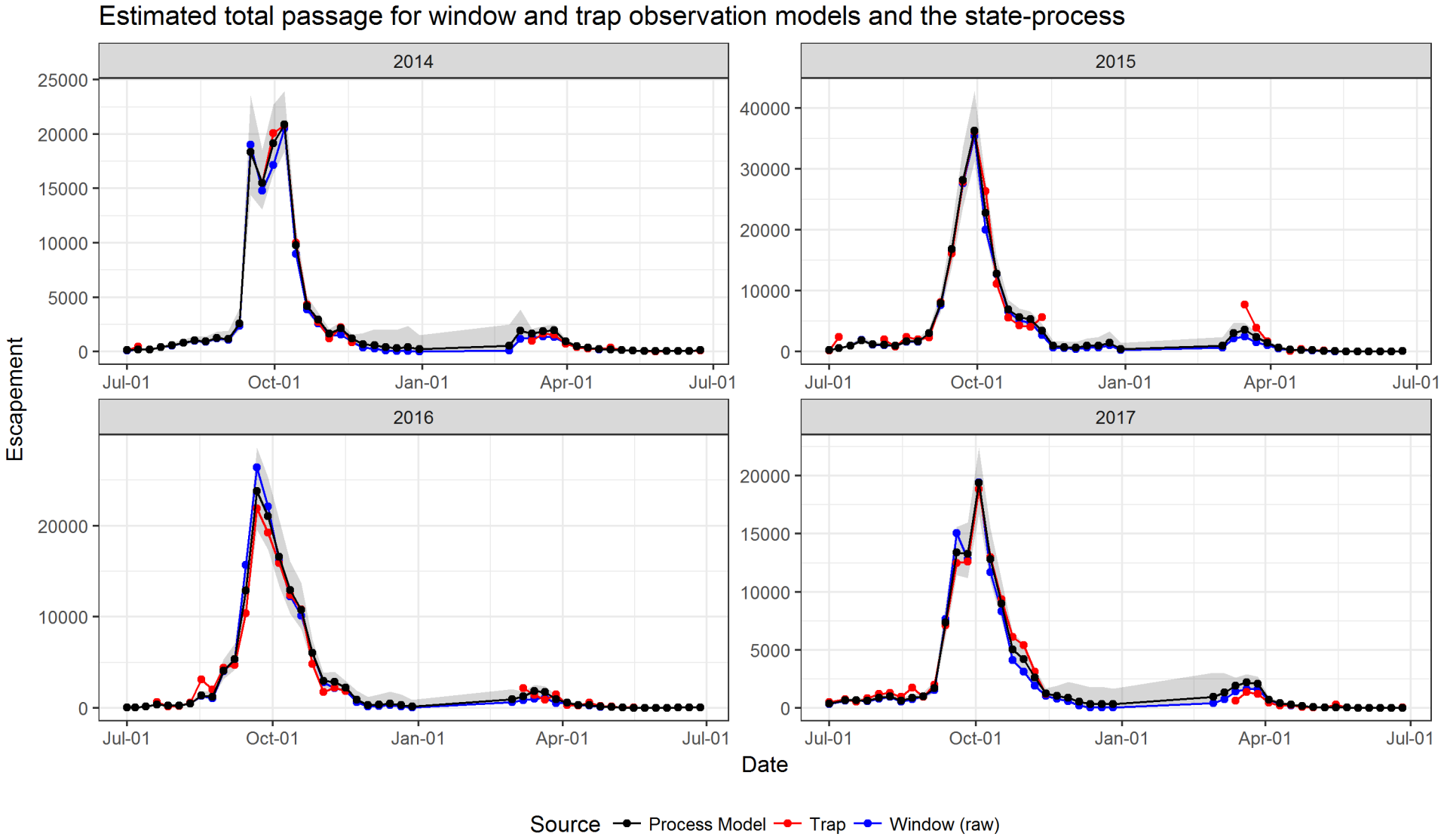


Lower Granite Passage Rates

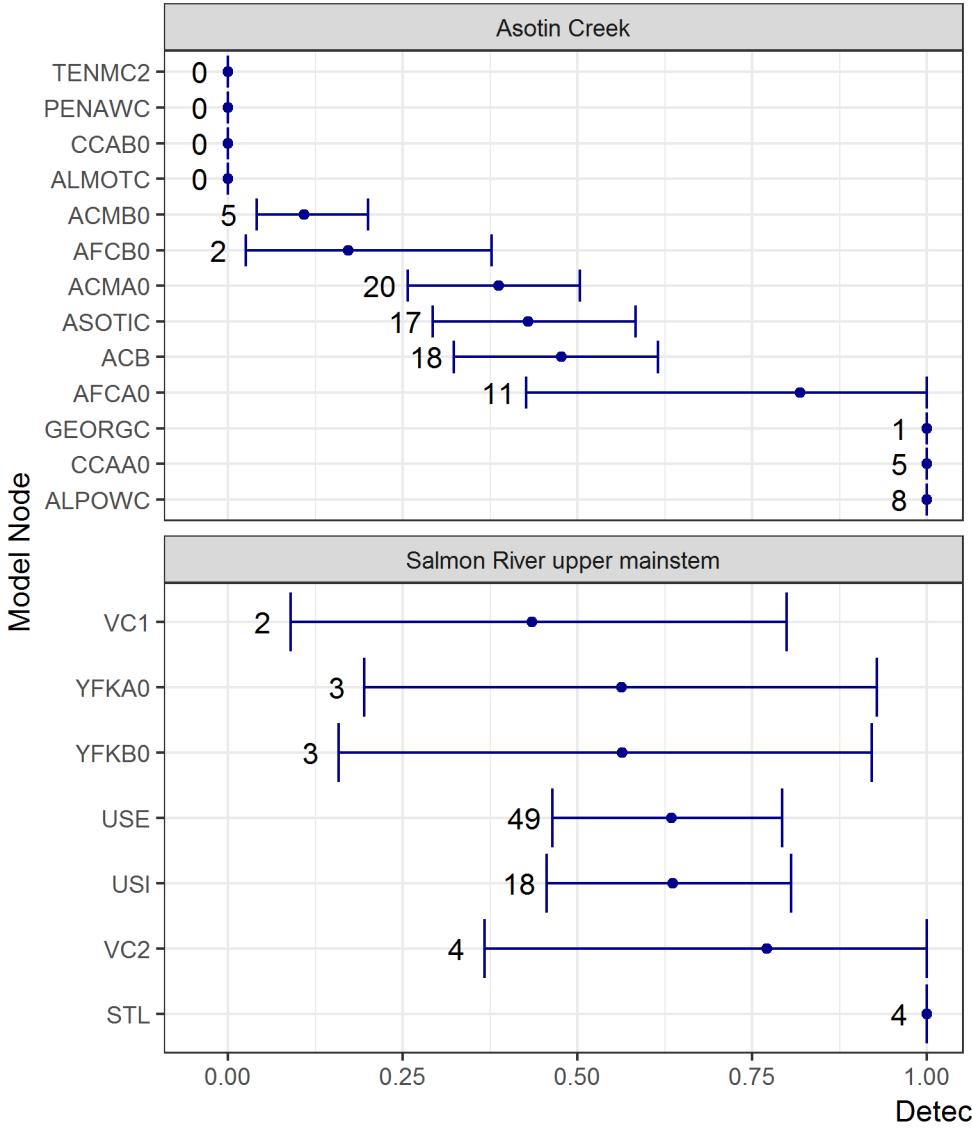


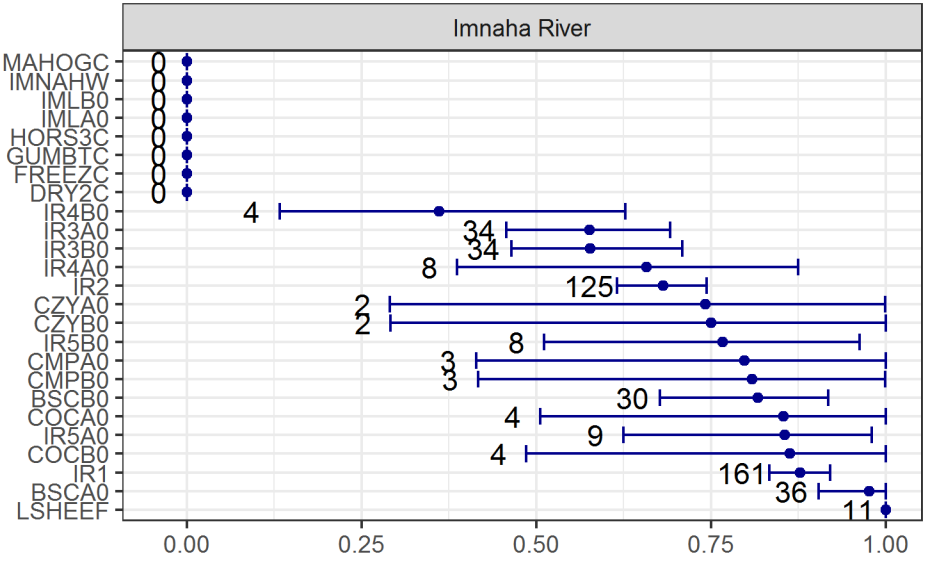


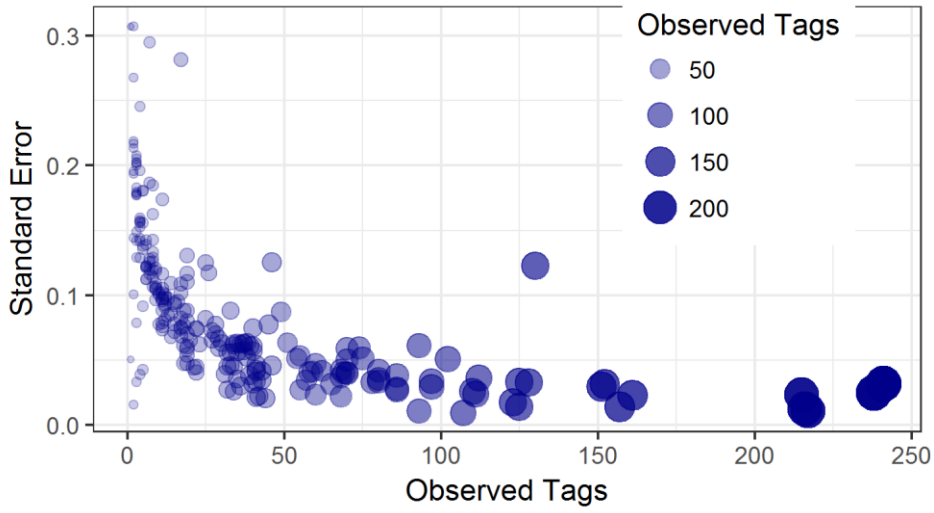
Lower Granite Escapement



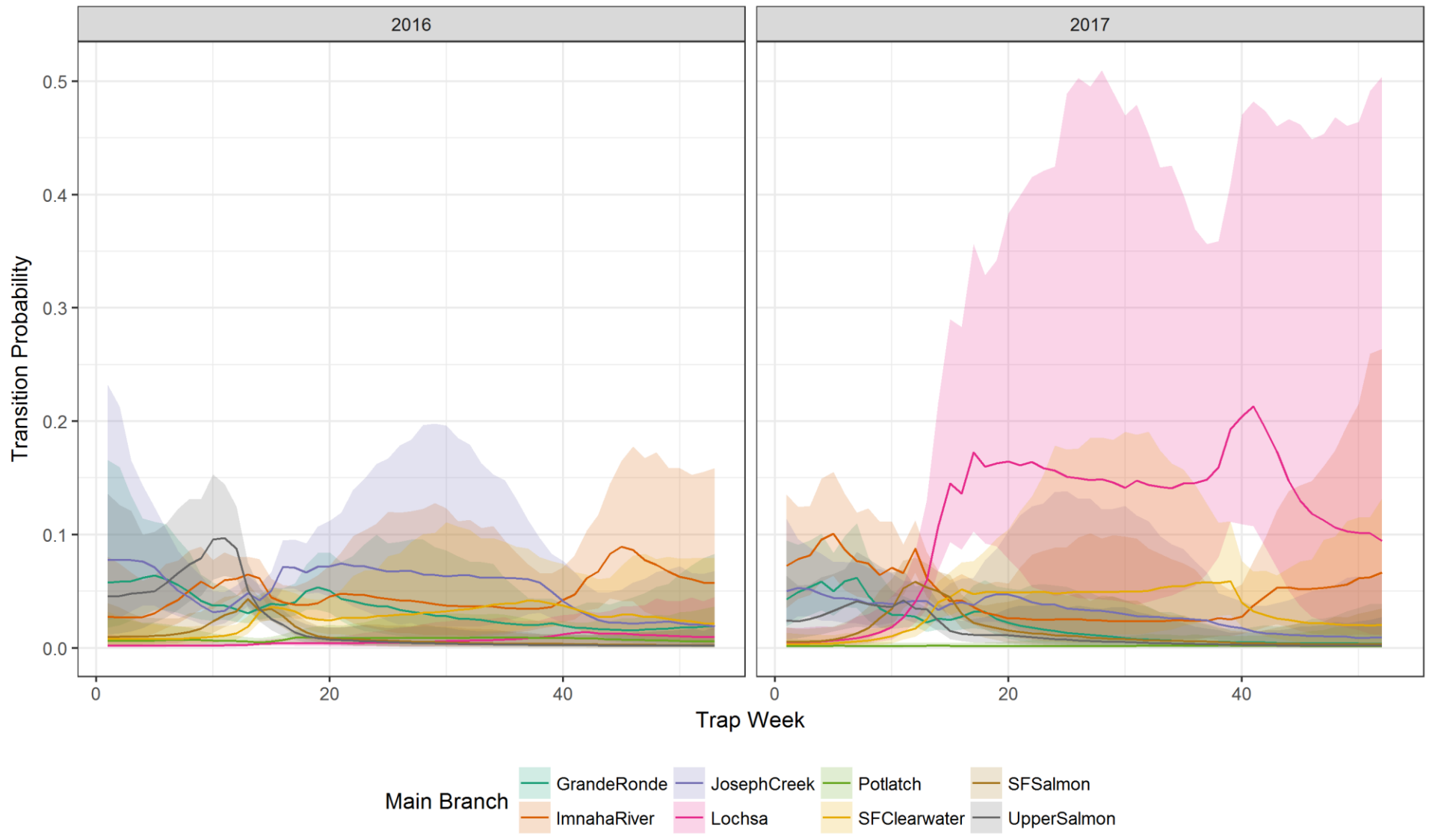
Detection Probabilities



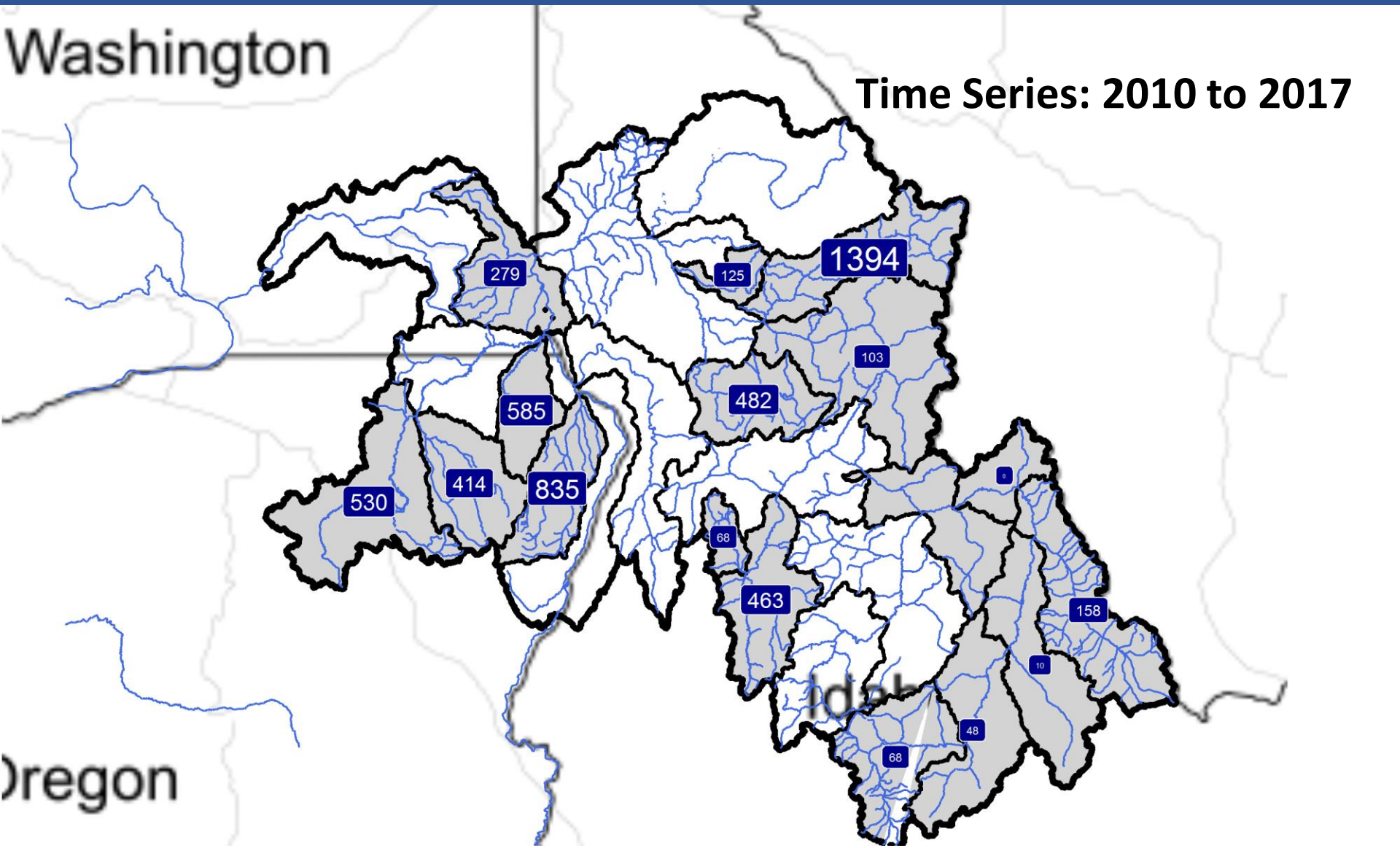




Transition Probabilities

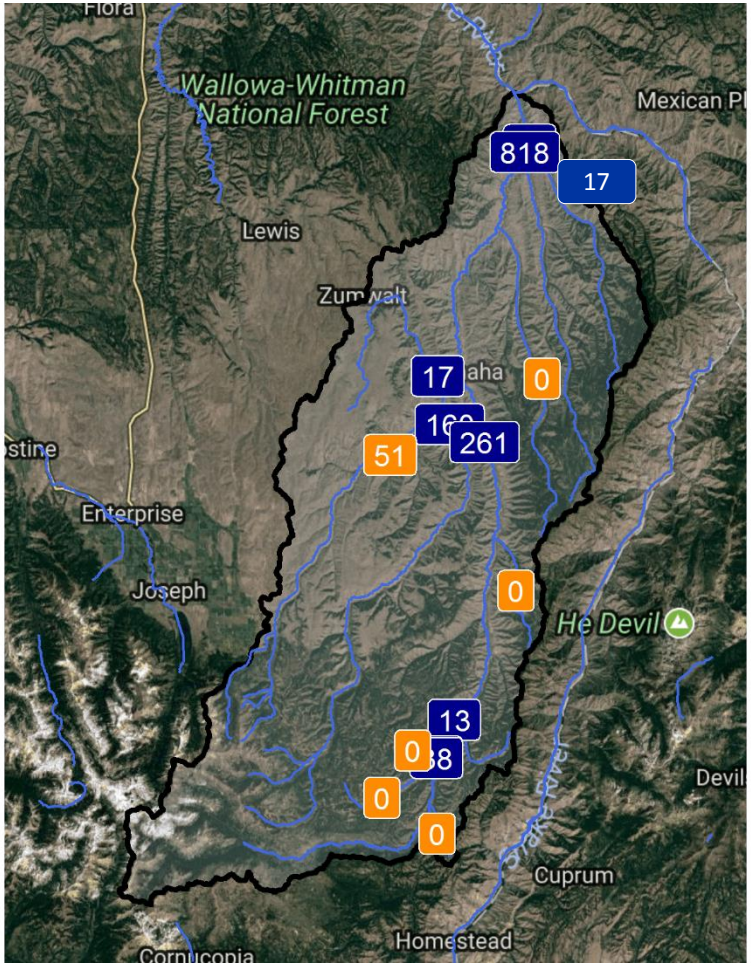


2017 Population NOSA

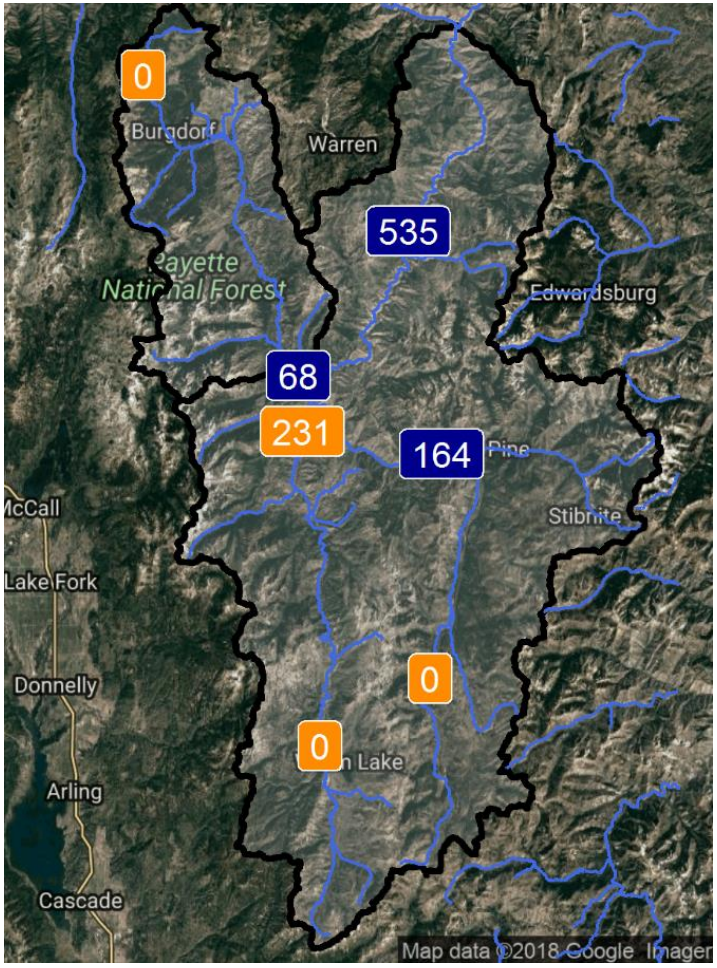


2017 Site Abundance

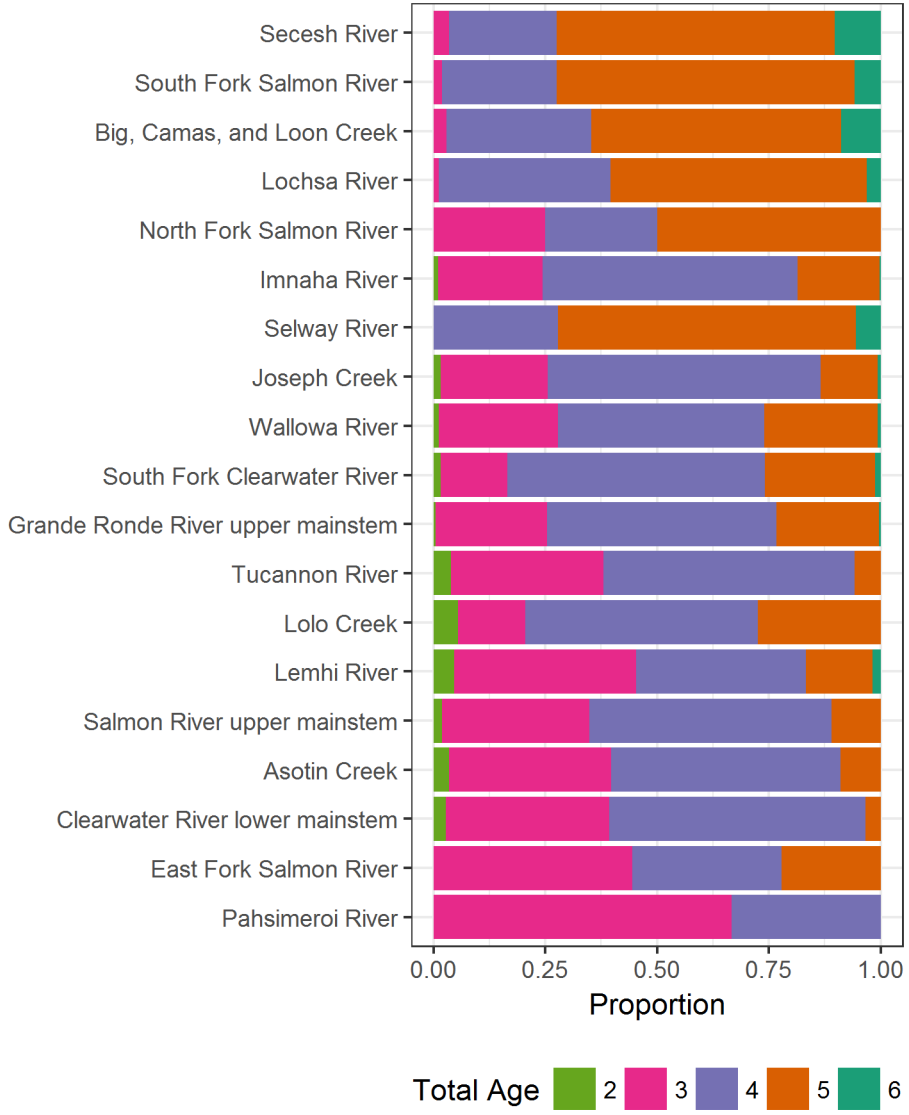
Imnaha River

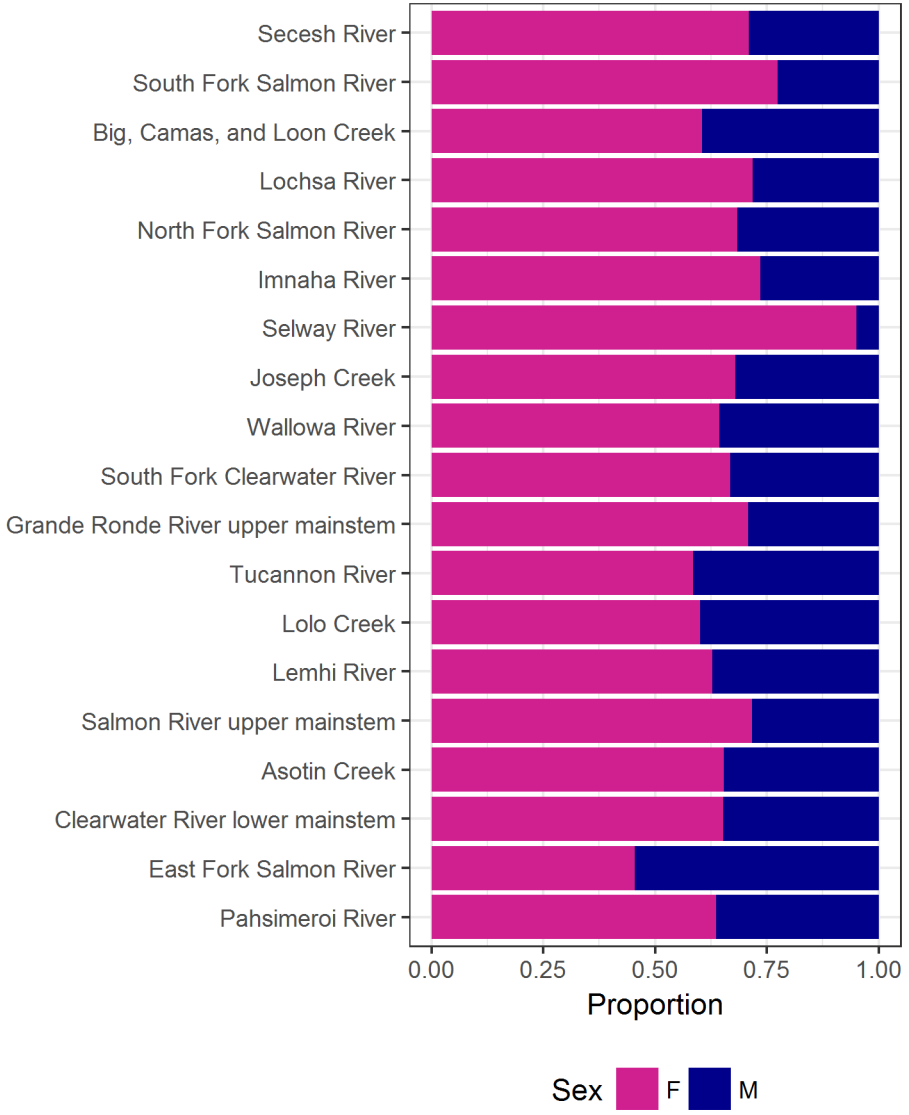


South Fork Salmon River



Life History Metrics





Partnerships

LOWER SNAKE RIVER
COMPENSATION PLAN
Hatchery Program

3D9.1BF2328B20

3D9.QBF1641BB4

3D9.1UF1955DD2

3D9.1BE1970B60

3D9.1BFS971444

3D9.1BF1TE288A

3D9.1BF1AI1964

3D9.1BF232OD0D

3D9.1BF2330NF0

3D9.1BF236AFS8

3D9.1BF23884D?

3D9.1BF23A0EB4

Model Details

- Hierarchical Modeling
  - Split complex process into multiple sections
  - Link sections together through mathematical equations

Example:

$$Female\ \% = \frac{n_F}{n_{Total}}$$

$$Female\ \# = Abundance\ * Female\ \%$$

- State-Space Modeling
  - Observation models
  - Process models

Example:

$$Detection\ Probability = \frac{Recaptures}{Marks}$$

$$Abundance = \frac{Captures}{Detection\ Probability}$$

Model Details

- Data gathering, processing and model runs all completed with R packages.
    1. STADEM
        - DART
        - Lower Granite Trap DB
    2. PITcleanr
        - PTAGIS
        - Lower Granite Trap DB
    3. DABOM

https://github.com/kevinsee/"package-name"

STADEM Details

Observation Process

$$Window\ Counts$$

$$Daytime\ Passage\ Rate = \frac{Day\ Tags}{Total\ Tags}$$

$$Reascension\ Rate = \frac{Tags\ Reascending}{Total\ Tags}$$

$$Trap\ Rate = \frac{Tags\ Trapped}{Total\ Tags}$$

State Process

$$Total\ Passage = \frac{Trap\ Catch}{Trap\ Rate}$$

$$Total\ Passage = \frac{Window\ Count}{Daytime\ Passage\ Rate}$$

$$Escapement = Total\ Passage * (1 - Reascension\ Rate)$$

DABOM Details

Observation Process

$$Detection\ Probability = \frac{Tags\ Observed}{Tags\ Upstream}$$

$$Estimated\ Tags = \frac{Tags\ Observed}{Detection\ Probability}$$

State Process

$$Transition\ Probability = \frac{Estimated\ Tags}{Tags\ Released}$$