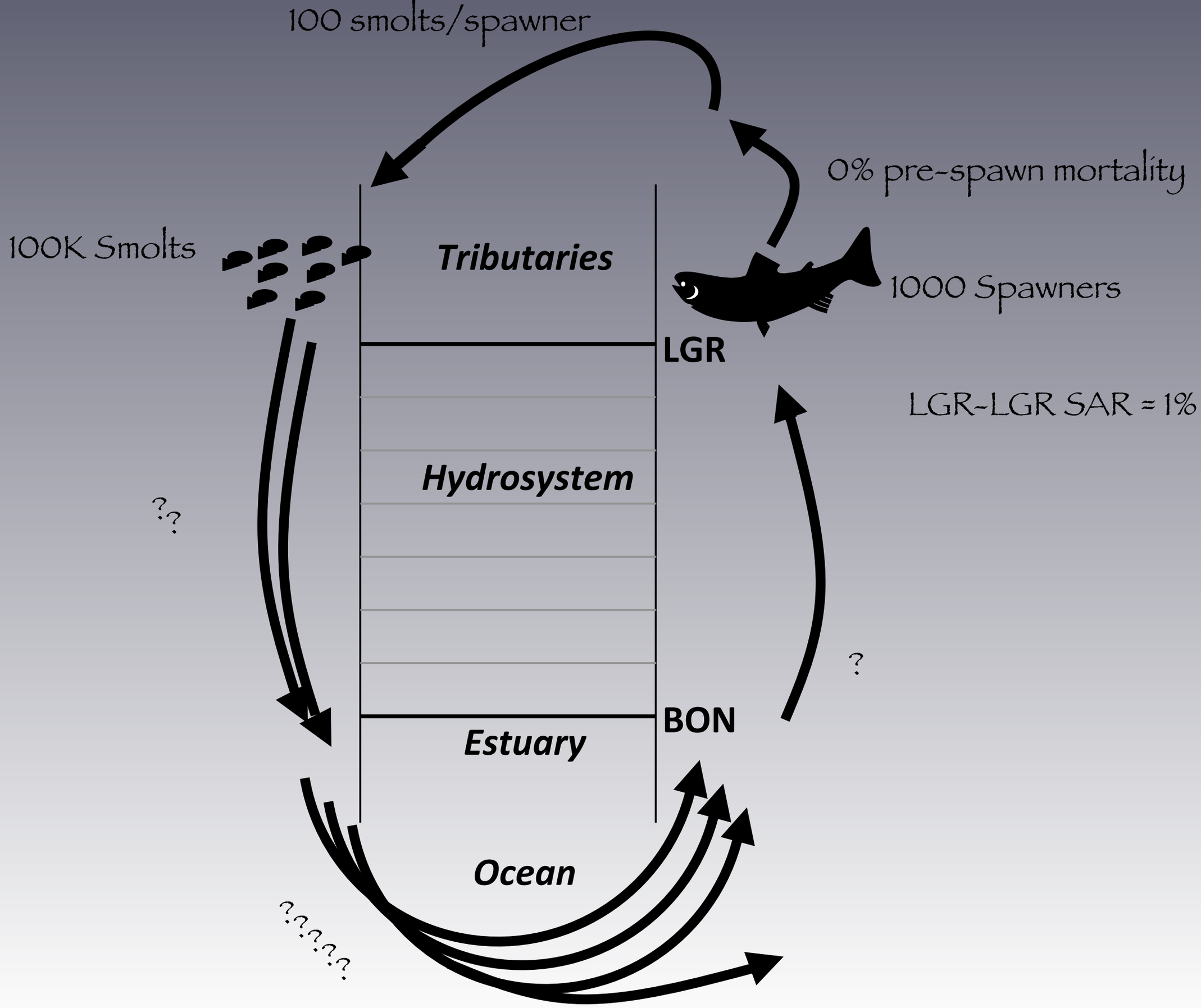
Life cycle model evaluation of Snake River spring/summer chinook under alternative spill and breach scenarios

Presenter: Robert B Lessard


100 smolts/spawner
0% pre-spawn mortality
100K Smolts
Tributaries
1000 Spawners
LGR
LGR-LGR SAR = 1%
Hydrosystem
??
?
BON
Estuary
Ocean
?????

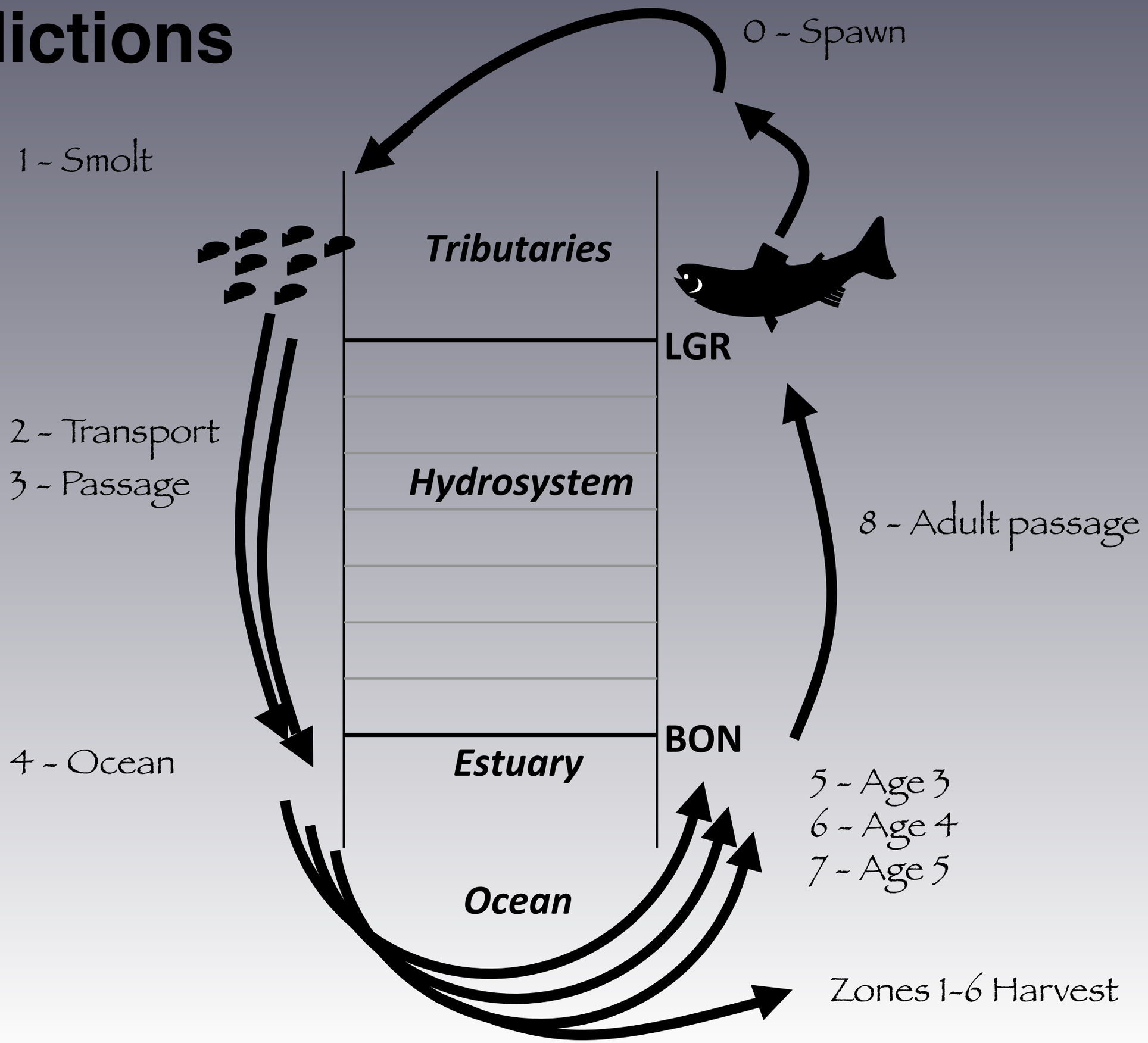
Evolution of studies

- Decades of FPC, ODFW, WDFW, FWS, NOAA, COE, and Tribal collaboration
  - Tributary monitoring programs
  - Juvenile and adult passage monitoring
  - Broad and fine scale survival studies
    - Reach, Ocean, LGR-LGR, SAR
- Quest for alternative recovery options

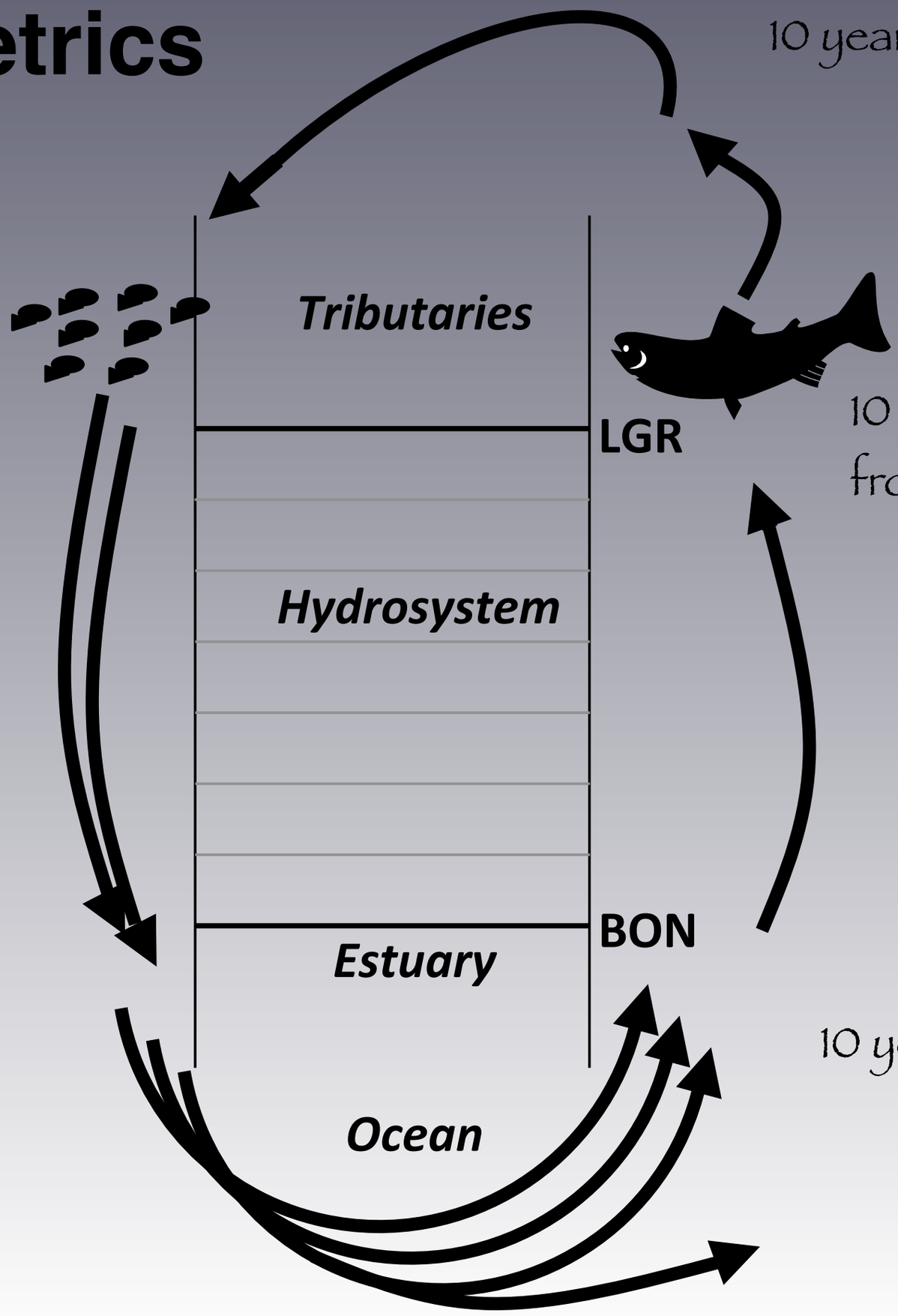
Life cycle objectives

- Develop life cycle predictions validated with empirical abundance and survival data
- Use validated model to make predictions
- Examine the sensitivity of population trends to tributary improvements
- Examine the sensitivity of population trends to spill and breach scenarios

Predictions



Output metrics



10 year average spawners

10 year average SAR
from 1000's of simulations

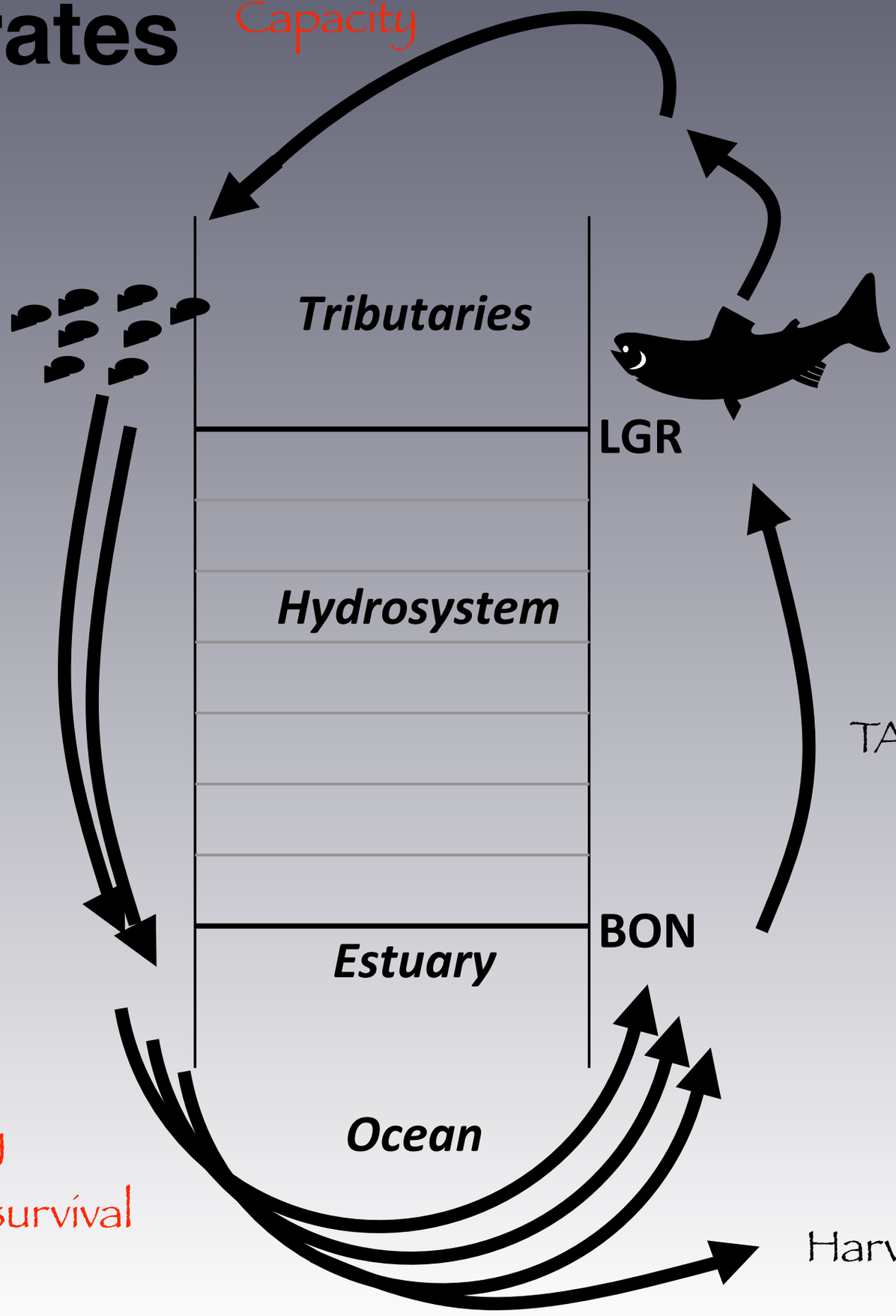
10 year average returns

Required rates

- Estimated
- Known

Productivity

Capacity



Transport survival

In river survival

TAC Conversion rates

Maturity

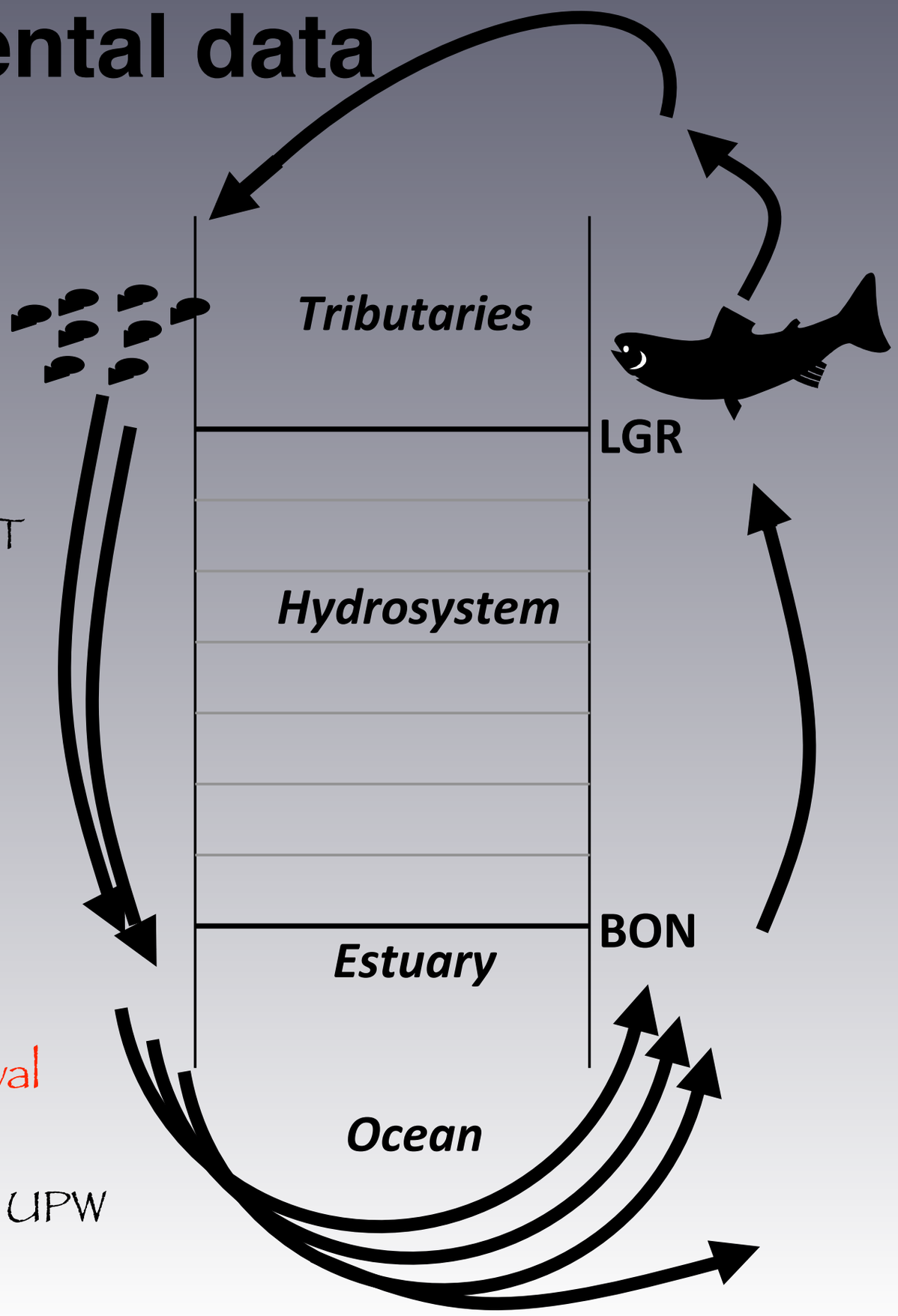
Ocean survival

Harvest rates

Environmental data

In river survival

* Water transit time WTT
* Powerhouse PITPH



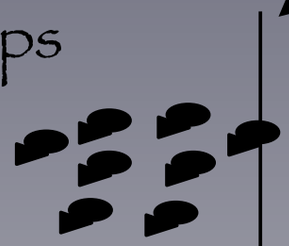
Ocean survival

* PDO
* Upwelling UPW
* PITPH

Demographic data

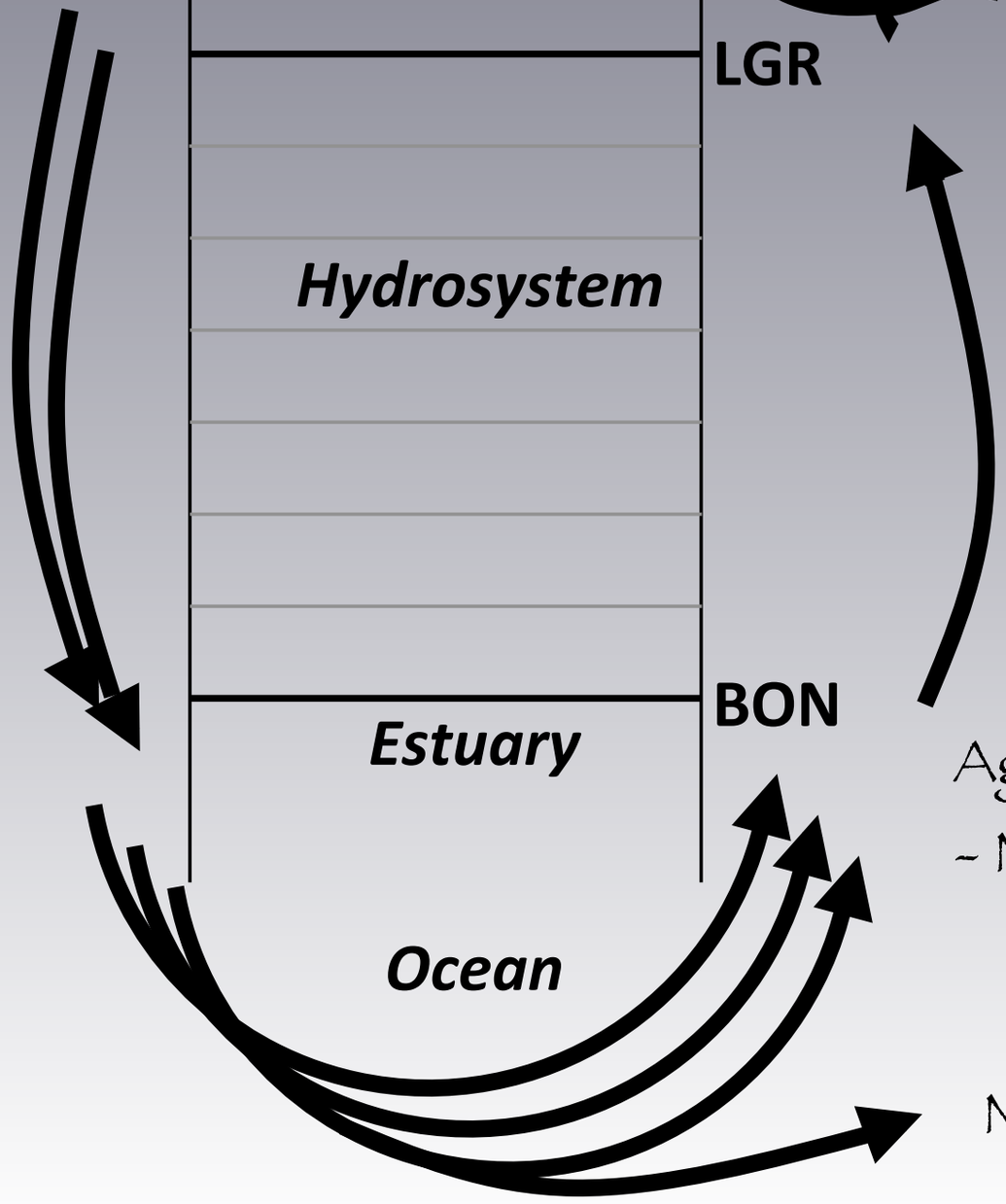
Spawners
- surveys

Smolts
- screw traps



PIT tag LGR SARs
- In river
- Transport
- Combined

In river survival
- PIT tag detections



Age of adult returns
- NOAA reconstructions

NOAA SPS harvest

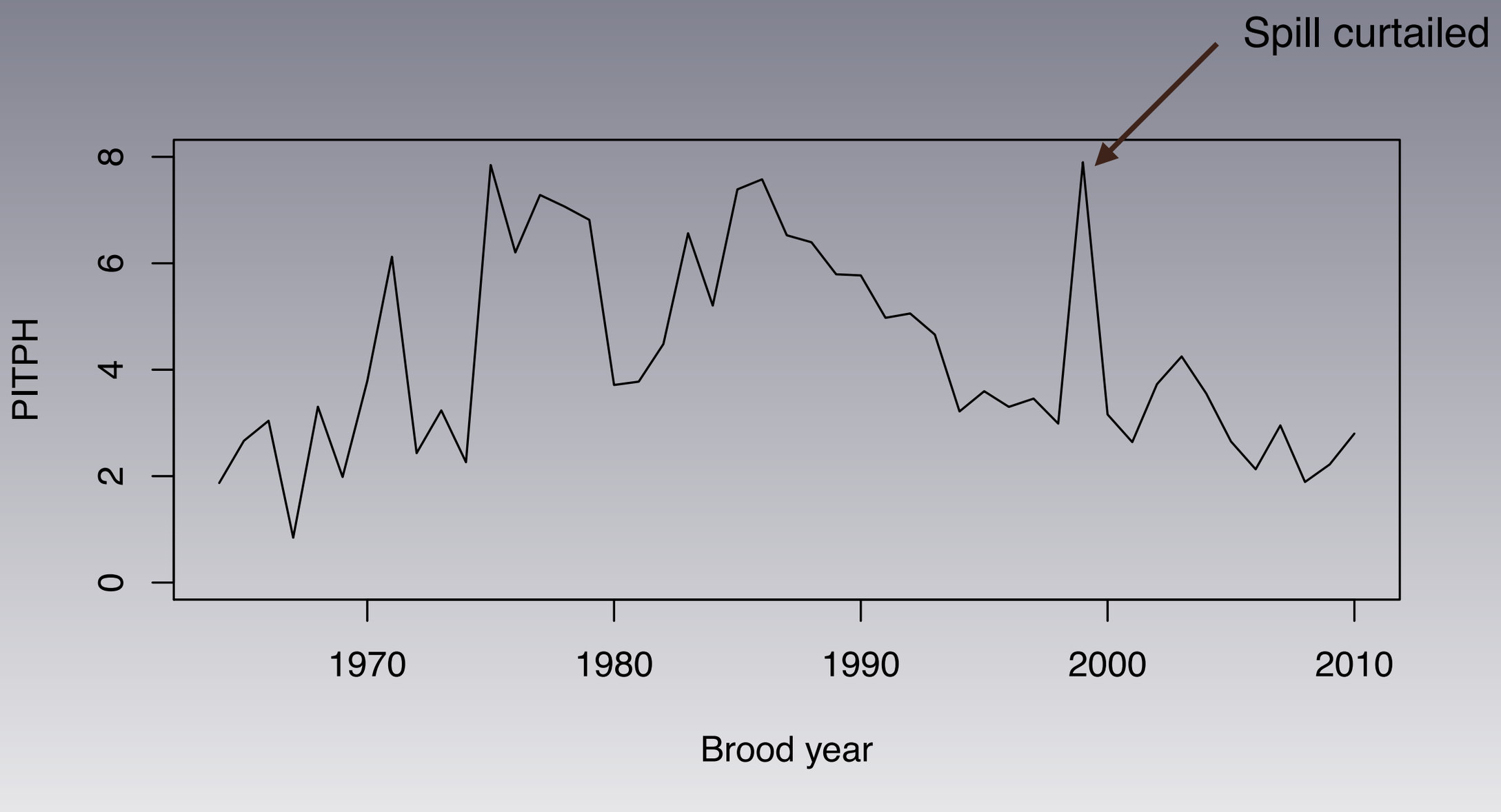
Demographic data

- 1967-2013 data range
- 6 Grande Ronde Imnaha MPG spawner and age class return time series
- 4 Grande Ronde Imnaha MPG smolt series
- Harvest, age class returns, spawners, survival rates
- But also, environmental data

Mainstem environment

- PIT tag derived index of powerhouse passage (PITPH, across all dams)
  - Daily detections at each dam (0-100%) at known spill%, flow and weir configuration
- Water transit time (WTT, all reservoirs)
  - Volume/discharge calculation at flow

PITPH

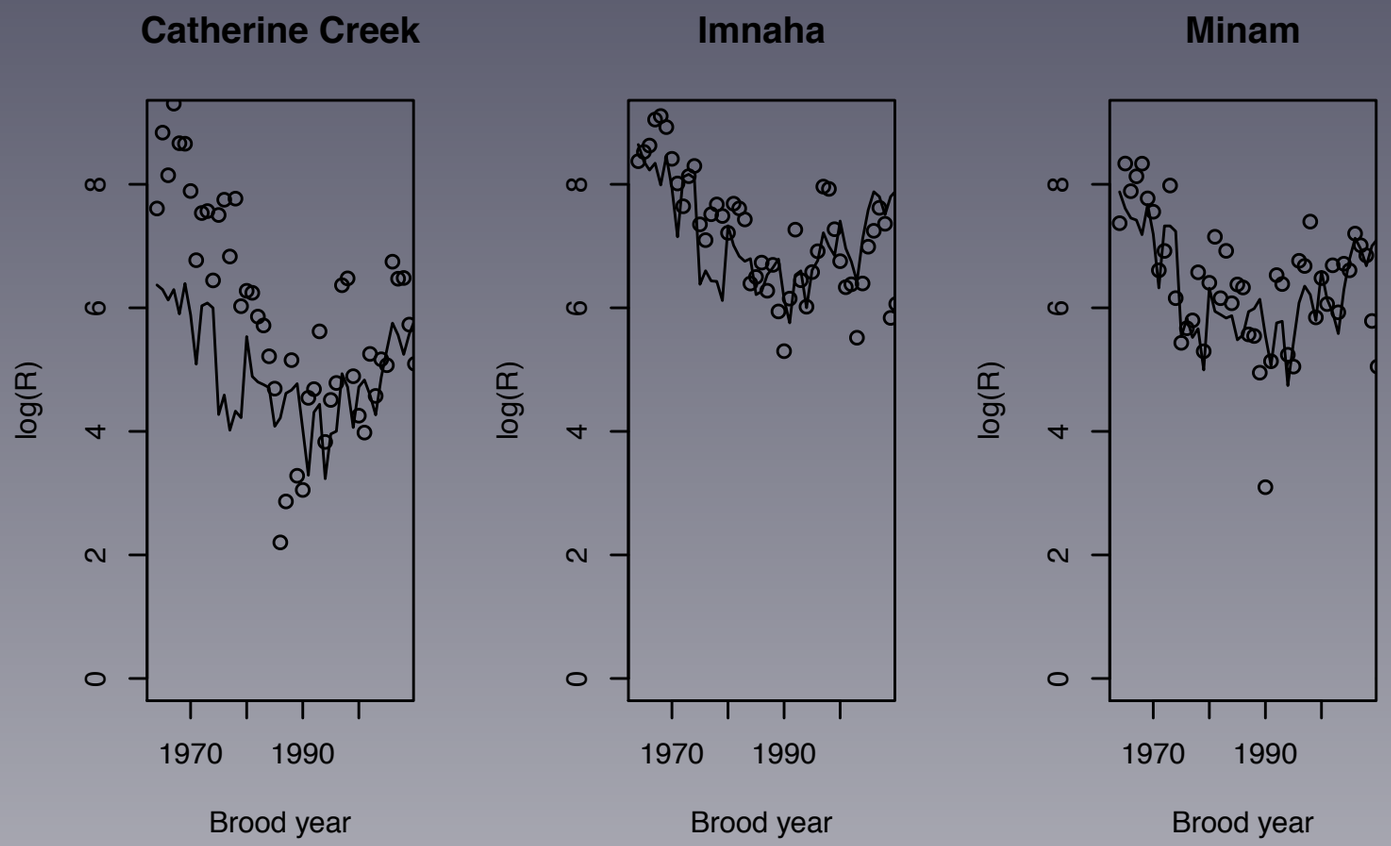

Spill curtailed
PITPH
0
2
4
6
8
1970
1980
1990
2000
2010
Brood year

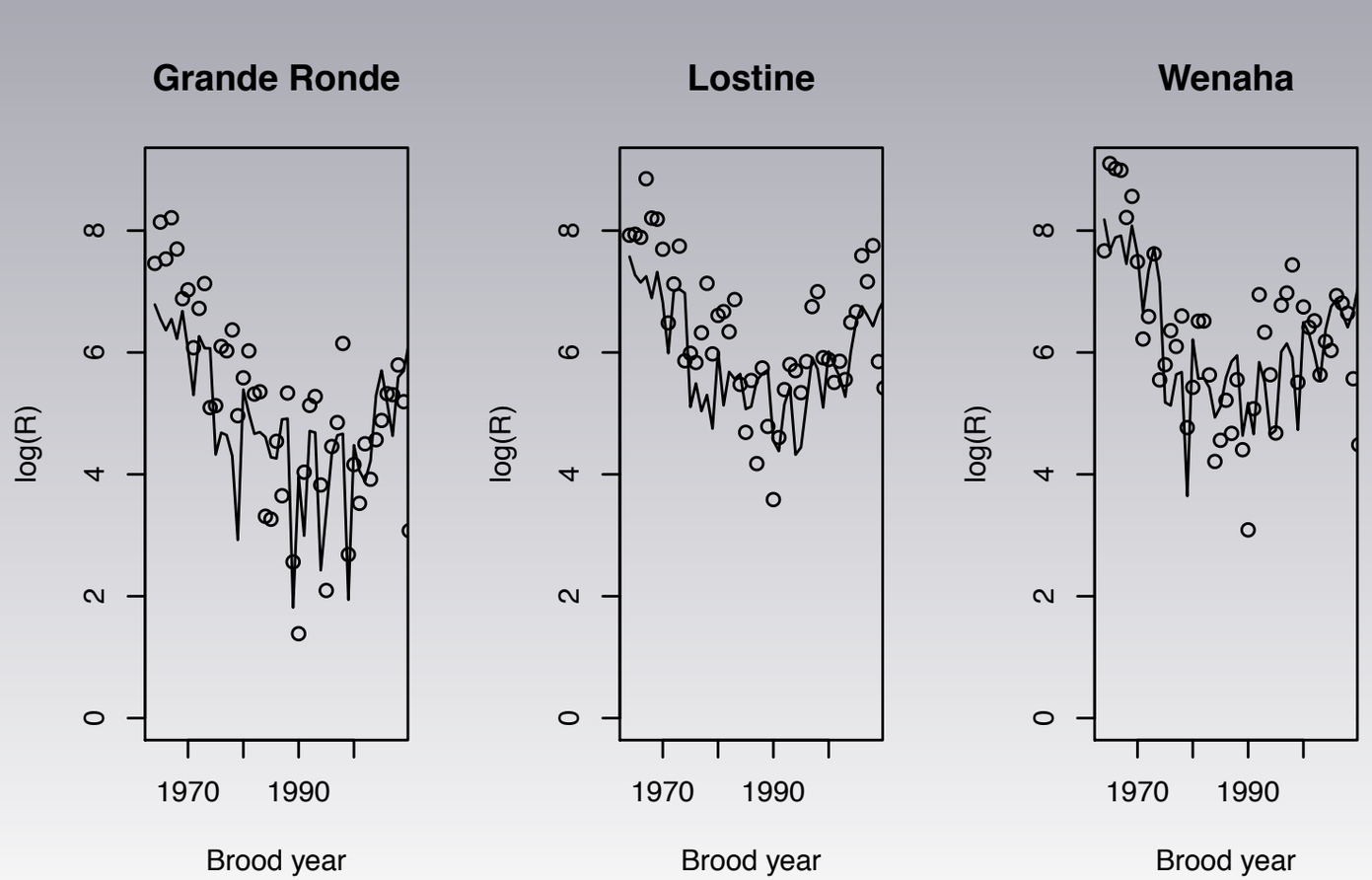
Ocean environment

- Pacific Decadal Oscillation (PDO) in May
- Upwelling (UPW) in April

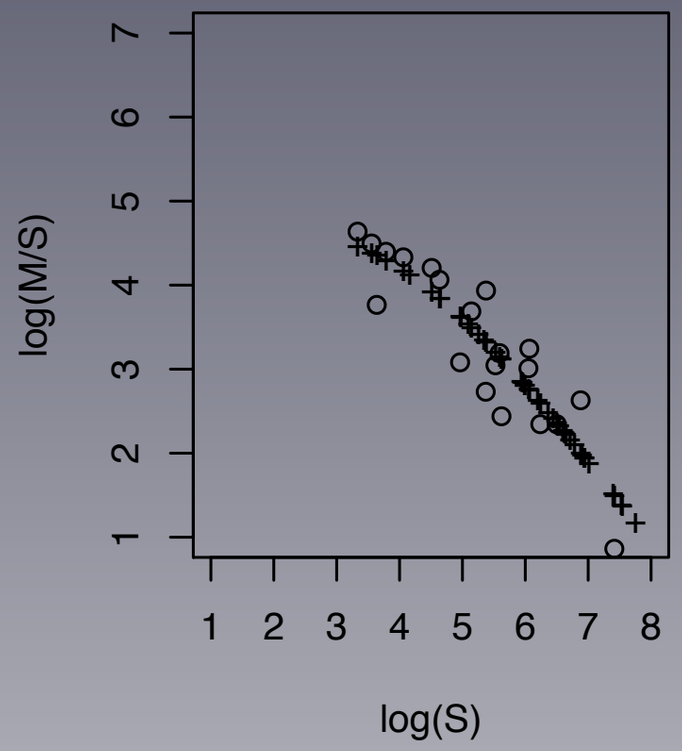
Statistical reconstruction

- Predict all life cycle stage abundances
- Find parameters that provide best fit to historical trends
  - Age class abundances
  - Survival rates, SARs
- Map out the uncertainty in estimates

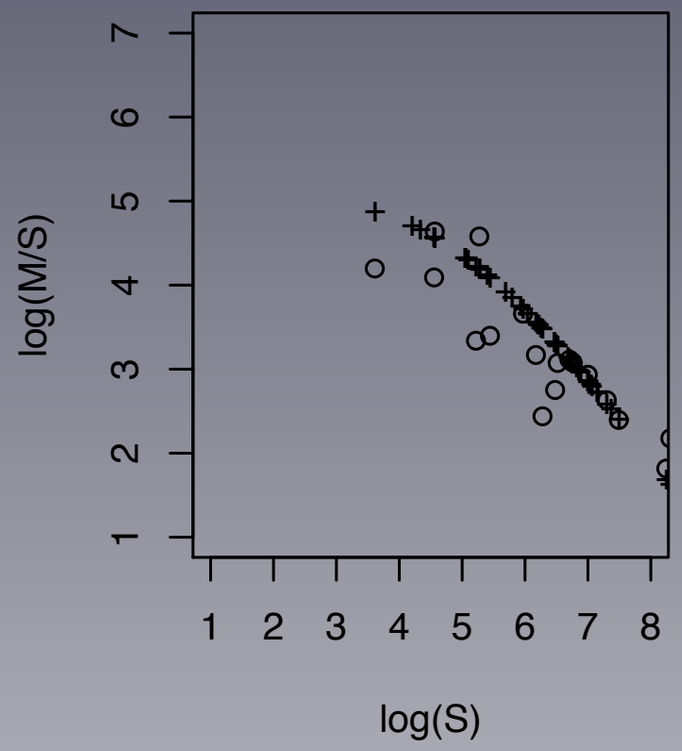

Catherine Creek
Imnaha
Minam
log(R)
0
2
4
6
8
1970
1990
Brood year


Grande Ronde
Lostine
Wenaha
log(R)
0
2
4
6
8
1970
1990
Brood year

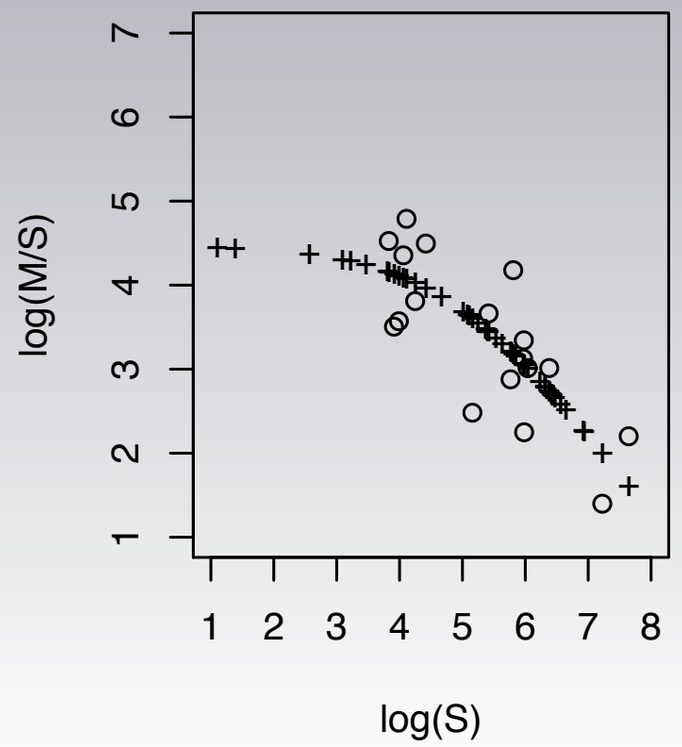
Catherine Creek



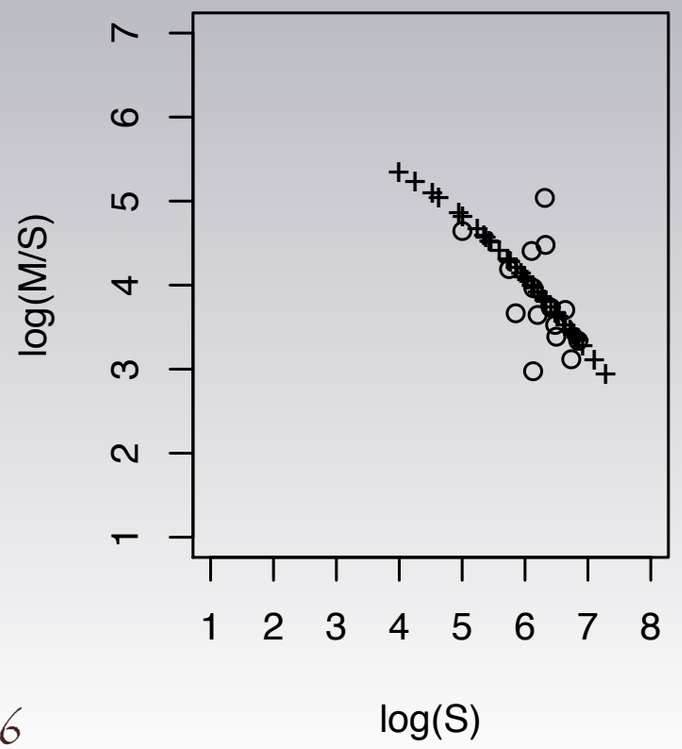
Lostine

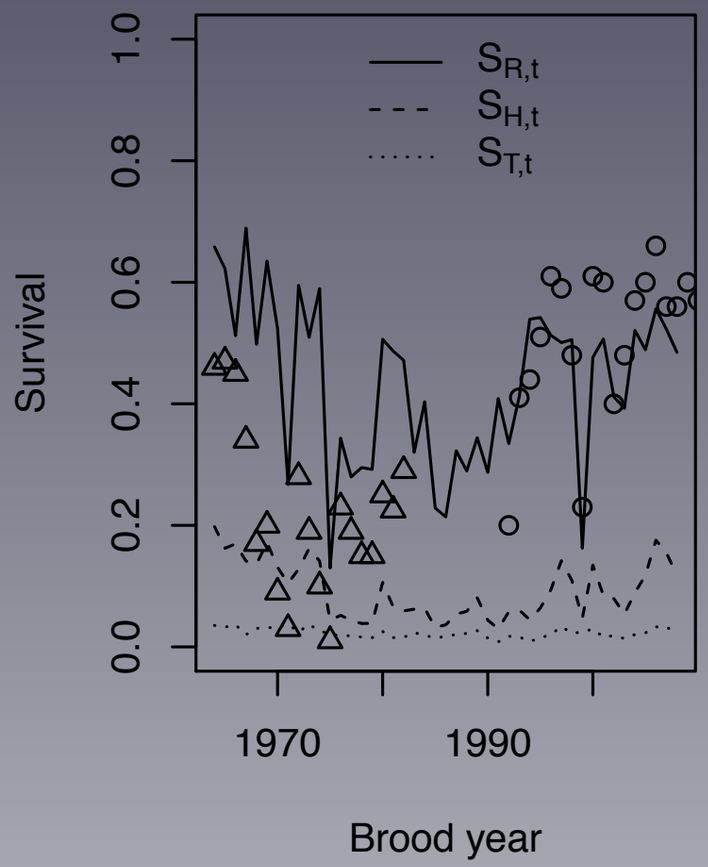


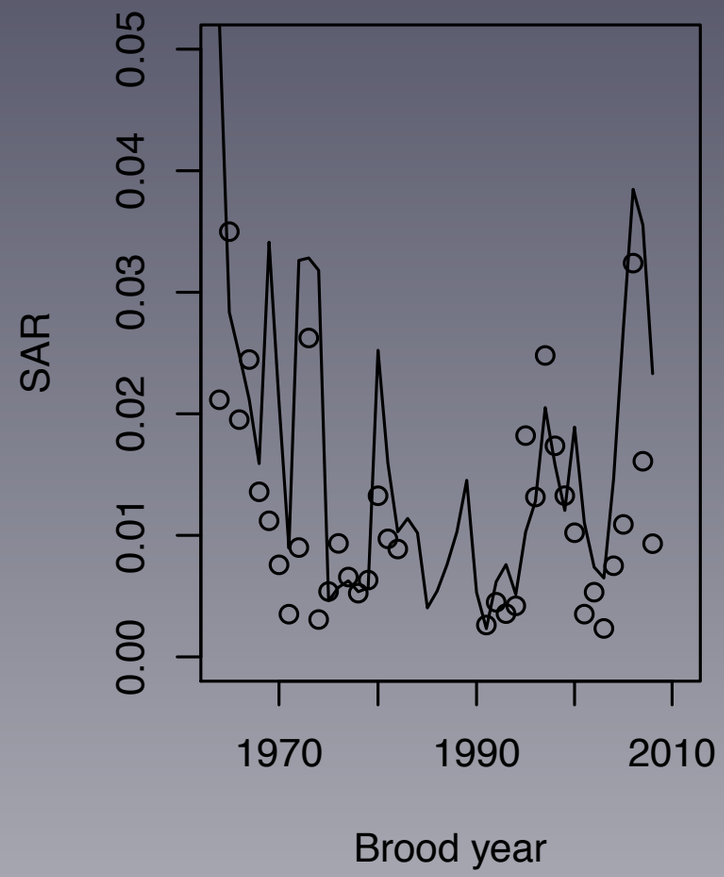
Grande Ronde

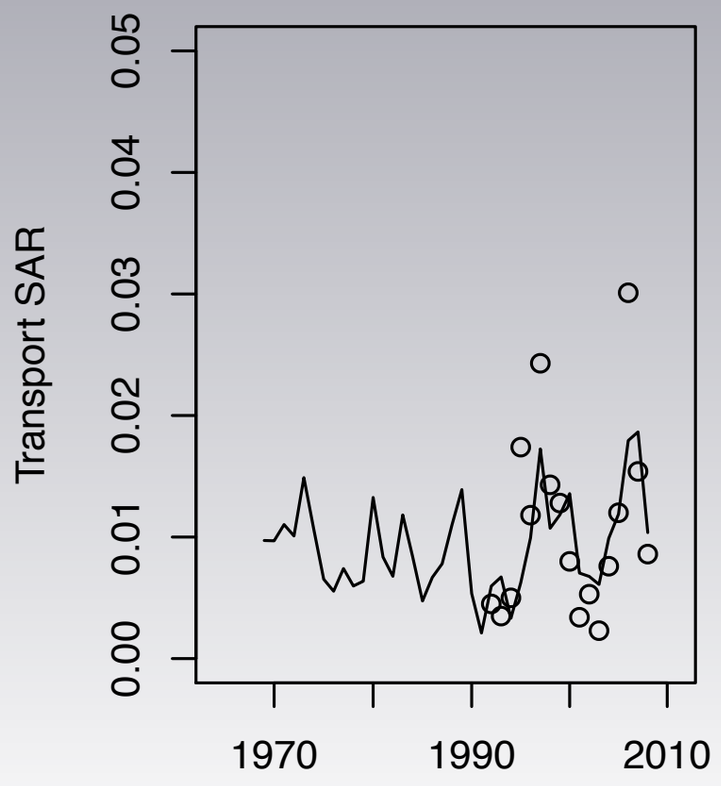


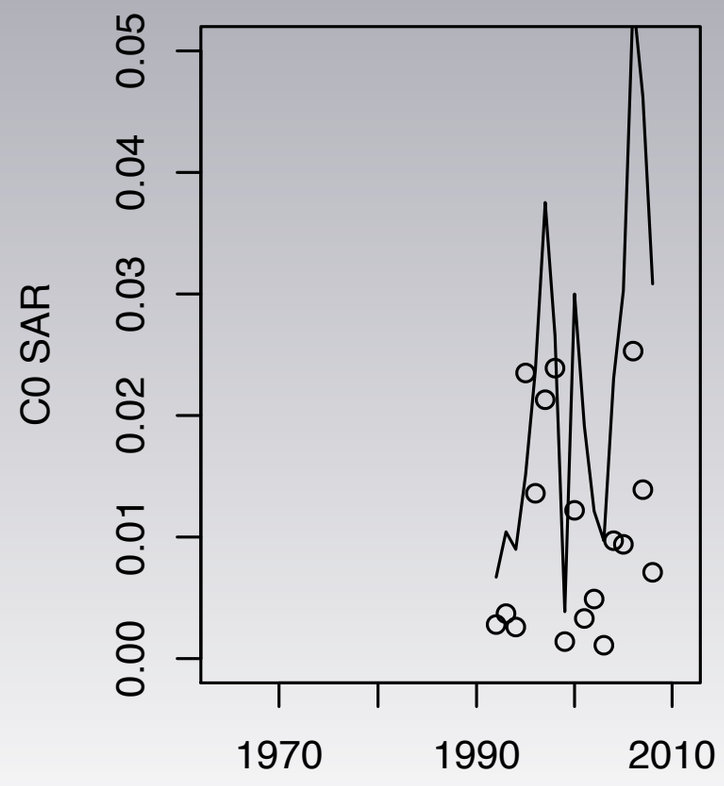
Minam




Survival
0.0
0.2
0.4
0.6
0.8
1.0
$S_{R,t}$
$S_{H,t}$
$S_{T,t}$
1970
1990
Brood year

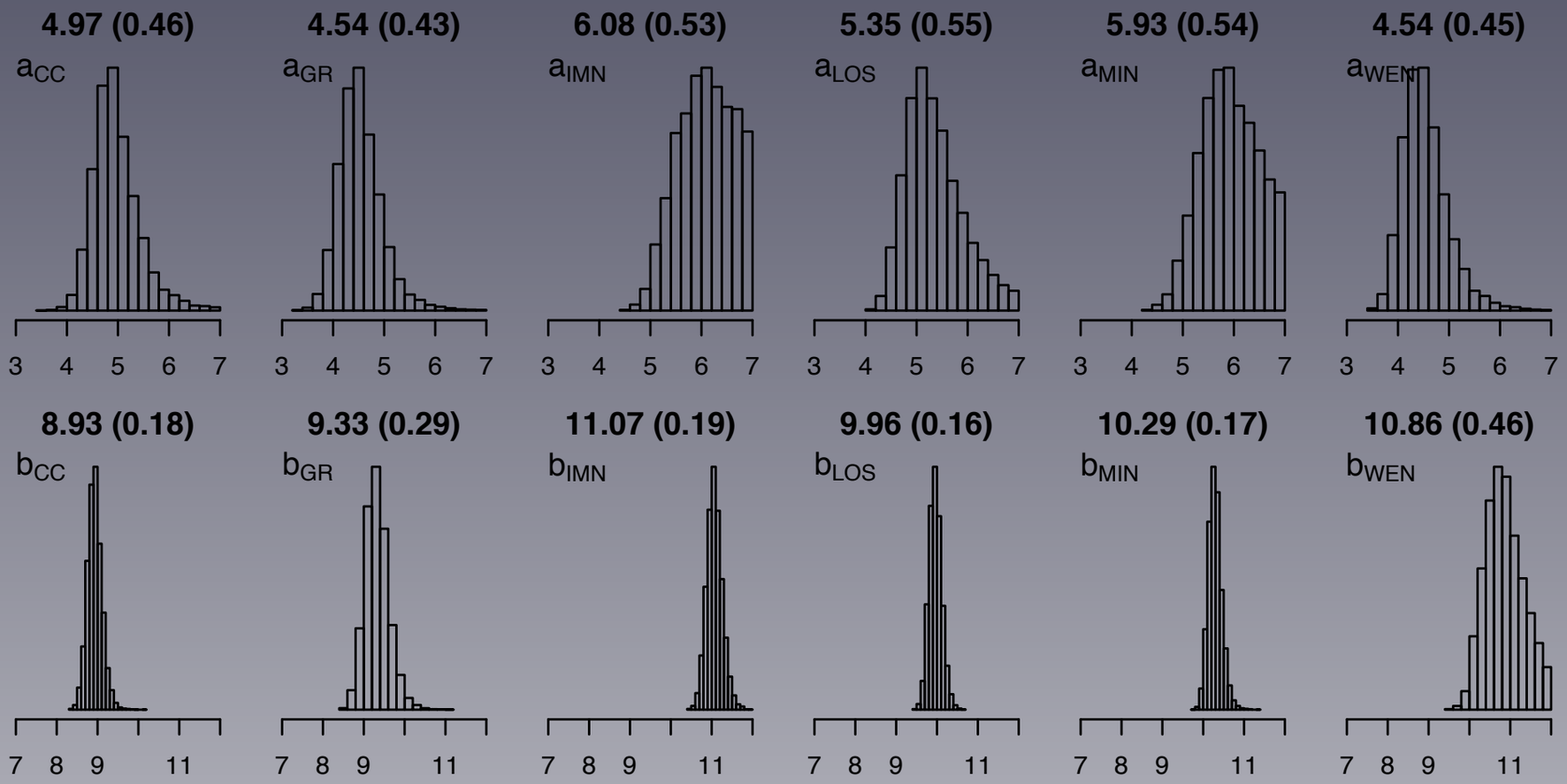

SAR
0.00
0.01
0.02
0.03
0.04
0.05
1970
1990
2010
Brood year


Transport SAR
0.00
0.01
0.02
0.03
0.04
0.05
1970
1990
2010
Brood year


C0 SAR
0.00
0.01
0.02
0.03
0.04
0.05
1970
1990
2010
Brood year

Performance comparison

- Use uncertainty in inference about what drives survival
- Express alternatives in terms of drivers
  - PITPH, WTT
  - Productivity, Capacity
- Map out the uncertainty in performance metrics


4.97 (0.46)
a_{CC}
4.54 (0.43)
a_{GR}
6.08 (0.53)
a_{IMN}
5.35 (0.55)
a_{LOS}
5.93 (0.54)
a_{MIN}
4.54 (0.45)
a_{WEN}
3 4 5 6 7
8.93 (0.18)
b_{CC}
9.33 (0.29)
b_{GR}
11.07 (0.19)
b_{IMN}
9.96 (0.16)
b_{LOS}
10.29 (0.17)
b_{MIN}
10.86 (0.46)
b_{WEN}
7 8 9 11
1.44 (0.31)
δ_R
−0.22 (0.07)
δ_{PH}
−0.04 (0.02)
δ_{WTT}
−1.52 (0.31)
γ_H
−3.77 (0.12)
γ_T
−0.24 (0.07)
γ_{PDO}
0.5 1.5 2.5 3.5
−0.4 0.0
−0.15 −0.05
−2.5 −1.5 −0.5
−4.2 −3.8 −3.4
−0.5 −0.2 0.1
0.01 (0)
γ_{UPW}
−0.21 (0.08)
γ_{PH}
0.7 (0.17)
m_2
−0.005 0.010 0.025
−0.6 −0.2
0.55 0.65 0.75 0.85

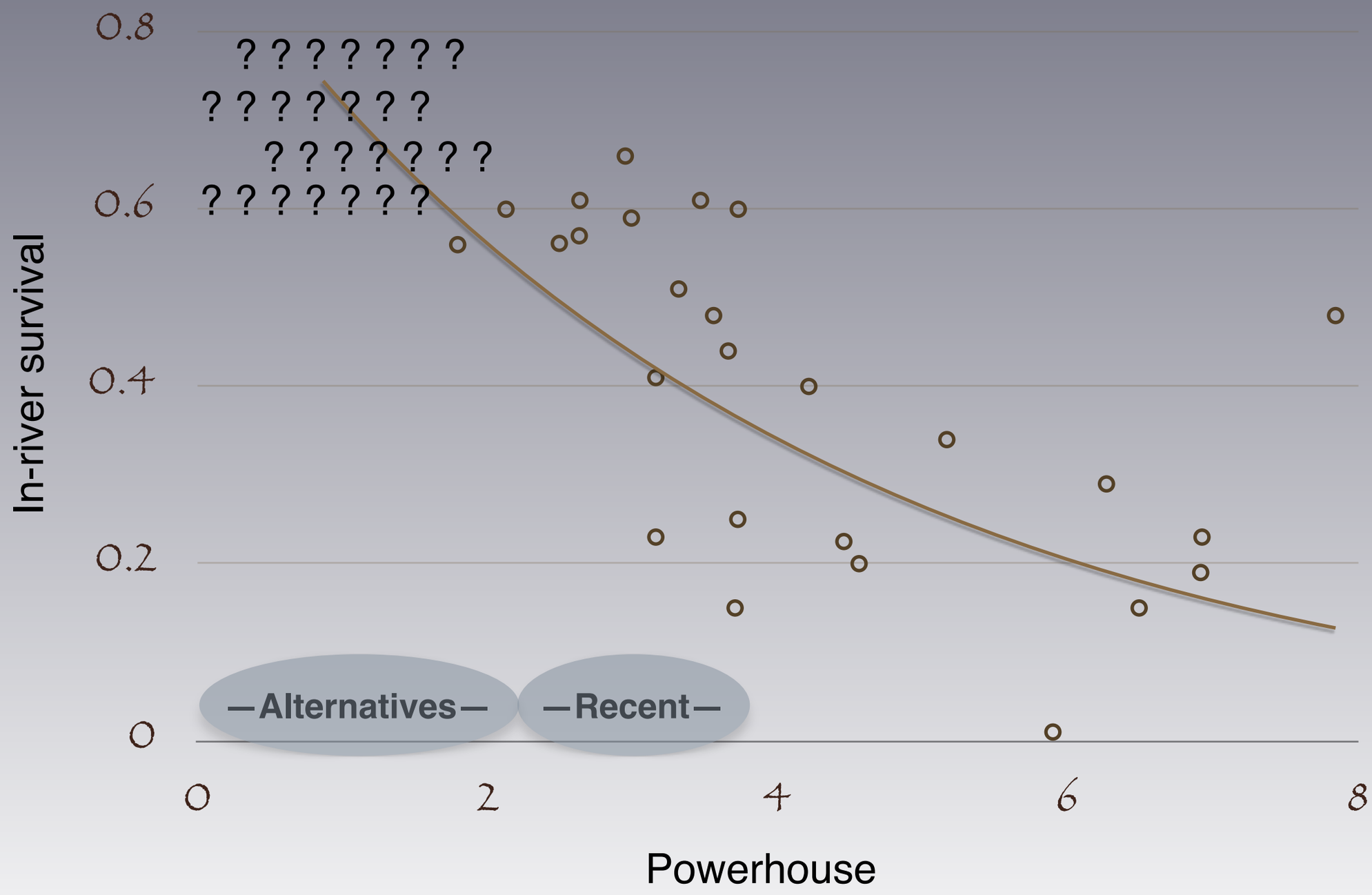
Hydro scenarios

- BiOp, 115/120%, 120%, 125% TDG
- High, Average, Low flow conditions
- Breach of lower 4 Snake dams
  - Adjust PITPH by removing 4 dams passages
  - Adjust WTT by reevaluating with tailraces at 90-100 below minimum operating pool elevation

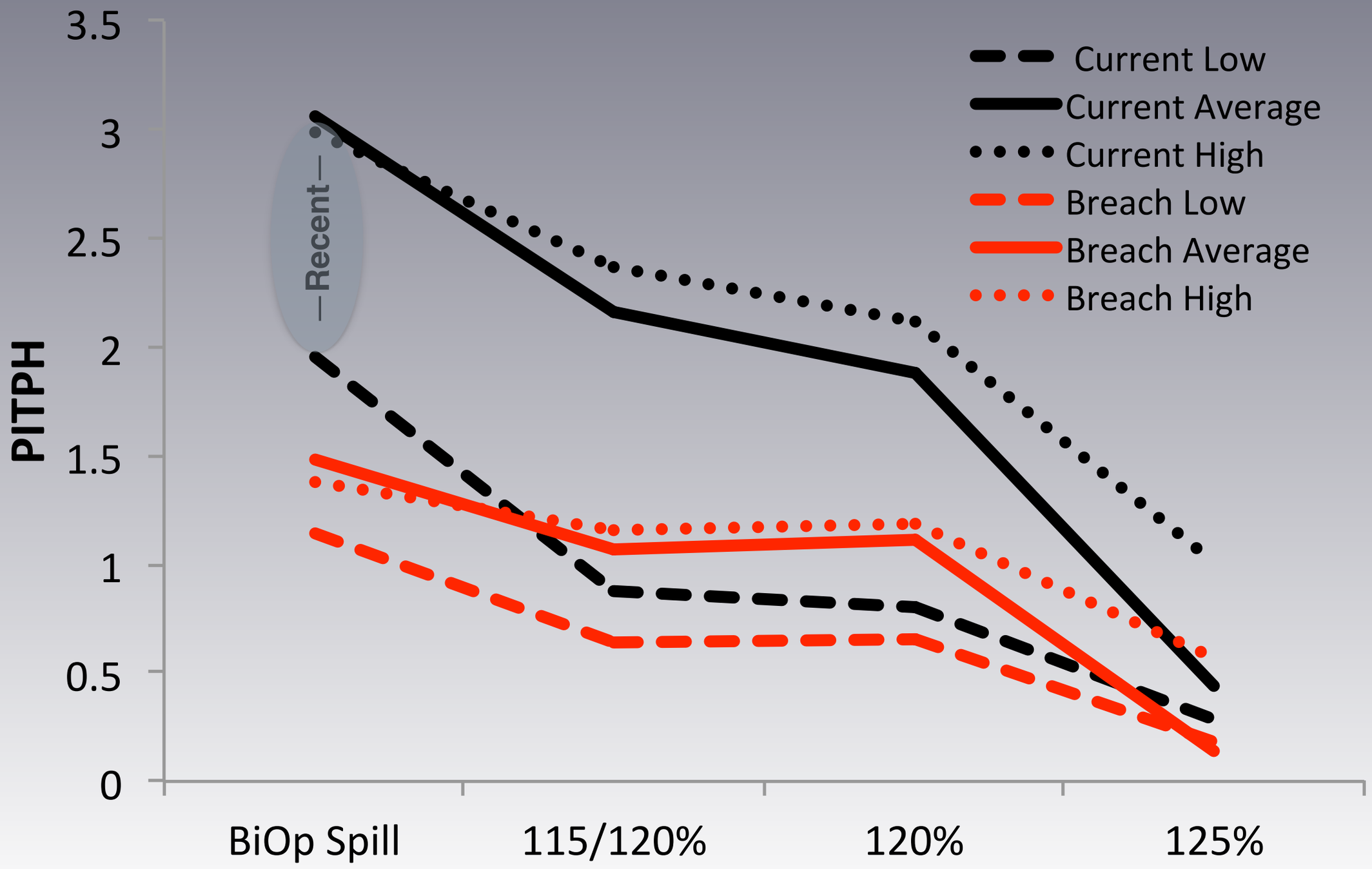
Simulated conditions

- Harvest rate increasing to 20% at 5000
  - Zone 6 < 17% currently
- Random "PDO" mimics empirical pattern
- Upwelling drawn at random from historical data
- Conversion drawn at random from 20 recent years
- Fixed 20/0 % transportation (current/breach)
- Predict 2036-2045 average SAR and Abundance

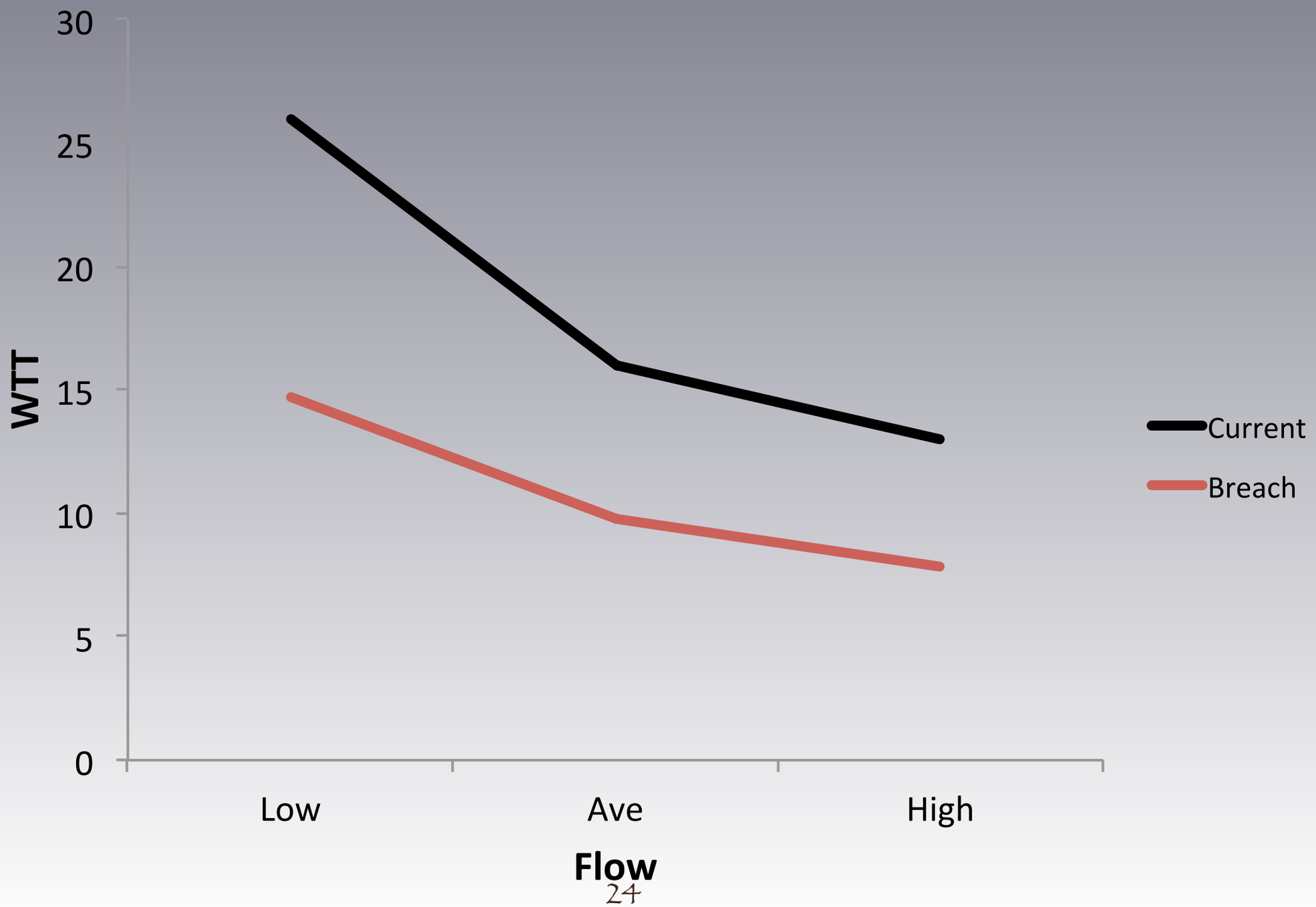
In-river survival

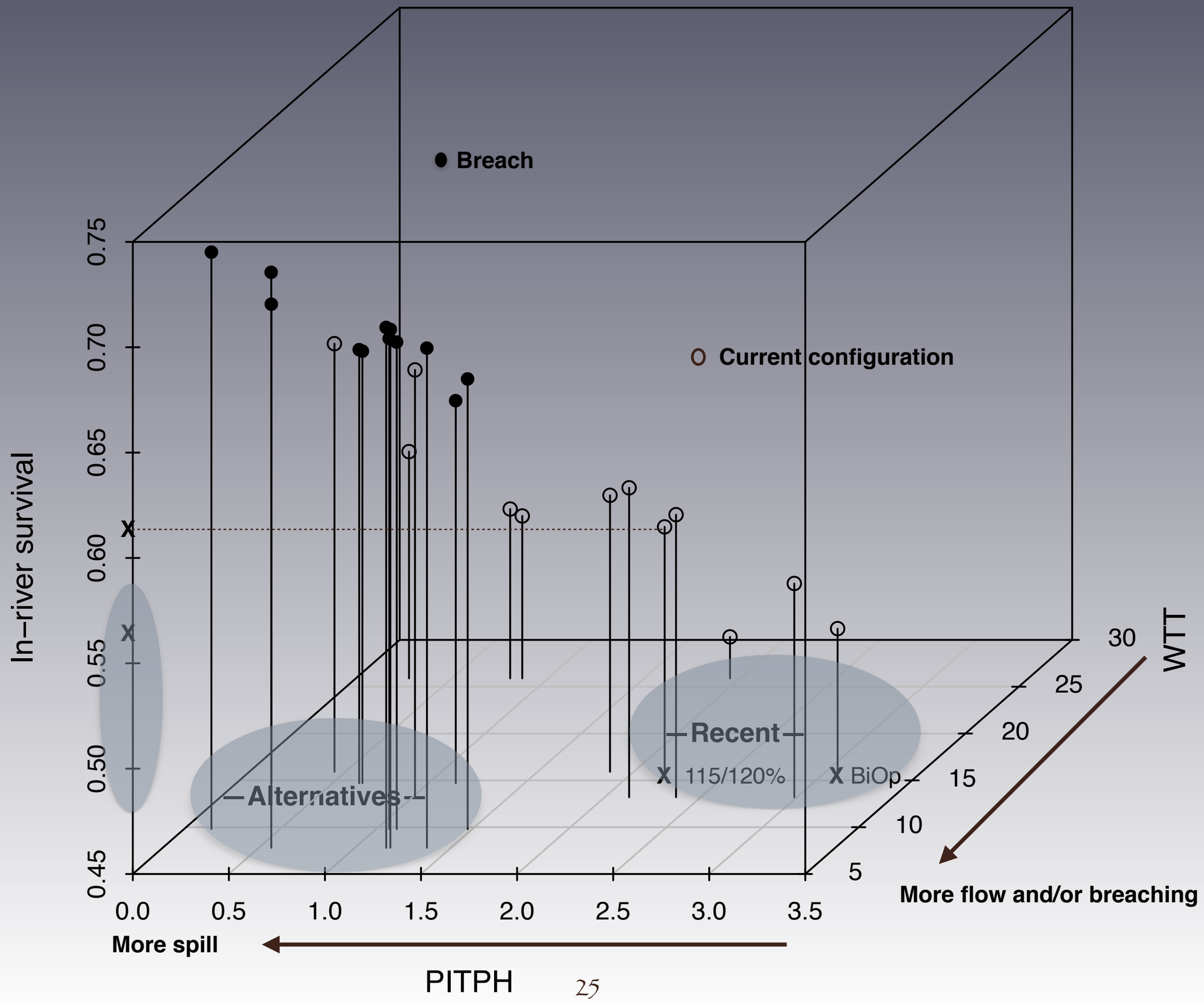


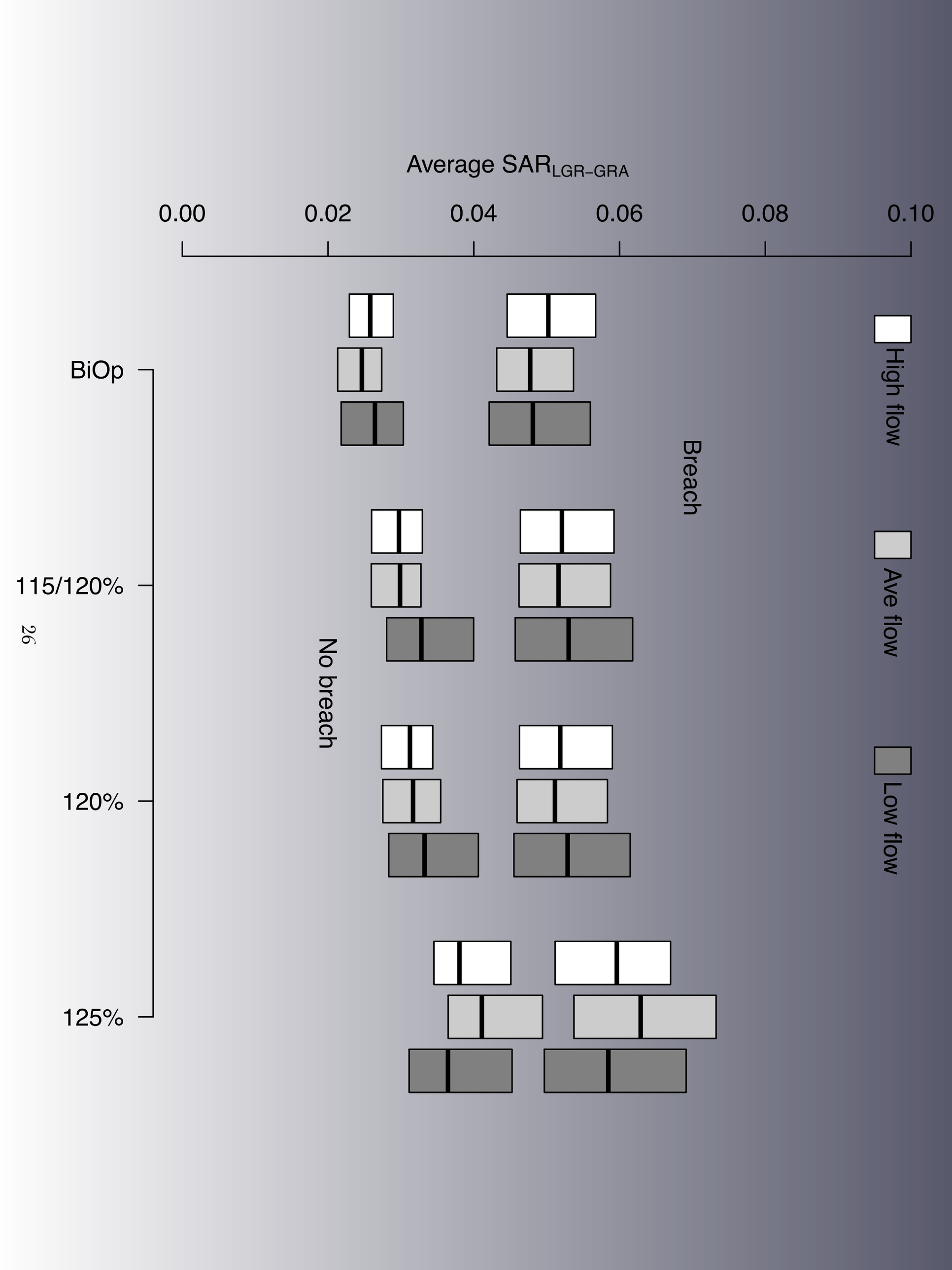
Scenarios & PITPH



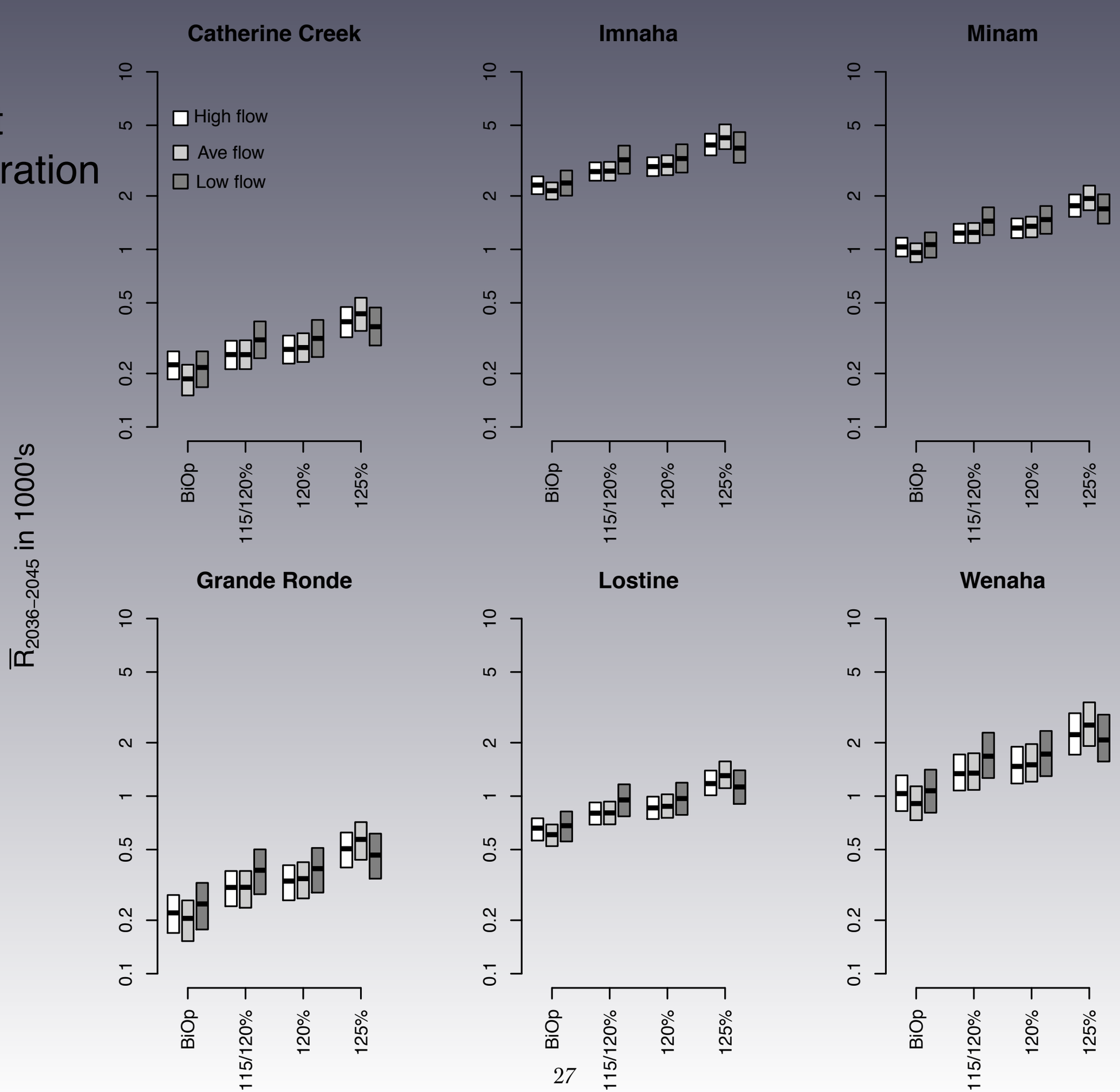
Scenarios & WTT




Breach
Current configuration
In−river survival
0.75
0.70
0.65
0.60
0.55
0.50
0.45
Alternatives
Recent
115/120%
BiOp
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
More spill
PITPH
5
10
15
20
25
30
WTT
More flow and/or breaching

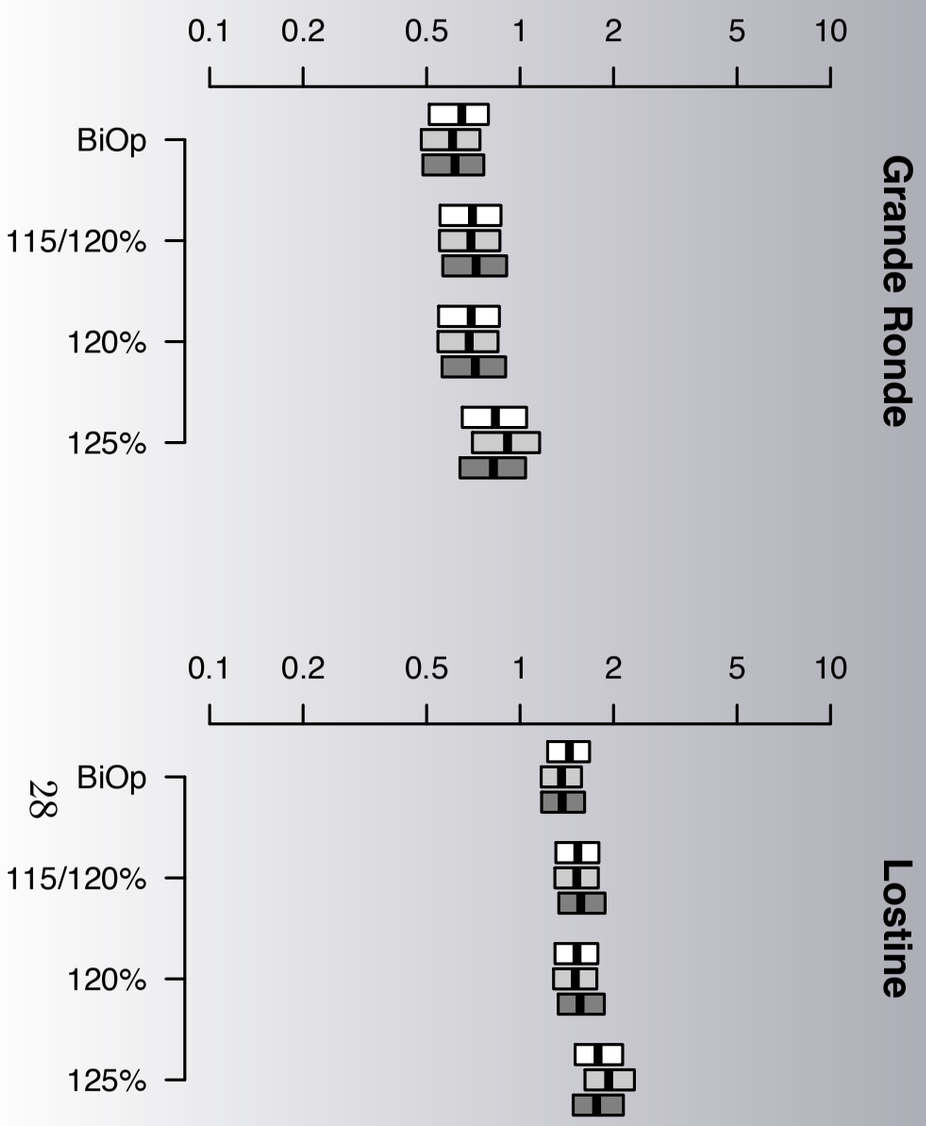

Average SAR$_{LGR-GRA}$
0.00
0.02
0.04
0.06
0.08
0.10
BiOp
115/120%
120%
125%
No breach
Breach
High flow
Ave flow
Low flow

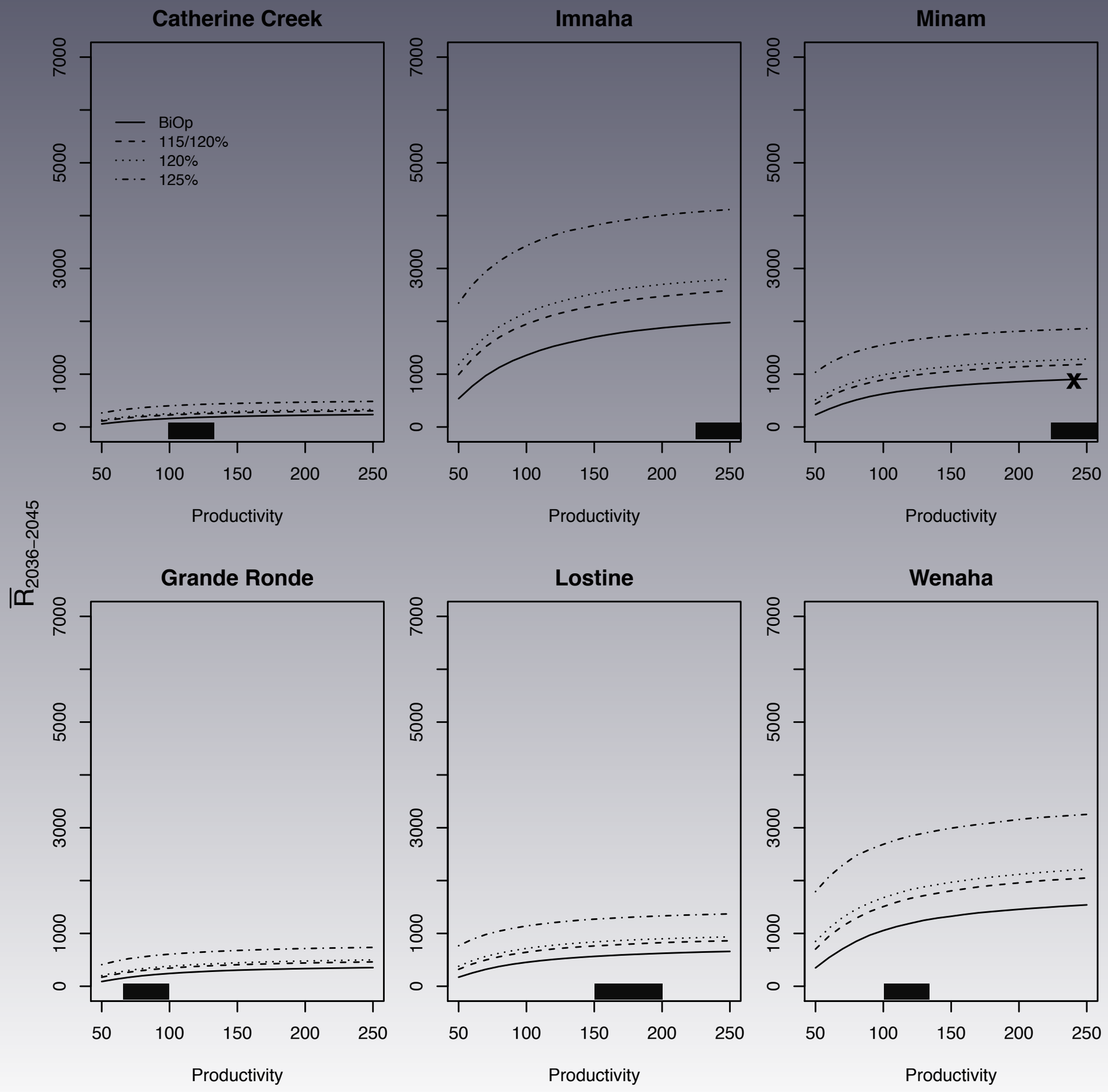
Current configuration

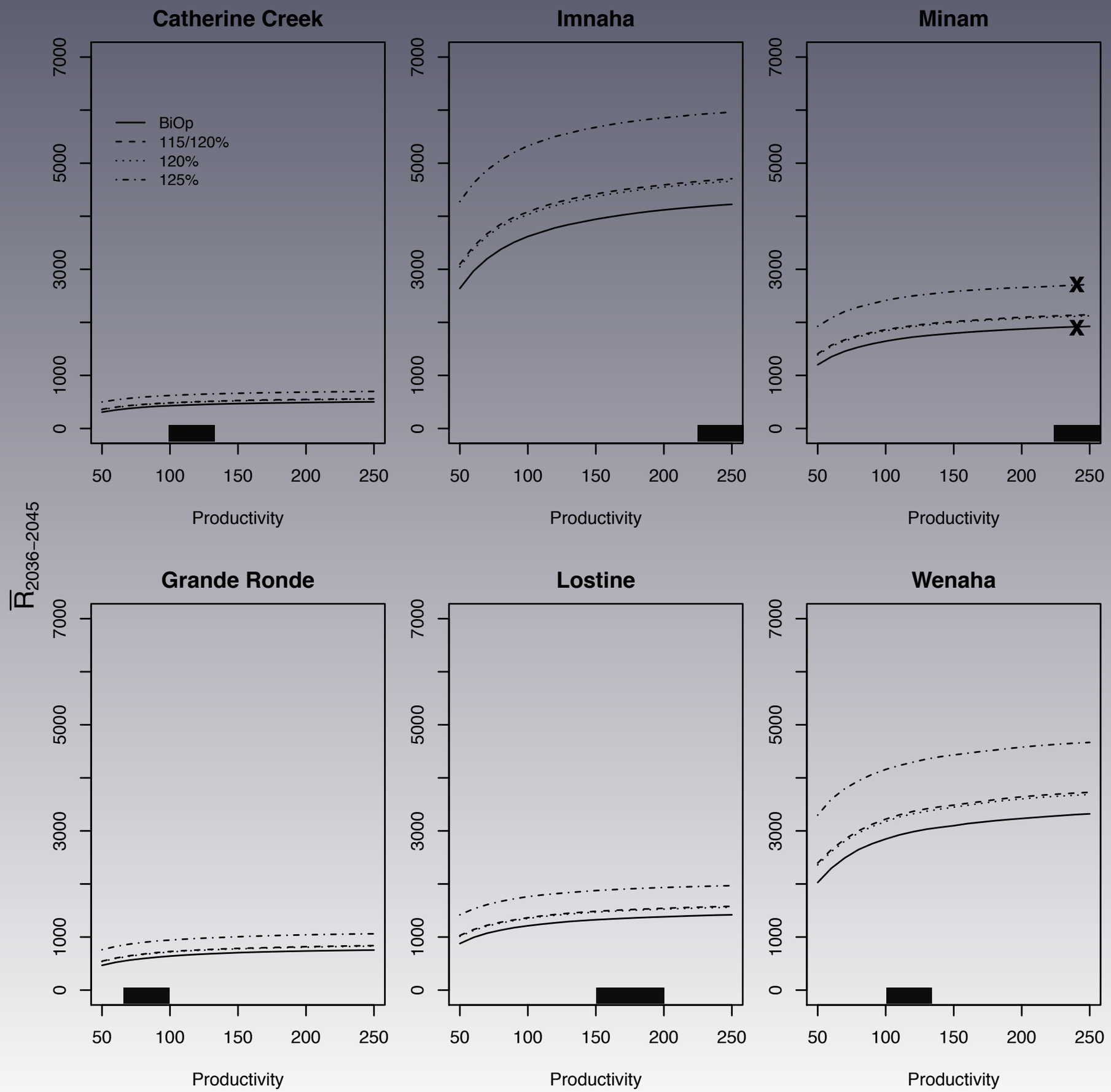


Breach

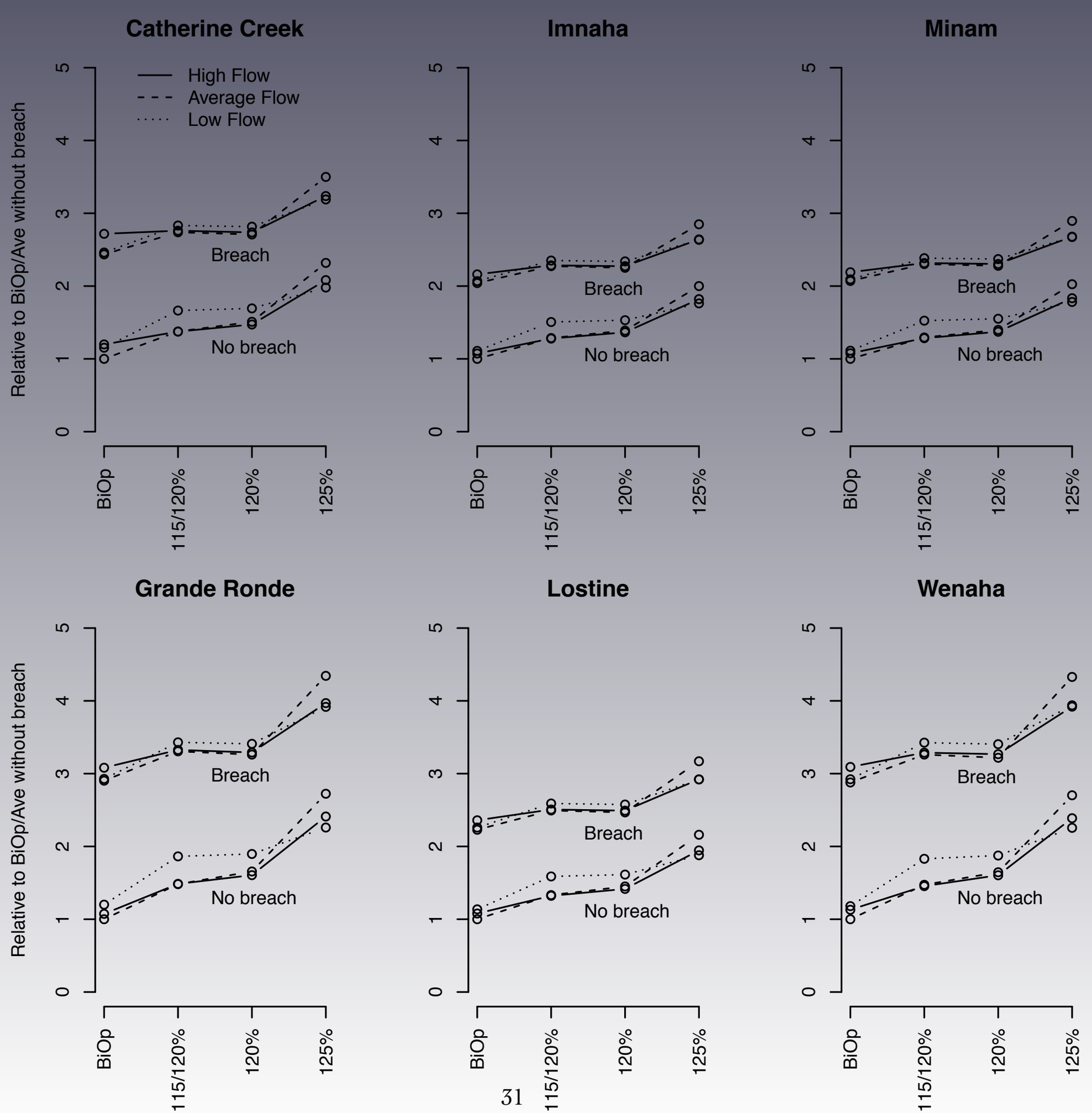
$\overline{R}_{2036-2045}$ in 1000's




Catherine Creek
Imnaha
Minam
Grande Ronde
Lostine
Wenaha
BiOp
115/120%
120%
125%
0
1000
3000
5000
7000
50
100
150
200
250
Productivity
$\overline{R}_{2036-2045}$


Catherine Creek
Imnaha
Minam
Grande Ronde
Lostine
Wenaha
BiOp
115/120%
120%
125%
0
1000
3000
5000
7000
50
100
150
200
250
Productivity
$\overline{R}_{2036-2045}$

Return abundance



Key findings

- More spill always predicts higher survival and abundance, regardless of flow.
- Breach/BiOp >= Current/125%
- Potential for 4X increase with 125% and Breach