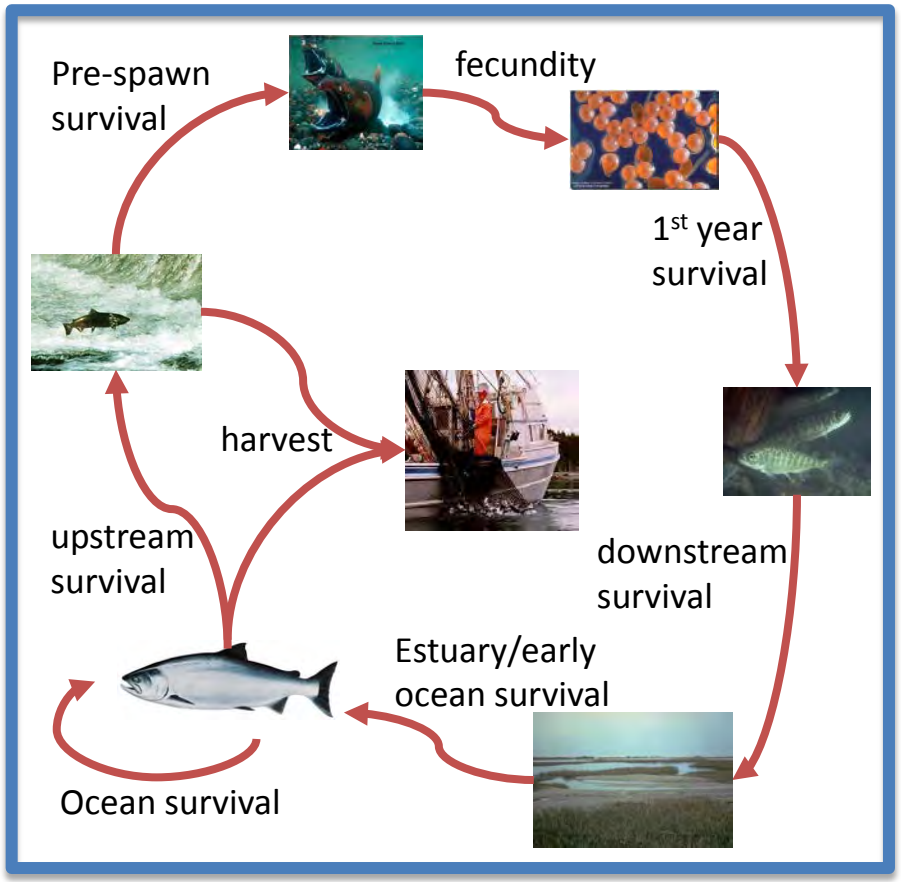
Life-Cycle Modeling of salmon populations in the Columbia River Basin



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Ryan Bellmore (USGS)
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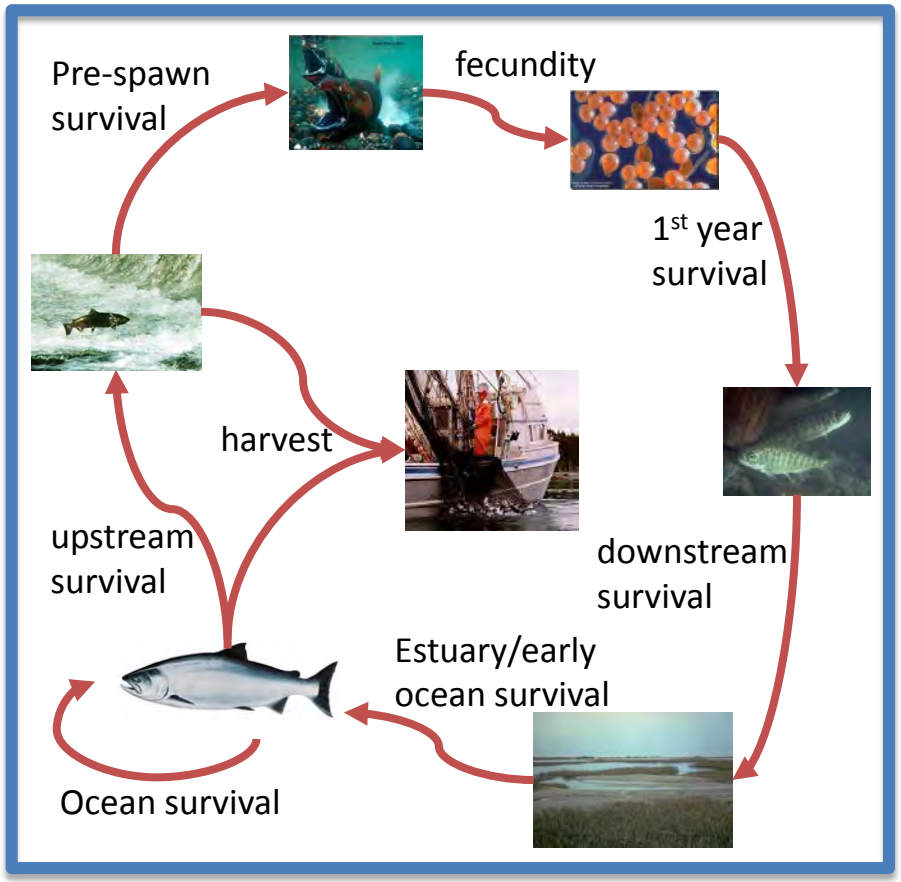
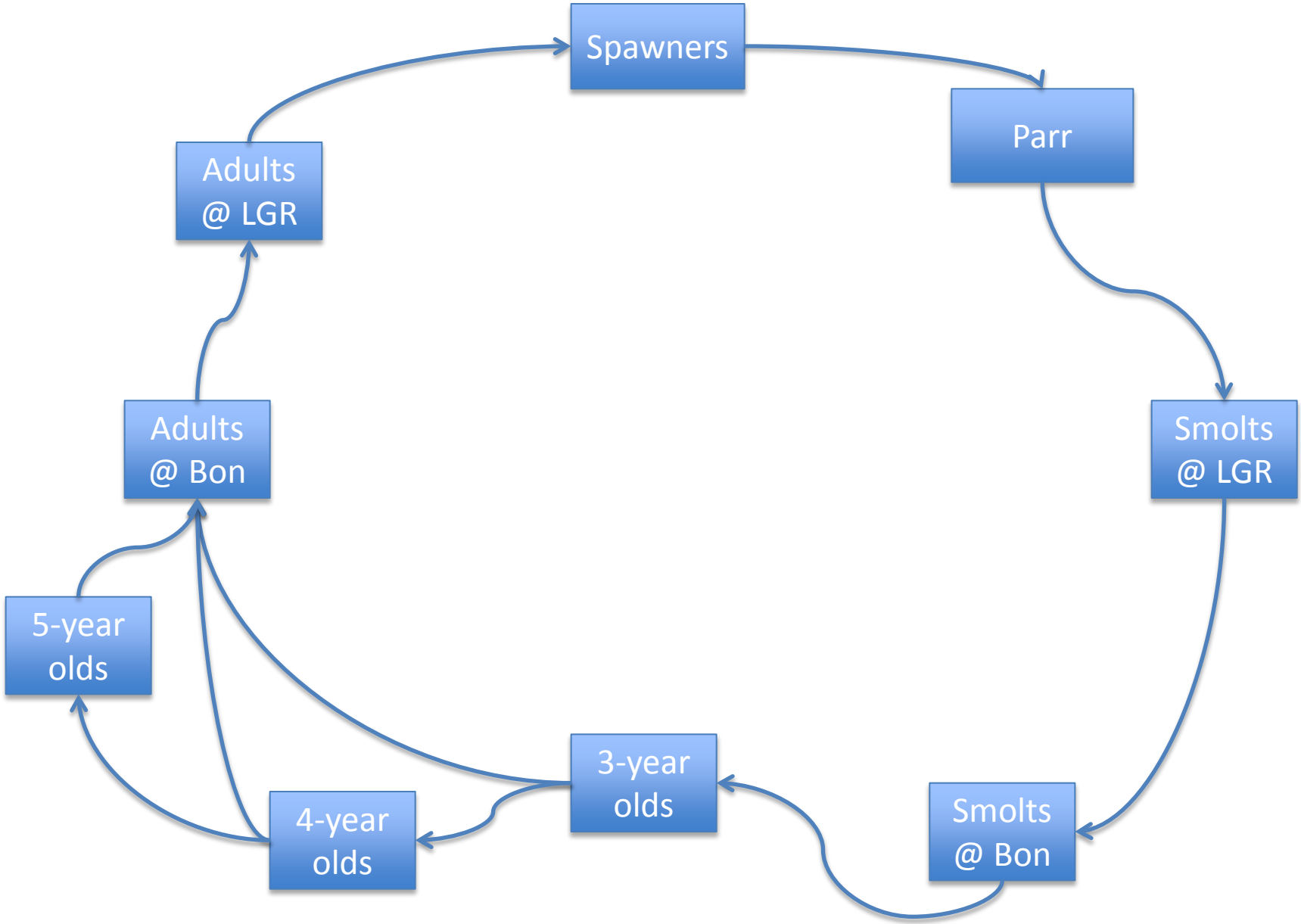
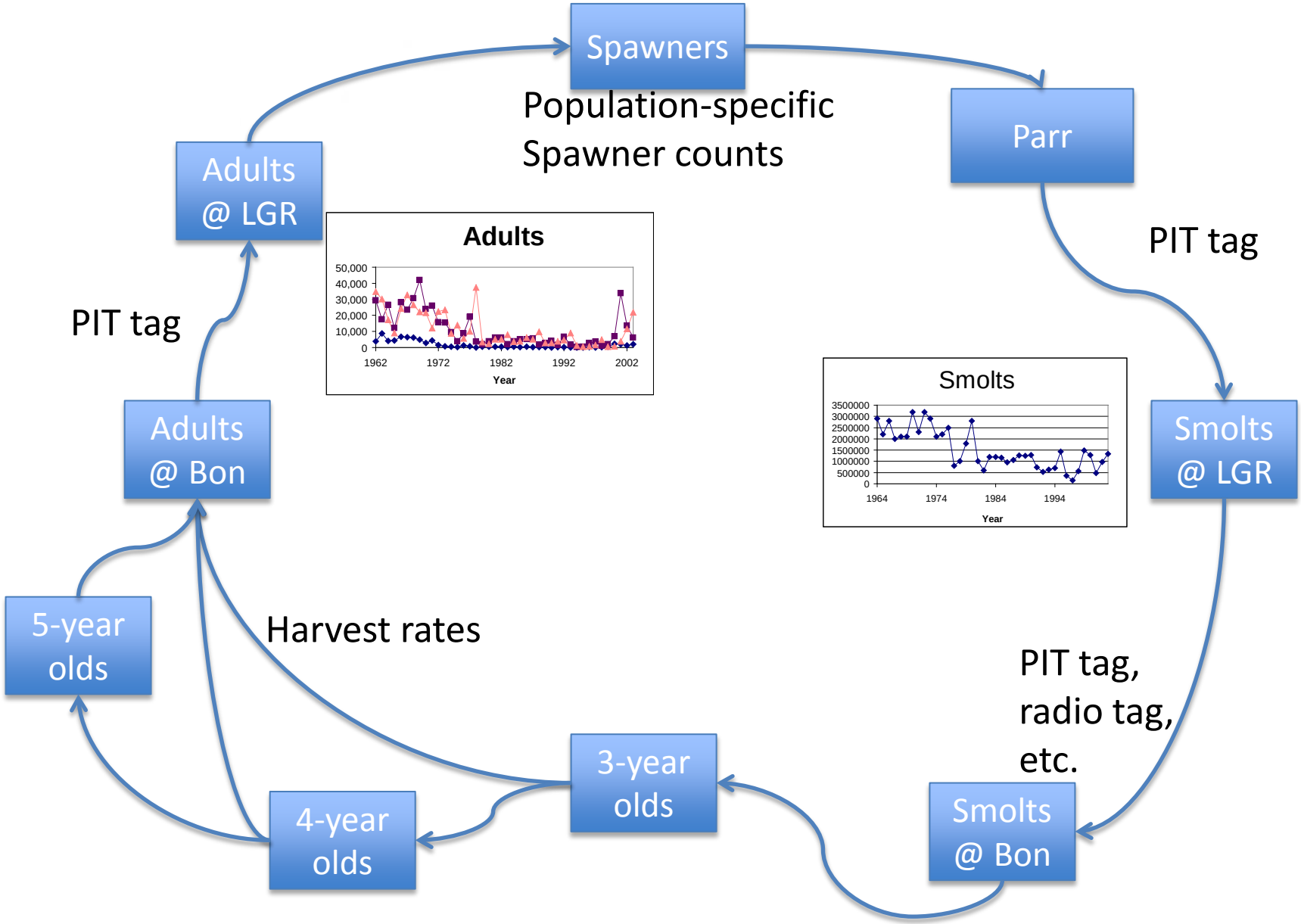
Bob Lessard (CRTFC)
Lisa Crozier (NOAA)
Rich Hinrichsen (BPA)
Chris Pinney (ACOE)

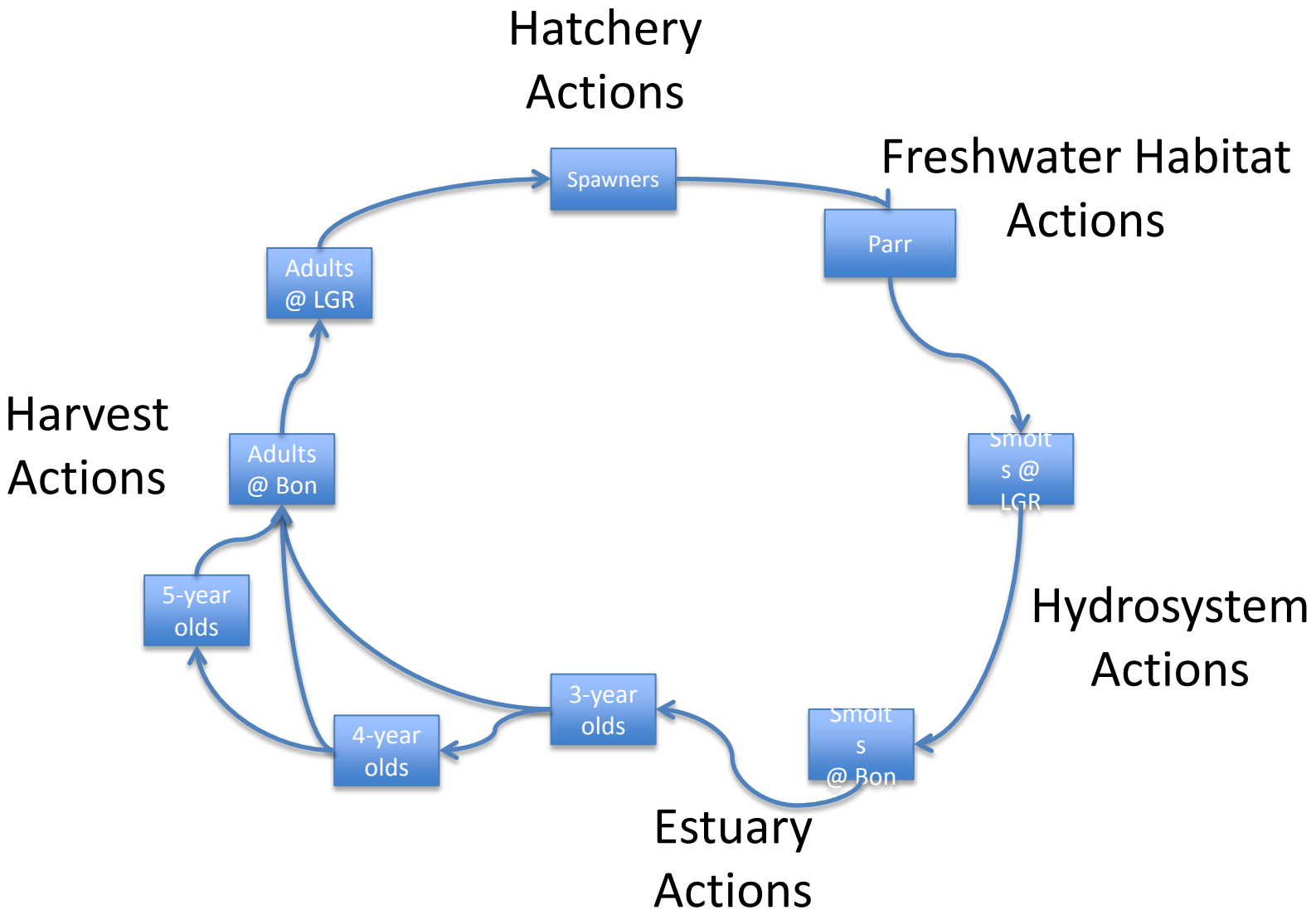
Life-Cycle Modeling of salmon populations in the Columbia River Basin

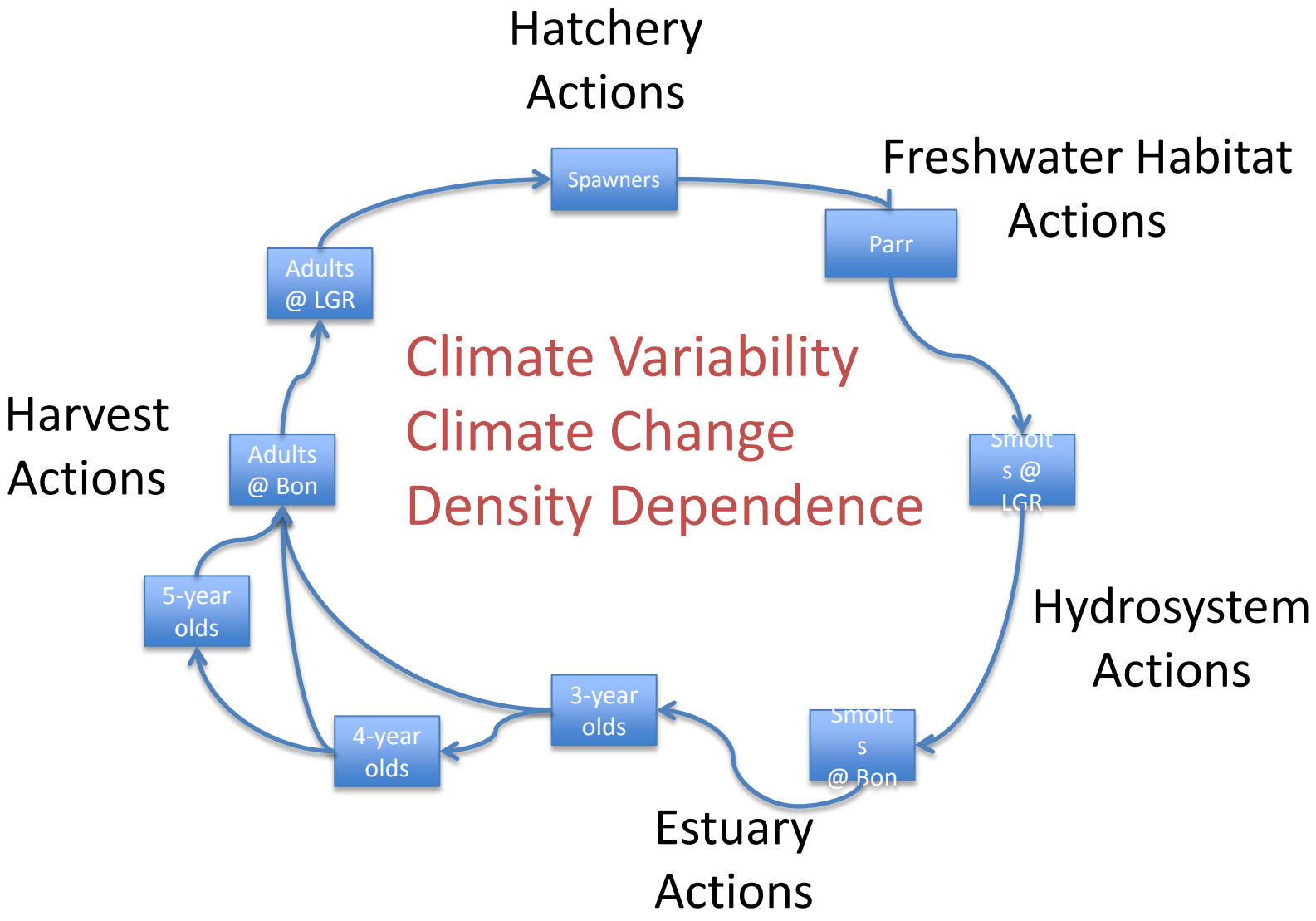


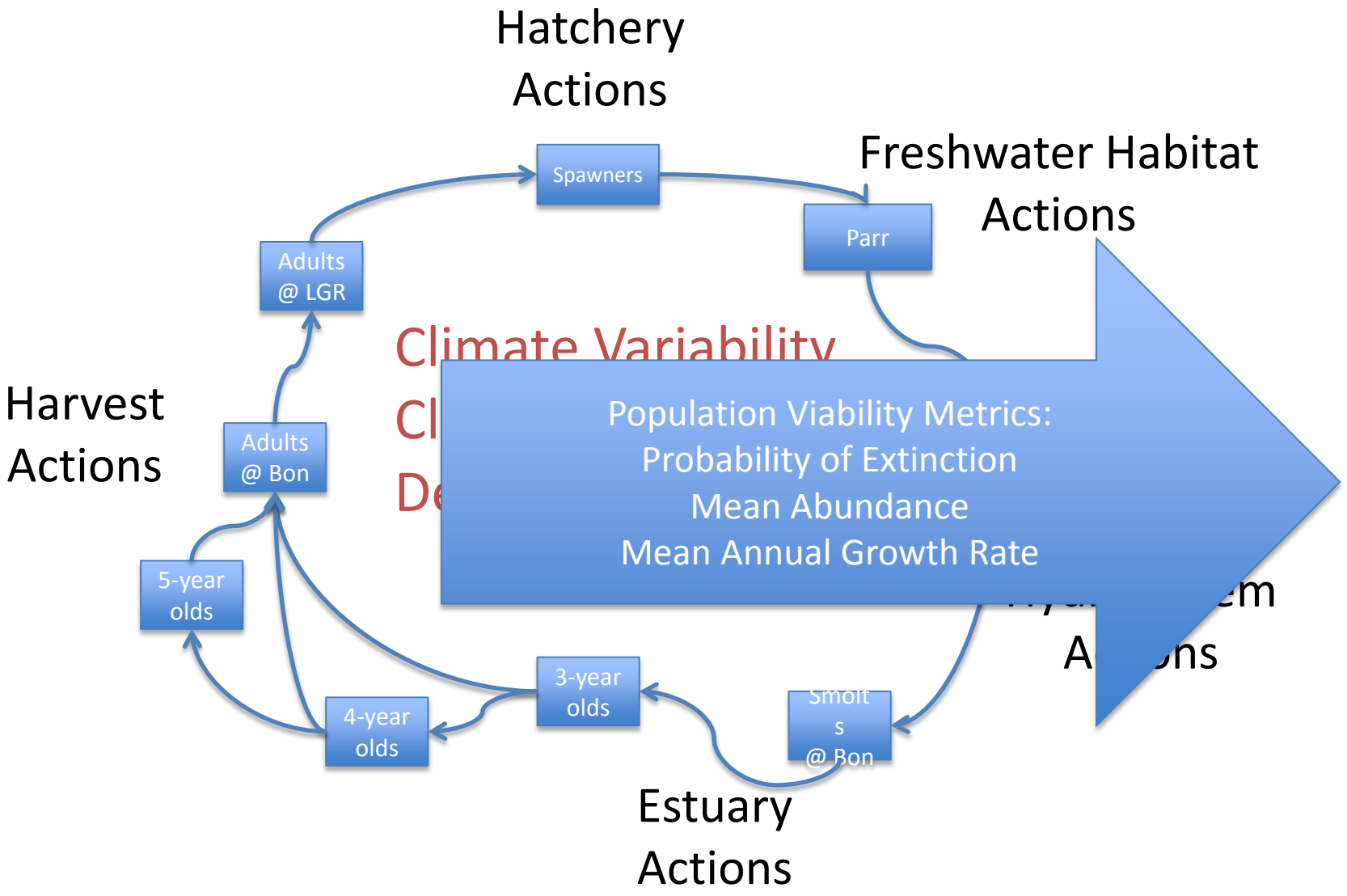
1) Overview of Modeling
2) Habitat relationships
3) Estuary Ocean
4) Hatchery effects
5) Spatial interactions

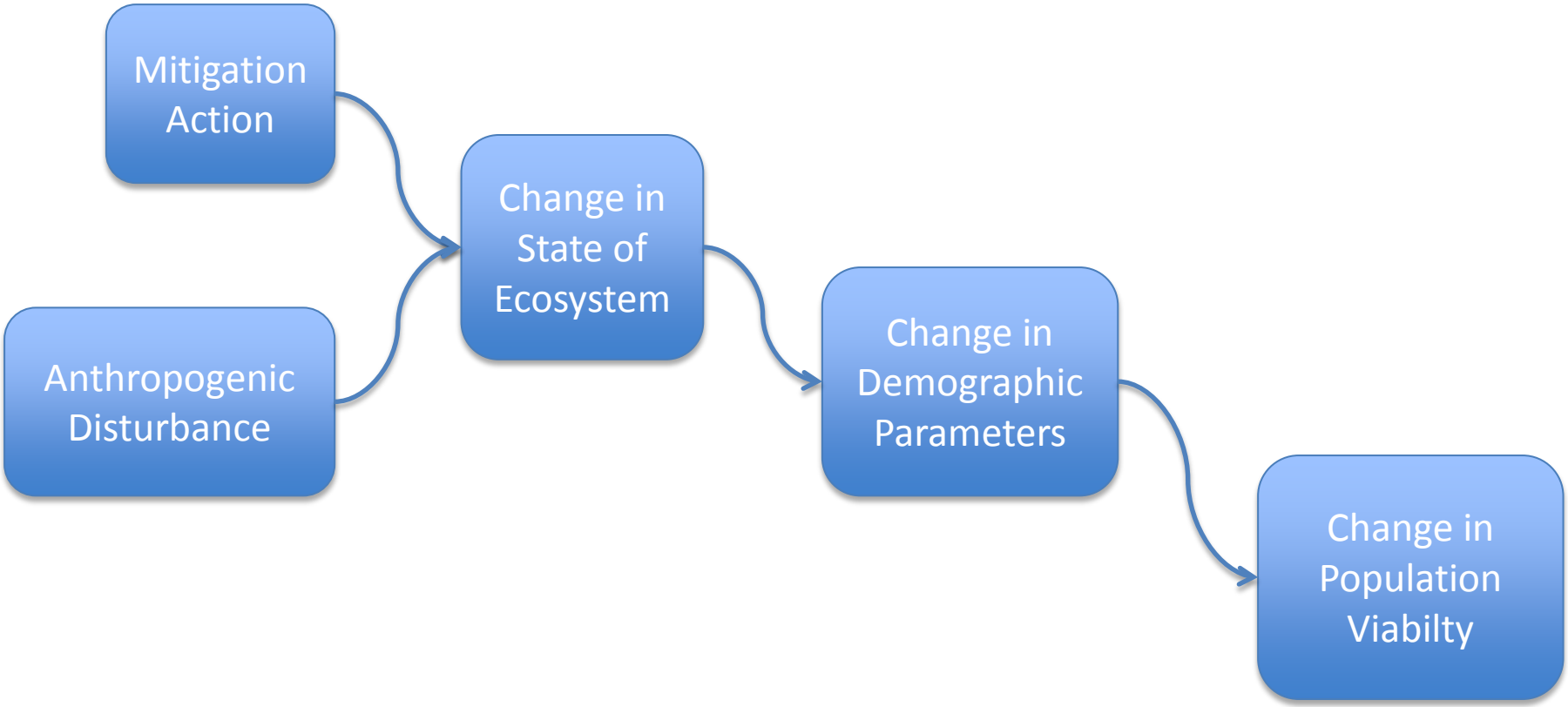

Spawners
Parr
Smolts
@ LGR
Smolts
@ Bon
3-year
olds
4-year
olds
5-year
olds
Adults
@ Bon
Adults
@ LGR

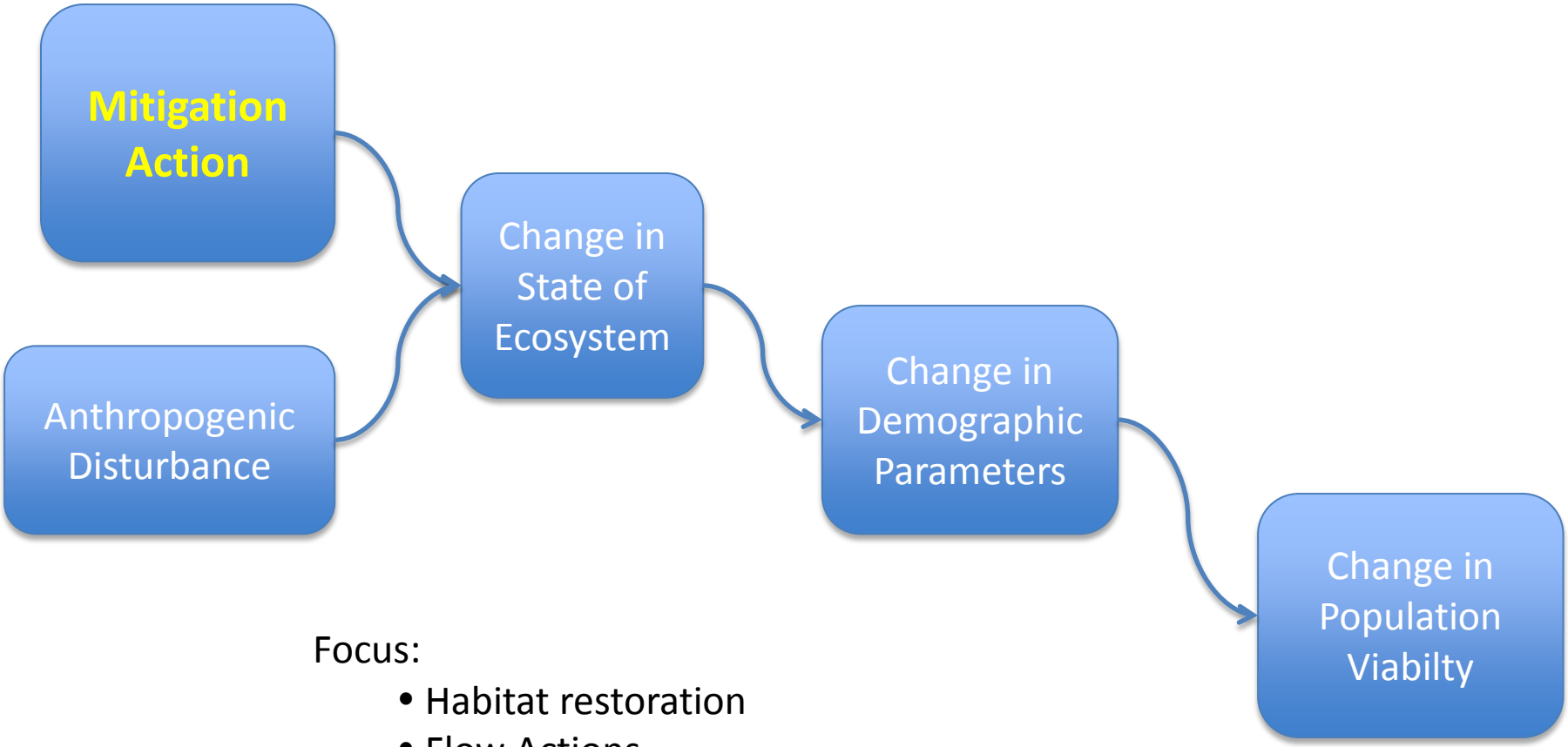

Spawners
Population-specific
Spawner counts
Parr
PIT tag
Smolts
@ LGR
Smolts
@ Bon
PIT tag,
radio tag,
etc.
3-year
olds
4-year
olds
5-year
olds
Harvest rates
Adults
@ Bon
PIT tag
Adults
@ LGR
Adults
50,000
40,000
30,000
20,000
10,000
0
1962
1972
1982
1992
2002
Year
Smolts
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
1964
1974
1984
1994
Year


Hatchery Actions
Spawners
Freshwater Habitat Actions
Parr
Adults @ LGR
Harvest Actions
Adults @ Bon
Smolts @ LGR
5-year olds
Hydrosystem Actions
3-year olds
4-year olds
Smolts @ Bon
Estuary Actions


Hatchery Actions
Spawners
Freshwater Habitat Actions
Parr
Adults @ LGR
Climate Variability
Climate Change
Density Dependence
Harvest Actions
Adults @ Bon
Smolts @ LGR
5-year olds
Hydrosystem Actions
3-year olds
4-year olds
Smolts @ Bon
Estuary Actions


Hatchery Actions
Spawners
Freshwater Habitat Actions
Parr
Adults @ LGR
Climate Variability
Harvest Actions
Adults @ Bon
Population Viability Metrics:
Probability of Extinction
Mean Abundance
Mean Annual Growth Rate
5-year olds
3-year olds
4-year olds
Smolts @ Bon
Estuary Actions


Mitigation Action
Anthropogenic Disturbance
Change in State of Ecosystem
Change in Demographic Parameters
Change in Population Viabilty

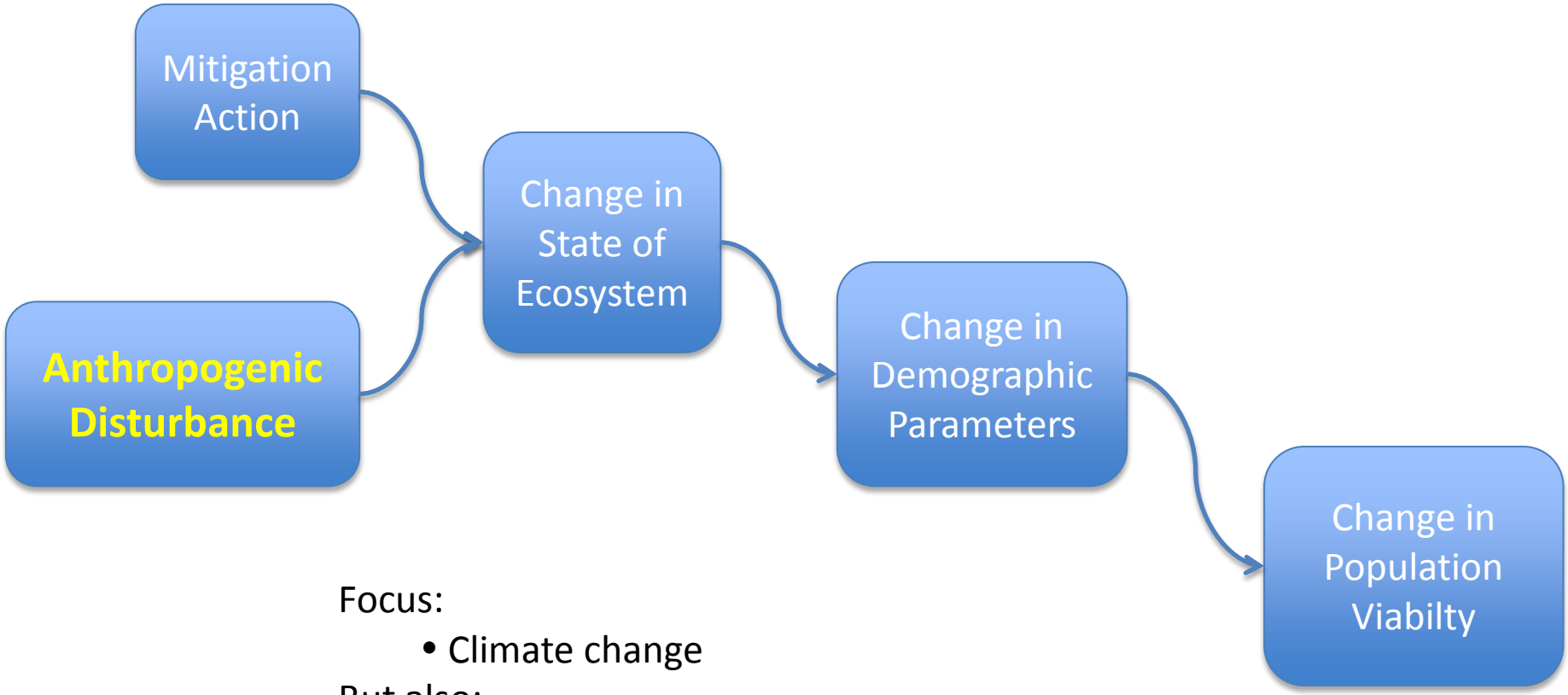


Focus:

- Habitat restoration
- Flow Actions

But also:

- Harvest reduction
- Hatchery actions
- Hydro Actions
- Estuary actions

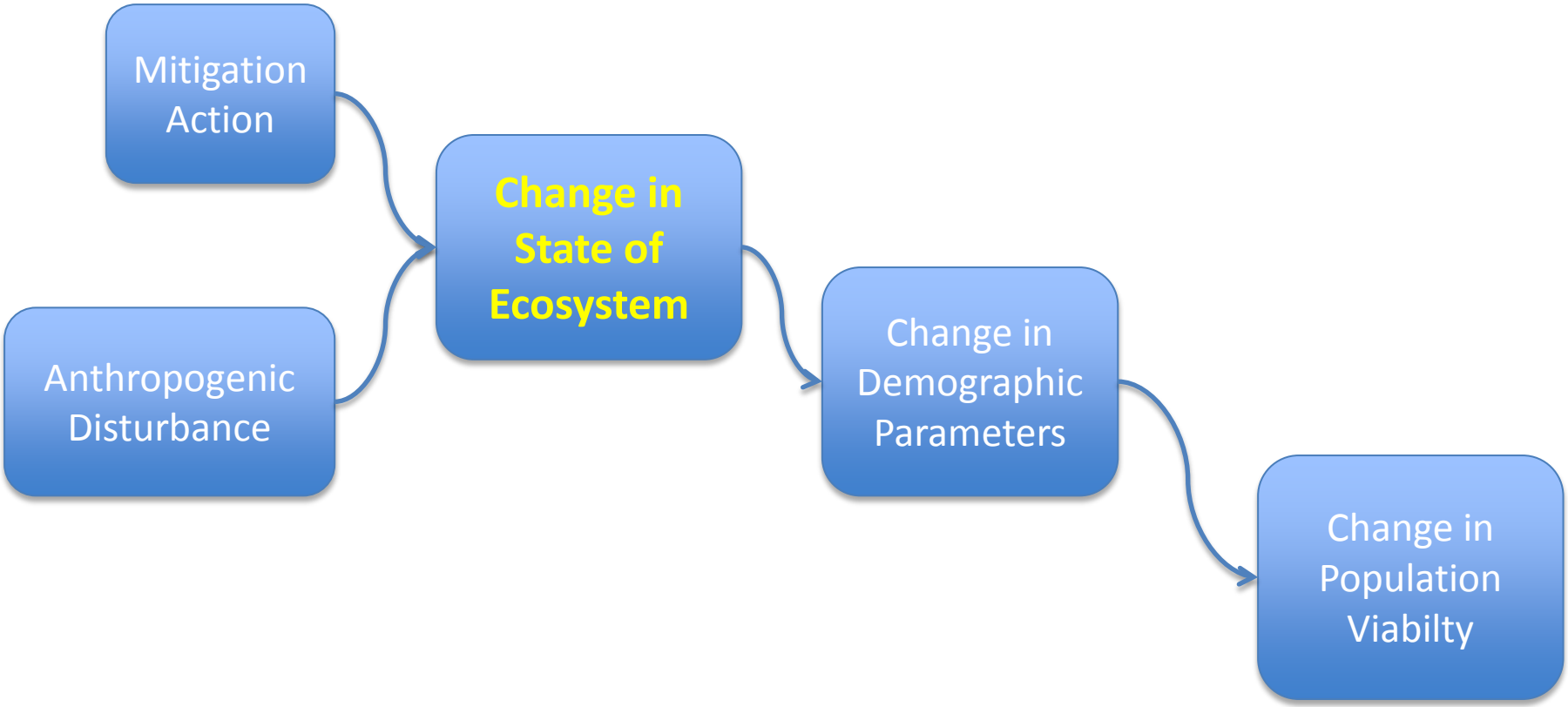


Focus:

- Climate change

But also:

- Other habitat impacts (e.g. invasive spp.)



- Changes in river flows, temperatures
- Habitat
- Nutrients, community composition?
- pollutants?

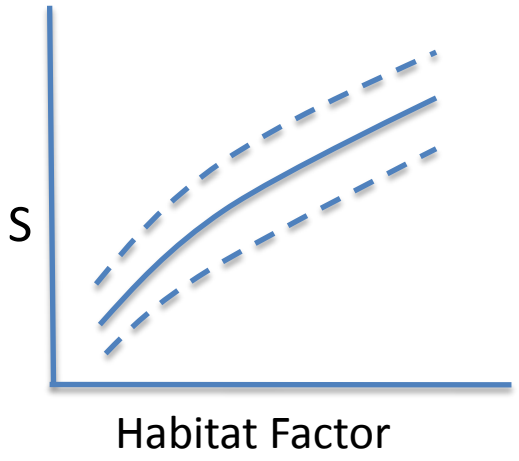
Mitigation Action

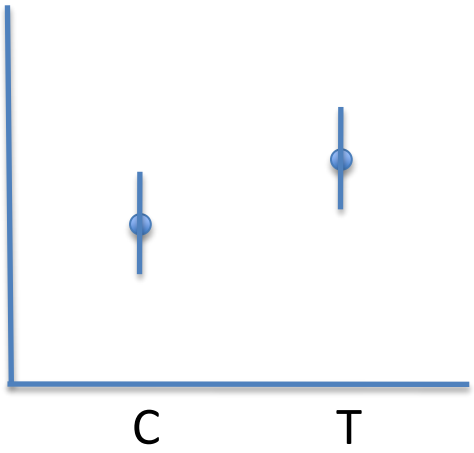
Anthropogenic Disturbance

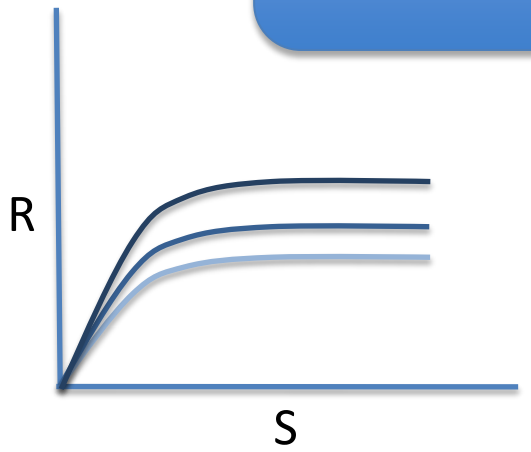
Change in State of Ecosystem

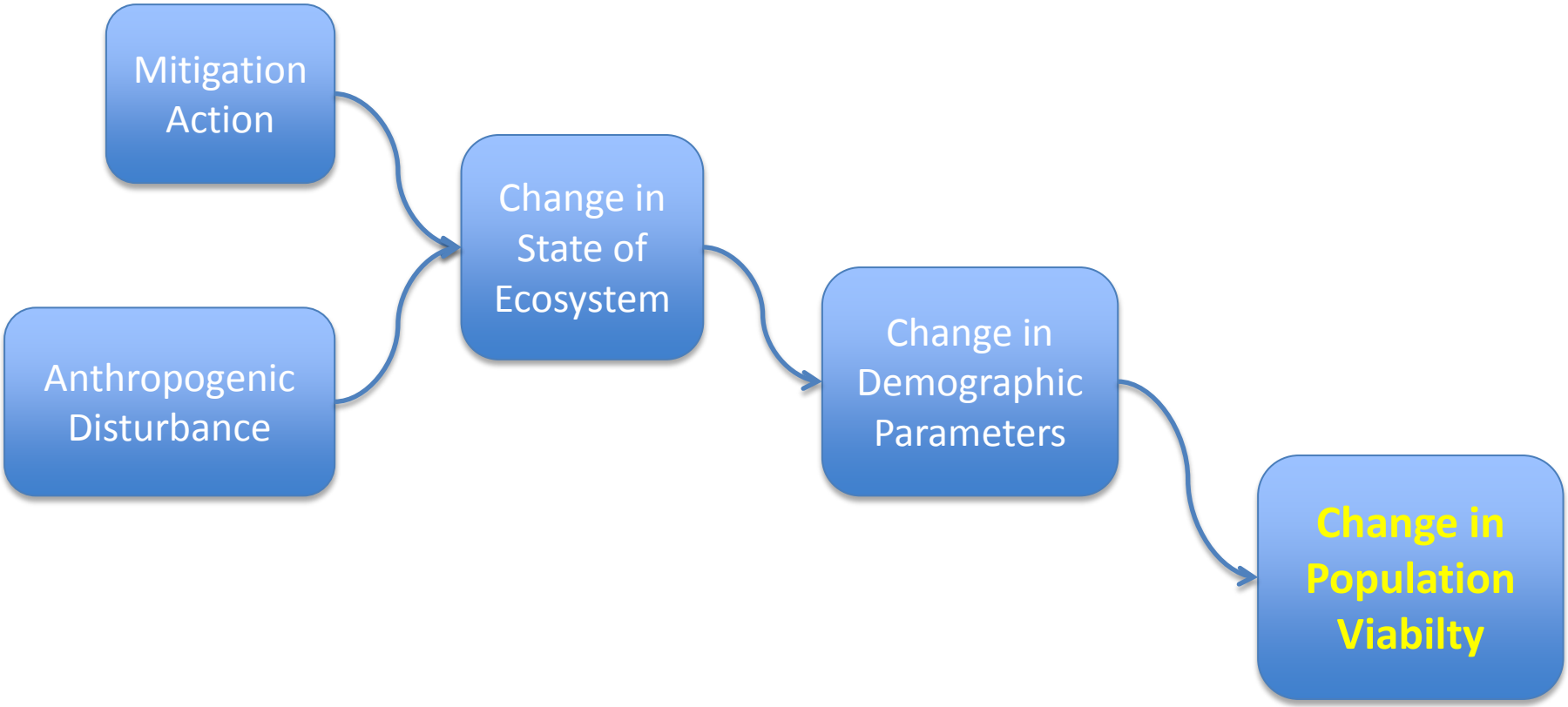
Change in Demographic Parameters

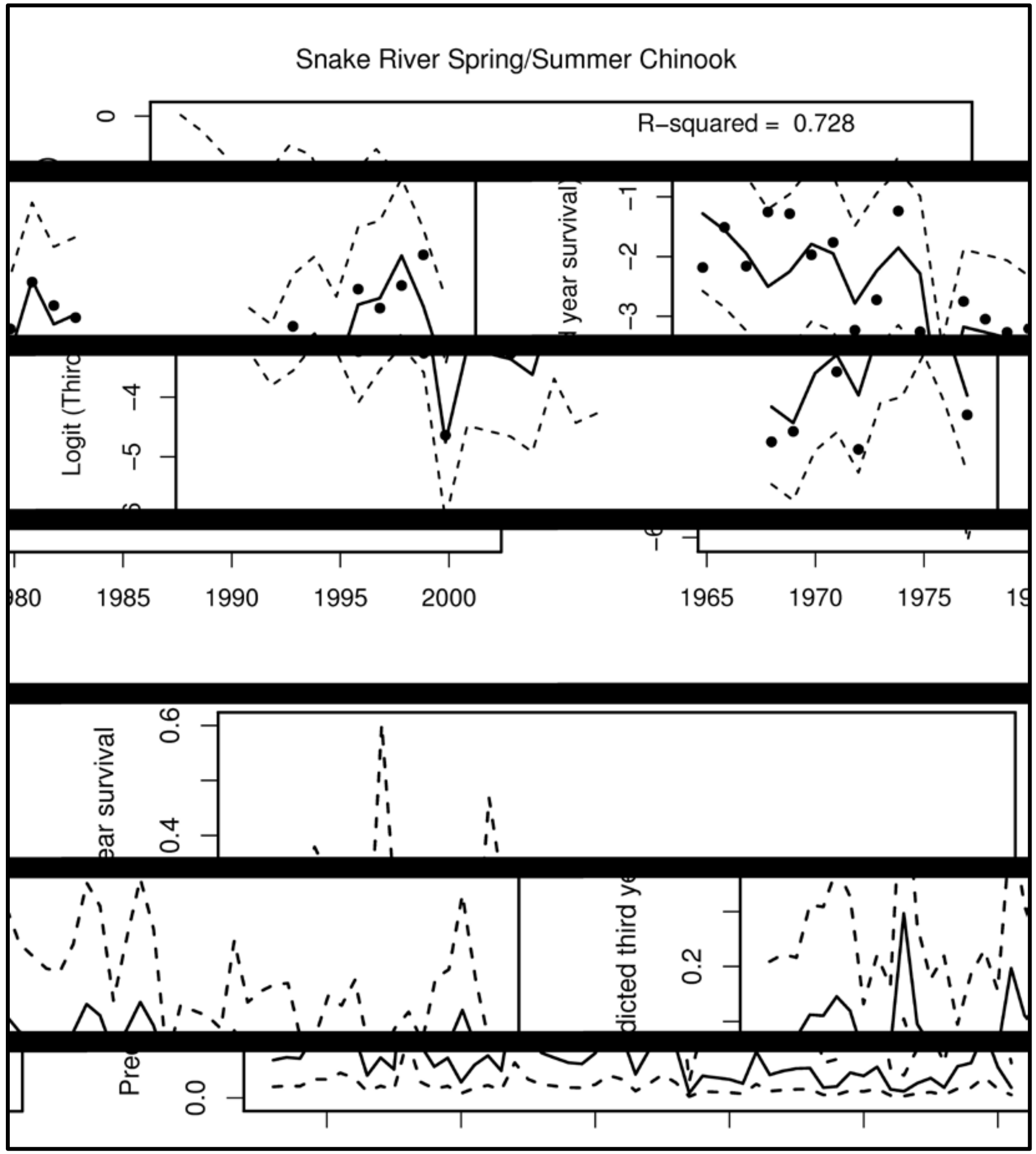
Change in Population Viabilty



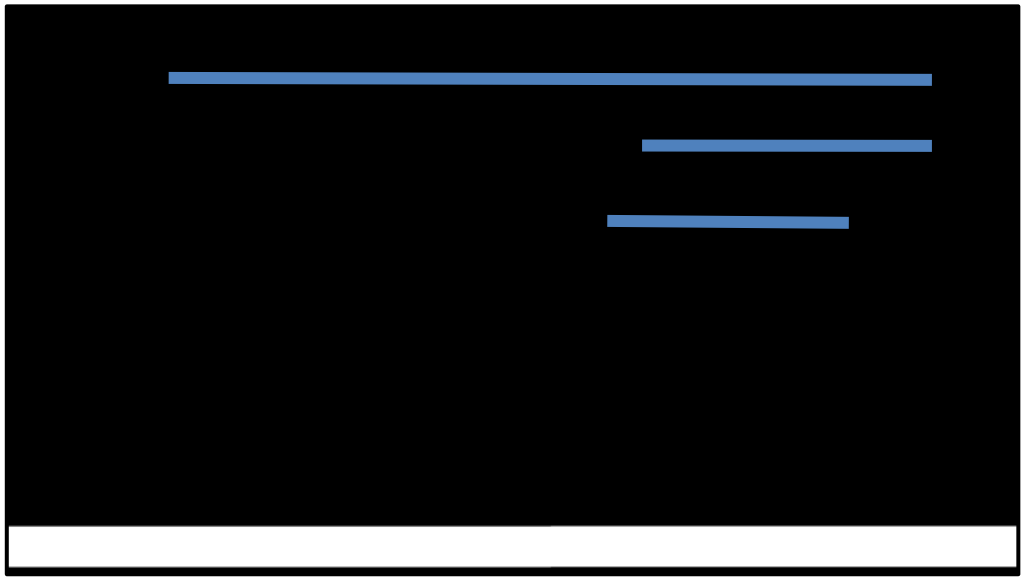





Mitigation Action
Anthropogenic Disturbance
Change in State of Ecosystem
Change in Demographic Parameters
Change in Population Viabilty


Snake River Spring/Summer Chinook
R−squared = 0.728
Logit (Third
year survival)
1980
1985
1990
1995
2000
1965
1970
1975
year survival
dicted third ye
Pre
0.6
0.4
0.2
0.0

Future Climate Scenarios



"Historic"

"Recent"

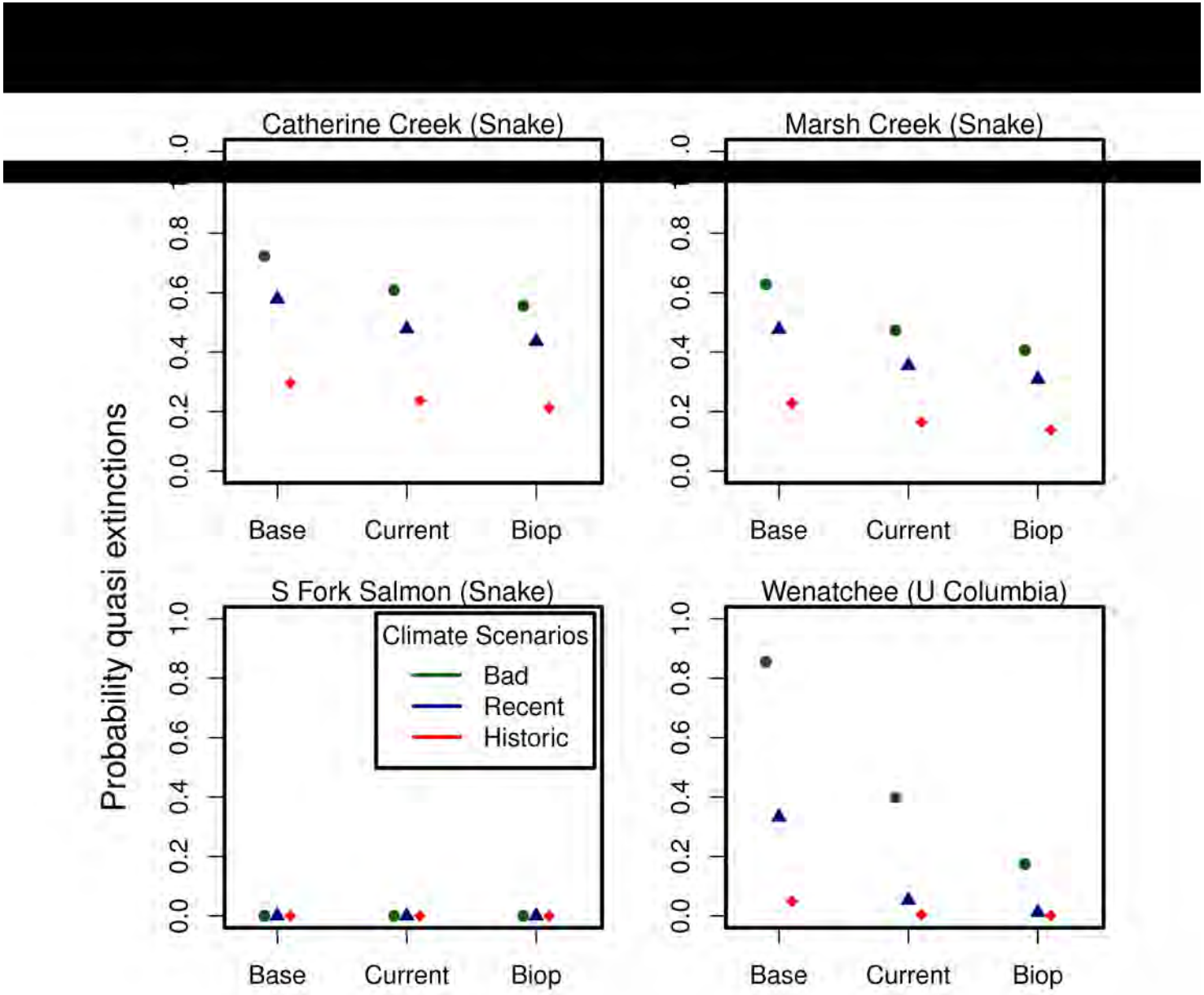
"Bad"

Hydro Scenarios

"Base"

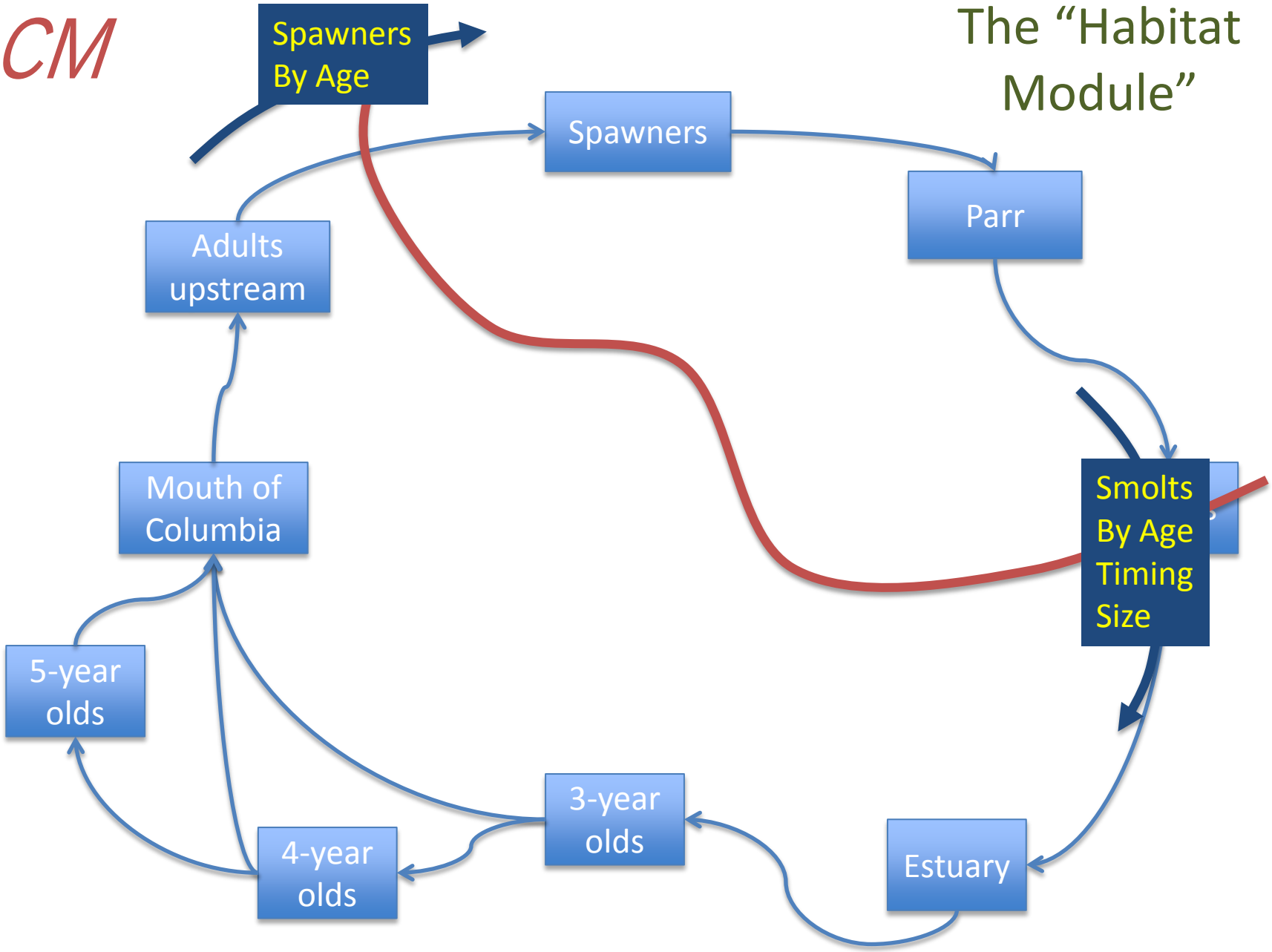
"Current"

"Biop"


Catherine Creek (Snake)
Marsh Creek (Snake)
S Fork Salmon (Snake)
Wenatchee (U Columbia)
Probability quasi extinctions
0.0
0.2
0.4
0.6
0.8
1.0
Base
Current
Biop
Climate Scenarios
Bad
Recent
Historic

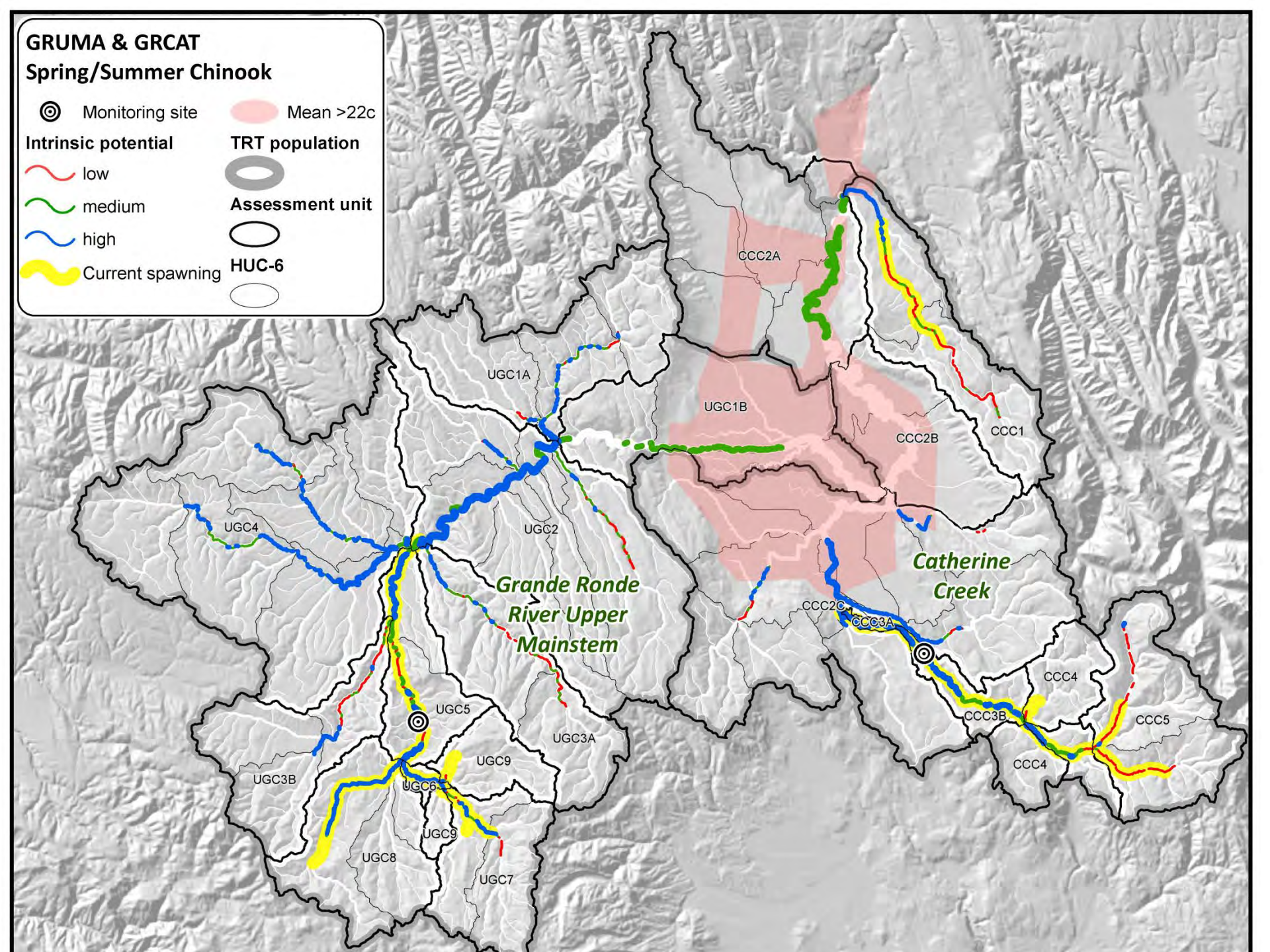
xLCM

The "Habitat Module"



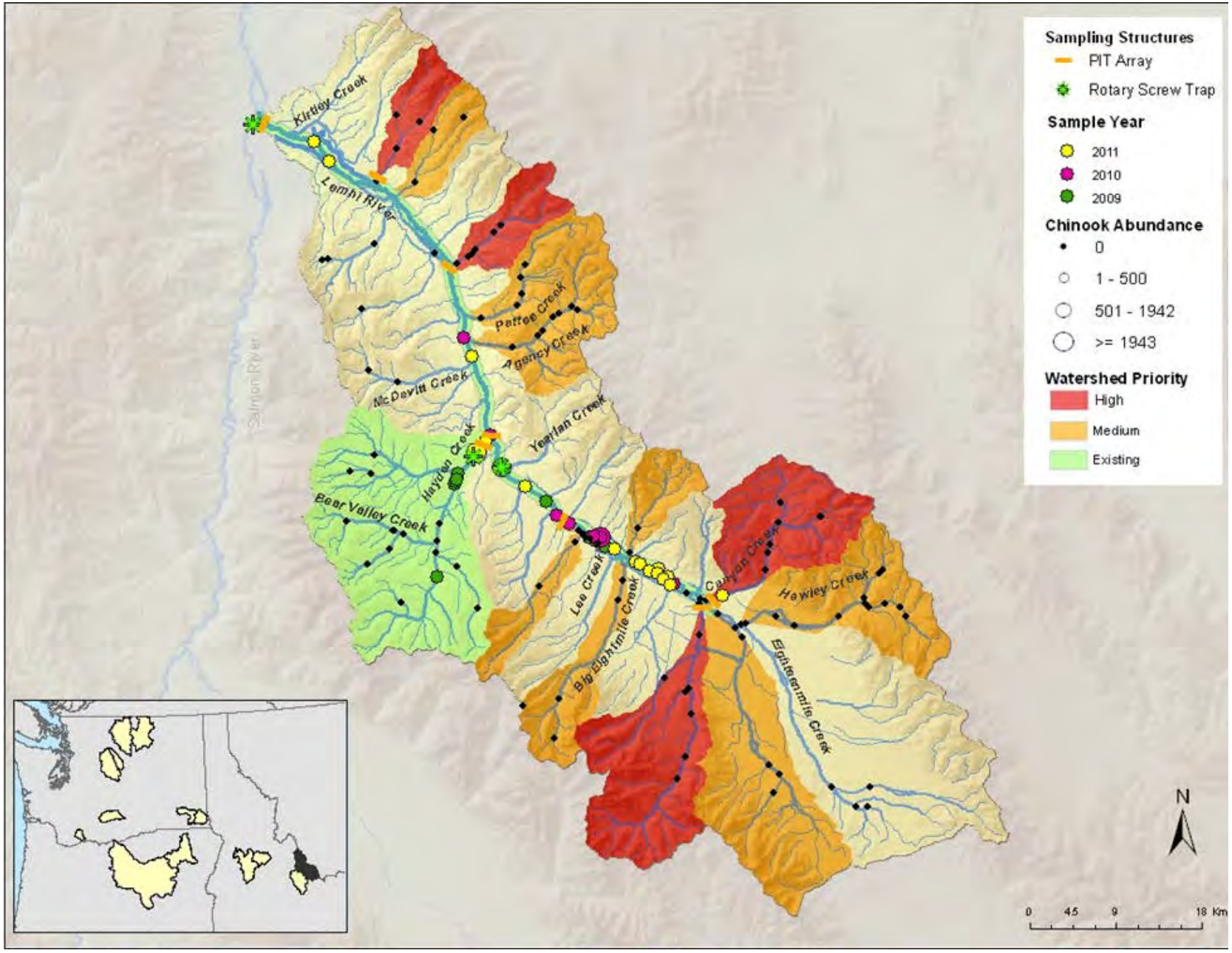
2.2 Grande Ronde/Catherine Creek/Minam/Lostine sp/su Chinook (Carmichael, Cooney, CRITIFC)

Topics: Flow and habitat restoration effects on life stage survival/capacity, hatchery supplementation program.


GRUMA & GRCAT
Spring/Summer Chinook
Monitoring site
Mean >22c
Intrinsic potential
TRT population
low
medium
high
Current spawning
Assessment unit
HUC-6
CCC2A
UGC1A
UGC1B
CCC2B
CCC1
UGC4
UGC2
Grande Ronde
River Upper
Mainstem
Catherine
Creek
CCC2C
CCC3A
CCC4
CCC3B
CCC5
CCC4
UGC5
UGC3A
UGC9
UGC3B
UGC6
UGC9
UGC8
UGC7

2.3 Lemhi sp/su Chinook (Beasley/Jordan)

Stream connections and life stage survival/rearing capacity. ISEMP Production model.


Sampling Structures
PIT Array
Rotary Screw Trap
Sample Year
2011
2010
2009
Chinook Abundance
0
1 - 500
501 - 1942
>= 1943
Watershed Priority
High
Medium
Existing
Kirtley Creek
Lemhi River
Salmon River
Pettee Creek
Agency Creek
McDevitt Creek
Hayden Creek
Yearian Creek
Bear Valley Creek
Lee Creek
Big Eightmile Creek
Cabin Creek
Hawley Creek
Eightmile Creek
N
0
4.5
9
18 Km

2.4 Wenatchee/Entiat sp Chinook (Jorgensen, Jordan, WDFW)

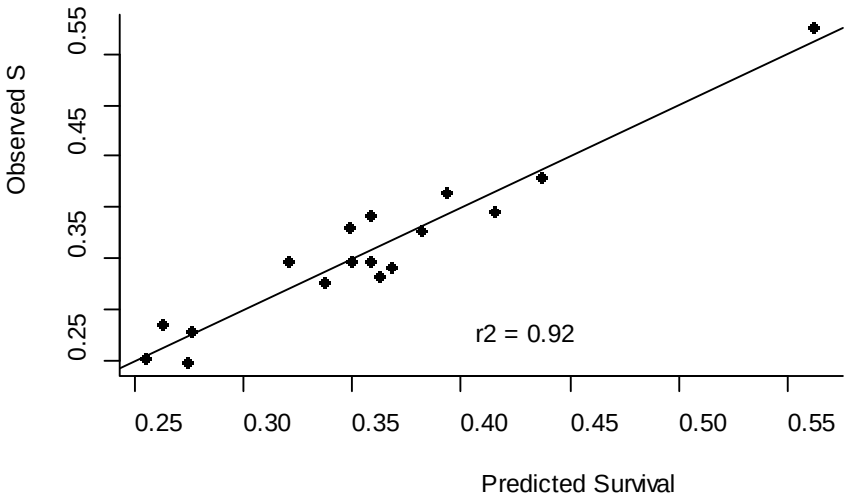
Build on previous matrix model and Shiraz efforts, address stream structure.

2.5 Salmon River Basin sp/su Chinook (Crozier et al.)

Freshwater climate and climate change. Density dependence

Updated analyses of parr to smolt survival: Environmental effects are important

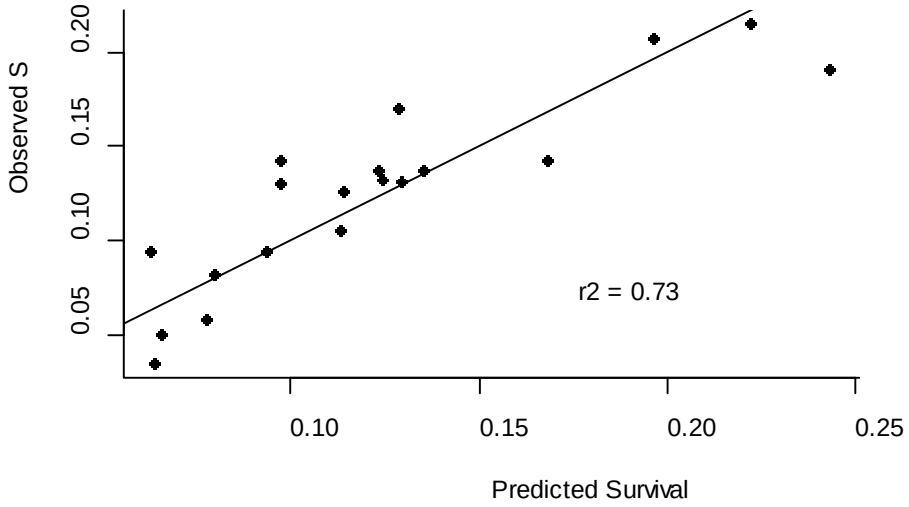
Survival~Flow+Fish Length



Marsh, Cape Horn, Bear Valley, Elk, Camas

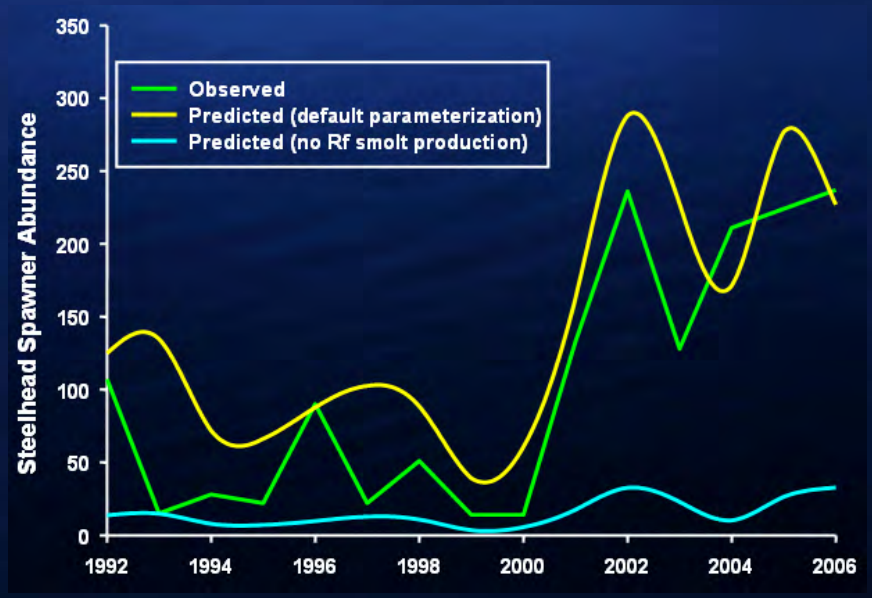
Lake, Secesh River, South Fork, Valley Creek

Survival~Flow+Fish Length



2.7 Yakima River steelhead (Courter, Fredrickson, Kendall, Cooney)
Flow management/tributary reconnects/habitat restoration, modeling anadromous/resident interactions in mainstem and tributary reaches

Integration of Two Model Frameworks

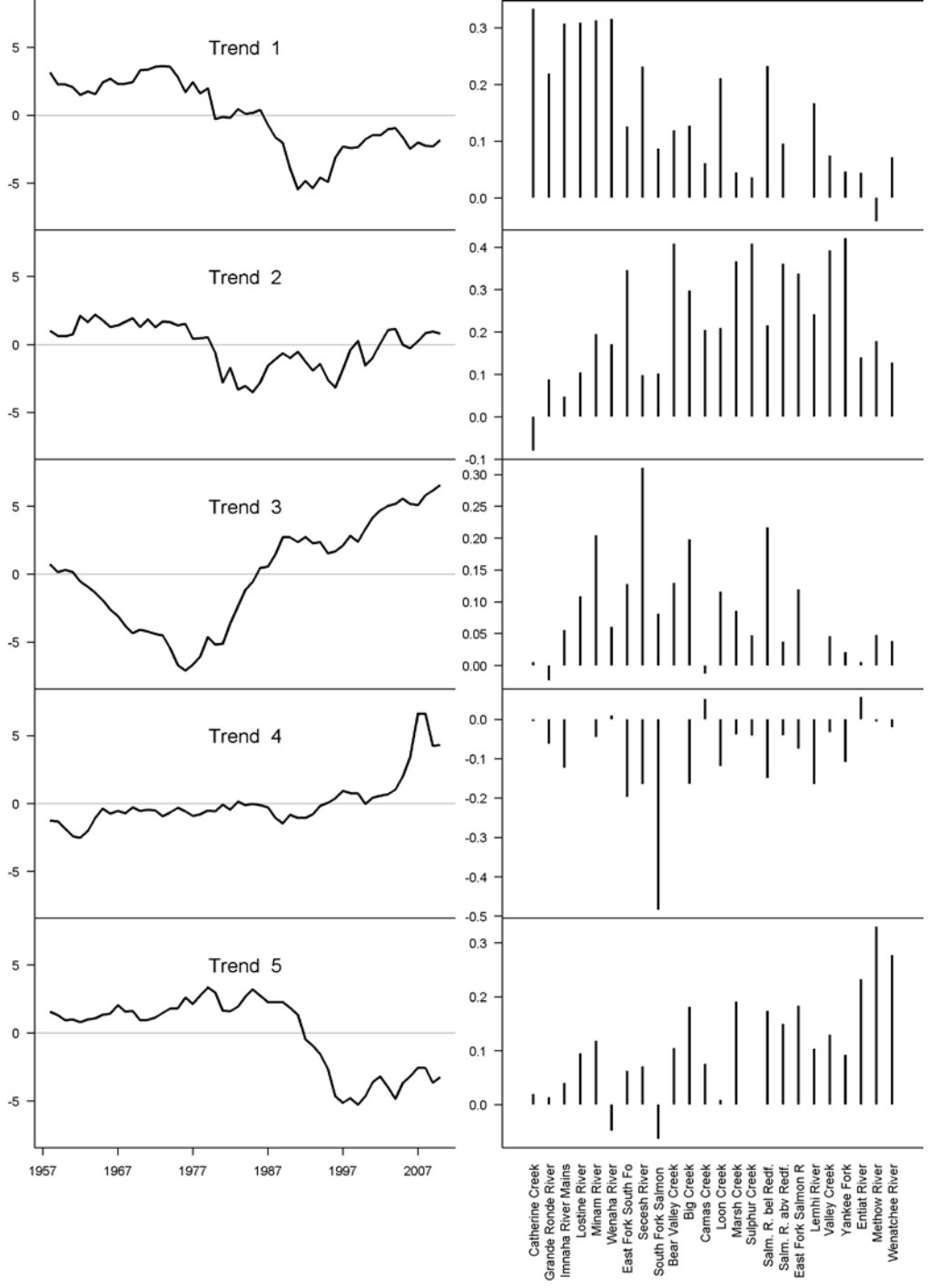


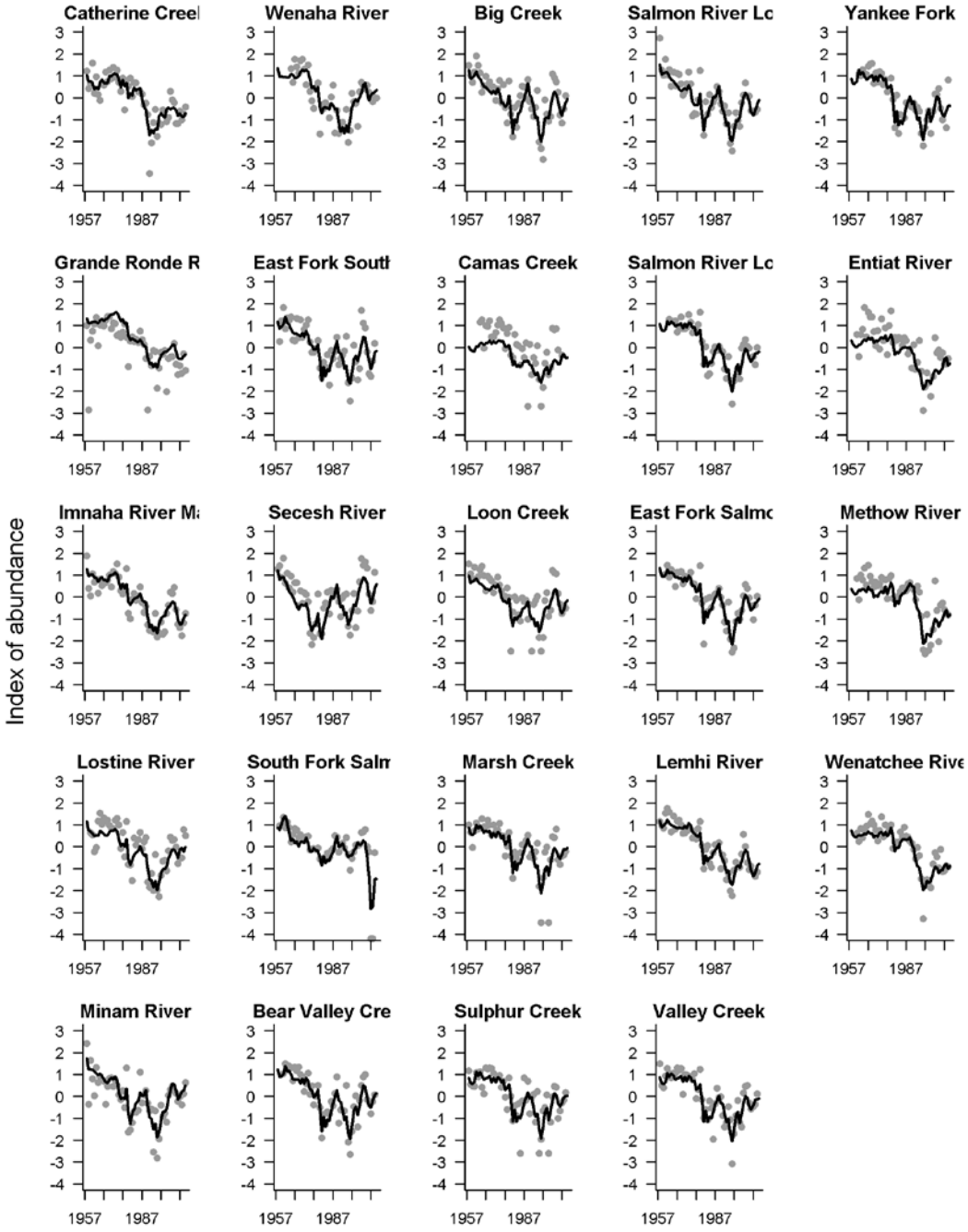
Effects of Water Management on Population Viability

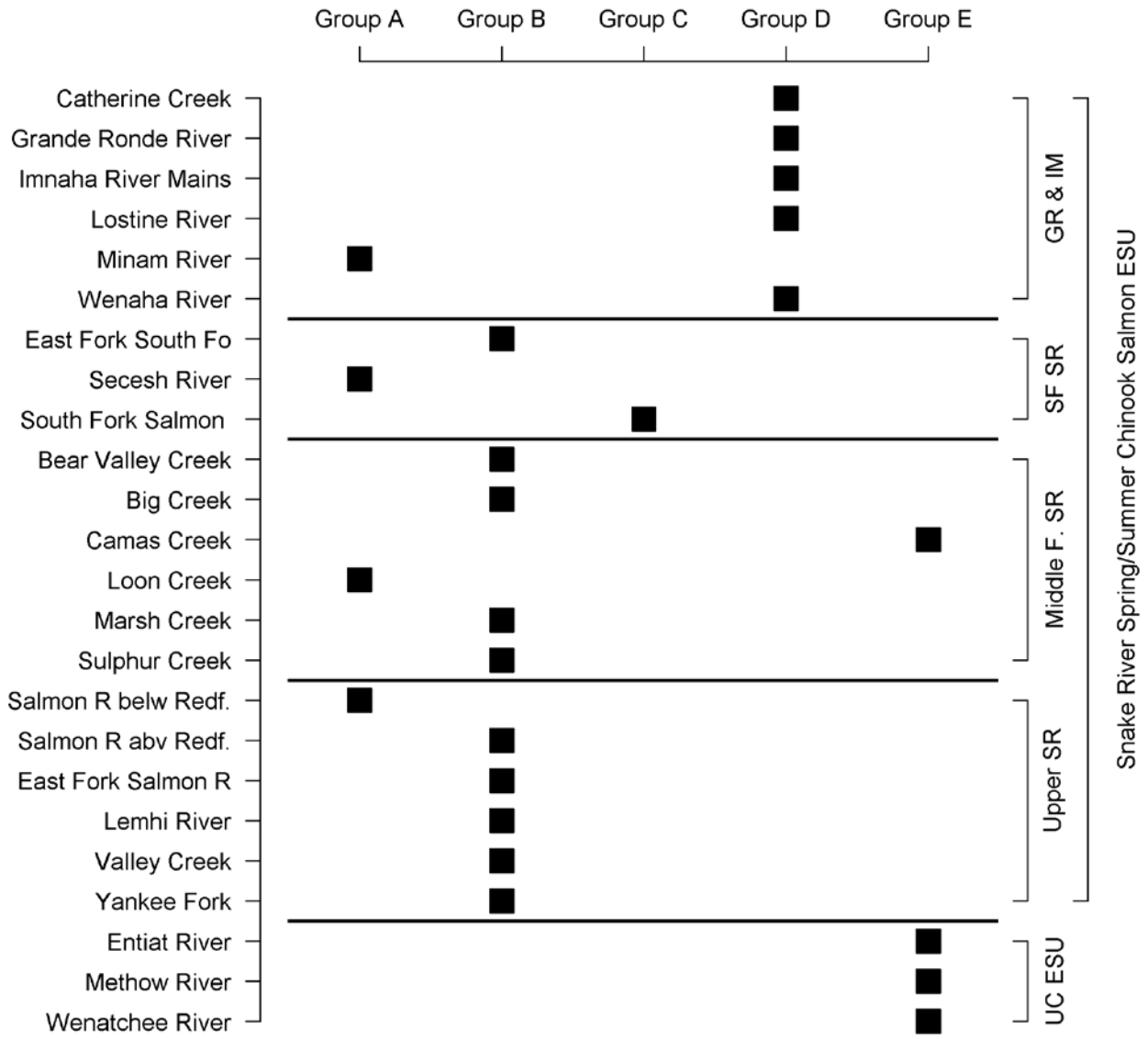
3.1 Snake River fall Chinook (Connor, Hegg, Zabel et al.)
Model under development. Flow and temperature management. Hatchery supplementation. Hydro actions

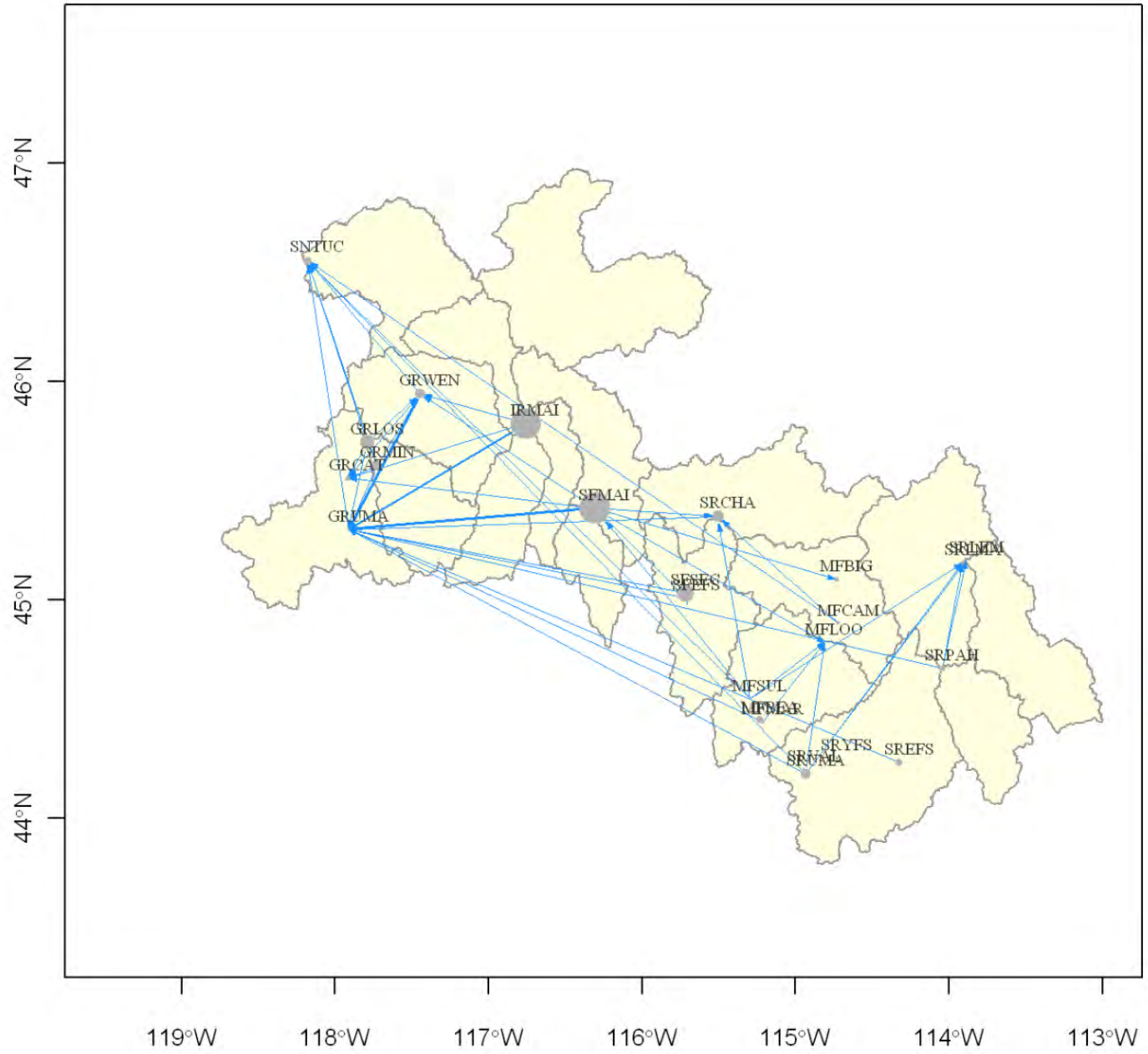
3.2 Methow River spring Chinook (Newsom and Bellmore)
Food web dynamics and population viability

3.3 South Fork Salmon and Secesh (Jordan and Beasely)
ISEMP production model


Trend 1
Trend 2
Trend 3
Trend 4
Trend 5
1957
1967
1977
1987
1997
2007
Catherine Creek
Grande Ronde River
Imnaha River Mains
Lostine River
Minam River
Wenaha River
East Fork South Fo
Secesh River
South Fork Salmon
Bear Valley Creek
Big Creek
Camas Creek
Loon Creek
Marsh Creek
Sulphur Creek
Salm. R. bel Redf.
Salm. R. abv Redf.
East Fork Salmon R
Lemhi River
Valley Creek
Yankee Fork
Entiat River
Methow River
Wenatchee River


Index of abundance
Catherine Creel
Wenaha River
Big Creek
Salmon River Lc
Yankee Fork
Grande Ronde R
East Fork Soutl
Camas Creek
Salmon River Lc
Entiat River
Imnaha River Mi
Secesh River
Loon Creek
East Fork Salmc
Methow River
Lostine River
South Fork Salm
Marsh Creek
Lemhi River
Wenatchee Rive
Minam River
Bear Valley Cre
Sulphur Creek
Valley Creek
3
2
1
0
-1
-2
-3
-4
1957
1987

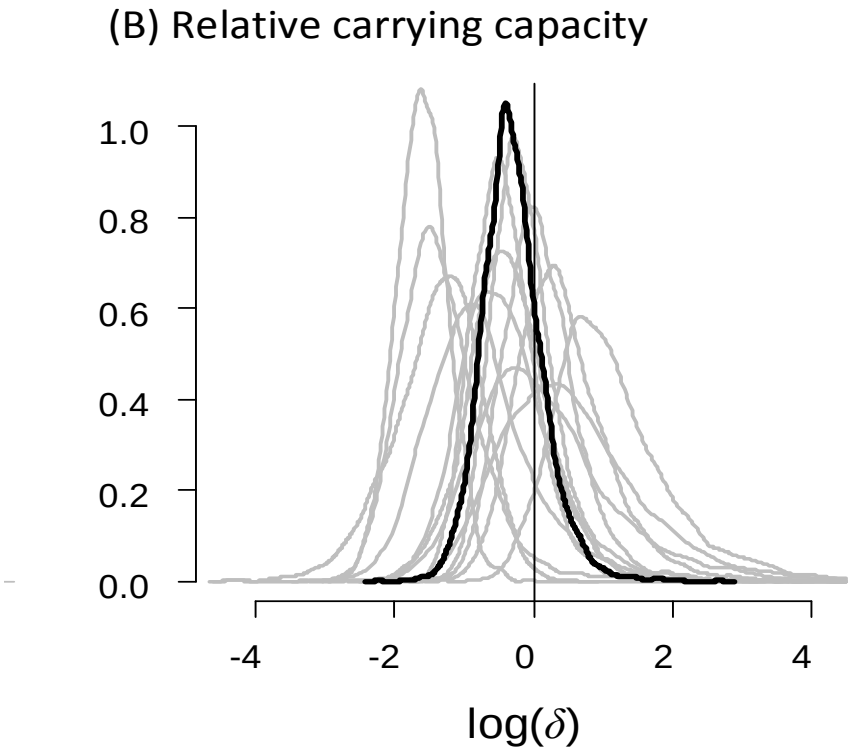

Group A
Group B
Group C
Group D
Group E
Catherine Creek
Grande Ronde River
Imnaha River Mains
Lostine River
Minam River
Wenaha River
East Fork South Fo
Secesh River
South Fork Salmon
Bear Valley Creek
Big Creek
Camas Creek
Loon Creek
Marsh Creek
Sulphur Creek
Salmon R belw Redf.
Salmon R abv Redf.
East Fork Salmon R
Lemhi River
Valley Creek
Yankee Fork
Entiat River
Methow River
Wenatchee River
GR & IM
SF SR
Middle F. SR
Upper SR
UC ESU
Snake River Spring/Summer Chinook Salmon ESU


47°N
46°N
45°N
44°N
119°W
118°W
117°W
116°W
115°W
114°W
113°W
SNTUC
GRWEN
IRMAI
GRLOS
GRMIN
GRCAT
GRUMA
SFMAI
SRCHA
MFBIG
MFCAM
MFLOO
SRPAH
MFSUL
SRYFS
SREFS

8.1 Hatchery effects: Impacts of hatcheries on wild salmon productivity

Impacts of hatcheries on wild salmon productivity: lessons from long-term monitoring

Eric R. Buhle[1], Mark D. Scheuerell[1], Michael J. Ford[1], Tom Cooney[1], Rich Carmichael[3]



Acknowledgements!

Thanks to ACOE, BPA and NOAA for funding

Also, Thanks to all the agencies that support their researchers to participate in this project