Ecological Risks to Natural Populations of Chinook Salmon by Hatchery Releases of Chinook and Coho Salmon

Throughout the Greater Puget Sound Region

~~ A PCD RISK 1 Model* Assessment ~~

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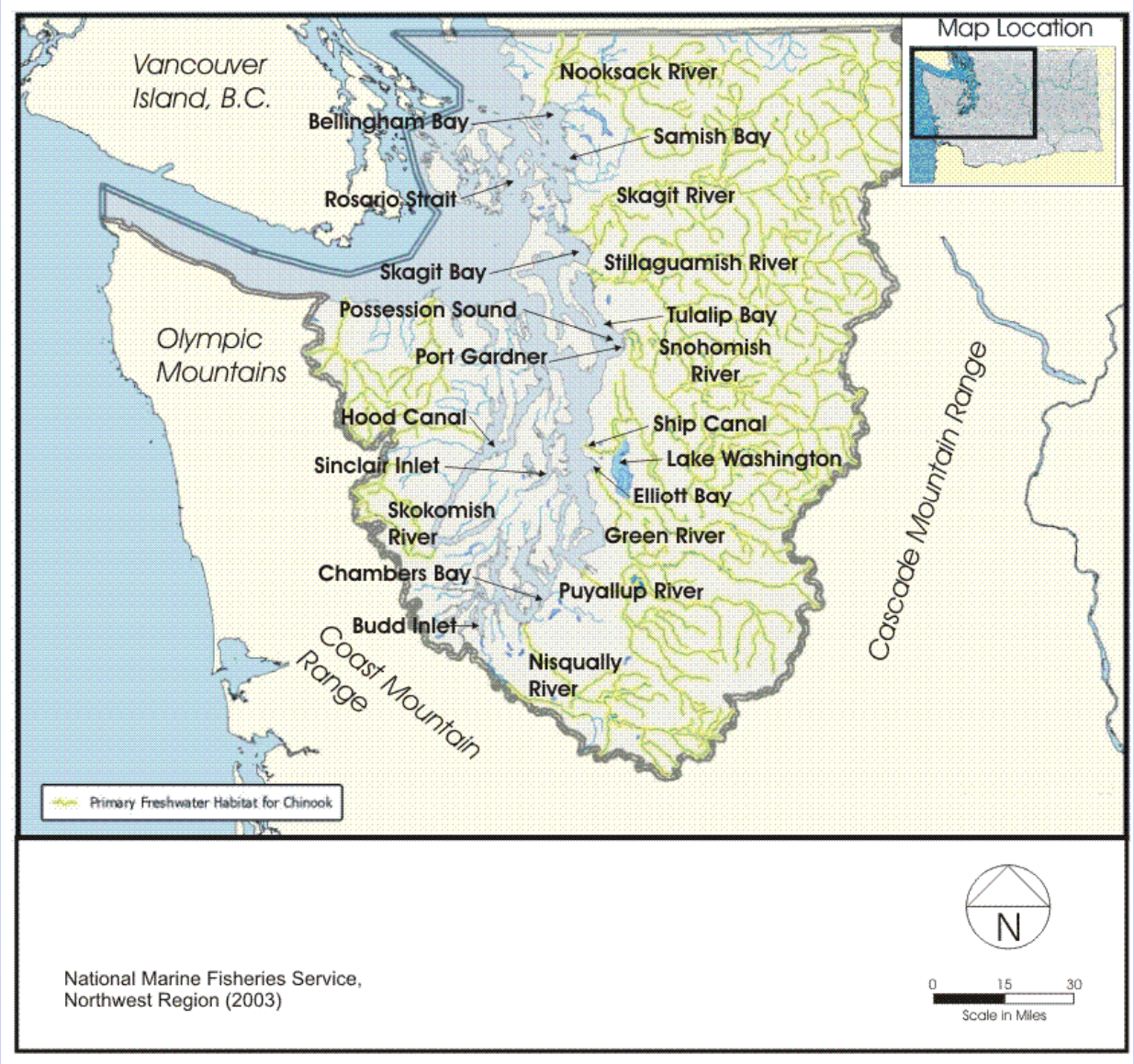
* Busack, C.A., K.P. Currens, T.N. Pearsons and L. Mobrand. 2005. Tools for evaluating ecological and genetic risk in hatchery programs. Final Report. Bonneville Power Administration Project No. 2003-058-00; Contract No. BPA 00016399. 84p.

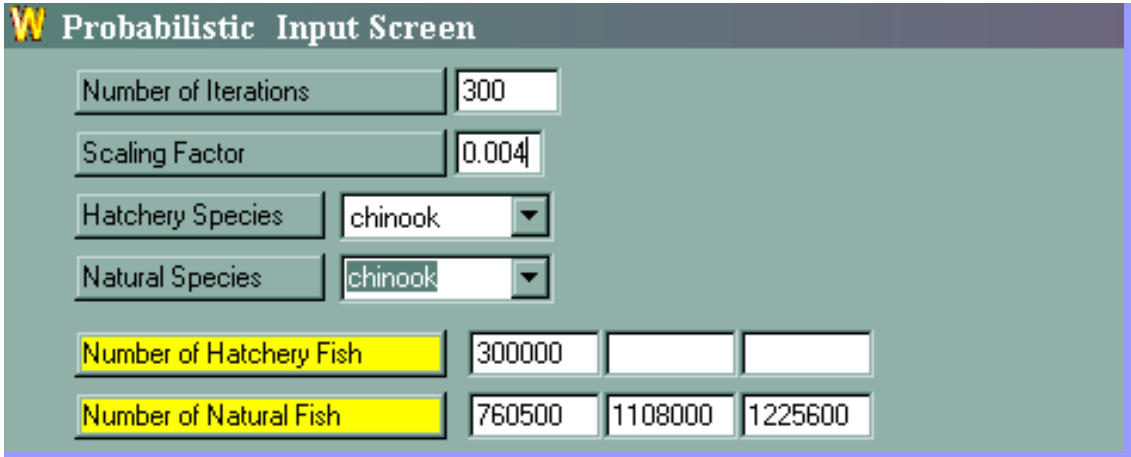
Project Scope

- Effects assessment as part of the Puget Sound Hatchery Environmental Impact Statement, Washington State Co-Managers
- PCD RISK 1 modeled indices of relative risk due to competition and predation by hatchery juvenile Chinook and coho salmon on natural “wild” juvenile Chinook populations
- Only addresses direct mechanisms of interaction within the freshwater riverine environment
- Provide a testable, quantitative assessment of relative risks within and between hatchery programs

Project Focus



- 12 major river basins throughout the Strait of Juan de Fuca, Hood Canal and Puget Sound regions
- ESA listed Category 1 and 2 watersheds for natural Chinook salmon populations
- 21 program releases of sub-yearling Chinook
- 9 program releases of yearling Chinook
- 14 program releases of yearling coho salmon



Input screen for probabilistic use of PCD RISK 1. Input values are for Icy Creek Hatchery, Green - Duwamish River, on station release of yearling Chinook salmon.

Data sources for parameterizing the model

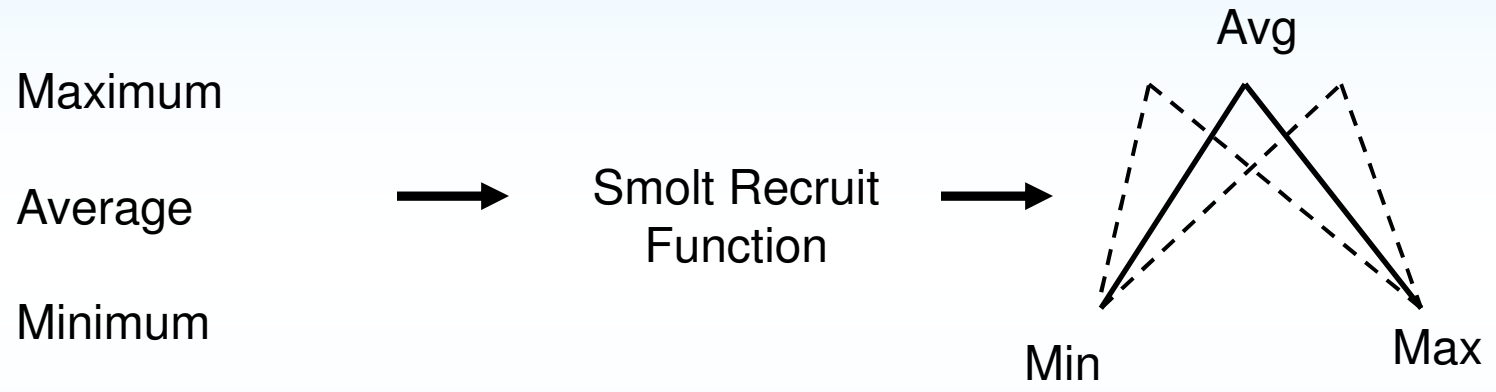
- Hatchery and Genetic Management Plans
- Puget Sound Chinook Harvest Management Plan
- Completed Ecosystem, Diagnosis and Treatment* ('EDT') analyses
- Regional downstream migrant fish trapping data
- Fish movement behavior studies
- WDOE river temperature data

* Mobrand – Jones and Stokes. Mobrand Biometrics, Vashon, WA

‘Wild’ Chinook salmon within the model environment

1. Juvenile abundance
2. Fish size
3. Freshwater distribution spatially and temporally

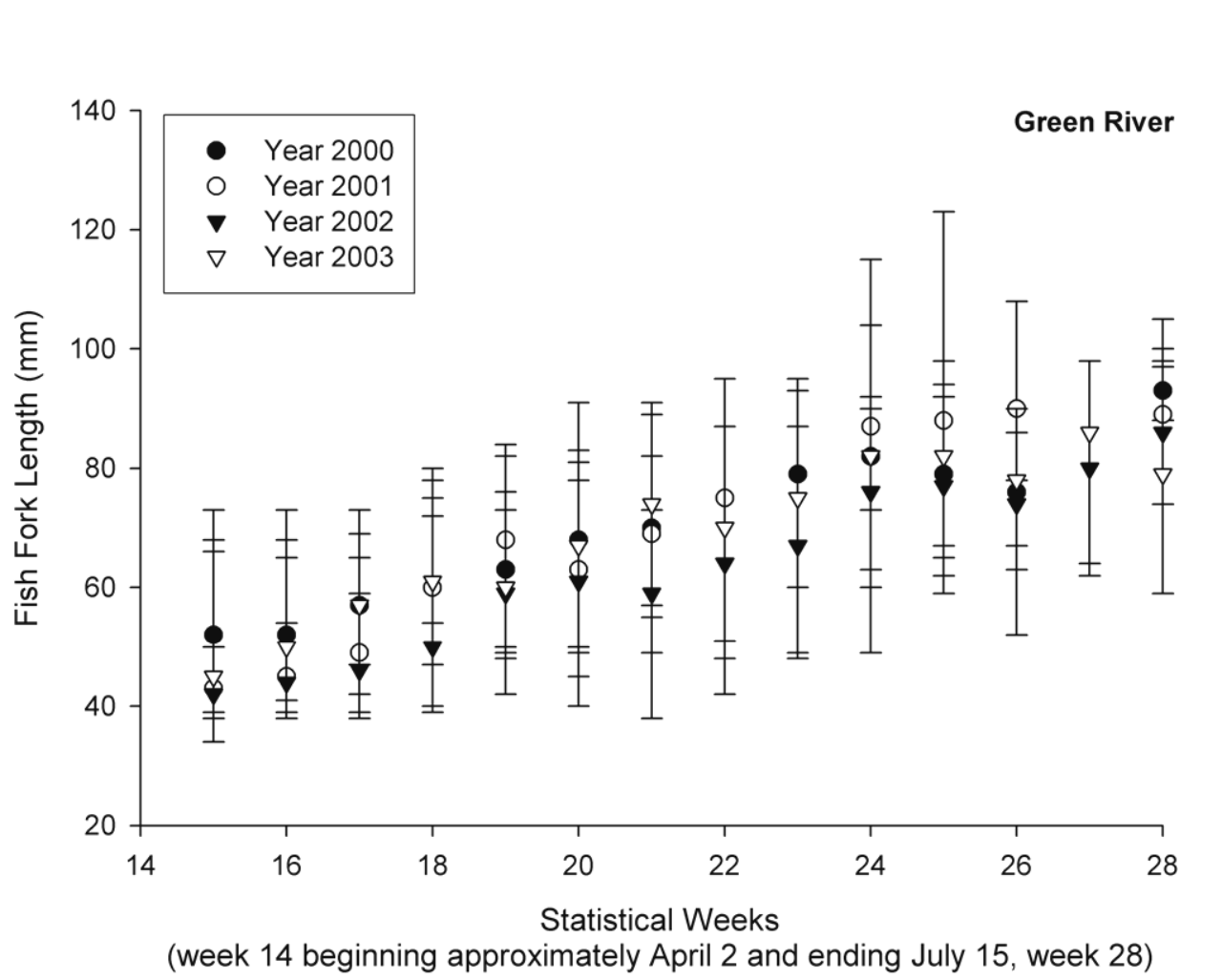
Abundance of natural juvenile Chinook salmon and triangular distributions



Spawner abundance (years 2000 – 2005)

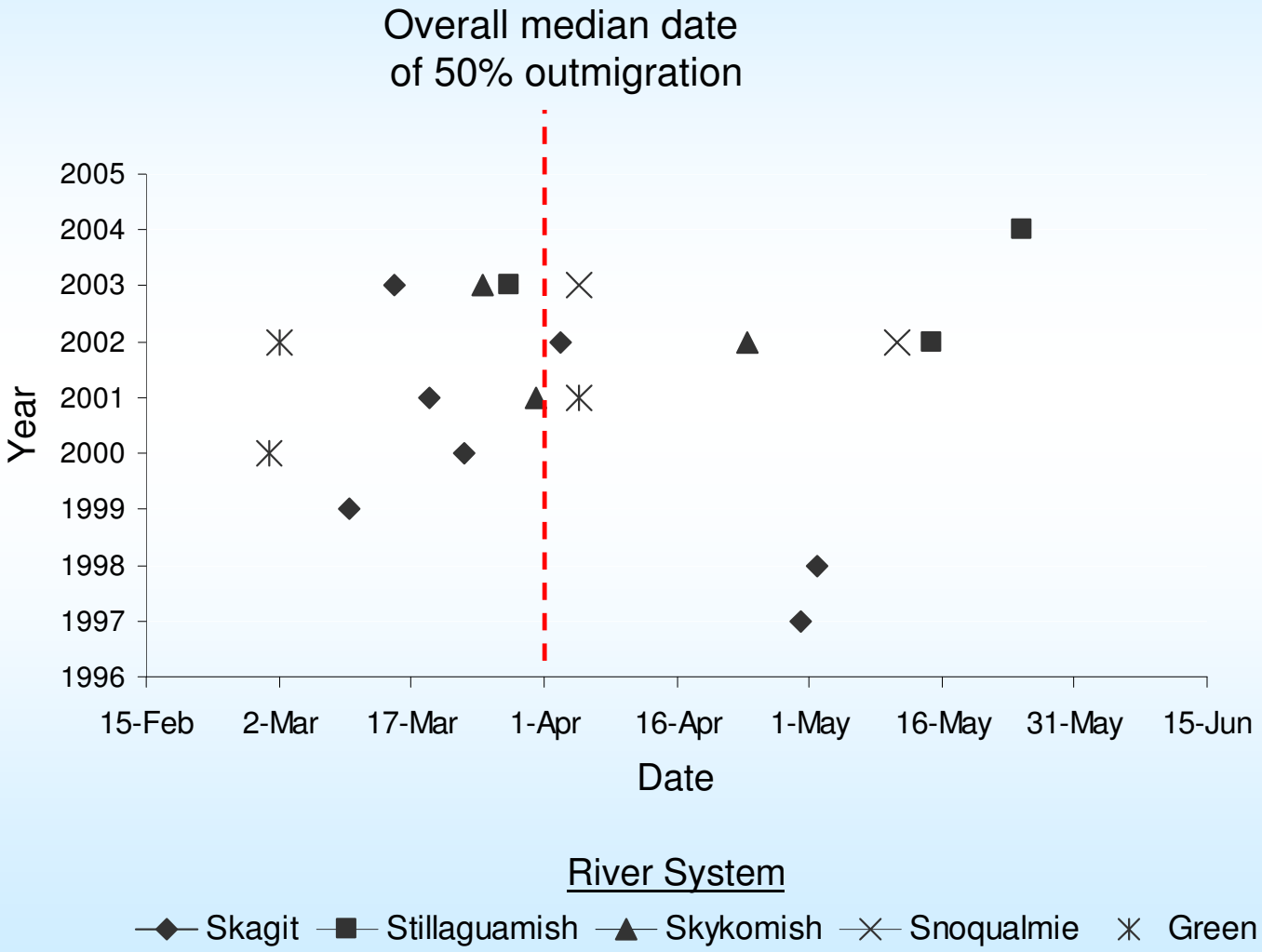
EDT productivity and capacity

Juvenile abundance triangular distribution

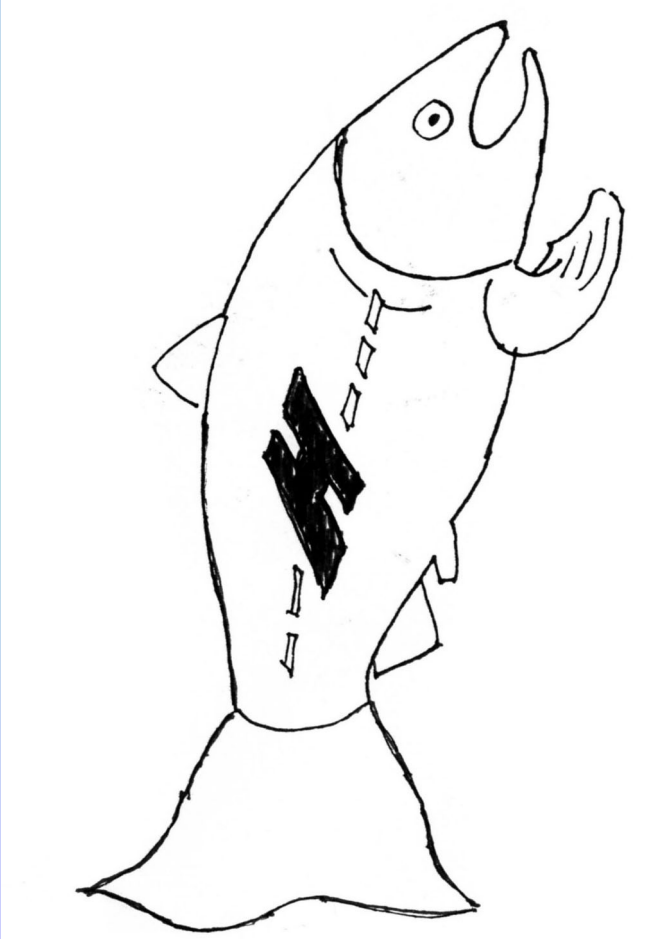


Average fish fork lengths with associated observed minimum and maximum lengths by statistical week and year for natural juvenile Chinook salmon captured by an outmigrant trap in the Green River, Washington. Data from Seiler et al. 2002a, 2004a, 2004b and Volkhardt et al. 2005.

Observed median date at which fifty-percent of populations consisting of natural-origin Chinook salmon passed respective trap locations in river basins throughout the Puget Sound, Washington

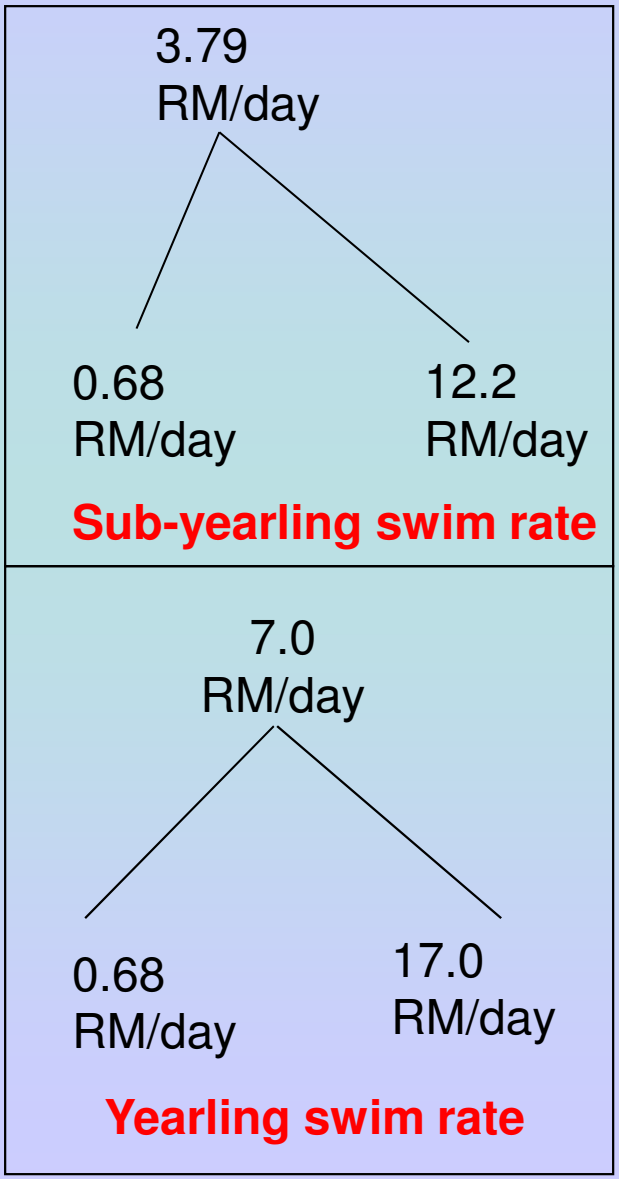


Program hatchery fish within the model environment



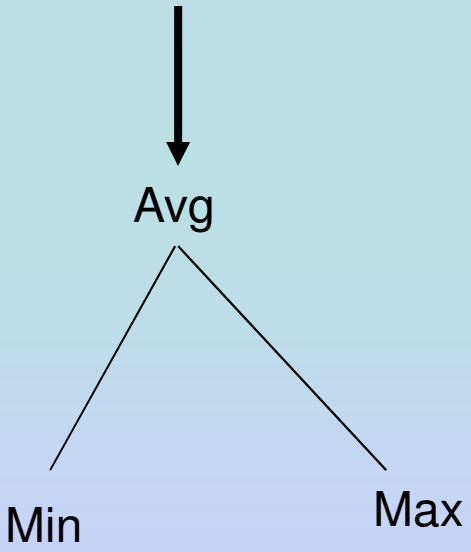
1. Abundance
2. Size
3. Freshwater residence time
4. Survival

Hatchery Fish Movement Rates

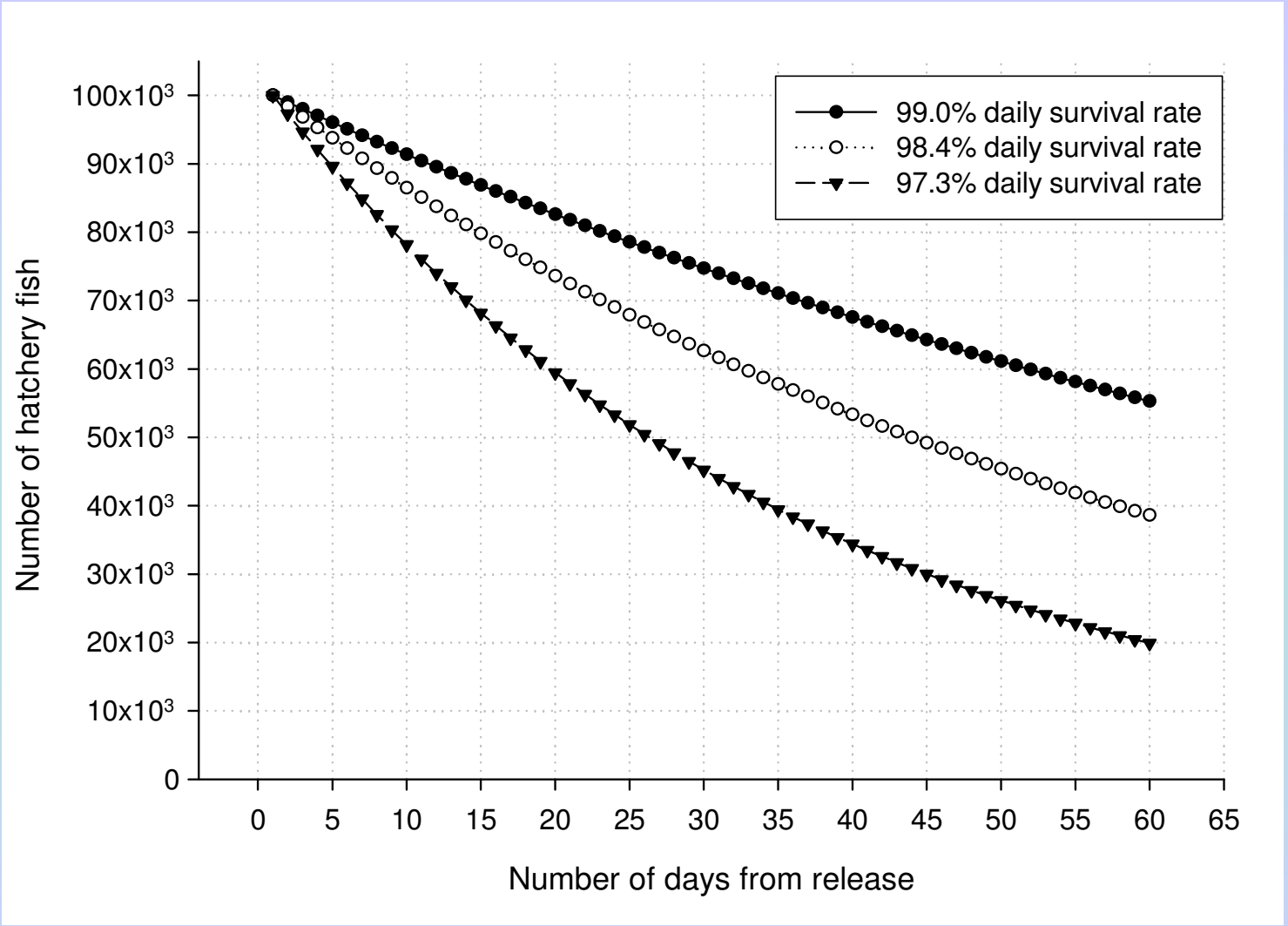


$\sqrt{RM}$ = *Release Location*

Monte Carlo simulated days of fish co-occurrence
With associated 95% confidence bounds

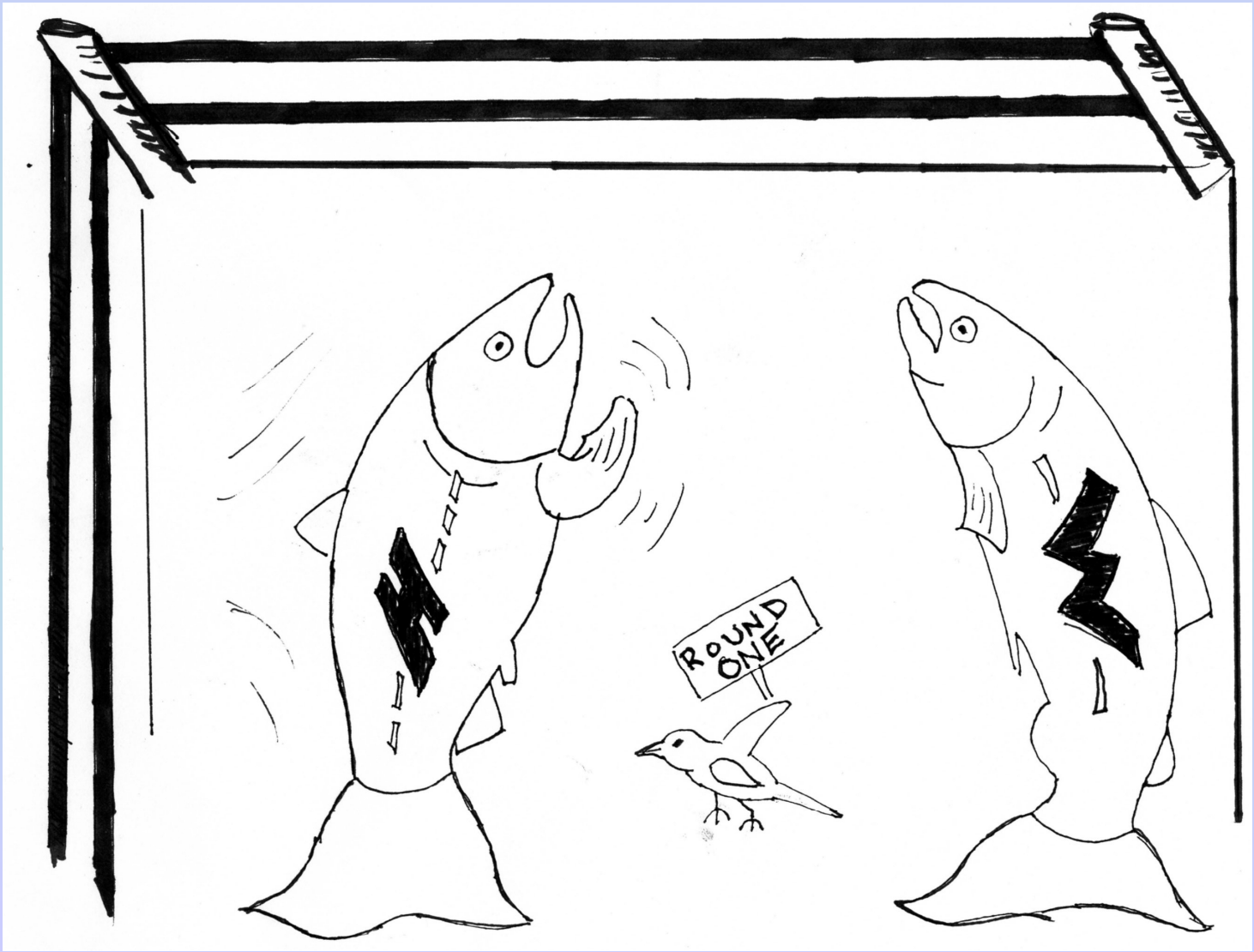


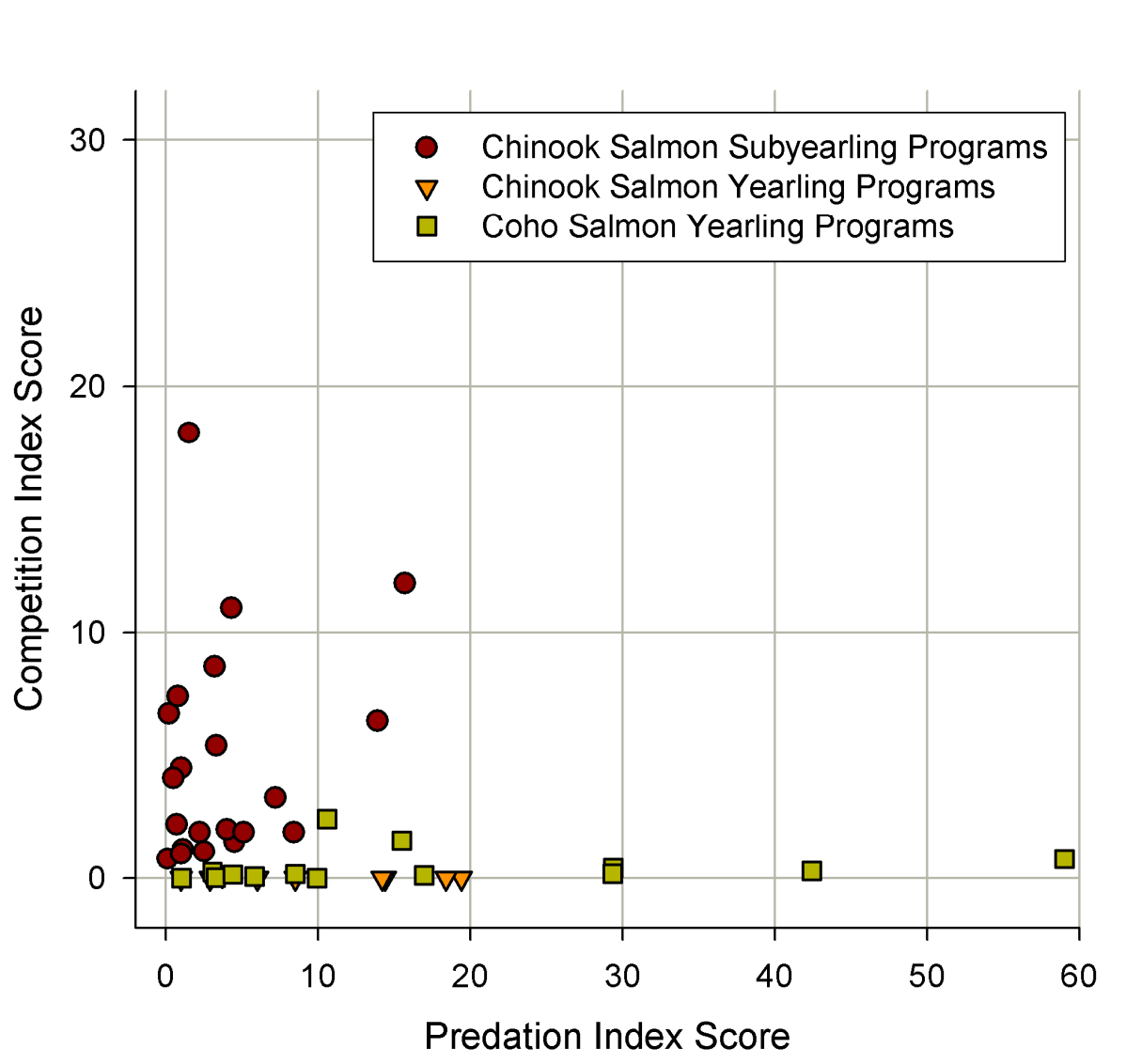
Hatchery fish residence time



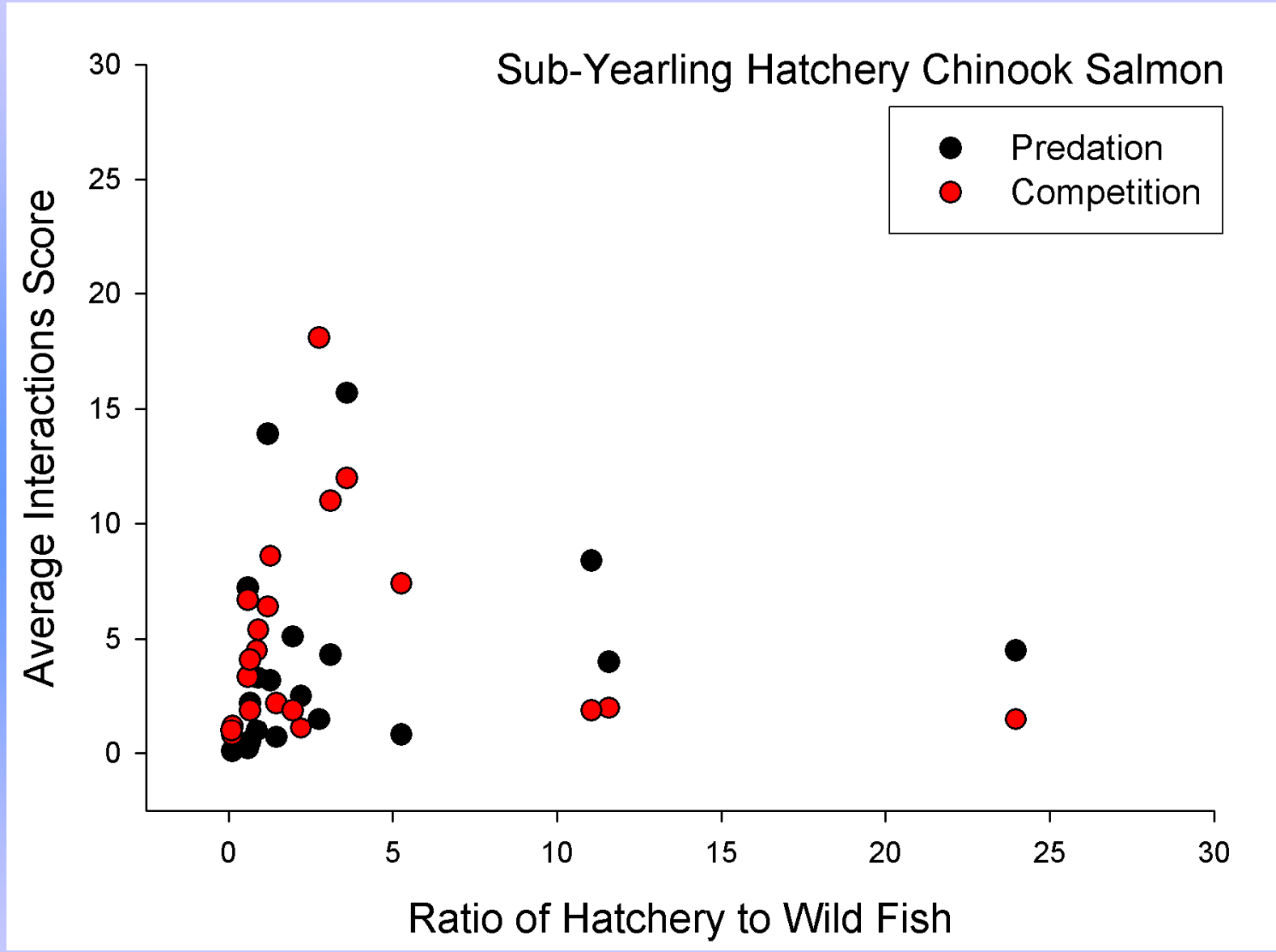
Abundance of hatchery fish over time in relation to specified daily survival rates using the *PCD RISK 1* decay rate function *(DSR = S (1/t)* .

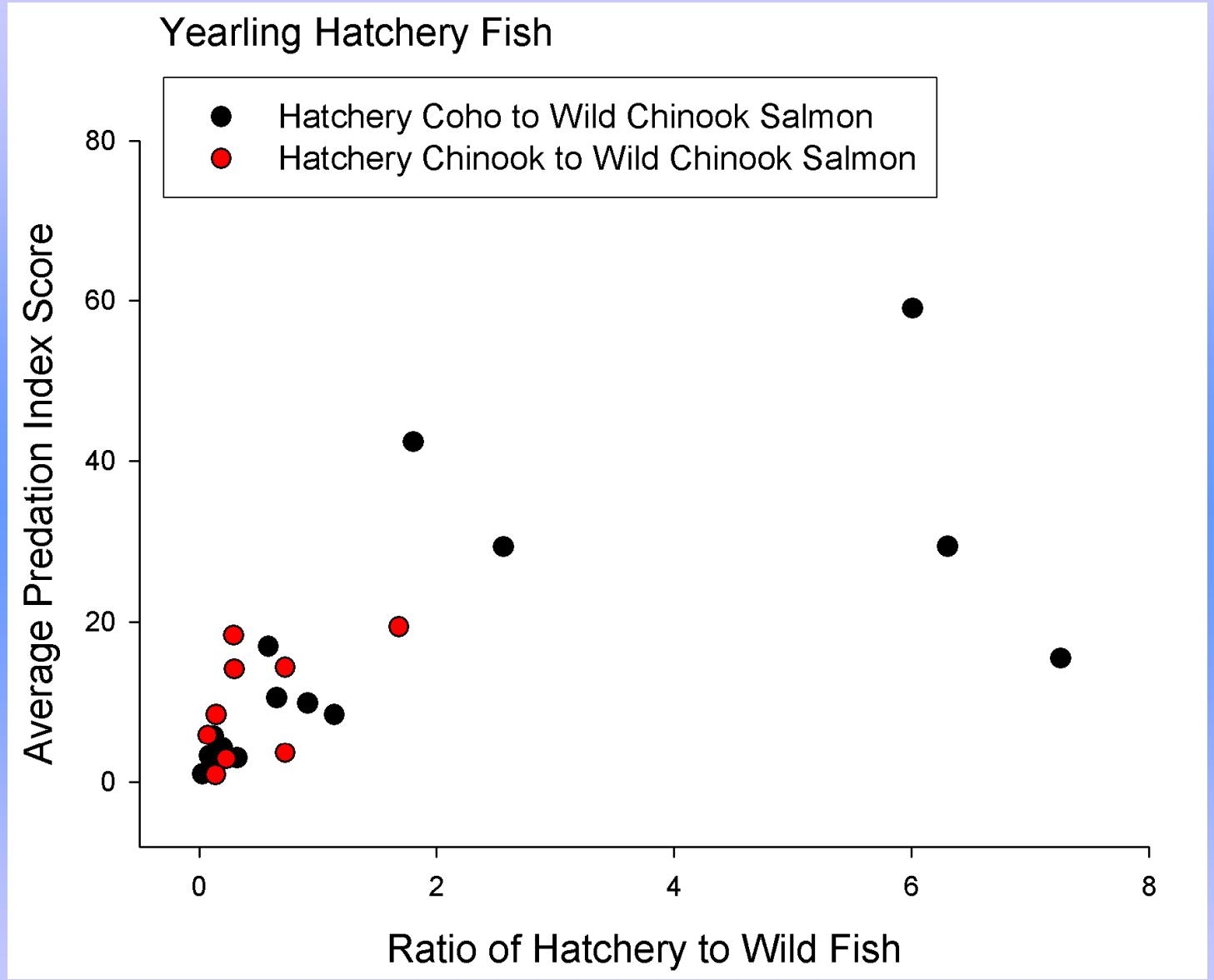
Some Results

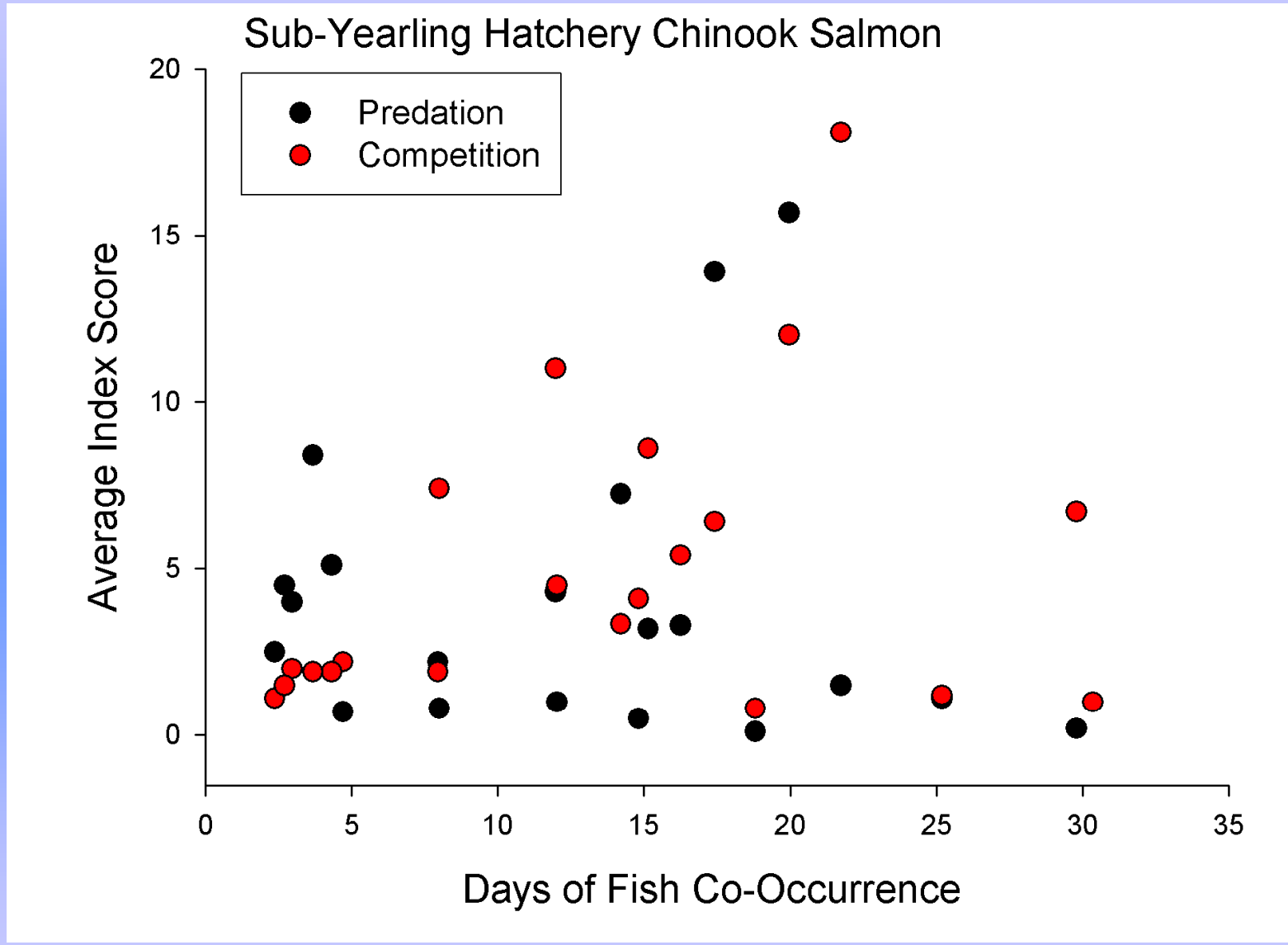


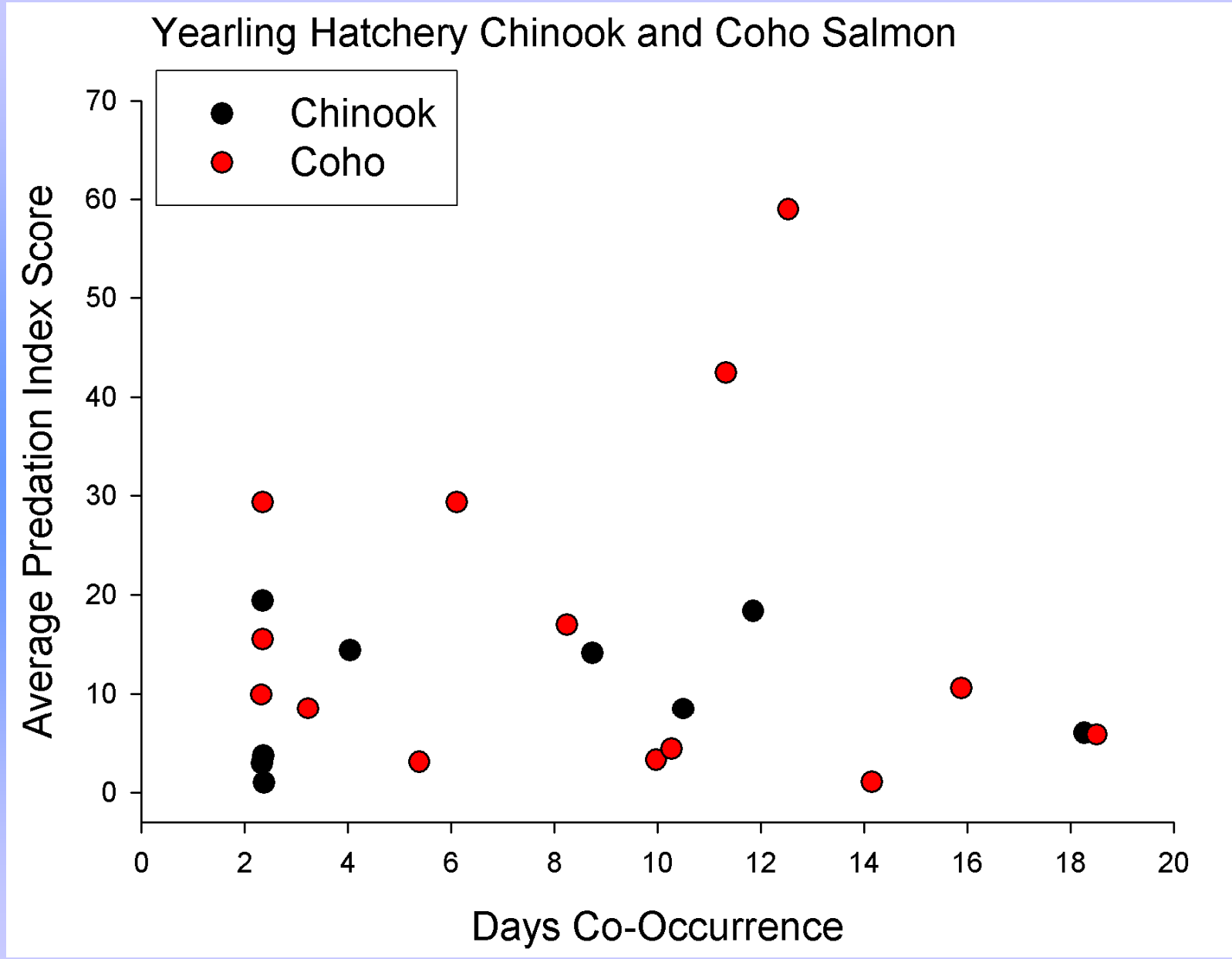


Relationship between average index scores for predation and competition equivalence.

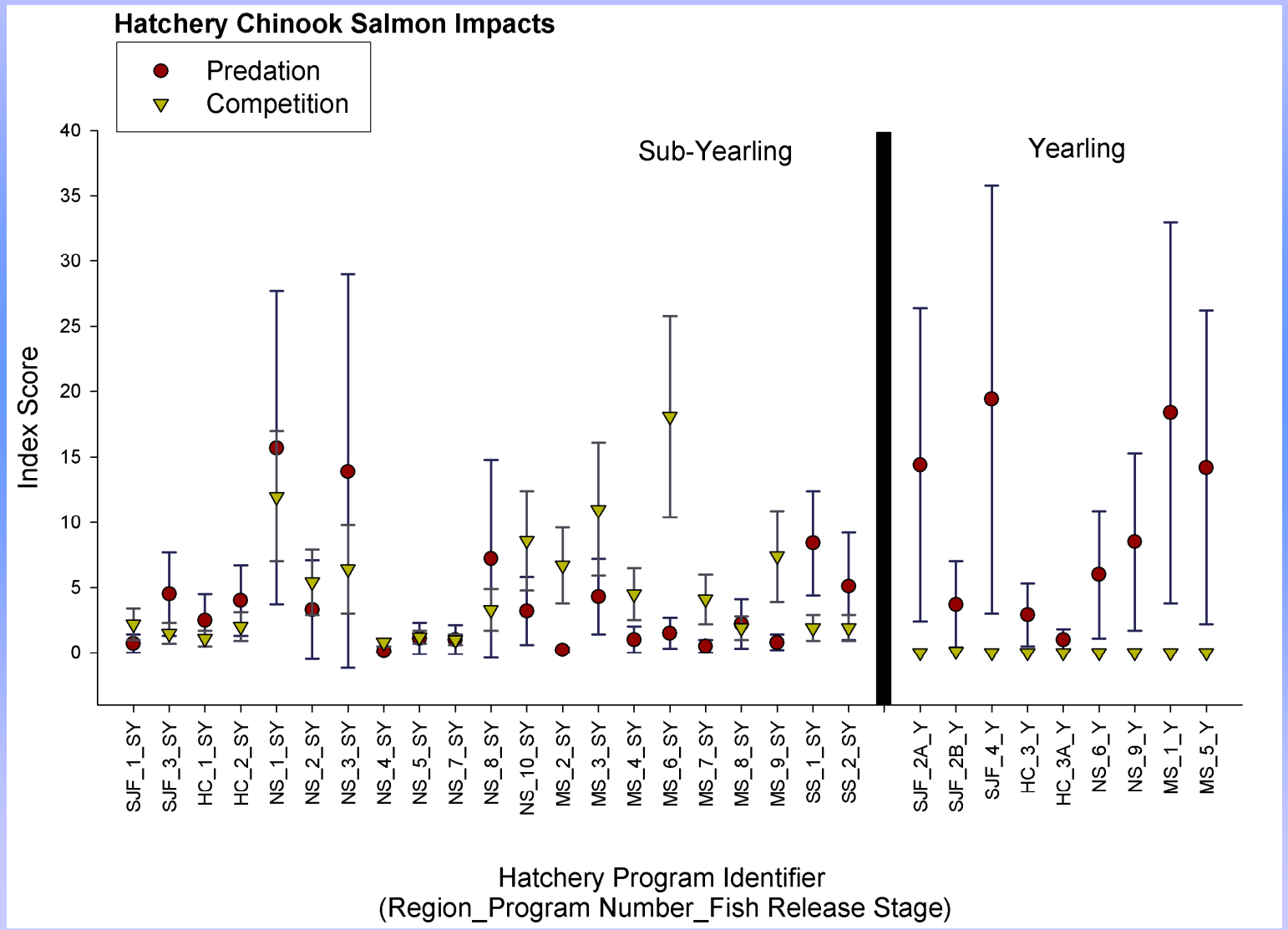

Sub-Yearling Hatchery Chinook Salmon
Predation
Competition
Average Interactions Score
0
5
10
15
20
25
30
Ratio of Hatchery to Wild Fish
0
5
10
15
20
25
30

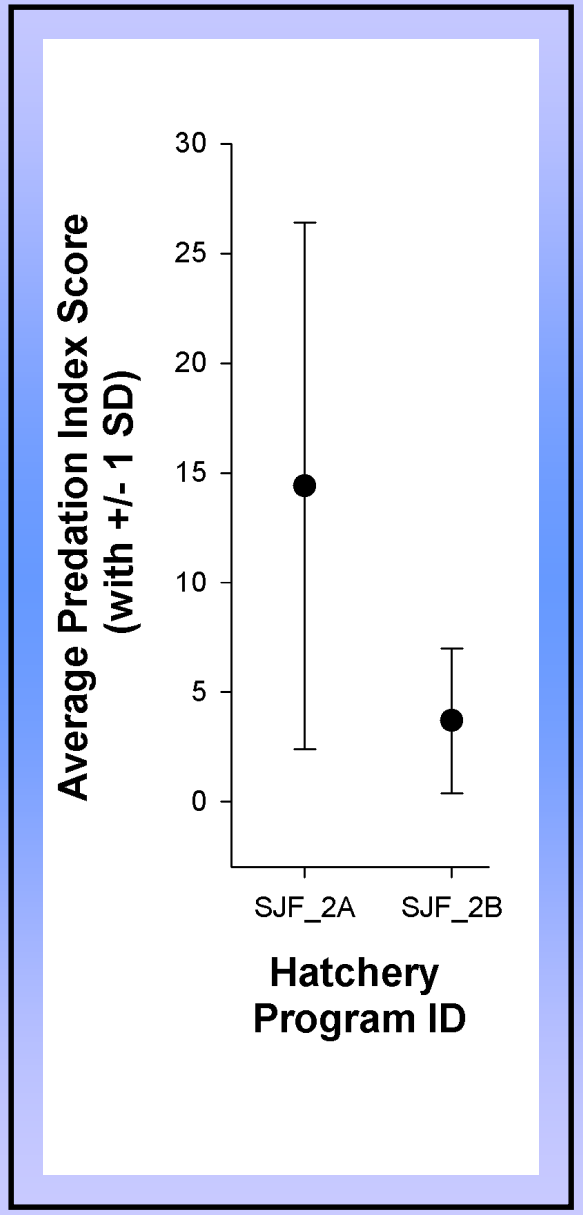

Yearling Hatchery Fish
Hatchery Coho to Wild Chinook Salmon
Hatchery Chinook to Wild Chinook Salmon
Average Predation Index Score
80
60
40
20
0
0
2
4
6
8
Ratio of Hatchery to Wild Fish


Sub-Yearling Hatchery Chinook Salmon
Predation
Competition
Average Index Score
Days of Fish Co-Occurrence
0
5
10
15
20
25
30
35

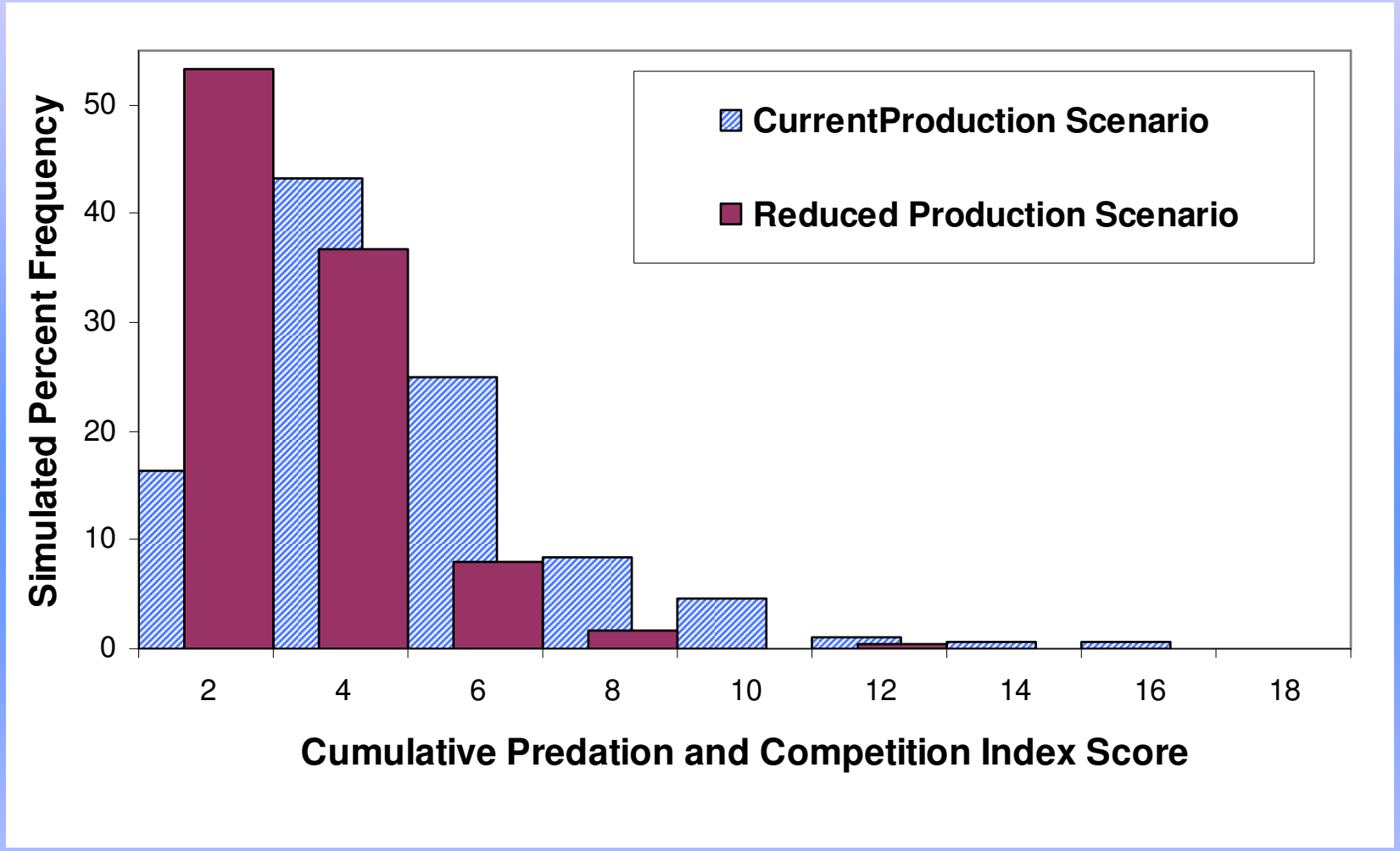

Yearling Hatchery Chinook and Coho Salmon
Chinook
Coho
Average Predation Index Score
0
10
20
30
40
50
60
70
0
2
4
6
8
10
12
14
16
18
20
Days Co-Occurrence

PCD RISK 1 simulated index scores (and associated ± one standard deviation) for predation and competition impacts





Parameter	Yearling Chinook Hatchery Program SJF 2A	SJF 2B
Release Date	April 15	June 1
RM Release	10.5	3
Wild Fish Size	45	78
Days Co-Occurrence	1_2_9	1_1_5
River ºC	5_7_9	7_10_13
Habitat Complexity	3_8_13	9_14_19



Risk: a probability of occurring and a consequence

Some Conclusions

- The model is transparent with an easy operational learning curve
- Has good empirical and theoretical basis
- Provides a quantitative framework from which to evaluate general management guidelines
- Can facilitate development of risk containment and reduction approaches / requirements
- As a heuristic tool, highlights research needs and therein key uncertainties

Conclusions (continued)

- Model outputs should be treated as index scores not actual ‘rates’
  - Distribution of fish
  - Piscivory rate
  - Fish encounters per day
  - Question of how to interpret outcomes of competition interactions
- Many of the model input variables are similar / confounding
  - Habitat segregation, population overlap, habitat complexity
- Model results only address freshwater, direct interactions, at the juvenile fish life stage
- No cumulative effects considerations


END