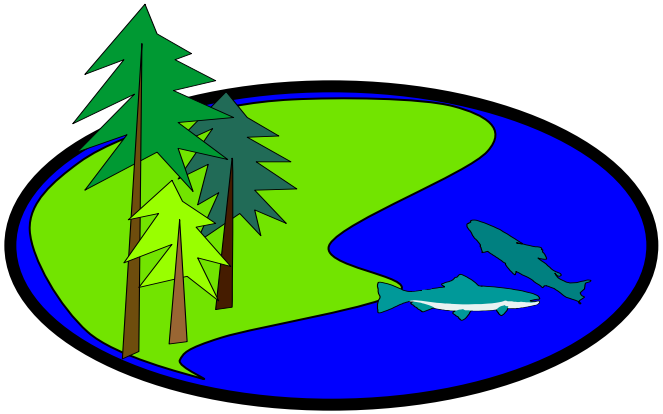
Ecological Risks of Hatchery Programs

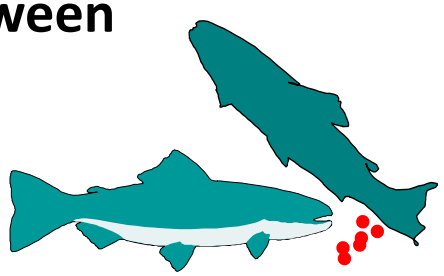


Kathryn Kostow
Oregon Department of Fish and Wildlife

Two Categories of Hatchery Risks:

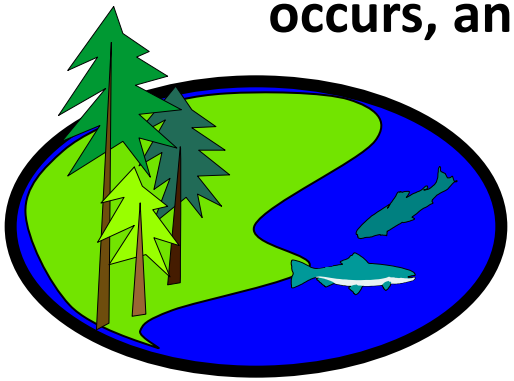
Genetic Risks:

Result from interbreeding between hatchery and wild fish



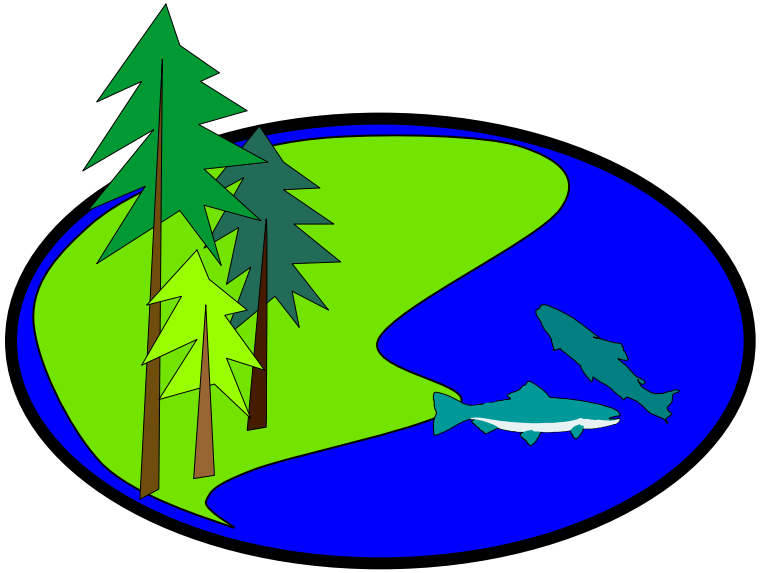
Ecological Risks:

May occur whether or not interbreeding occurs, and may affect multiple species



Both risks can occur at the same time

Ecological risks occur when the presence of hatchery fish detrimentally affects how wild fish interact with their environment or with other species

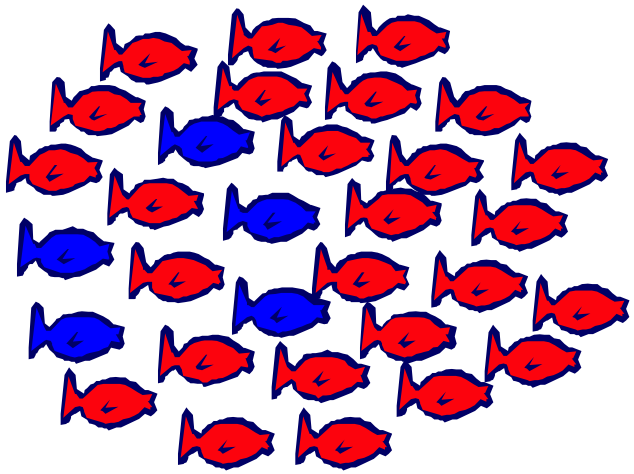


Impacts may include:

Increased density-dependent mortality
Decreased access to habitat
Displacement from cover
Decreased productivity
Increased competition
Increased predation
Increased harvest
Direct injury
Increased stress
Decreased growth
Decreased survival
Decreased condition
Disturbance of redds
Premature emigration
Increased exposure to disease
Decreased size of feeding territories
Displacement from feeding territories

Factors contributing to ecological risks:*

Large numbers of hatchery fish



A. Releases of large numbers of hatchery juveniles can:

- **Attract predators**
- **Prey on wild fish**
- **Occupy rearing habitats**
- **Disrupt feeding territories**
- **Trigger early emigration**

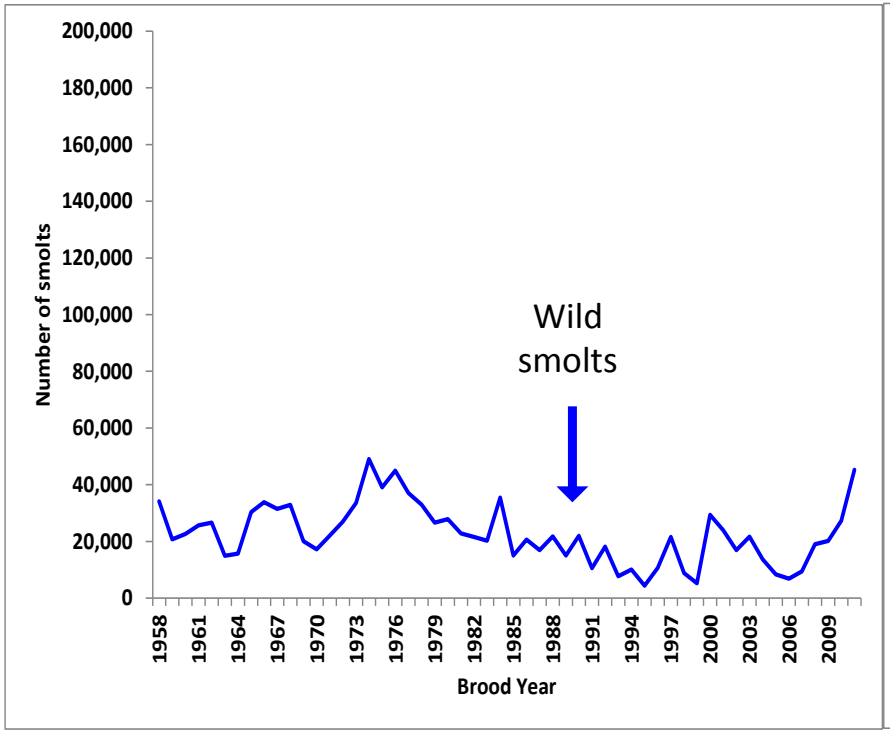
B. Returns of large numbers of hatchery adults can:

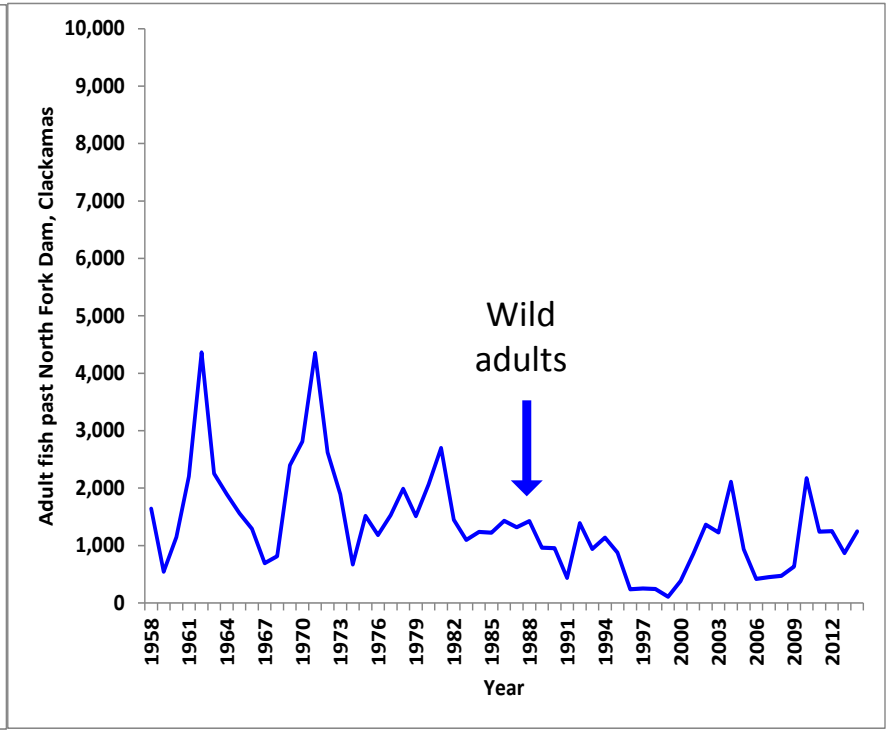
- **Increase harvest on wild fish**
- **Occupy spawning habitats**
- **Disrupt wild redds**
- **Produce offspring that occupy rearing habitats**

** Kostow 2009, RFBF*

Factors contributing to ecological risks:

What is “Large Numbers”?

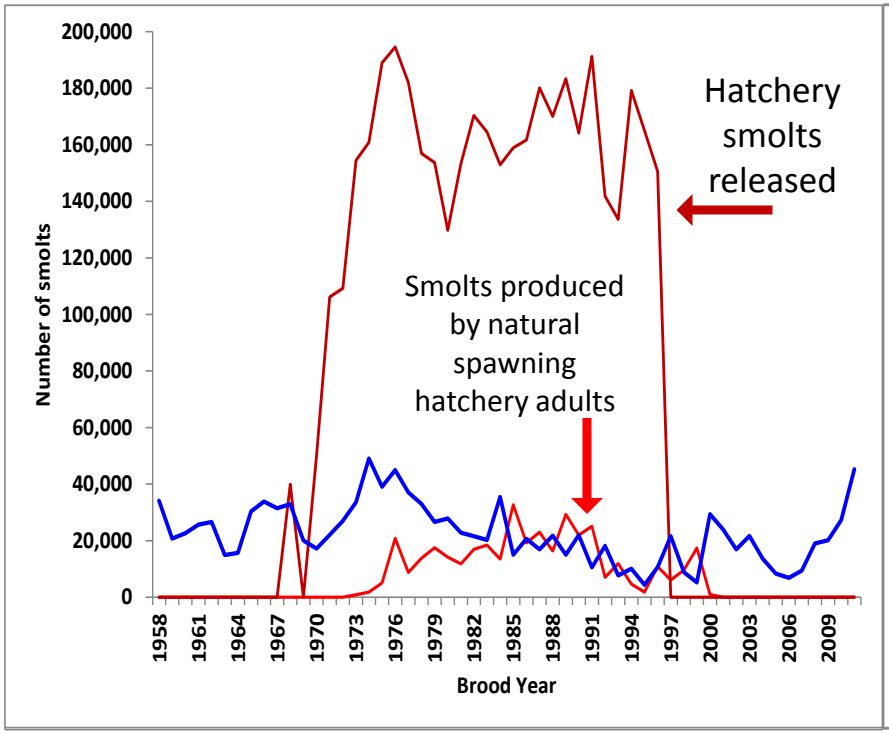


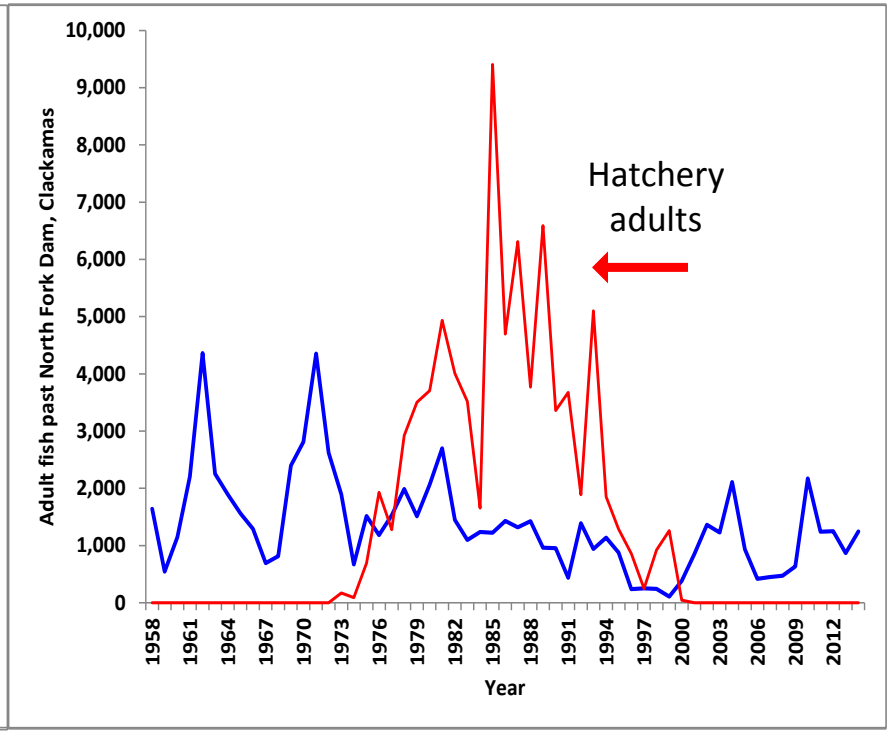


Wild Clackamas Winter Steelhead

Factors contributing to ecological risks:

What is "Large Numbers"?

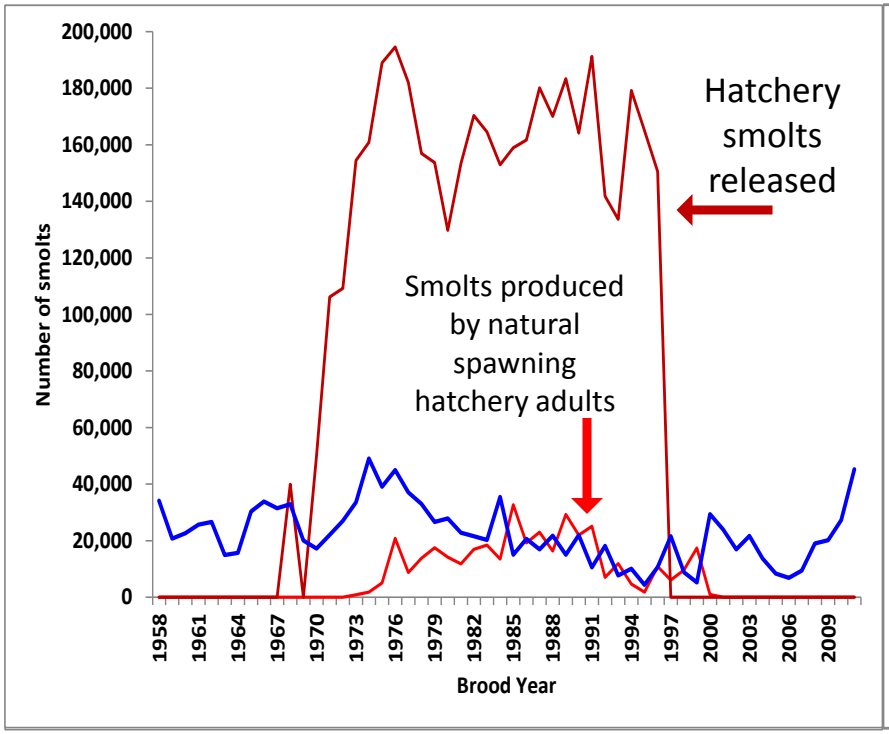


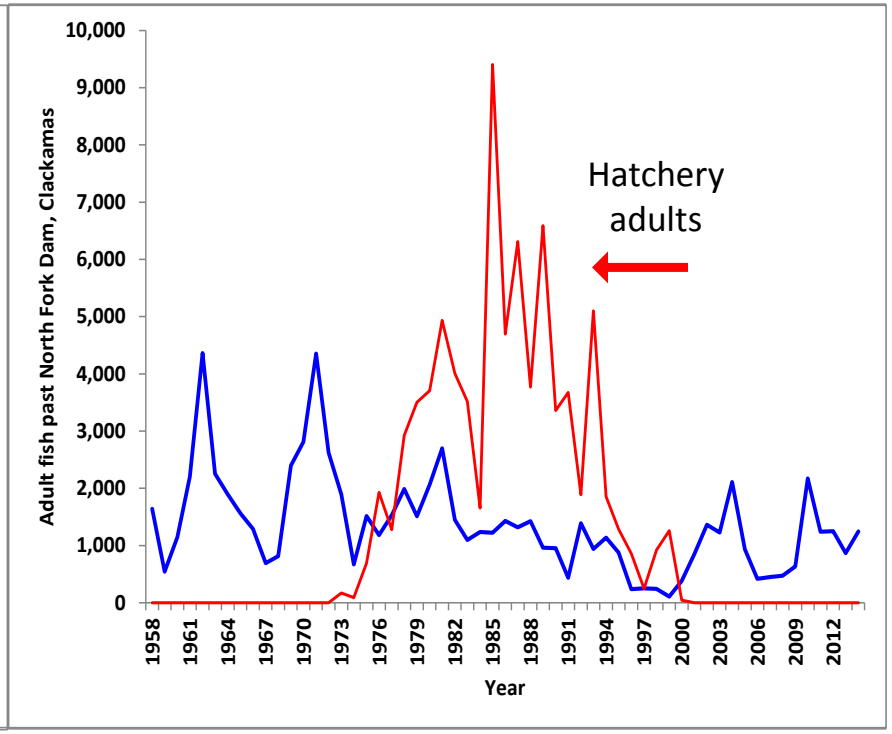


Wild Clackamas Winter Steelhead
Hatchery Summer Steelhead

Factors contributing to ecological risks:

What is "Large Numbers"?





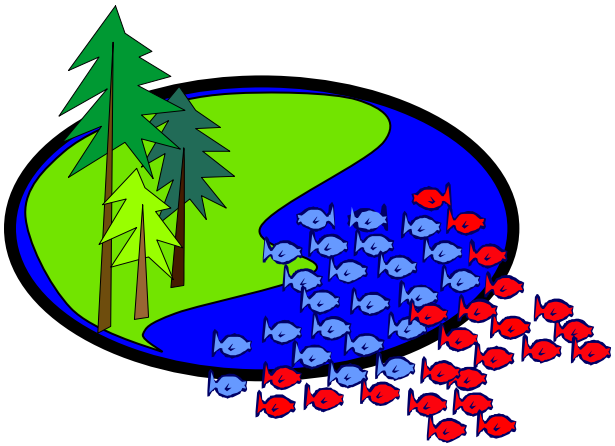
Recruits / Spawner (α) decreased by 50%
Maximum number of recruits decreased by 22%*

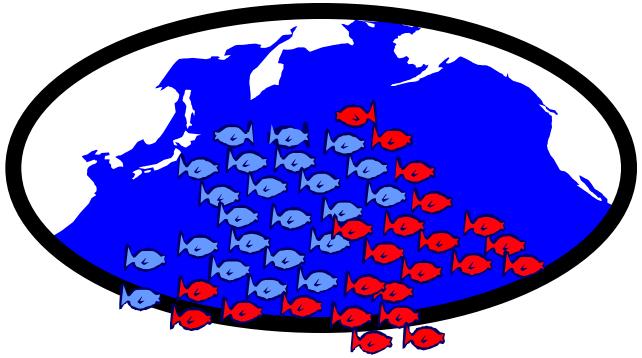
**** Kostow & Zhou 2006, TAFS***

Factors contributing to ecological risks:*

Increased density-dependent mortality

- **Decreased growth and condition**
- **Premature emigration**
- **Competition for food**
- **Displacement of wild fish into marginal habitats**
- **Decreased size and quality of feeding territories**
- **May also occur in the ocean or migration corridor**
- **Can occur across species**

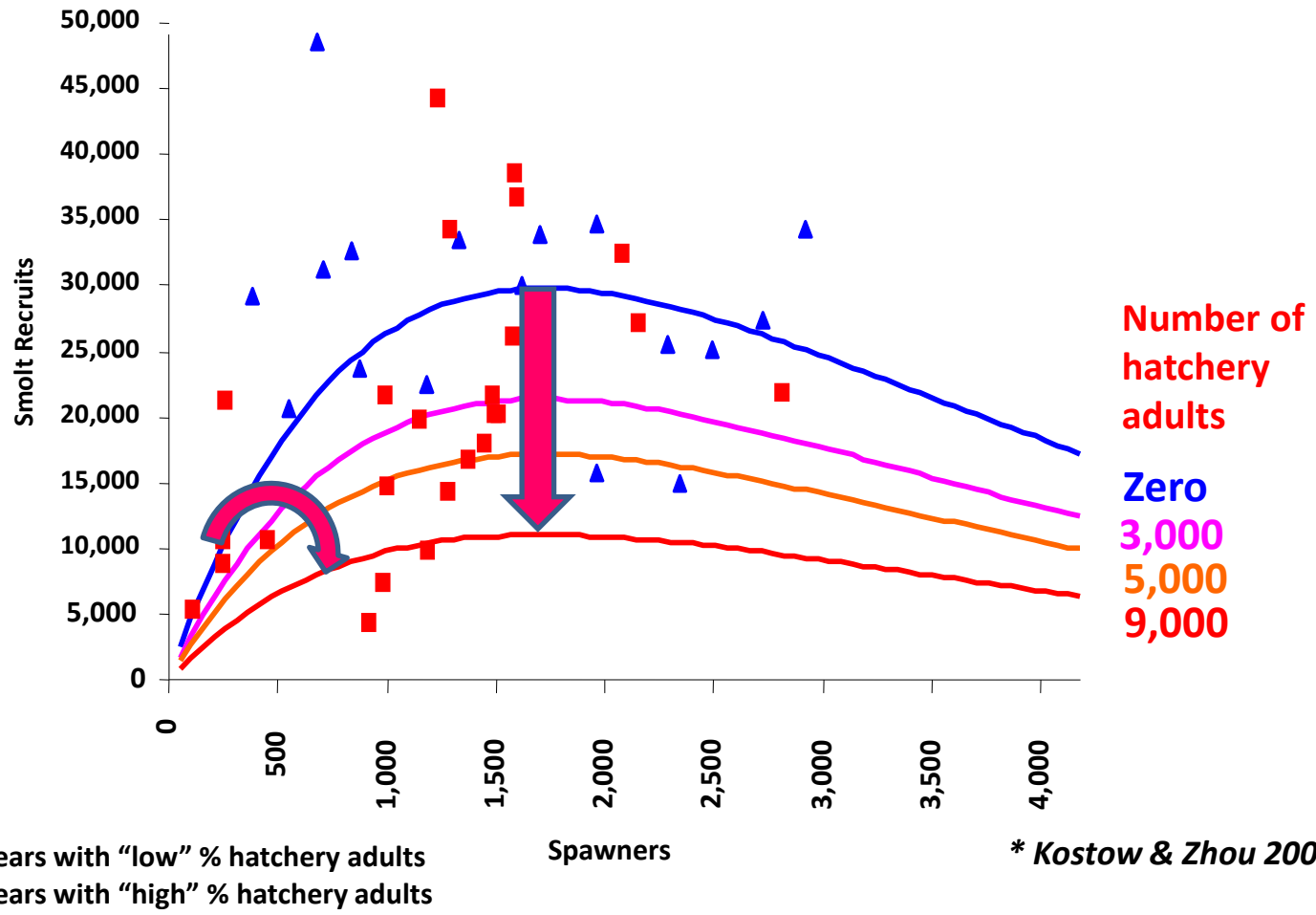




** Kostow 2009, RFBF*

Factors contributing to ecological risks:

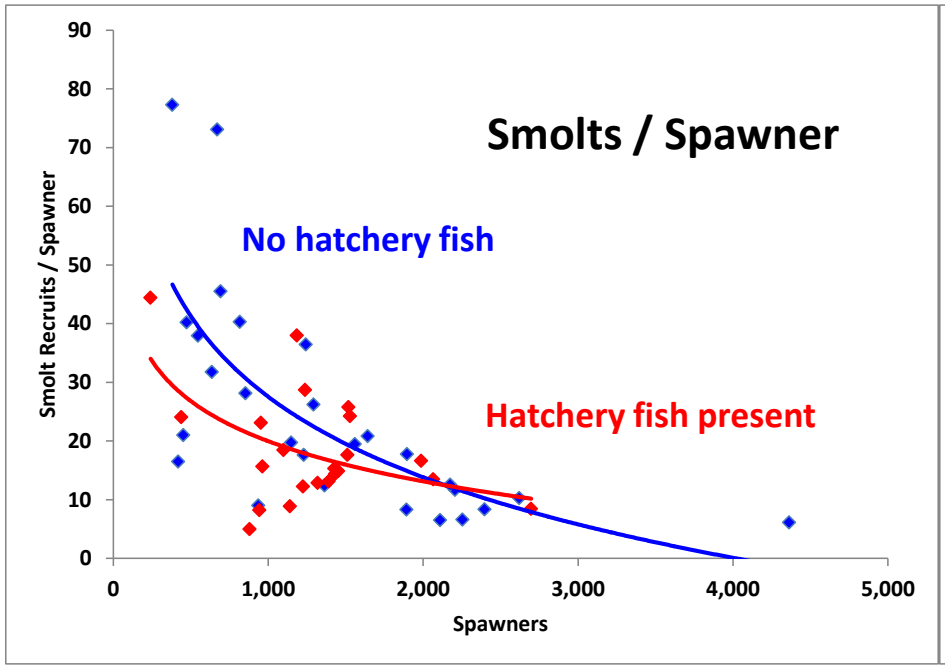
$$R_{Ly} = aS_{Wy} \exp\left[- bS_{Wy} + cS_{Hy} + \sum d_i H_{y+l} + \sum e_j I_{jy} + fO_y \right] + \sigma\varepsilon_y \quad *$$

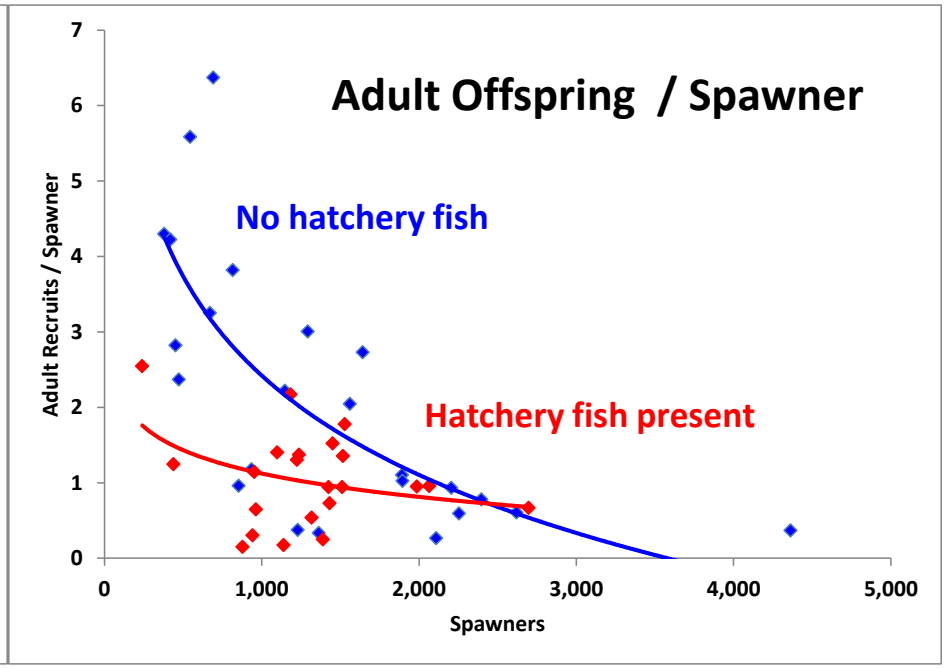


* Kostow & Zhou 2006, TAFS

Factors contributing to ecological risks:

The population looses resiliency because there is less of an increase in recruits/spawner at low spawner densities

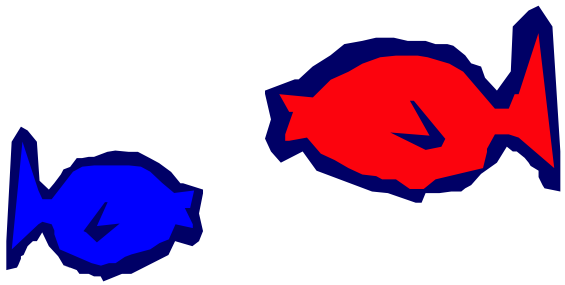




Wild Clackamas Winter Steelhead
Hatchery Summer Steelhead

Factors contributing to ecological risks:*

Characteristics of hatchery fish are disruptive to wild fish



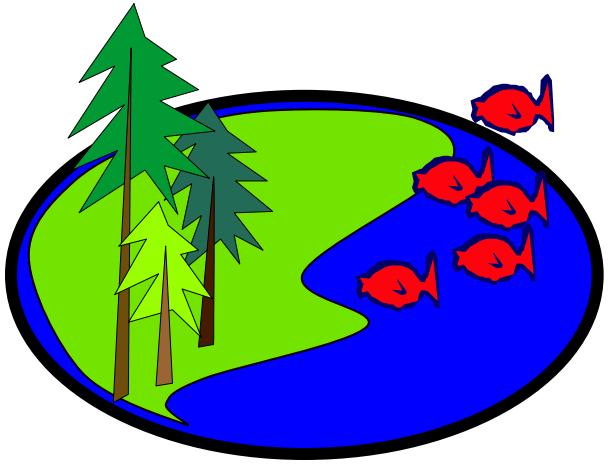
A. **Bigger**
B. **Different age**
C. **More aggressive**
D. **Different response to predators**
E. **Different surface orientation**
F. **Timing differences**

Hatchery fish can disrupt wild fish even when their own fitness is poor *

**Kostow, Marshall & Phelps 2003, TAFS*
Kostow 2004, CJFAS
** Kostow 2009, RFBF*

Factors contributing to ecological risks:*

Hatchery fish do not out-migrate immediately after they are released



A. Hatchery fish are released as pre-smolts

- **Remain in freshwater to rear**
- **Occupy rearing habitats**

B. Hatchery fish become residuals

- **Remain in freshwater until adults**
- **Occupy rearing habitats**
- **Prey on wild fish**

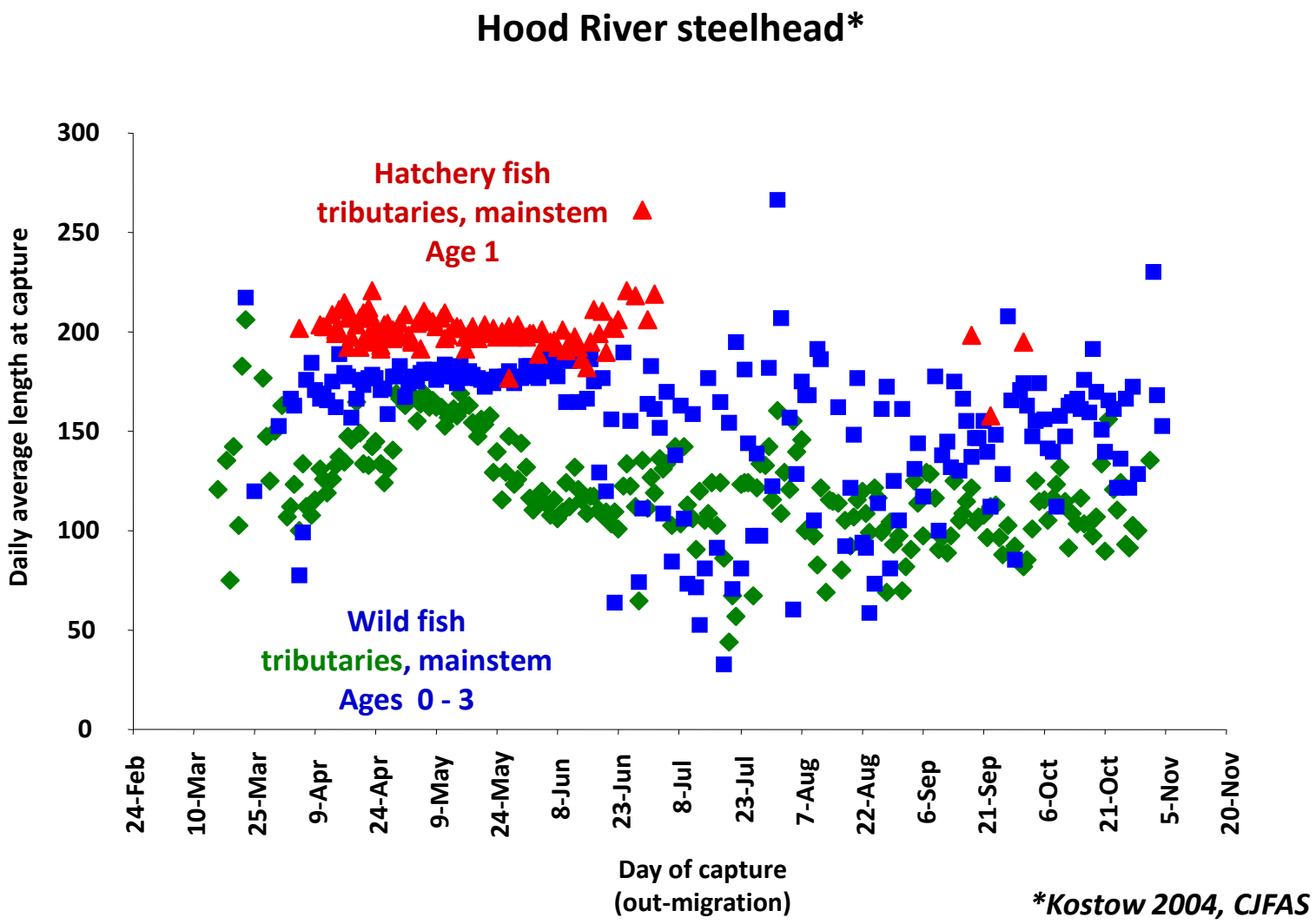
Steelhead

Chinook

Atlantic Salmon

** Kostow 2009, RFBF*

Factors contributing to ecological risks:

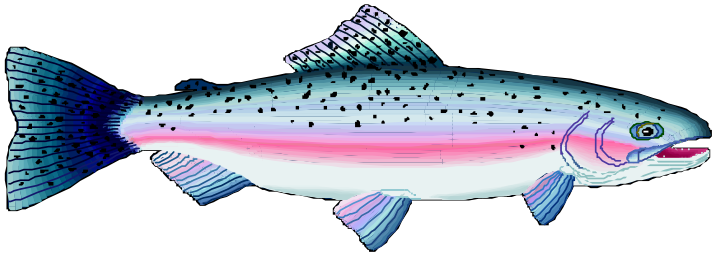


**Kostow 2004, CJFAS*

Factors contributing to ecological risks:

Species differences

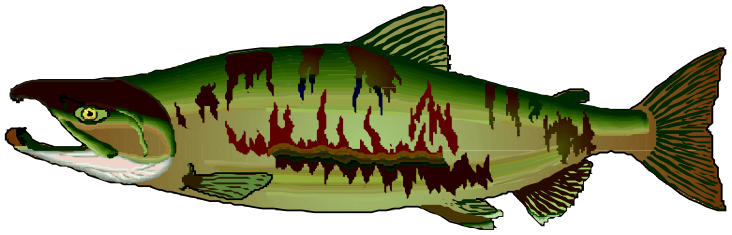
More opportunity for impacts:
Hatchery programs for stream-rearing and resident species



Steelhead
Coho
Atlantic Salmon
Stream-rearing Chinook
Rainbow Trout
Cutthroat Trout
Masu
Char

Less opportunity for impacts:
Hatchery programs for ocean-rearing species

Chum
Pinks
Ocean-rearing Chinook



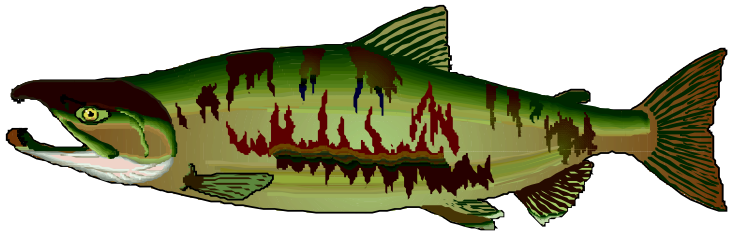
** Kostow 2009, RFBF*

Factors contributing to ecological risks:*

Species differences

Vulnerable to impacts due to hatchery programs for other species

Chum
Pinks
Ocean-rearing Chinook



** Kostow 2009, RFBF*

Strategies to decrease ecological risks:

An Overview of Risk-Reduction Strategies*

1. **Operate hatchery programs within an integrated management context**
2. **Only implement hatchery programs that provide a benefit**
3. **Reduce the number of hatchery fish that are released**
4. **Scale hatchery programs to fit carrying capacity**
5. **Limit the total number of hatchery fish that are released at a regional scale**
6. **Only release juveniles that are actively smolting and will promptly out-migrate**

*** Kostow 2009, RFBF; Kostow 2012, EBF**

Strategies to decrease ecological risks:

An Overview of Risk-Reduction Strategies*

7. Release smaller hatchery fish, provided they are smolting
8. Use acclimation ponds and volitional releases
9. Locate large releases of hatchery fish away from important natural production areas
10. Time hatchery fish releases to minimize ecological risks
11. Restrict the number of hatchery adults allowed into natural production areas
12. Mark 100% of the hatchery fish and monitor the effects of hatchery programs

* Kostow 2009, RFBF; Kostow 2012, EBF

Strategies to decrease ecological risks:

An Overview of Risk-Reduction Strategies*

13. **Reduce harvest impacts on wild fish**
    - **(SAF fisheries, mark-selective fisheries)**
14. **Reduce disease risk**
15. **Reduce facility operations risk**
16. **Reduce or remove non-native fish from natural production areas**
17. **Restrict resident hatchery fish releases to closed water bodies**
18. **Other strategies that are unique to a program**

*** Kostow 2009, RFBF; Kostow 2012, EBF**

An Overview of Risk-Reduction Strategies*

Reduce the opportunity for interactions

* Kostow 2009, RFBF; Kostow 2012, EBF

Some Concluding Principles

1. **Risk-reduction programs need to operate within a management context: establishes authority, sets objectives and priorities, coordinates and confirms agreement among participants**

2. **The most effective programs will be large in scope, covering large geographic areas such as an entire river basin, often across jurisdictions**

3. **Within a geographic area, the strategies may need to address multiple hatchery programs for multiple species**

4. **Most programs will employ multiple strategies to mitigate ecological risks**

5. **Attention to expected outcomes and periodic reassessment is needed to keep the programs moving in the intended direction**

6. **Risk-reduction programs may take years to reach complete full, effective implementation**

Thanks!

Acknowledgments:

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