Framework modeling of ecotype production for a sympatric population of anadromous and resident *O. mykiss*: Yakima River, Washington

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FISHERIES
YKFP
YAKAMA NATION

Yakima River Summer Run Steelhead

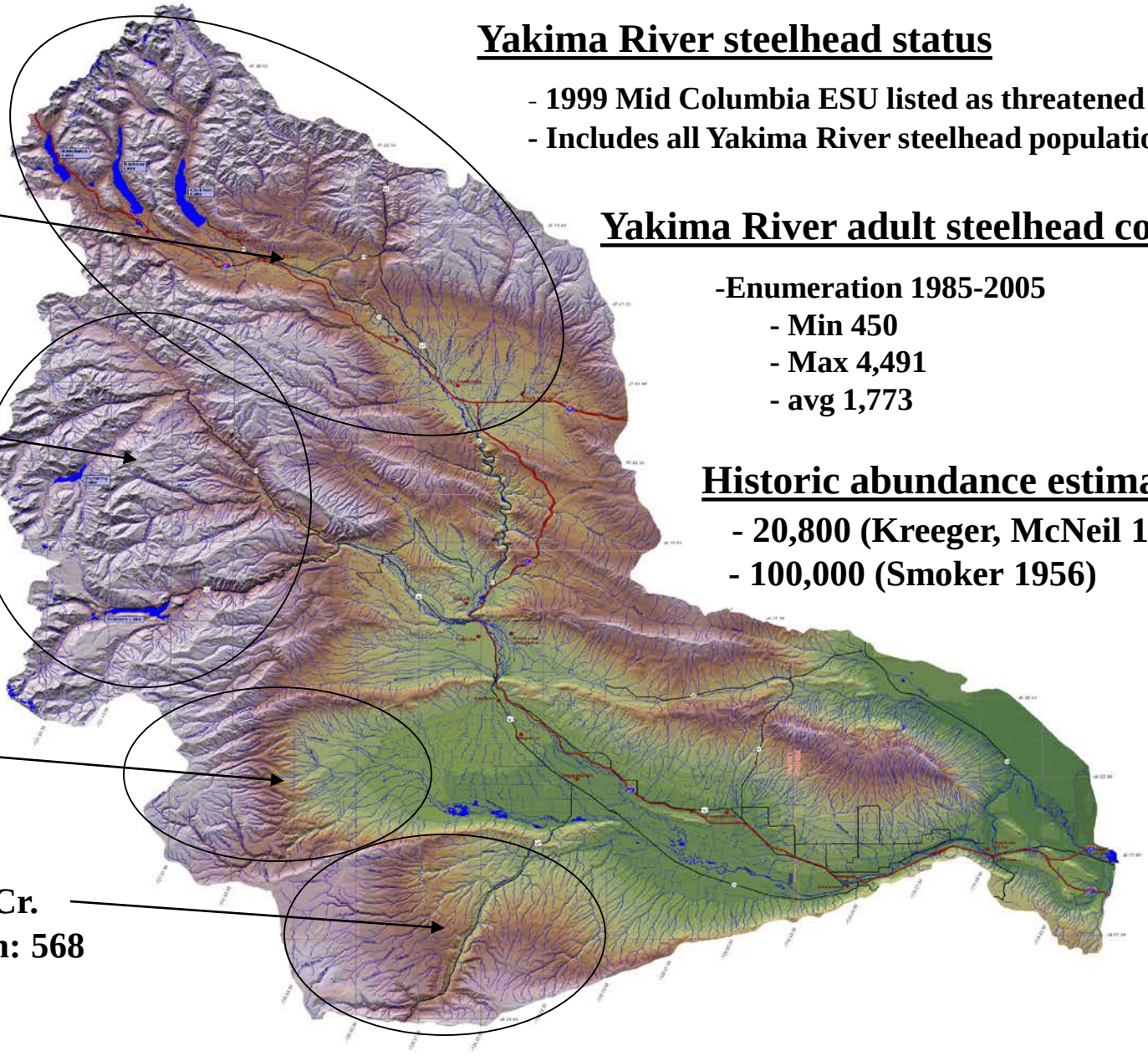
Populations

Upper Yakima R.
Gmean: 92

Naches R.
Gmean: 462

Toppenish Cr.
Gmean: 148

Satus Cr.
Gmean: 568



Yakima River steelhead status

- 1999 Mid Columbia ESU listed as threatened
- Includes all Yakima River steelhead populations

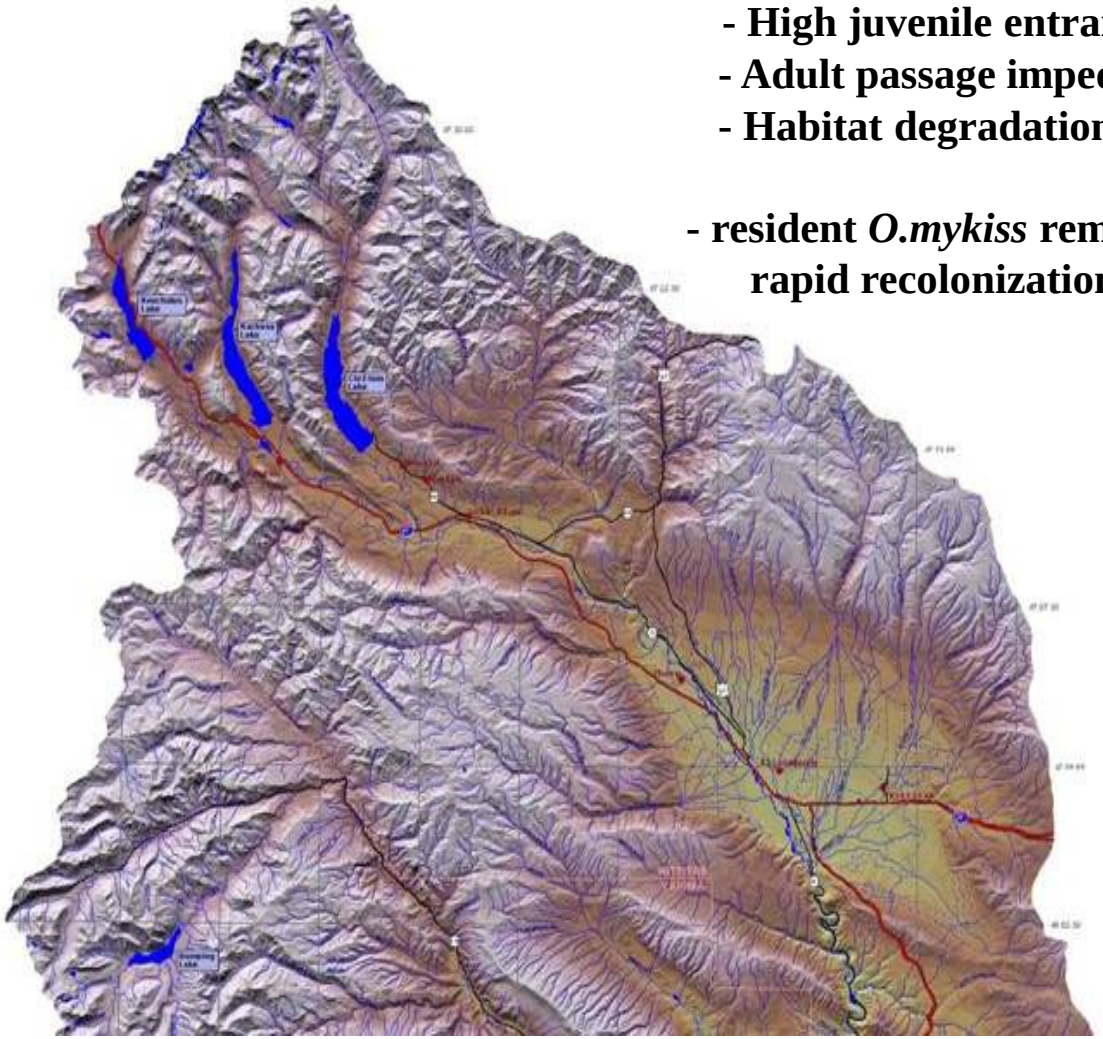
Yakima River adult steelhead counts

-Enumeration 1985-2005
- Min 450
- Max 4,491
- avg 1,773

Historic abundance estimates

- 20,800 (Kreeger, McNeil 1993)
- 100,000 (Smoker 1956)

Upper Yakima River Steelhead



Significant decline: 1850~1950

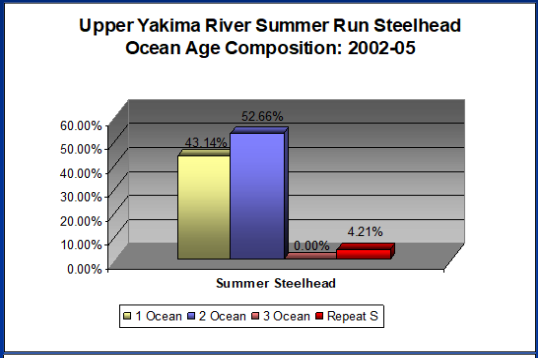
- **High juvenile entrainment rates**
- **Adult passage impedement**
- **Habitat degradation**

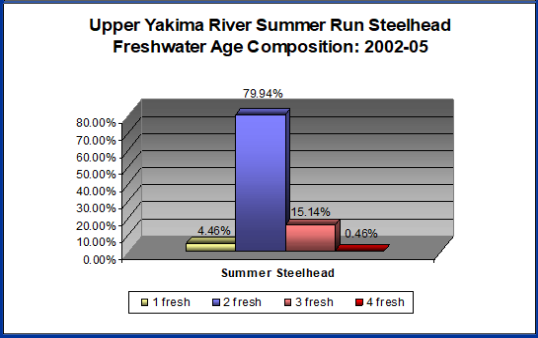
- **resident *O.mykiss* remaining above contributed to rapid recolonization (Berg 2001)**

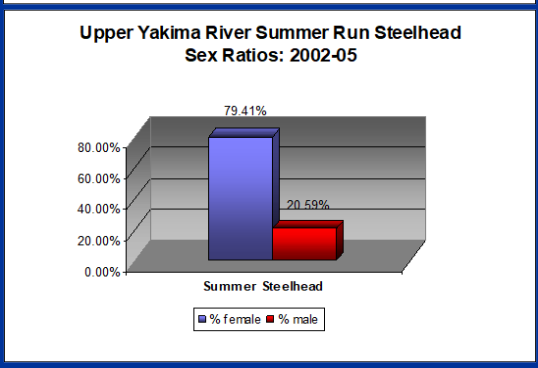
Return Year	Roza Adult count
1992	107
1993	15
1994	28
1995	22
1996	90
1997	22
1998	51
1999	14
2000	14
2001	133
2002	236
2003	128
2004	211
2005	224

Upper Yakima River Steelhead demographics

Age Structures 2002 – 2005







Ocean age composition

- 43.14% 1 ocean
- 52.66% 2 ocean
- 0.00% 3 ocean
- 4.21% repeat spawners

Freshwater age composition

- 4.46% 1 fresh
- 79.94% 2 fresh
- 15.14% 3 fresh
- 0.46% 4 fresh

Steelhead adult Sex ratios

- 79.41% female
- 20.59% male

Presentation Outline

I. Modeling objectives

II. Definition of sympatric population

1. Degree of sympatry in Upper Yakima River

III. Overview of anadromy and residency determinants

IV. *O.mykiss* Life Cycle Model synopsis & major components

1. Relative abundance and egg deposition
2. Freshwater growth and recruitment
3. Survival and adult recruitment

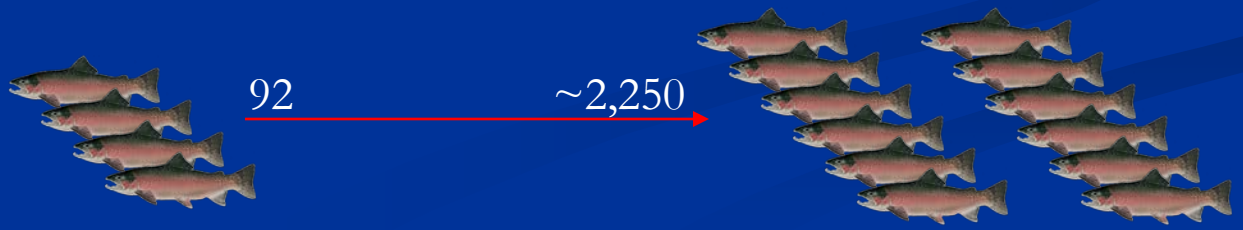
V. *O.mykiss* life cycle model pilot runs

1. Predictions and behavior
2. Future work and applications

Modeling Objectives

I. Sympatric *O. mykiss* population dynamics
   1. Life history interactions
   2. Environmental conditions

II. Identification of optimal management strategies
   1. Supplementation scenarios
      a. Life history brood source
      b. Magnitude of program
   2. Restoration scenarios
      a. Changes in survival
      b. Changes in habitat



What is a sympatric population of resident and anadromous *O.mykiss?*

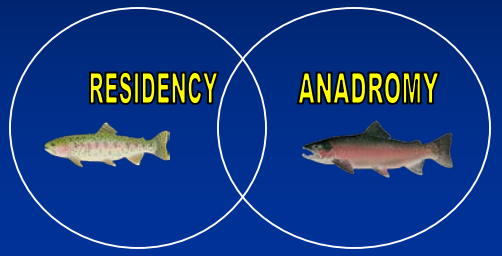
- Sympatry- "Occurring in the same area; *specifically* : occupying the same range without loss of identity from interbreeding".

- Prerequisites for a population of O.mykiss defined under sympatry:
  - Overlap in spatial and temporal distribution between resident and anadromous ecotypes.

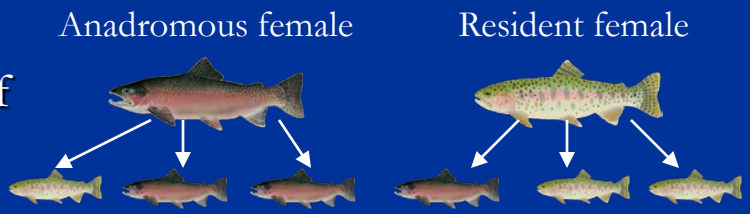
    1. Reproductive isolationism
       - Occur during freshwater rearing lifestages
       - Competition for food and space
    2. Spawning life stage
       - Inbreeding potential

Determinants of anadromy and residency:

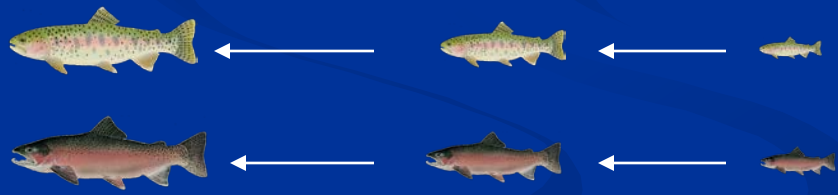
1. Degree of sympatry and interbreeding



2. Genetic inheritance of predisposition



3. Environmental factors directly affecting size and growth rates

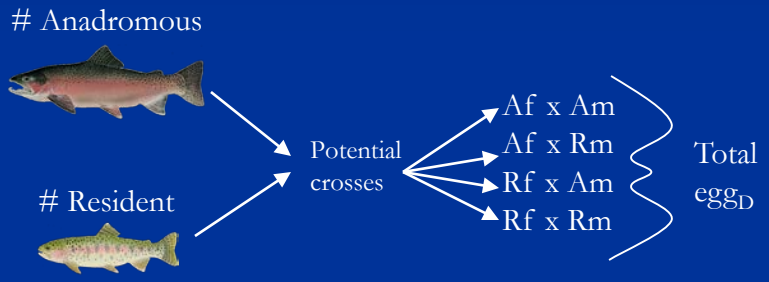


4. Relative productivity specific to anadromous and Resident ecotypes

O.mykiss Life Cycle Model synopsis

2.) Freshwater growth & recruitment

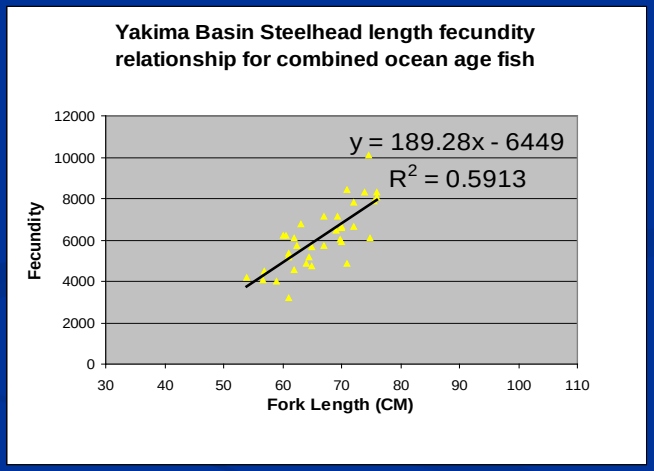
1.) Abundance and egg deposition:



3.) Survival & adult recruitment

Ecotype specific fecundity estimates

1.) Steelhead
- Sampled adults (brood years 86-87)
- 100% Upper Yakima steelhead sampled (2002-2005)
- mean fecundity by ocean age



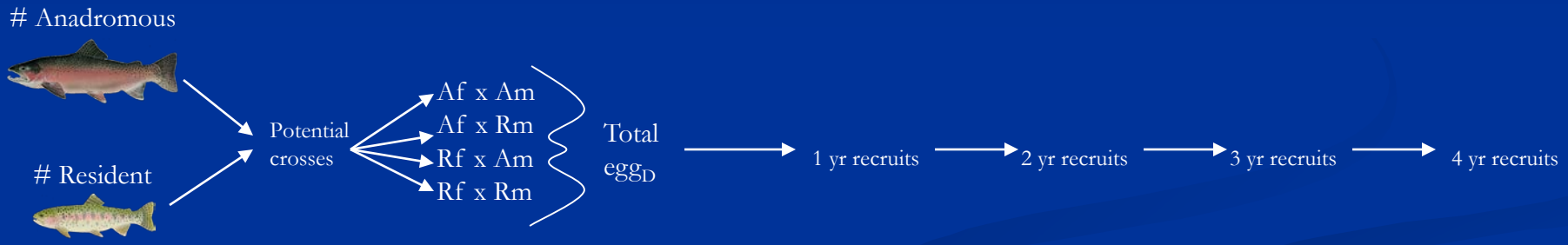
2.) Upper Yakima resident trout
- length fecundity relationship

F= (7.0055 * fork length) -1350.7
R^2 = 0.69 (A. Murdoch 1995)

O.mykiss Life Cycle Model synopsis

2.) Freshwater growth & recruitment

1.) Abundance and egg deposition:



3.) Survival & adult recruitment

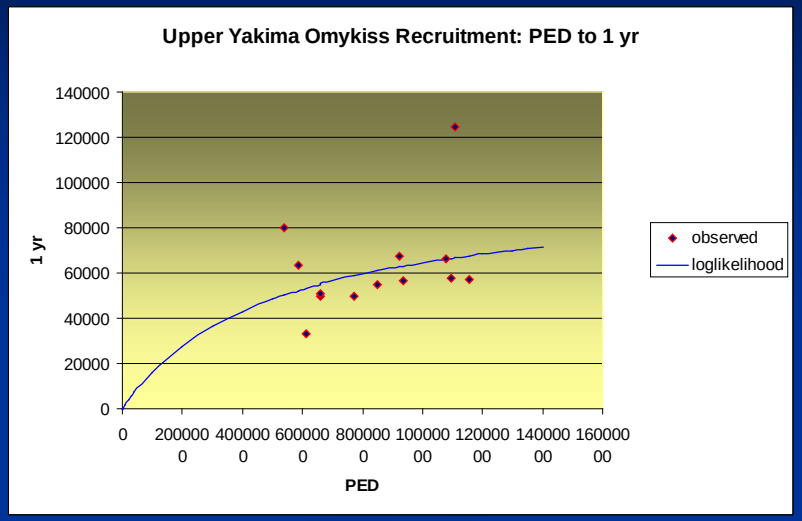
Development of freshwater recruitment curves

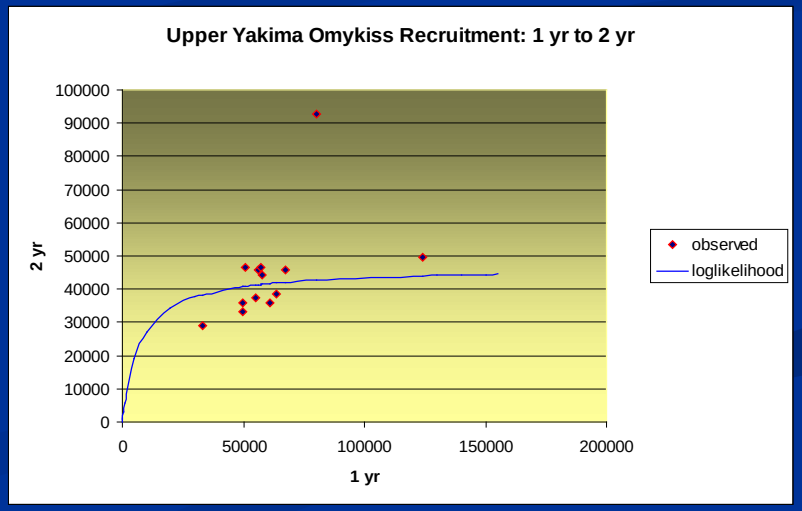
1.) O. mykiss age class abundance estimates

- WDFW (1991-2005)

2.) Recruitment curves

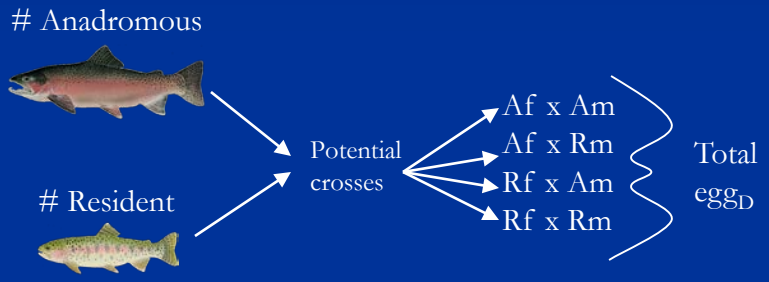
- 4 distinct curves constructed
- capturing density dependent effects
  - habitat's capacity & productivity
- negative log-likelihood used to fit curves





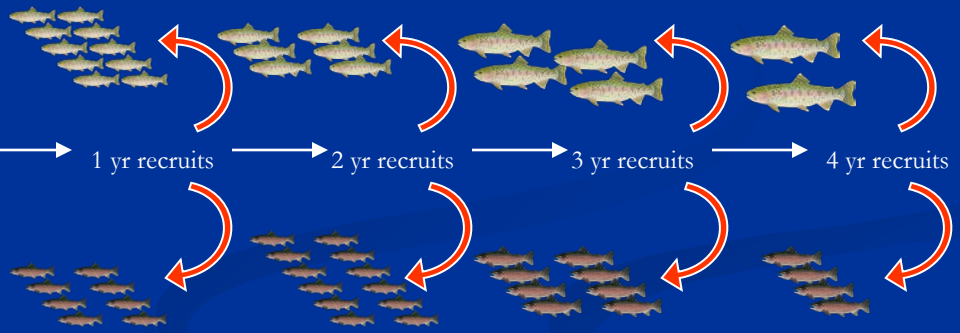
O.mykiss Life Cycle Model synopsis

1.) Abundance and egg deposition:



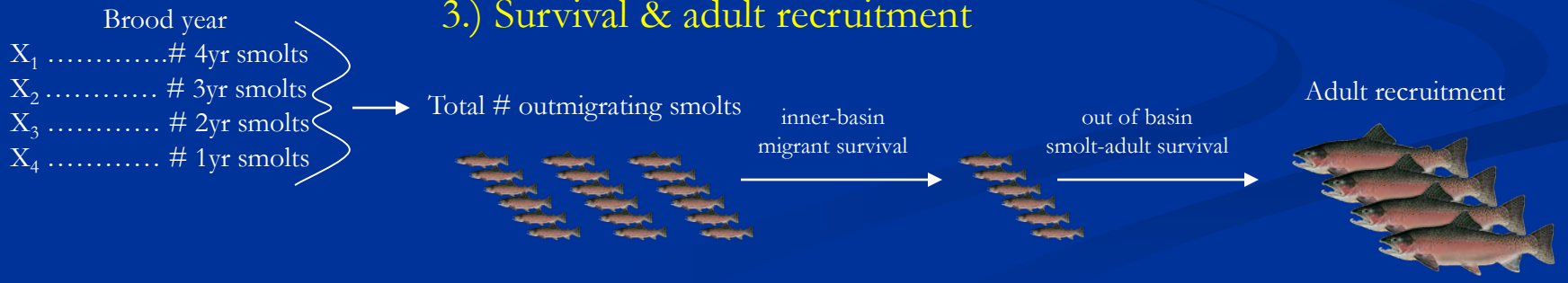
2.) Freshwater growth & recruitment

2.a.) Resident age class & maturity proportion

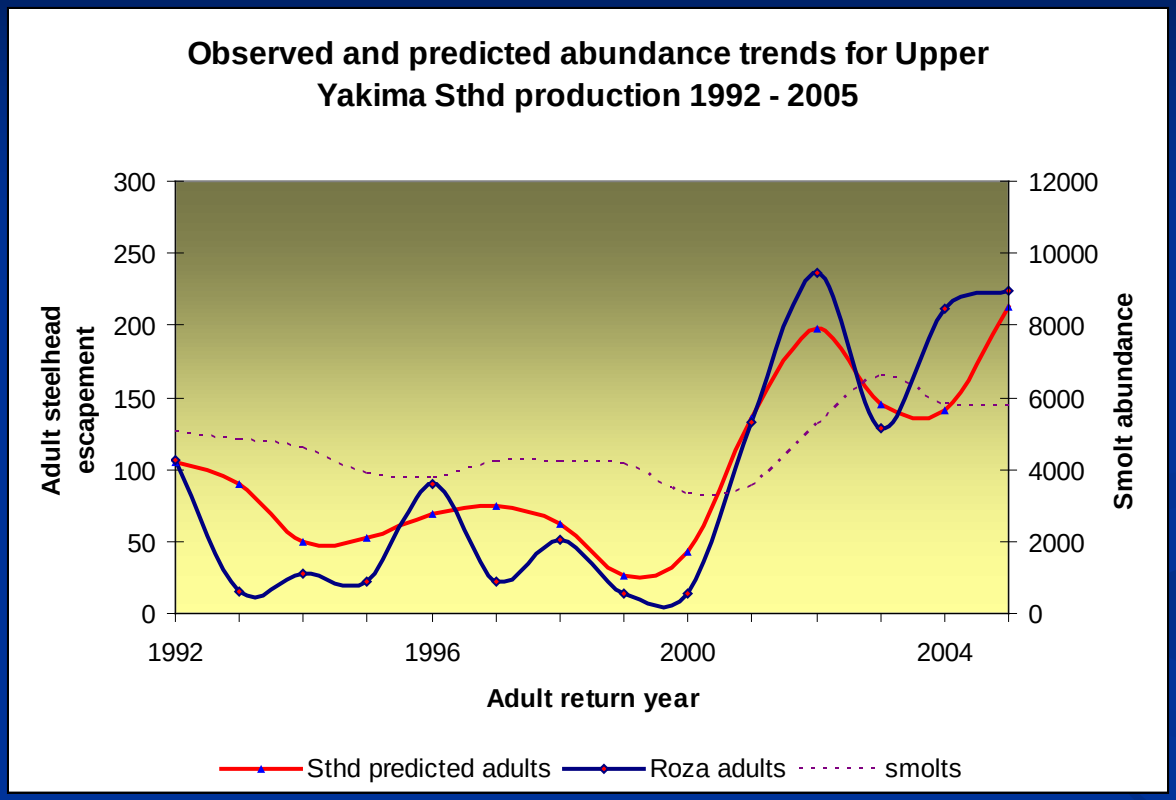


2.b) Anadromous recruitment & freshwater smolt age

3.) Survival & adult recruitment

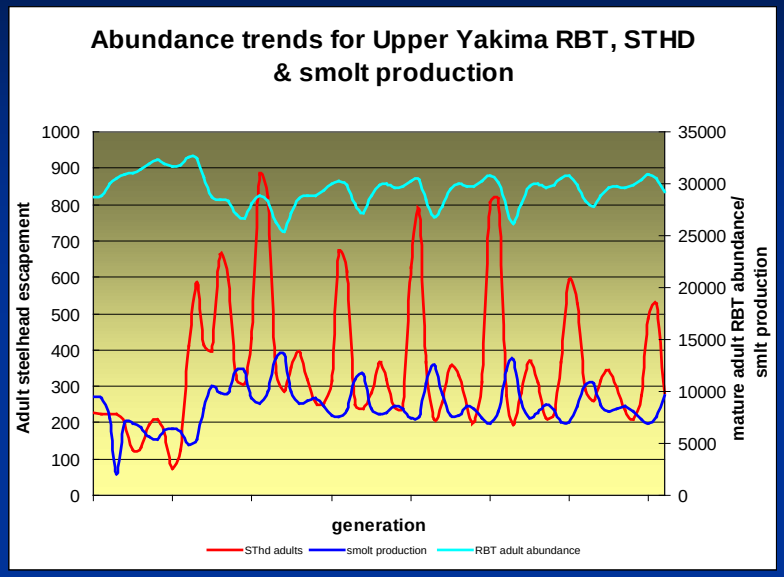


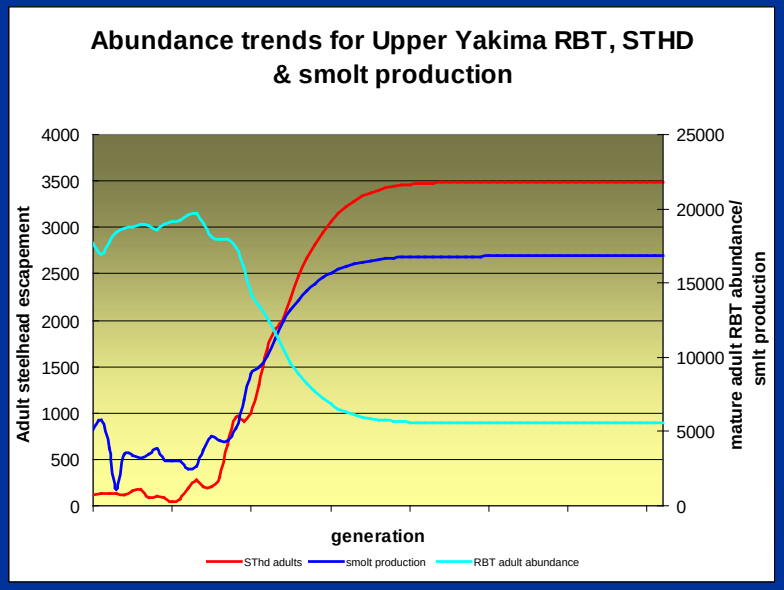
Sympatric *O. mykiss* model: pilot run



Observed vs predicted 1992 - 2005

Sympatric *O. mykiss* model: pilot run





Habitat restoration scenario

- Increased recruitment
  - 0 to 1 yr
  - Mean Abundance: 355

Threshold capacity limits

- Adult and smolt capacity estimates
  - ~ 3,500 adults
  - ~ 17,000 smolts
- Evaluate impacts to the resident pop.

Future direction and model revisions

I. Additional model components and work
   A. Stochastic elements
      1. Inner basin survival
      2. Genetic and Environmental influences
   B. Hatchery component
      1. Evaluate alternative supplementation strategies
         a. Magnitude of program
         b. Impacts of broodstock mining rates
         c. Alternative ecotype brood sources
            i. (Resident females vs Anadromous females)

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