Simulating Habitat Restoration:

Surprising Results from a Student Project on the Tucannon Salmon Model

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The Tucannon Salmon

The salmon population is described in Chapter 14 of *Modeling the Environment* (Island Press 1999).

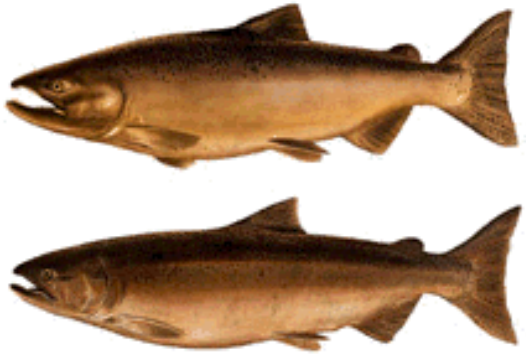
Extra Background on the Tucannon Salmon

The salmon pages provide additional information to supplement the introduction to the case in chapter 14 of the book. The additional background will be useful if you conduct a class project to expand and improve the salmon model in chapter 14.

Modeling the Life Cycle (a large file)
Graphical Analysis of the MSY

Links to Related Websites:

The US Army Corps of Engineers
The Bonneville Power Administration
The Northwest Power Planning Council
The Fish Passage Center
Northwest Fish Newsletter
list of sites (by Corps of Engineers)



The Chinook Salmon, Freshwater Phase.
The top fish is a male; the lower fish a female.
(photo courtesy of US Fish and Wildlife,
via the website of the US Army, Corps of Engineers)

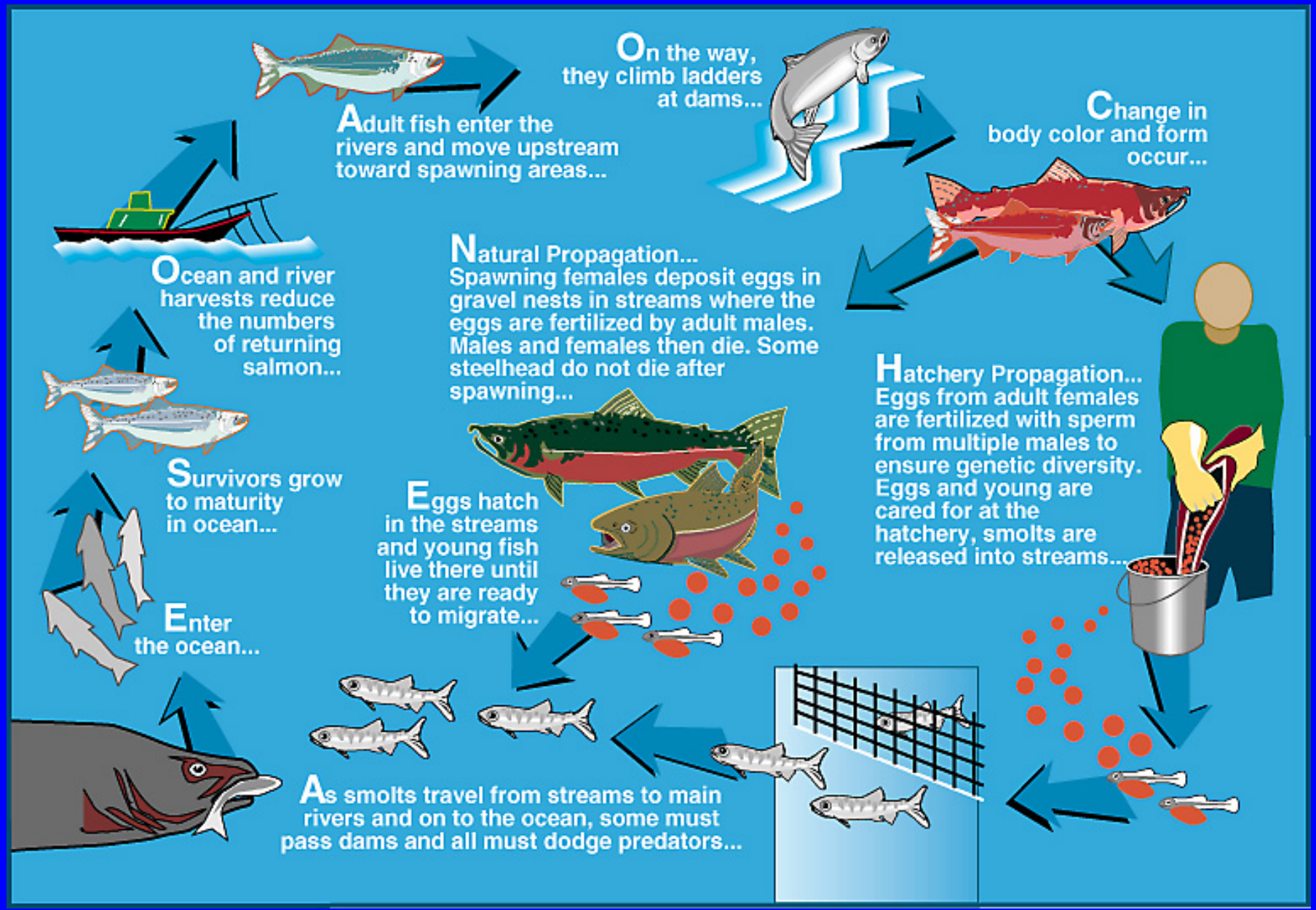
Eggs & Emergent Fry

Juveniles: Spend One Year Competing for Space in the Habitat

The Smolt Migration

Closer Look at the Migration Corridor

The Salmon Life Cycle



p. 155: Around 22,000 Returning Adults

Is ~20 Thousand Salmon Plausible?

The Columbia Basin drainage is around 800 times larger than the Tucannon.

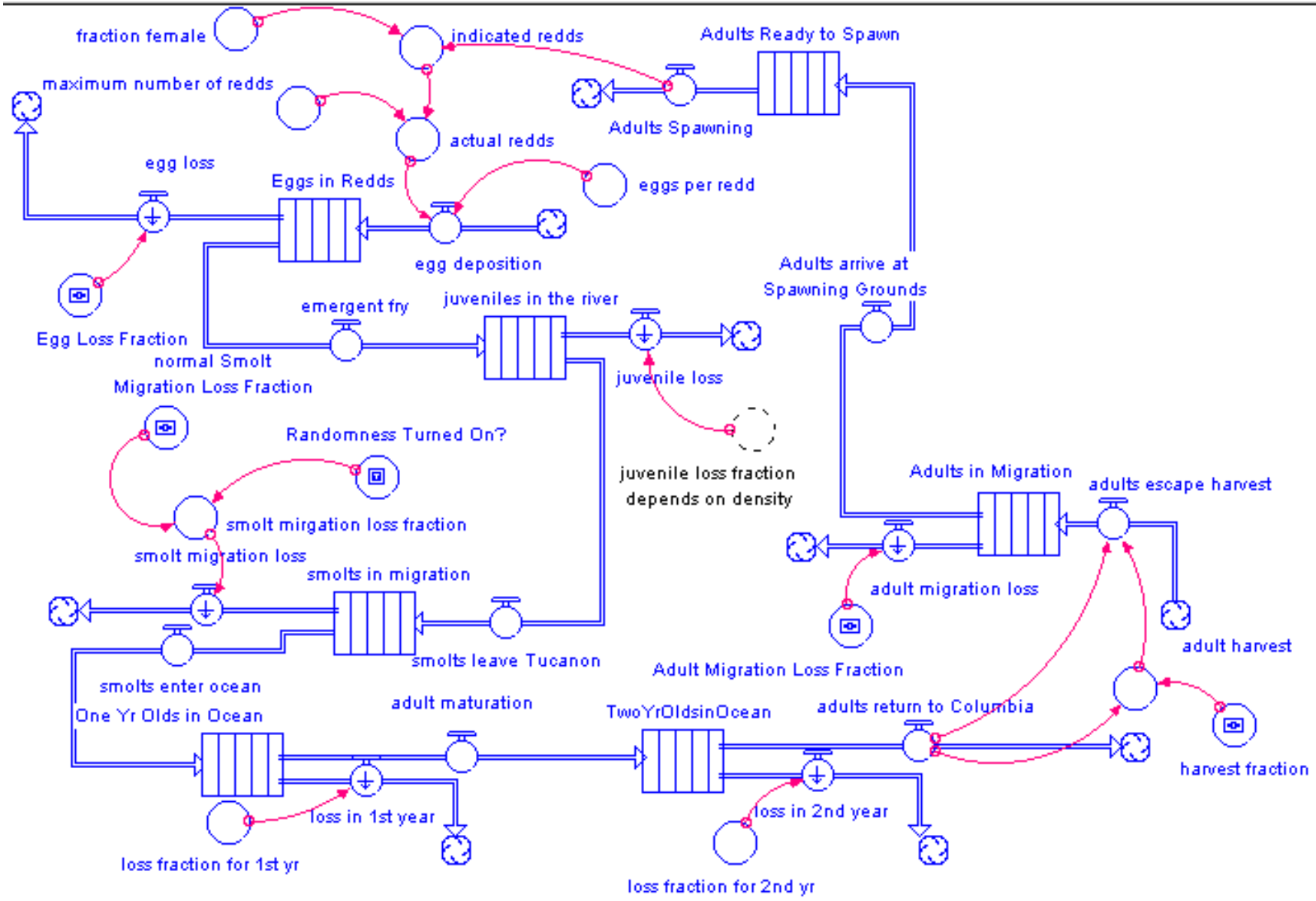
16 million adults is reasonable – see page 1-6 of the 1992 Corps. Of Engineers Columbia River Salmon Flow Measures EIS

End of the Photos:

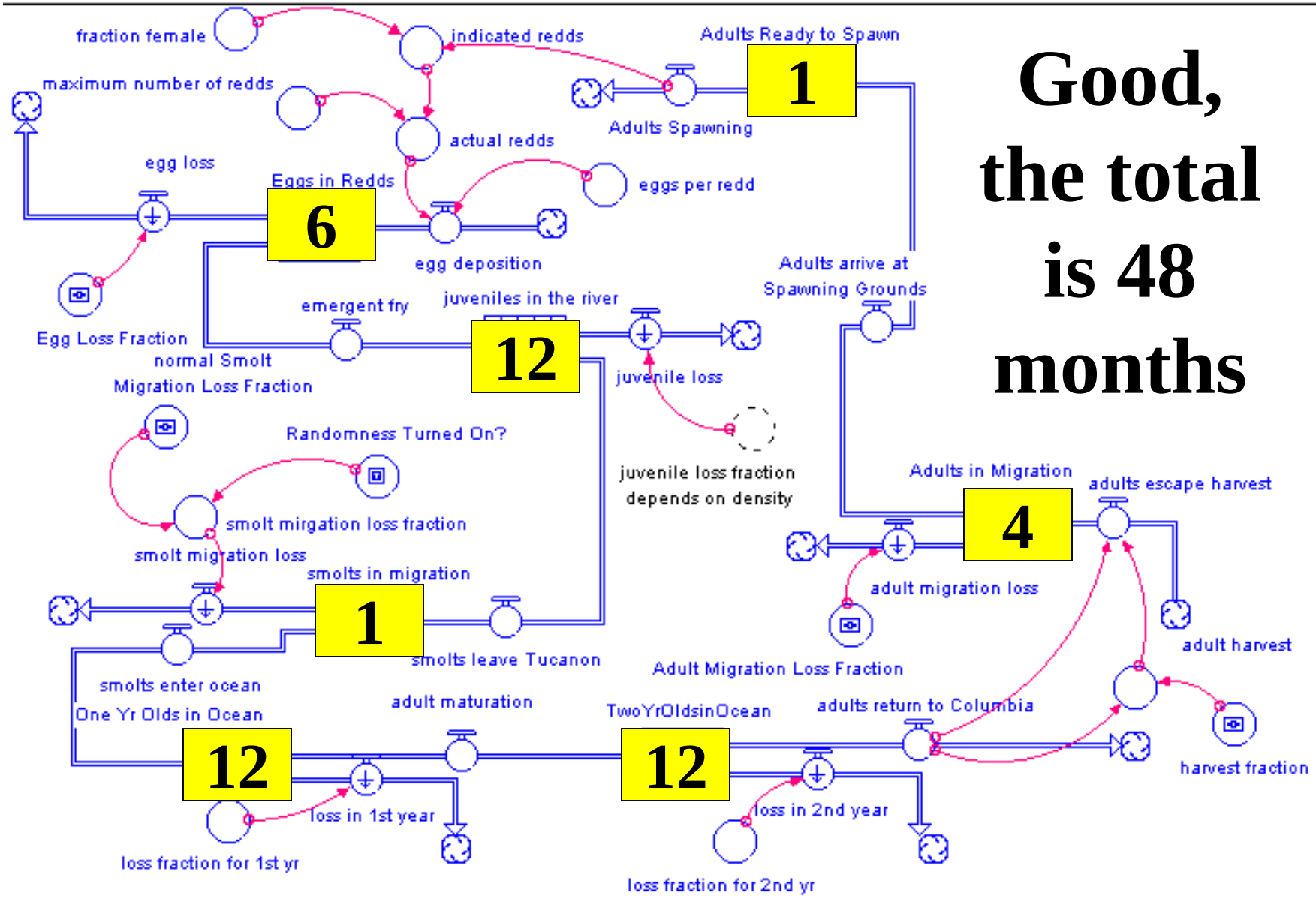
Now show us the “hard stuff”.
Let’s see the mathematical model of the salmon population.

The model is described in Chapter 14 of Modeling the Environment, my 1999 textbook from Island Press. The model may be downloaded from the website for the book, found at http://www.wsu.edu/~forda

Fig 14.2. The Salmon Model

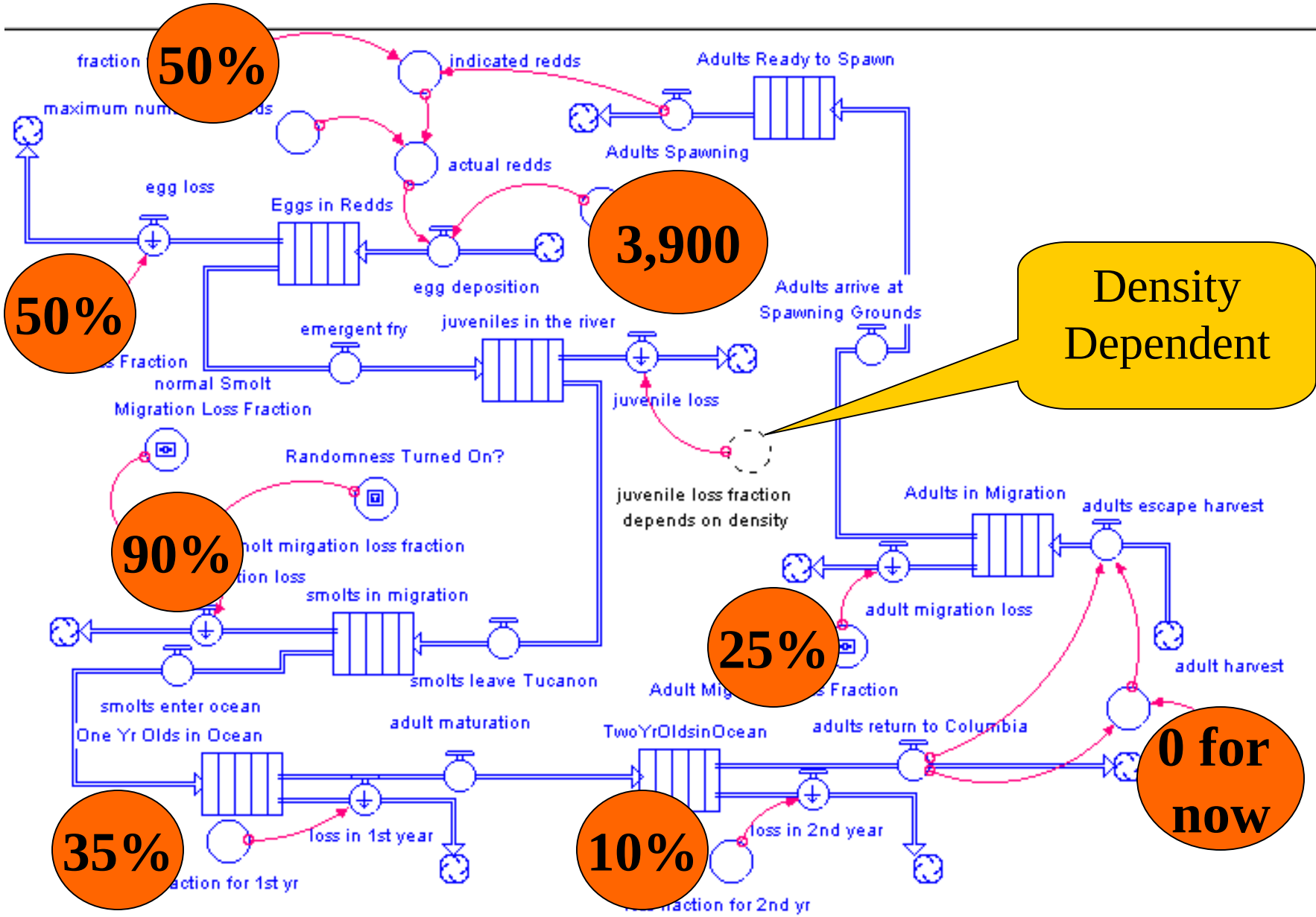


Model with Months in Each Stage of the Life Cycle

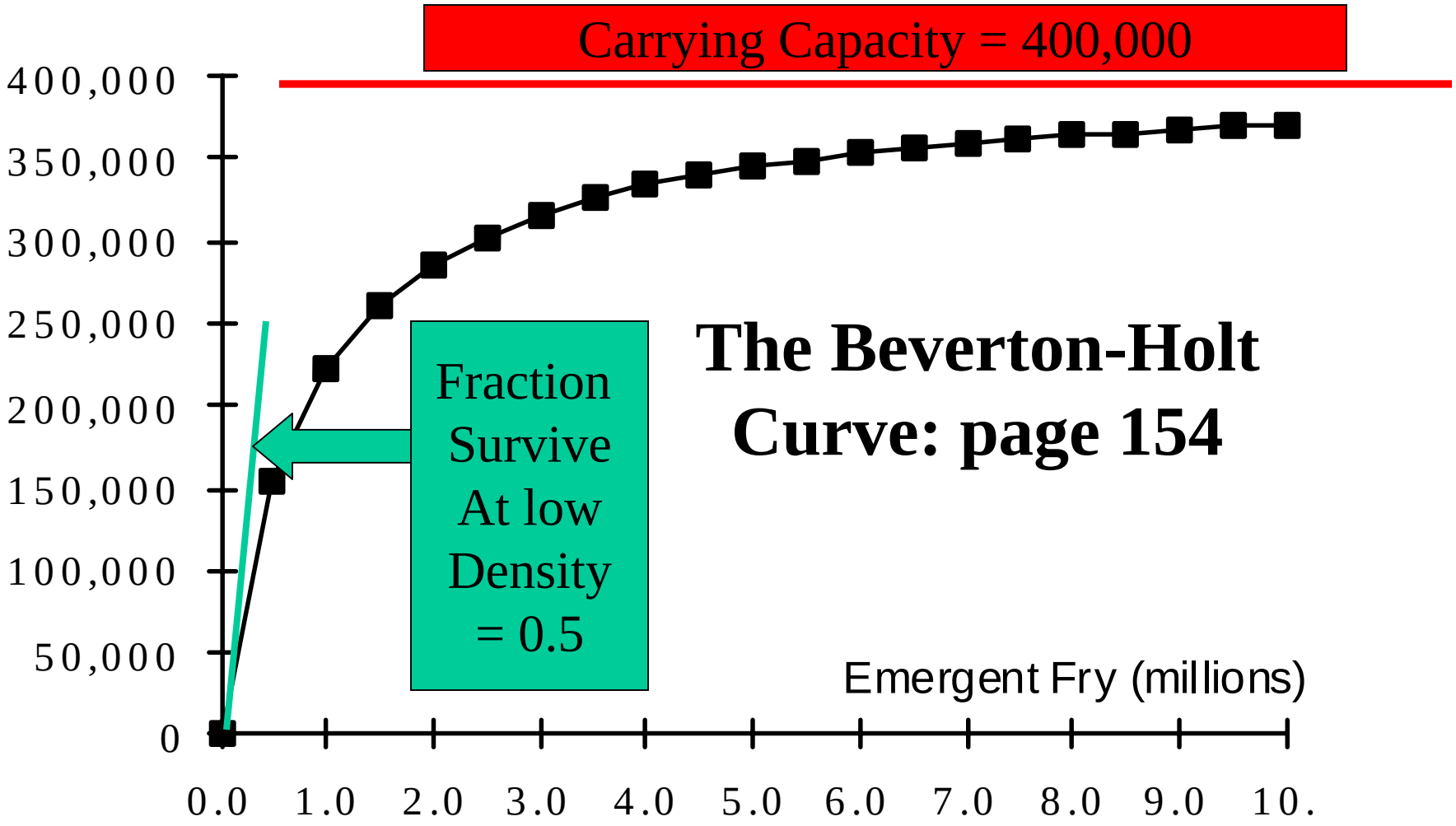


Good, the total is 48 months

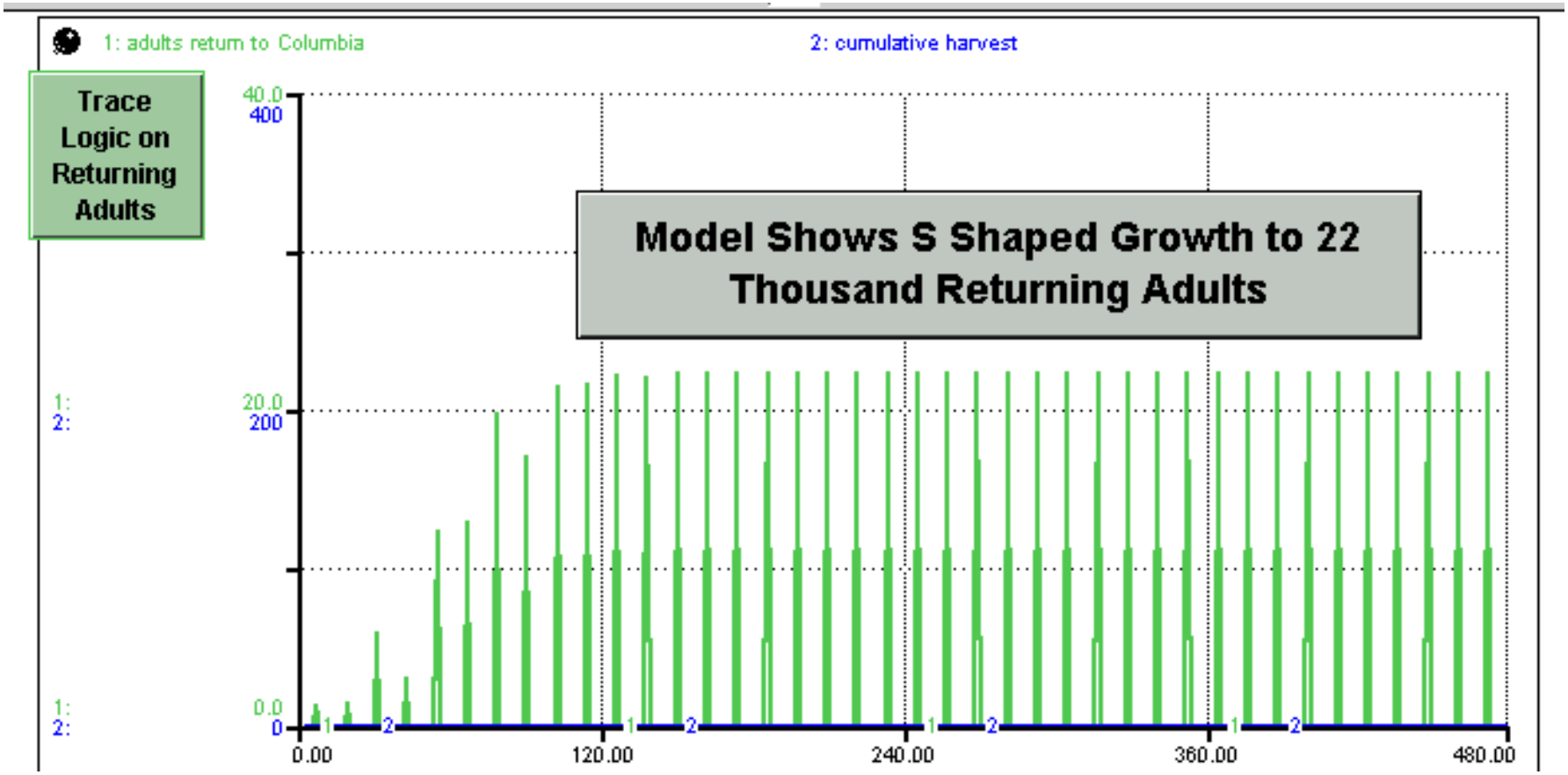
Density Independent Parameters



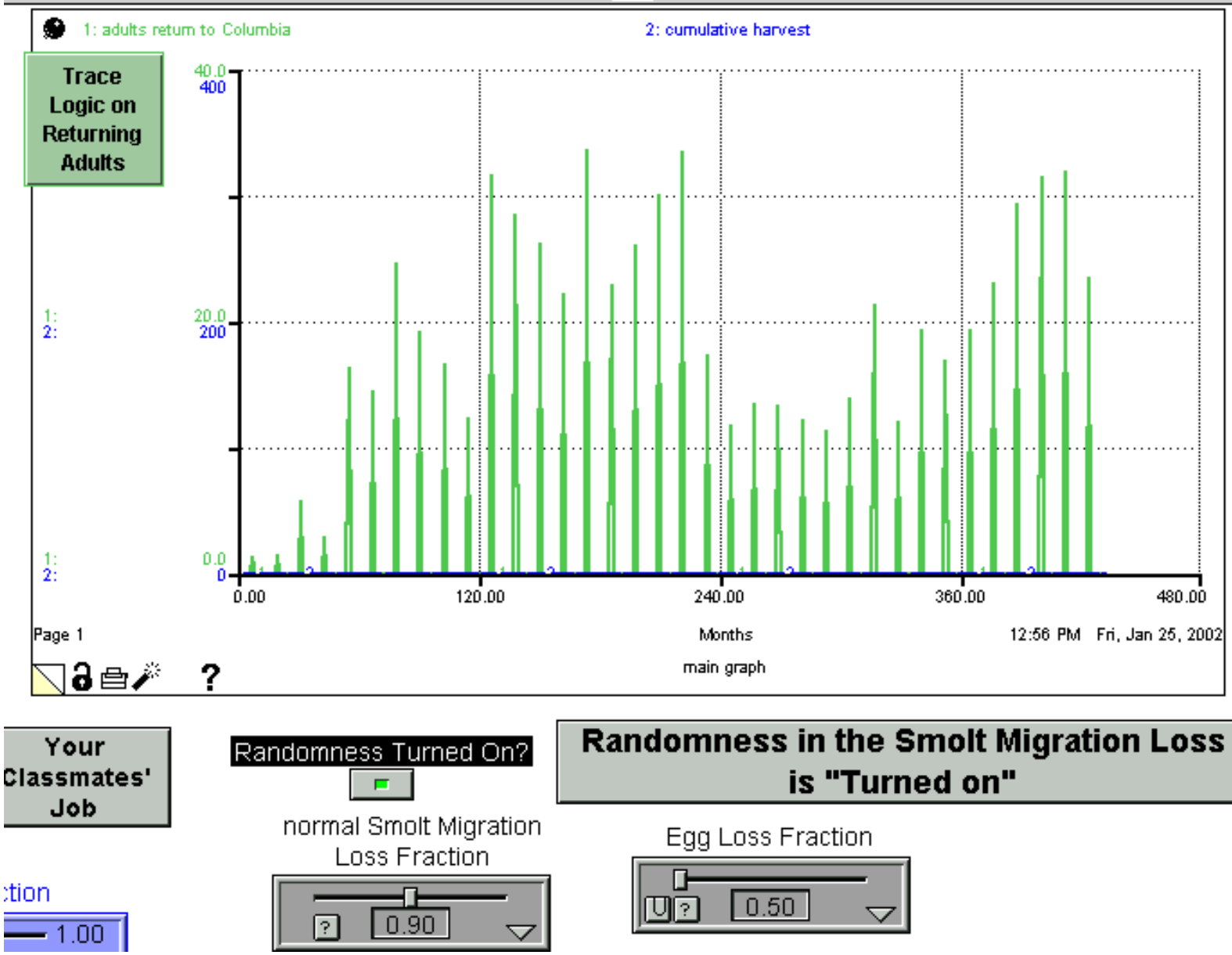
Juvenile Loss Depends on Density



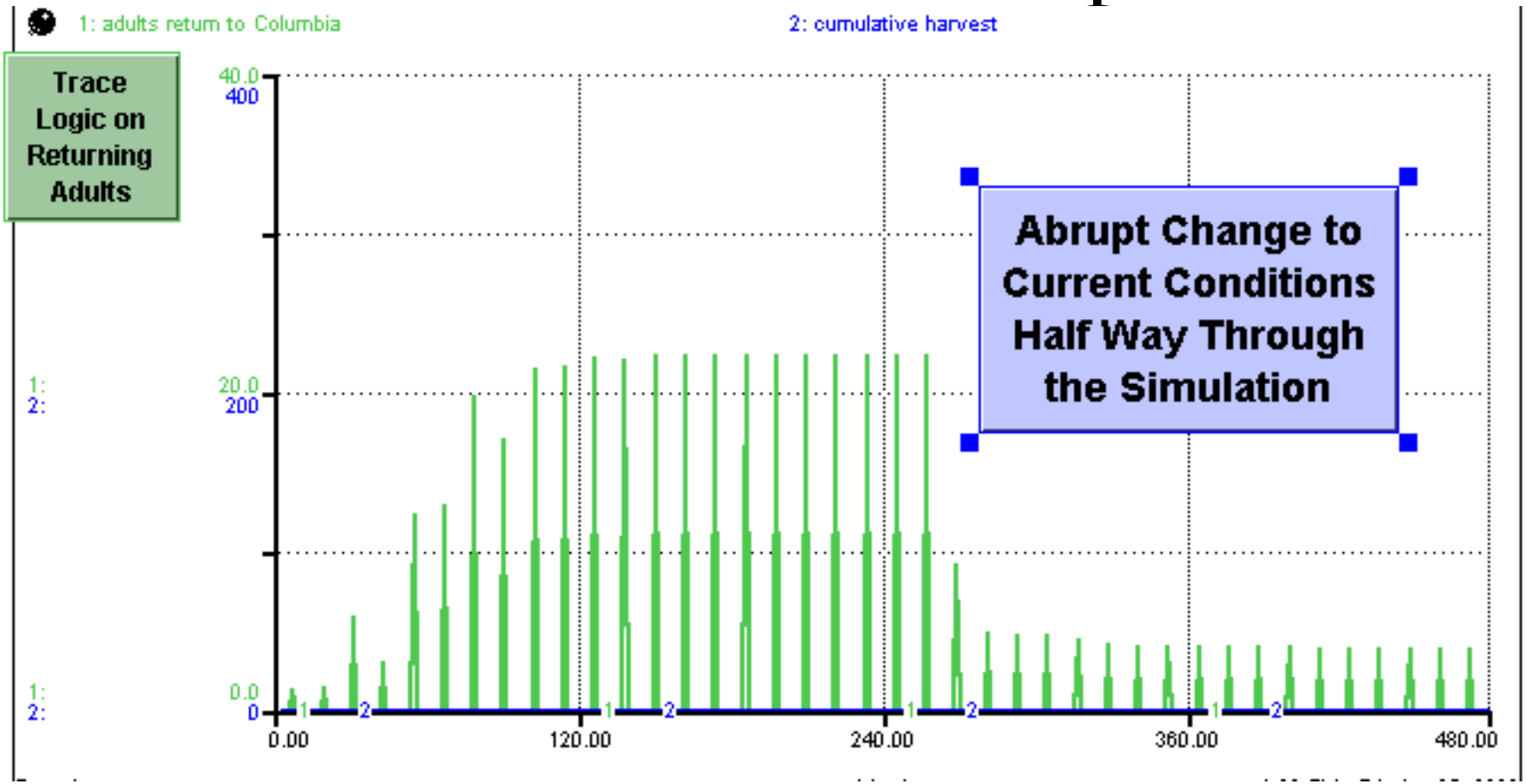
Do We Get S-Shaped Growth Under Undisturbed Conditions?



Do We See Large Variations?

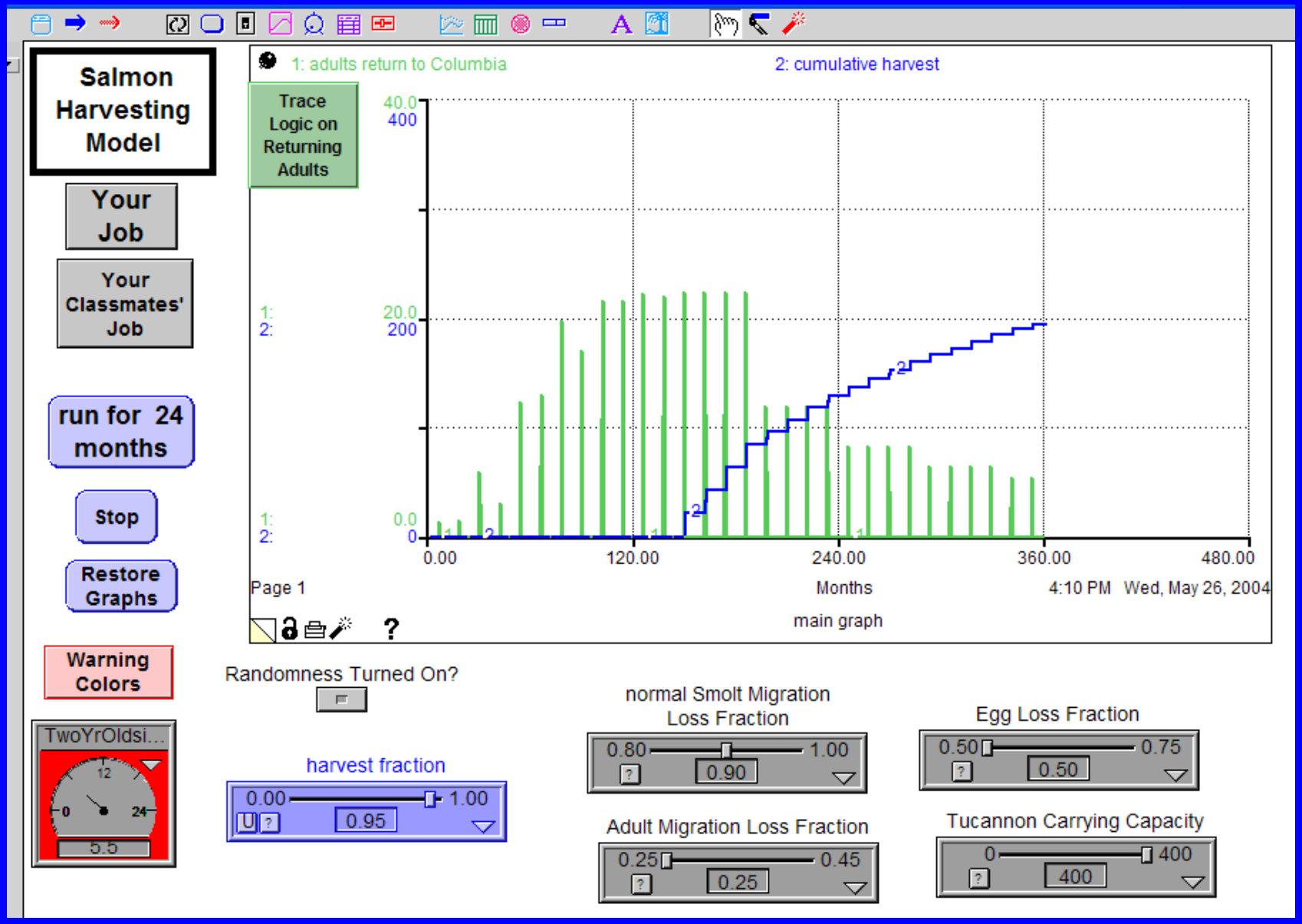


Do We See A Decline in Returns From Development?



The Model is Ready for Interactive Experimentation

Model for Experimentation at Skamania



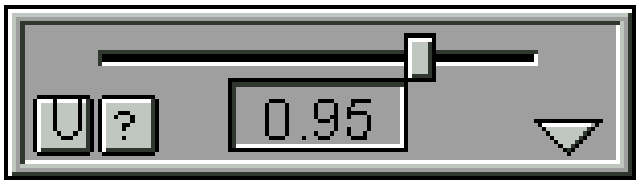
Discussion

- Likely results when Skamania teams experiment with the Tucannon Harvest Model
- Contrast with Fisheries around the world
- Lessons from “Fish Banks” Game
- Lessons from the Norwegian Fjord Experiment
- Generality of the Tendency to Over-invest (special issue of the *System Dynamics Review*, Summer 2004)
  - Reindeer grazing lands in the northern countries
  - Over development of irrigated lands in southern Spain
  - Over investment in Logging capacity in Indonesia

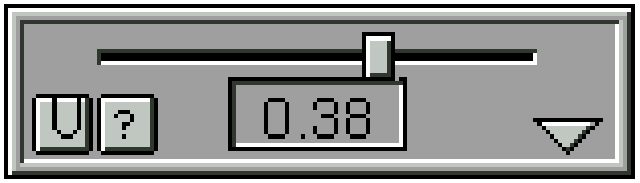
Example of a Student Project

Migration Inputs

normal Smolt Migration Loss Fraction

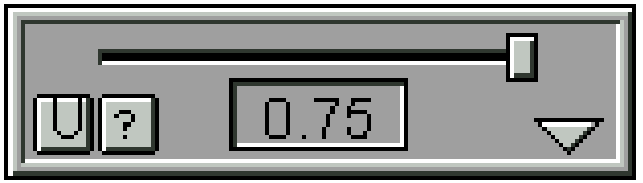


Adult Migration Loss Fraction

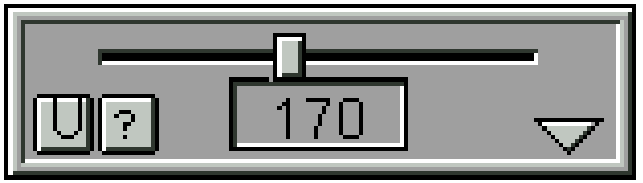


Habitat Inputs

Egg Loss Fraction

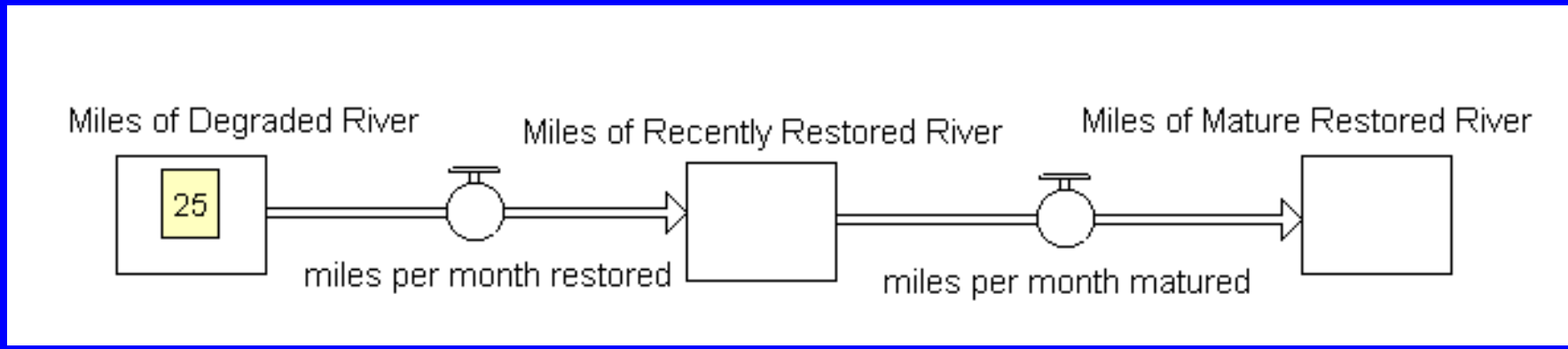


Tucannon Carrying Capacity



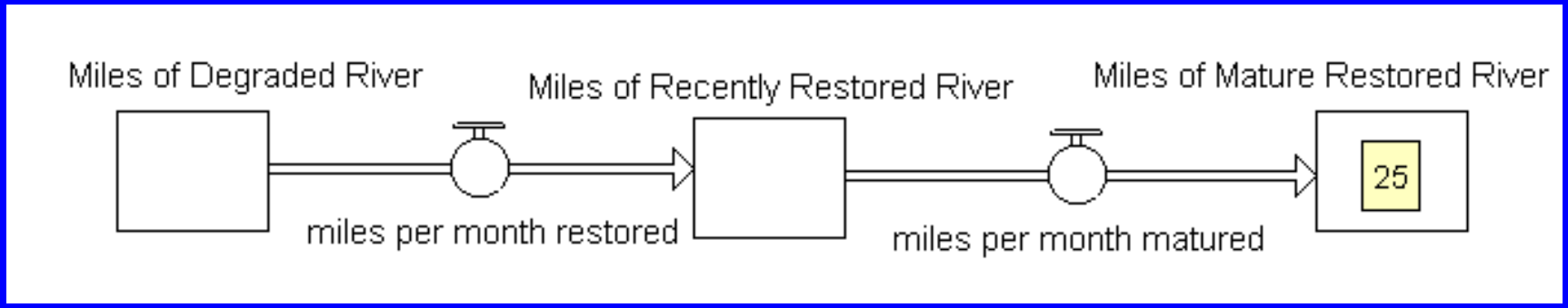
Project Idea:
Simulate Carrying Capacity in the Model

Student's Stocks & Flows



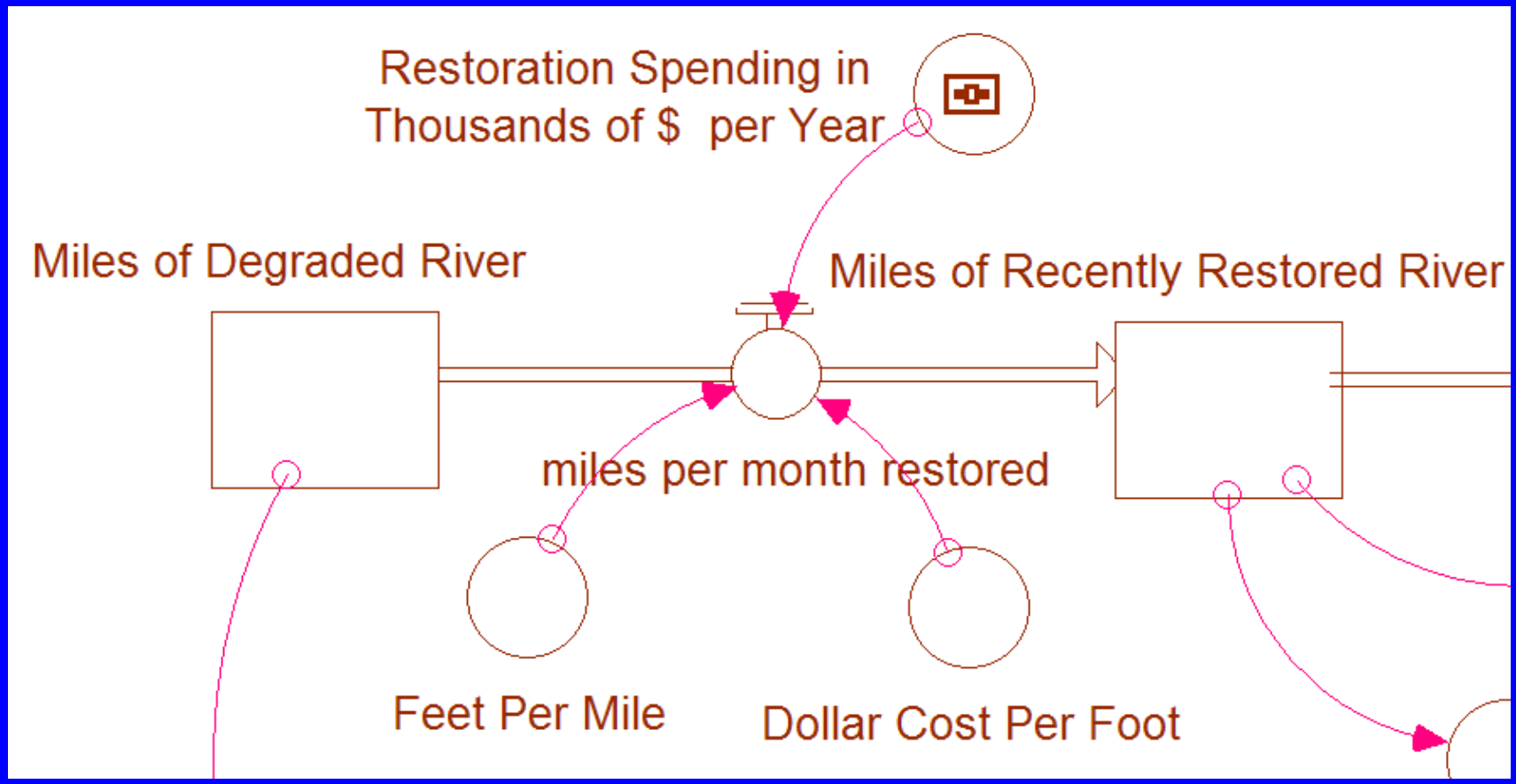
start with 25 miles of "Degraded River" with a capacity of 1 thousand smolts/mile

Fully Restored River



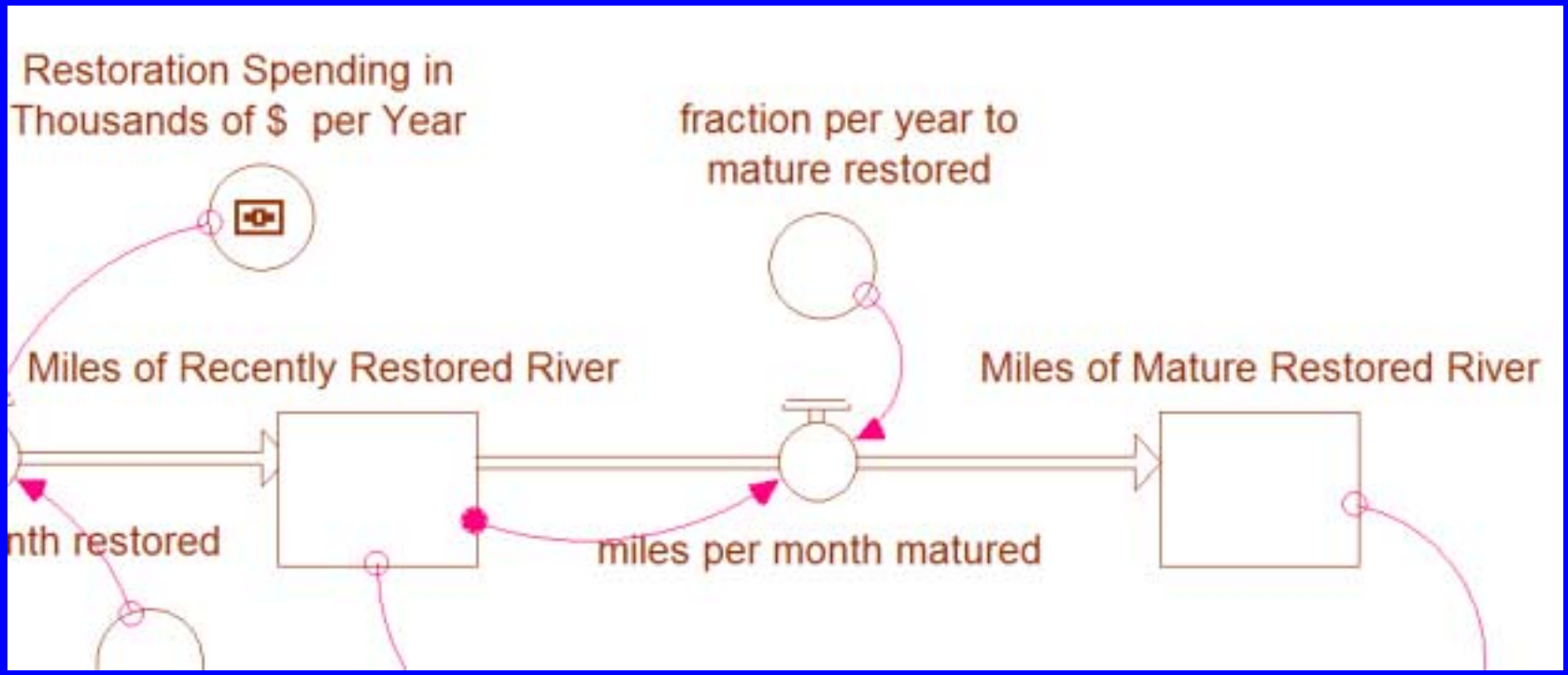
the other 25 miles of habitat is "Mature Restored River" with 8.3 thousand smolts/mile

Restoration Spending



For example: 25 miles times 5,280 feet per mile times $52 per foot of river is around $6,900 thousand. It takes around $7 million to restore the river.

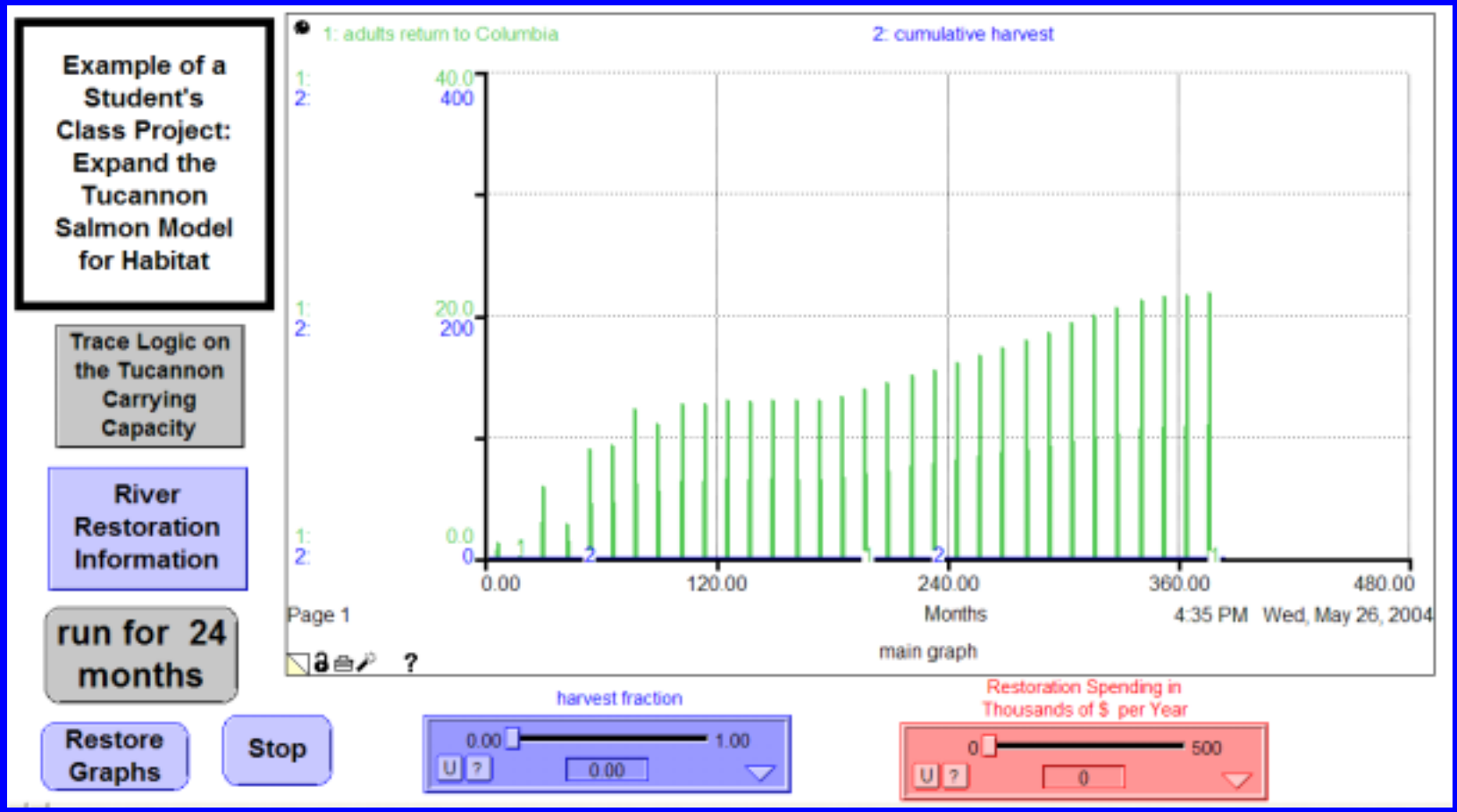
Nature Completes the Job



The student assumed that nature will convert recent restored miles to mature habitat at the rate of 10% per year.

Information Buttons in Student Model

The Student Model for Use at Skamania



The surprise comes when you experiment
with the harvest fraction,
which we will do at Skamania

Discussion of the Graduate Student's Experience

- Student's Initial Reaction to the simplicity of the simulated river conditions
- What could one really learn from such a simple model?
- His surprise came from experimenting with an "integrative" model, one that combined fluvial geomorphology with population biology.

Concluding Discussion: Transferability from Graduate School to K-12

- Transferability of web-based information
- Transferability of Interactive Models
- Transferability of Learning from "Integrative Models"