Species Life-Cycle Analysis Modules

http://www.nwfsc.noaa.gov/trt/slam/slam.cfm

Thanks to:
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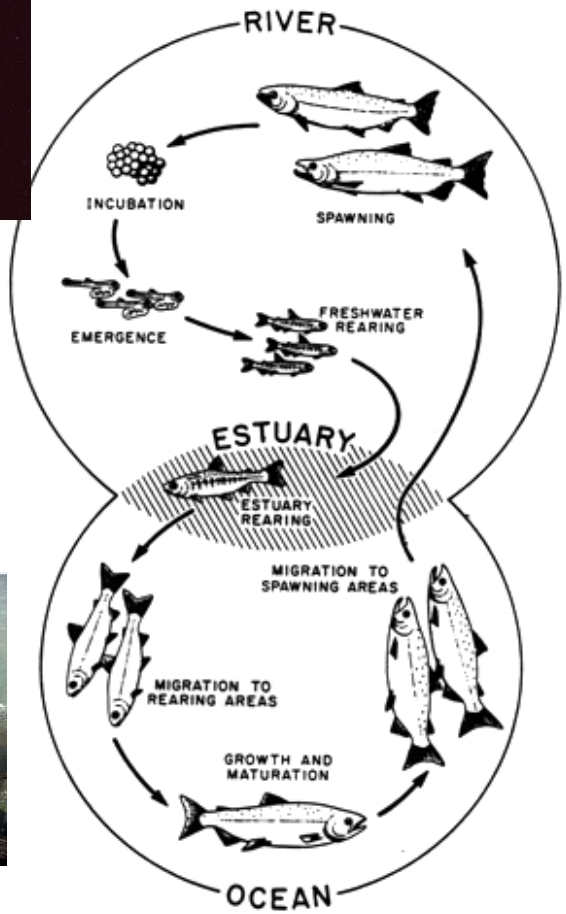
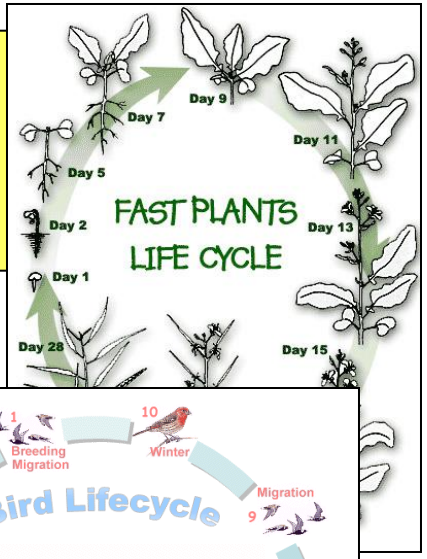
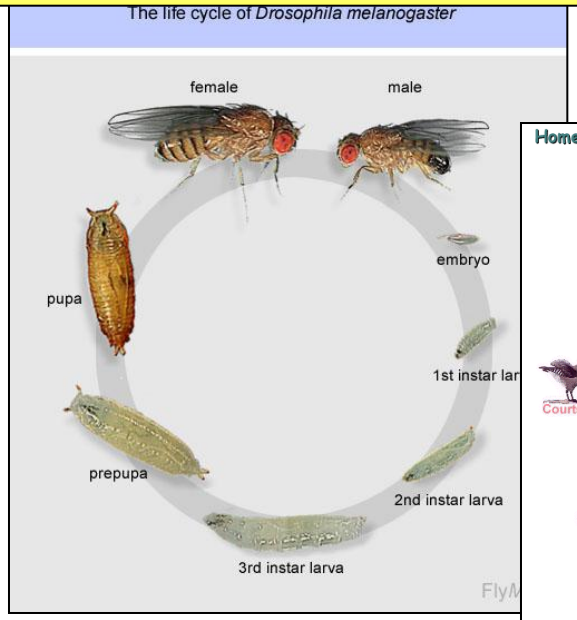
Why Life-cycle Models?

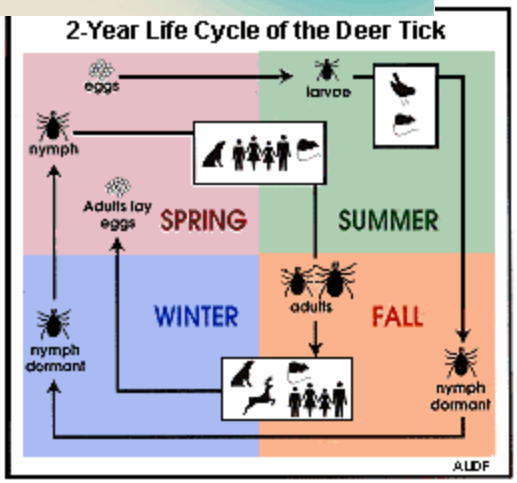
- Limiting life-stages
- Target restoration
- Assess population status
- Explore hypotheses and scenarios

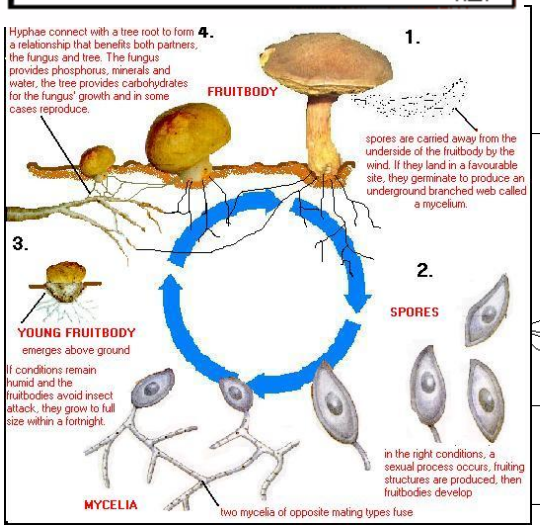


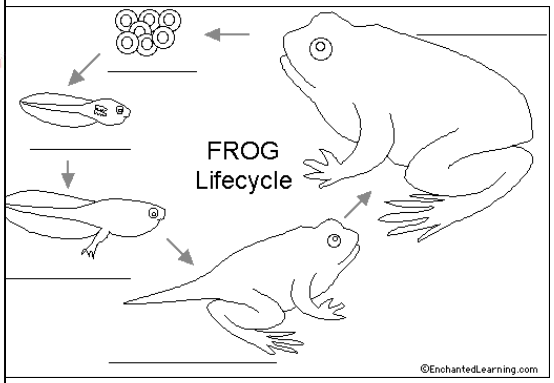
Not Just Fish!

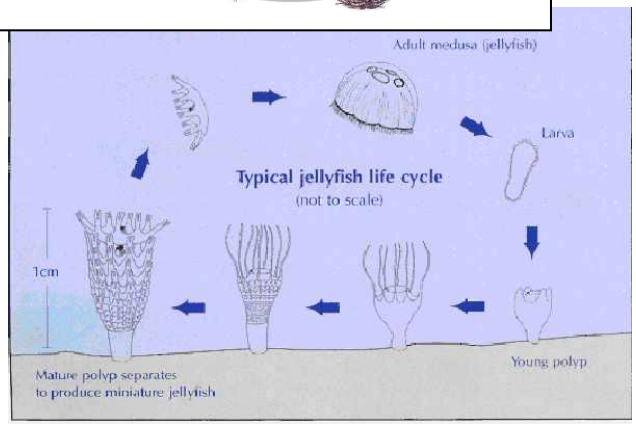








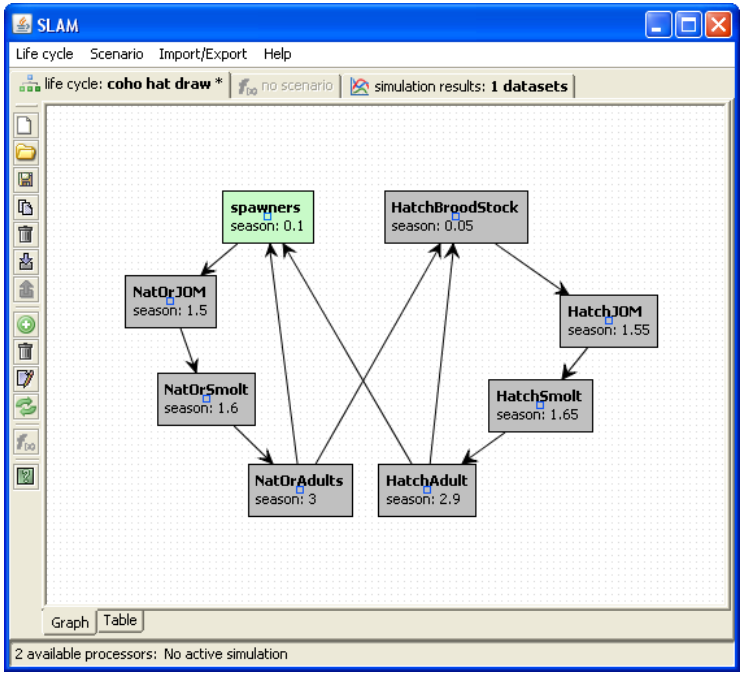




Current SLAM Applications

- All Oregon populations in LCR and Willamette for recovery plans (ODFW- Firman et al.)
- LCR Tule populations for harvest and recovery planning (NWFSC – Ford et al)
- All interior Columbia populations for recovery planning – starts with Salmon River Chinook (NWFSC – McClure, Zabel, and cast of thousands)
- McKenzie River Chinook for hydro operations (R2 for COE – Hendrix et al.)
- Skagit River Chinook with near shore focus (NWFSC – Greene et al.)
- Dungeness crab with focus on ocean acidification (NWFSC – McElhany et al.)
- Interior Columbia steelhead (USGS)

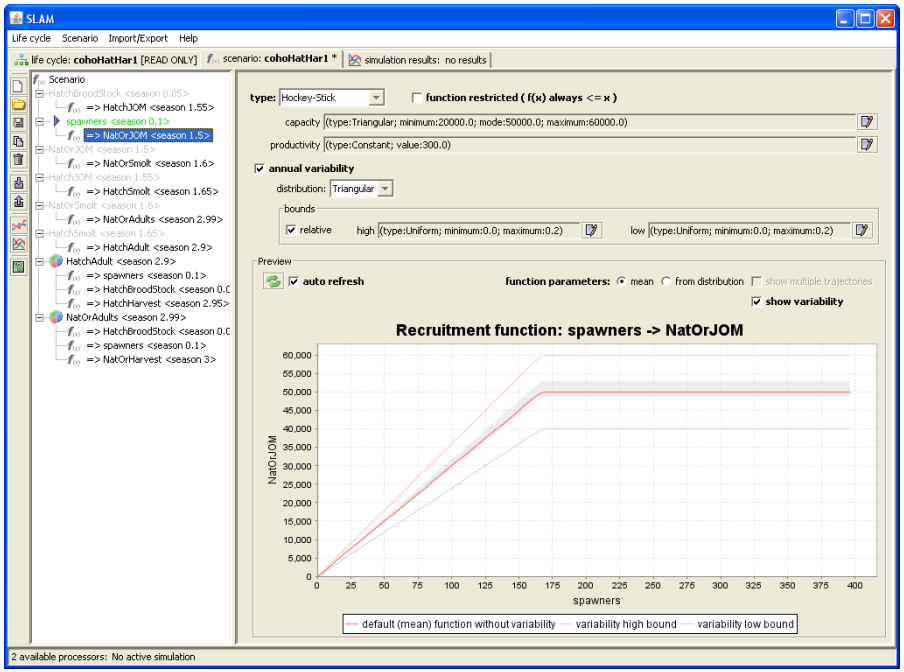
SLAM in a Nutshell…

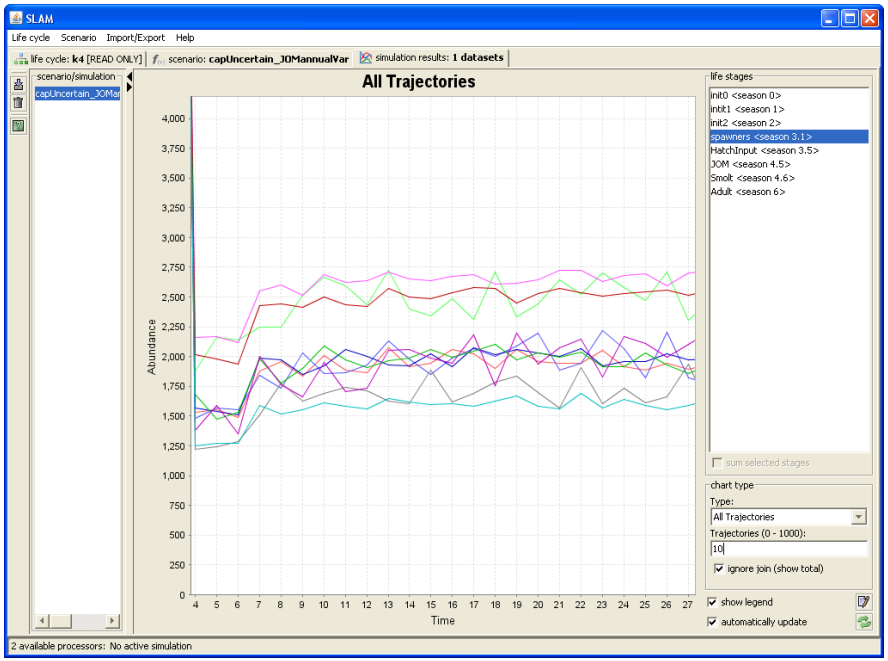


1. Life-cycle Structure

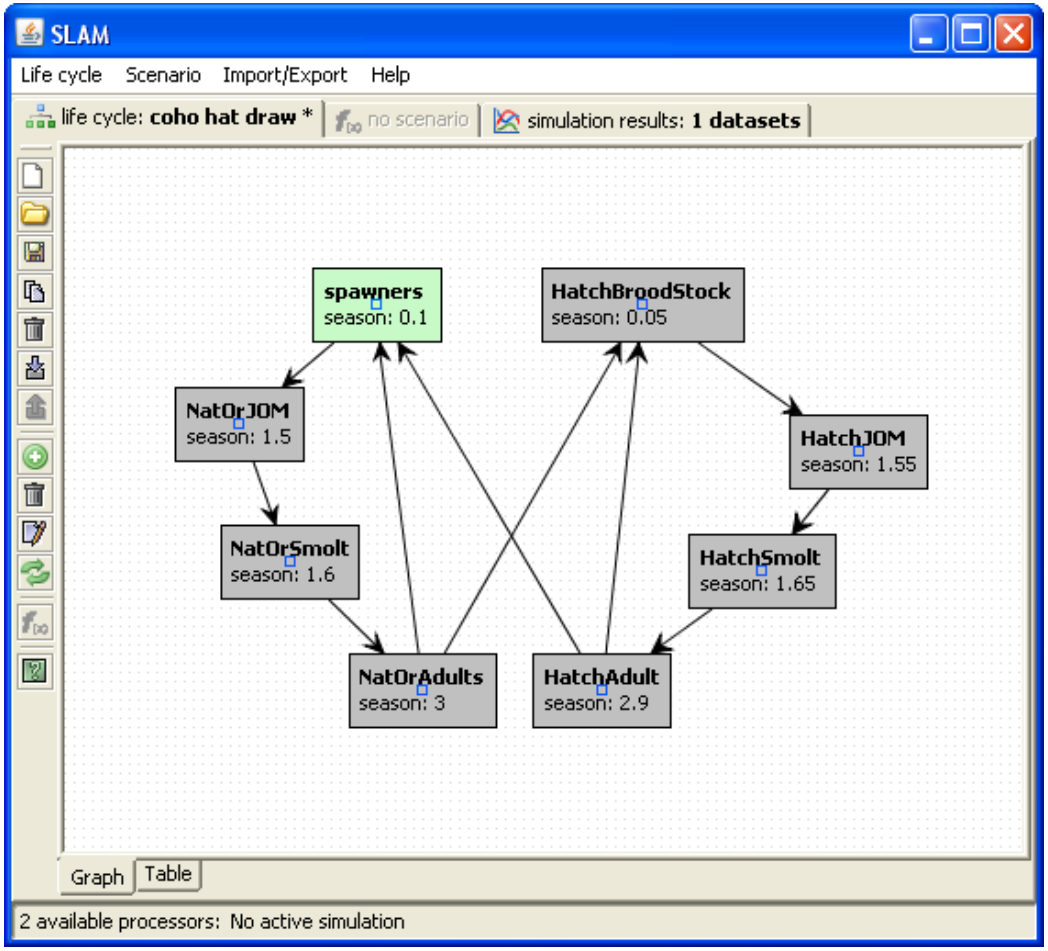
2. Scenario (functions and parameters)

3. Simulation Results



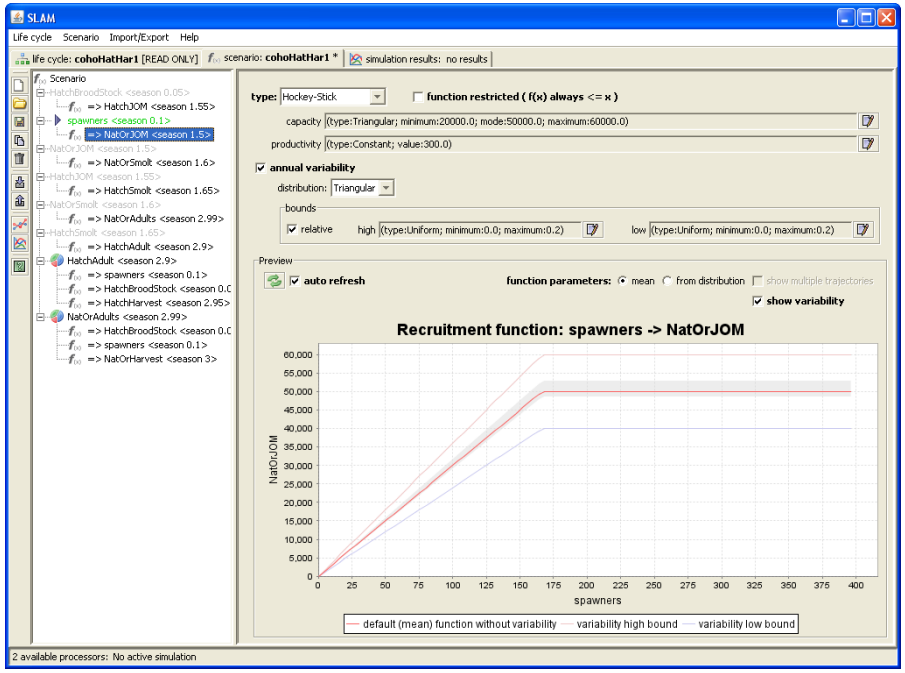


SLAM Life-cycle Components



- Life stage ("box")
  - Name, Year
  - Initial Stages
- Transition ("arrow")
  - Independent
  - "Same Value"
  - "Pool group"
  - Reproduction
- Influence Functions
- Splits (more than one arrow out of box)
- Joins (more than one arrow into a box)

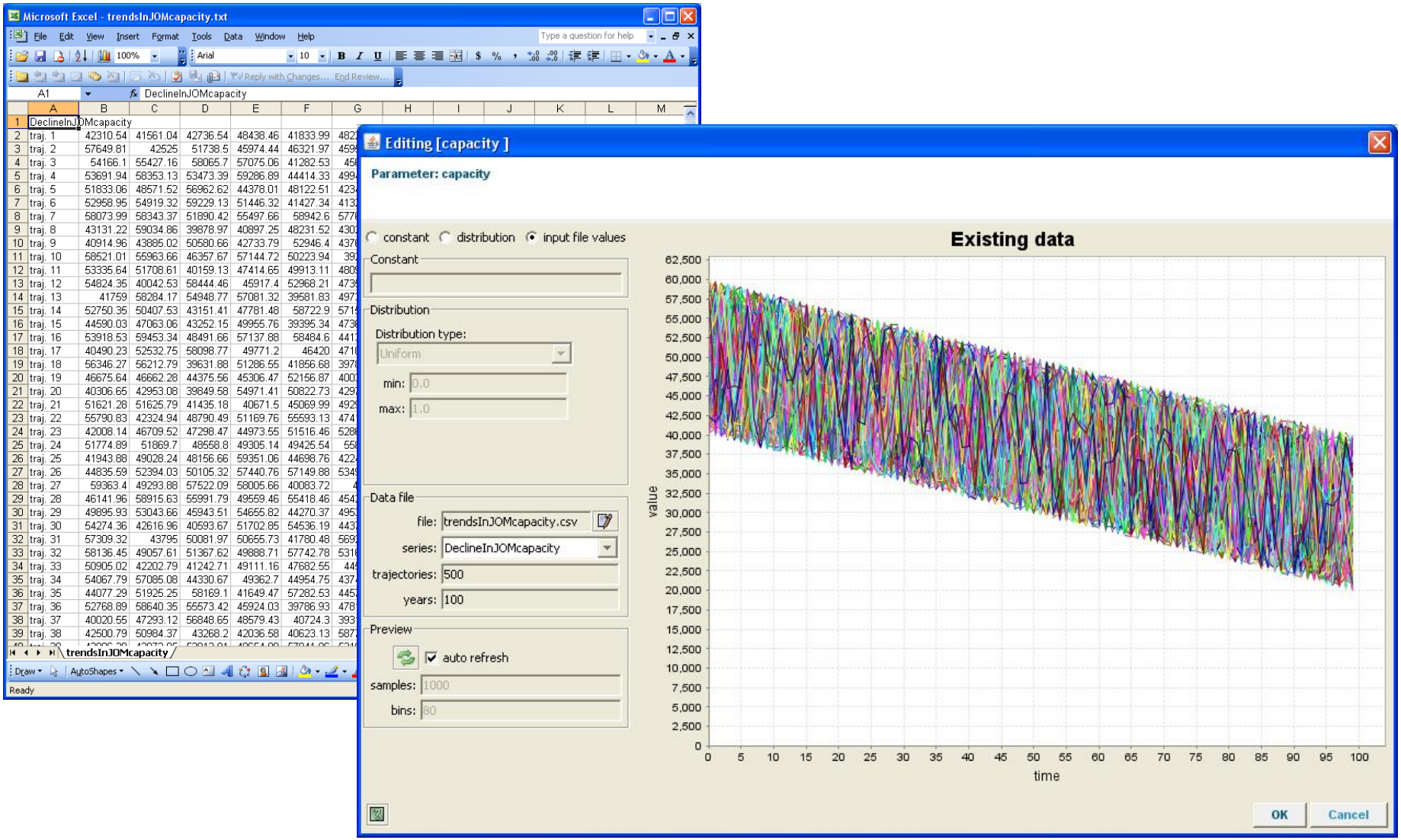
Transitions



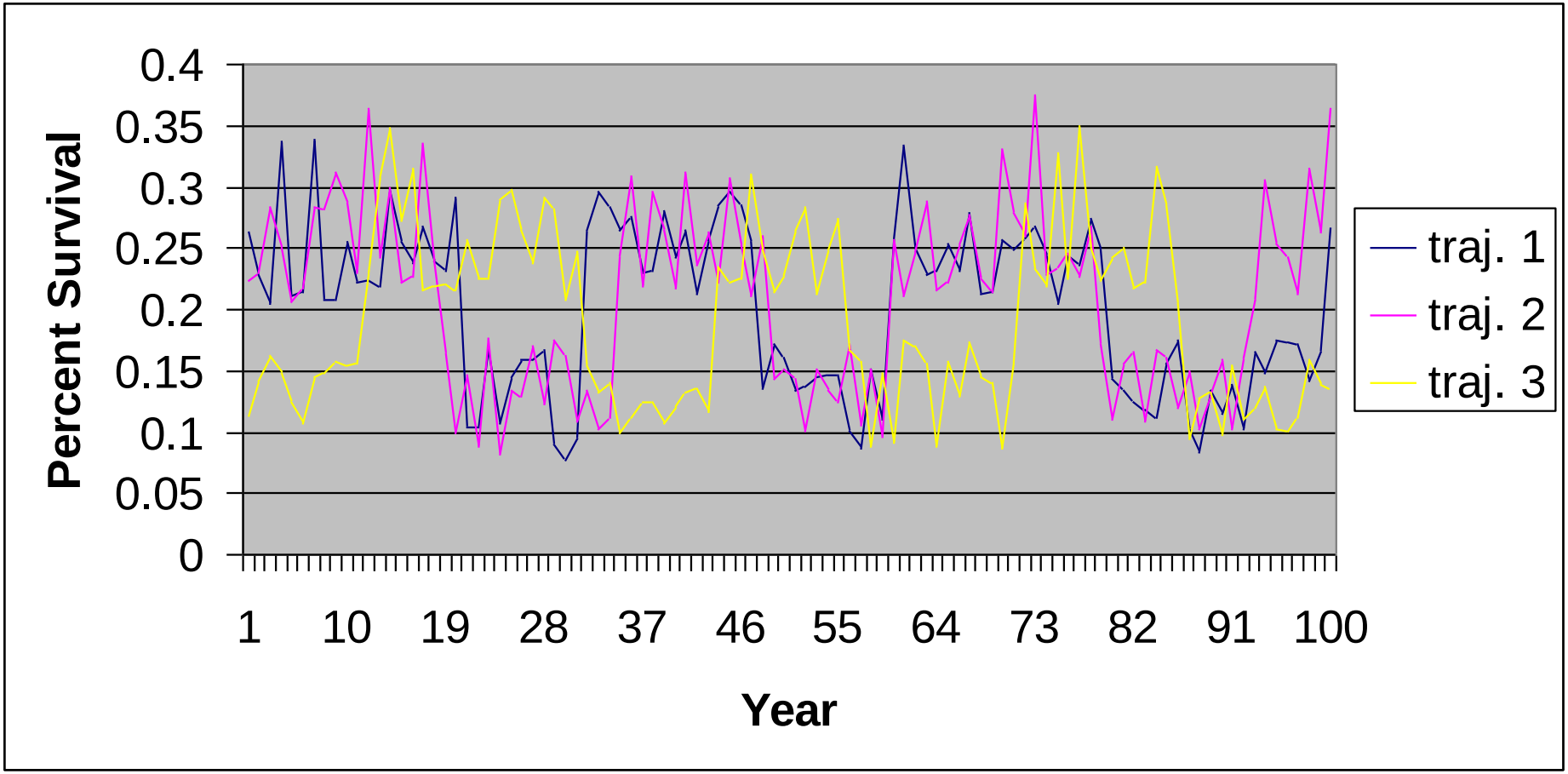
- Recruitment functions
  - Linear, Constant, Hockey Stick, Beverton-Holt, Ricker
- Uncertainty distributions
  - Productivity, capacity
- Annual variability

  -with or without uncertainty

External Parameter Time Series

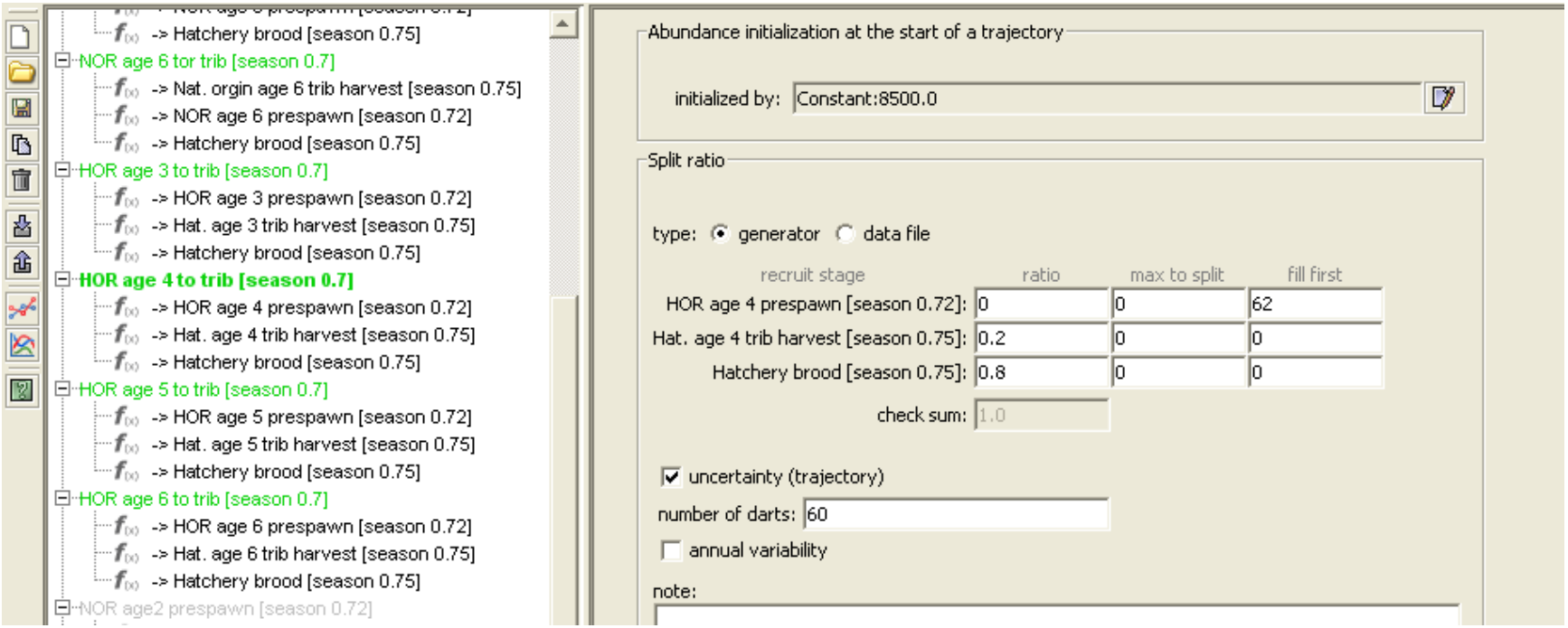


Input: Smolt to Ocean 2 Survival



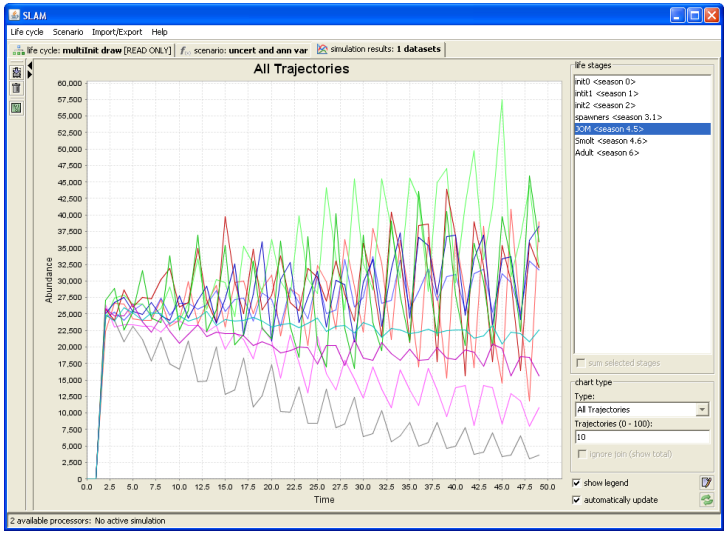
Splits

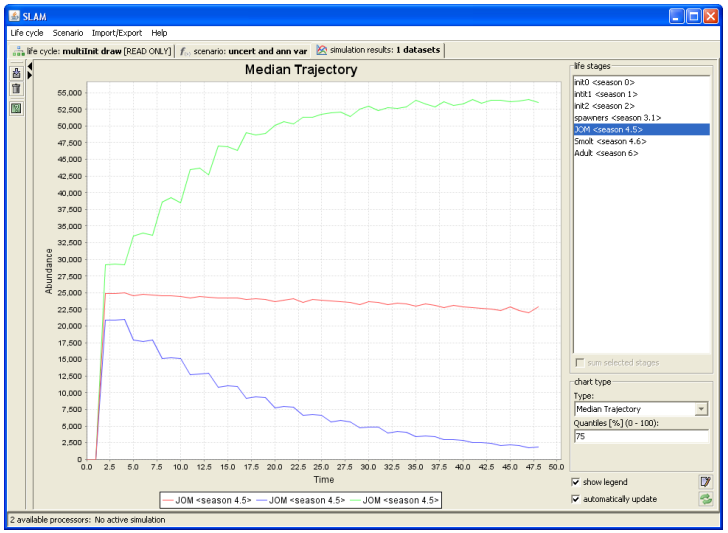
Fraction to each life-stage
Optional uncertainty and annual variability

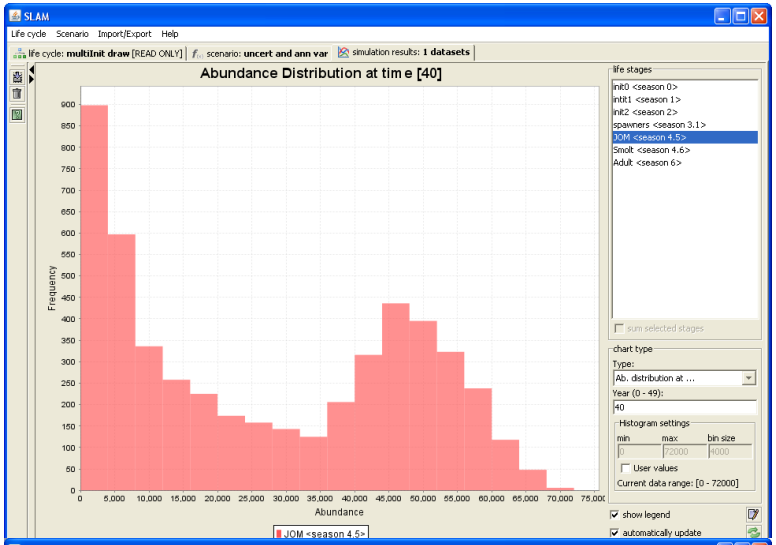


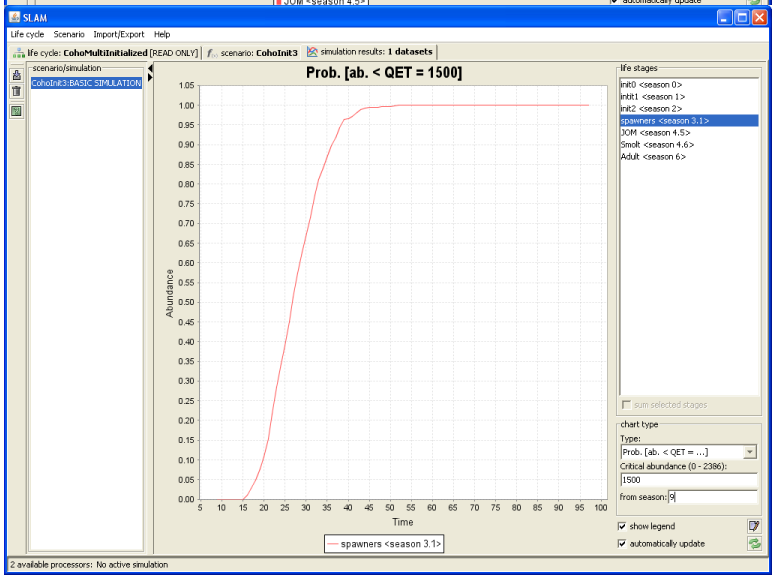
Simulation Output

- Abundance of every stage, every time period, every trajectory

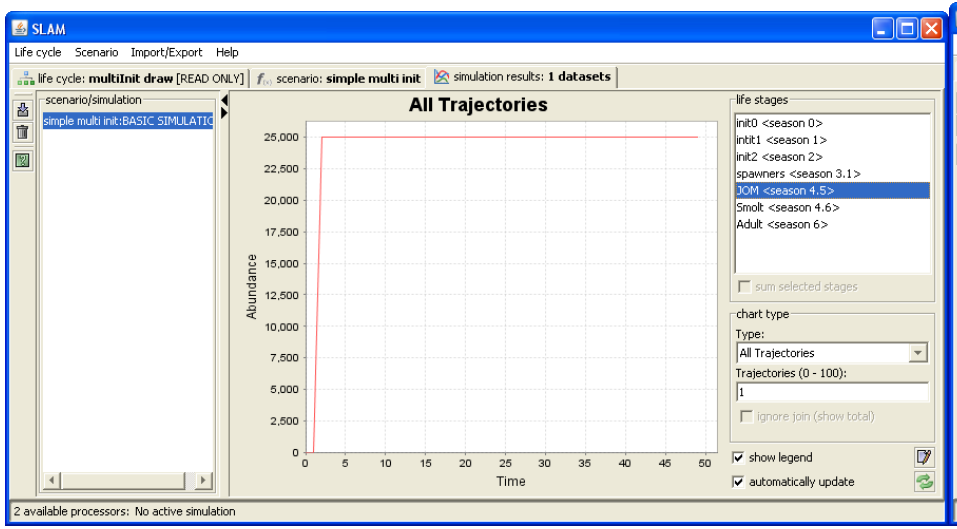


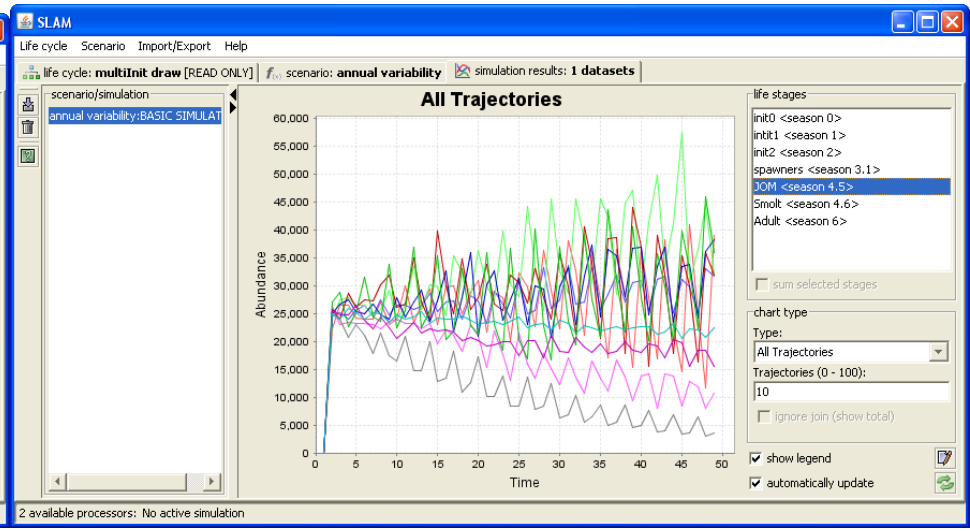


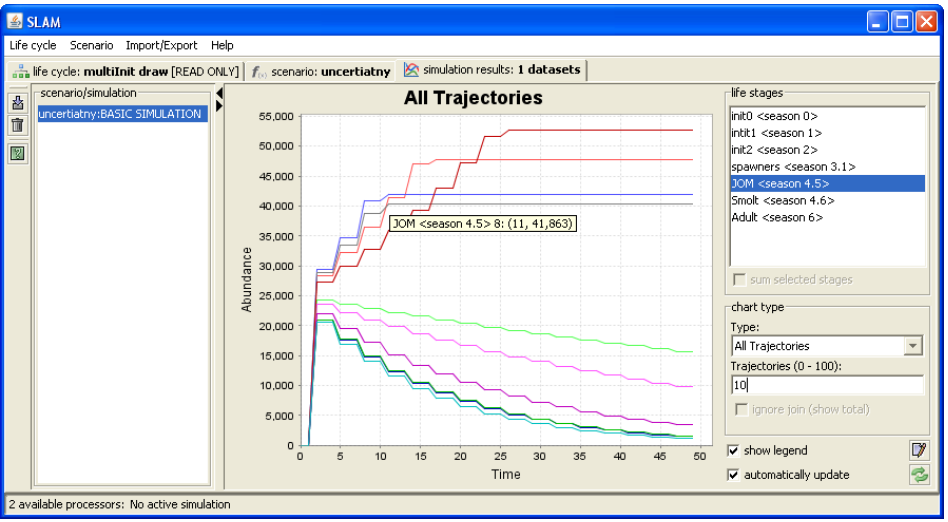


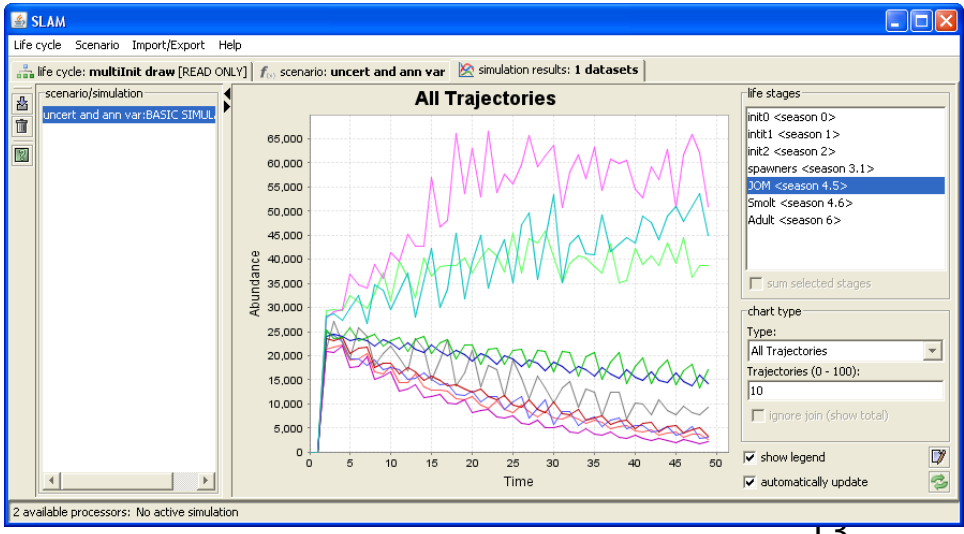


Uncertainty in Mean vs. Annual Variability



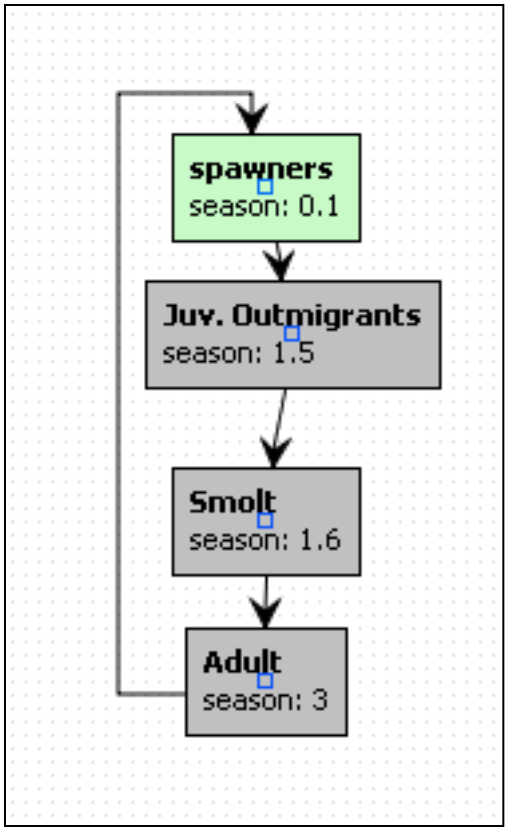




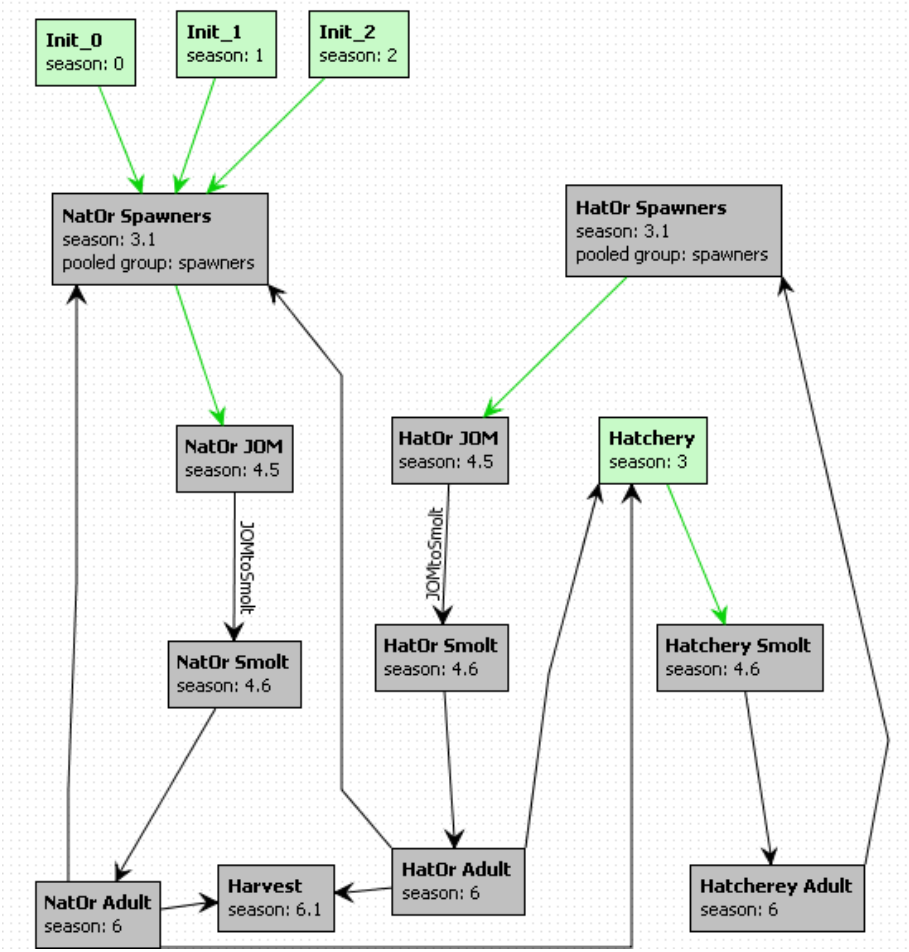


Some life-cycle diagrams…

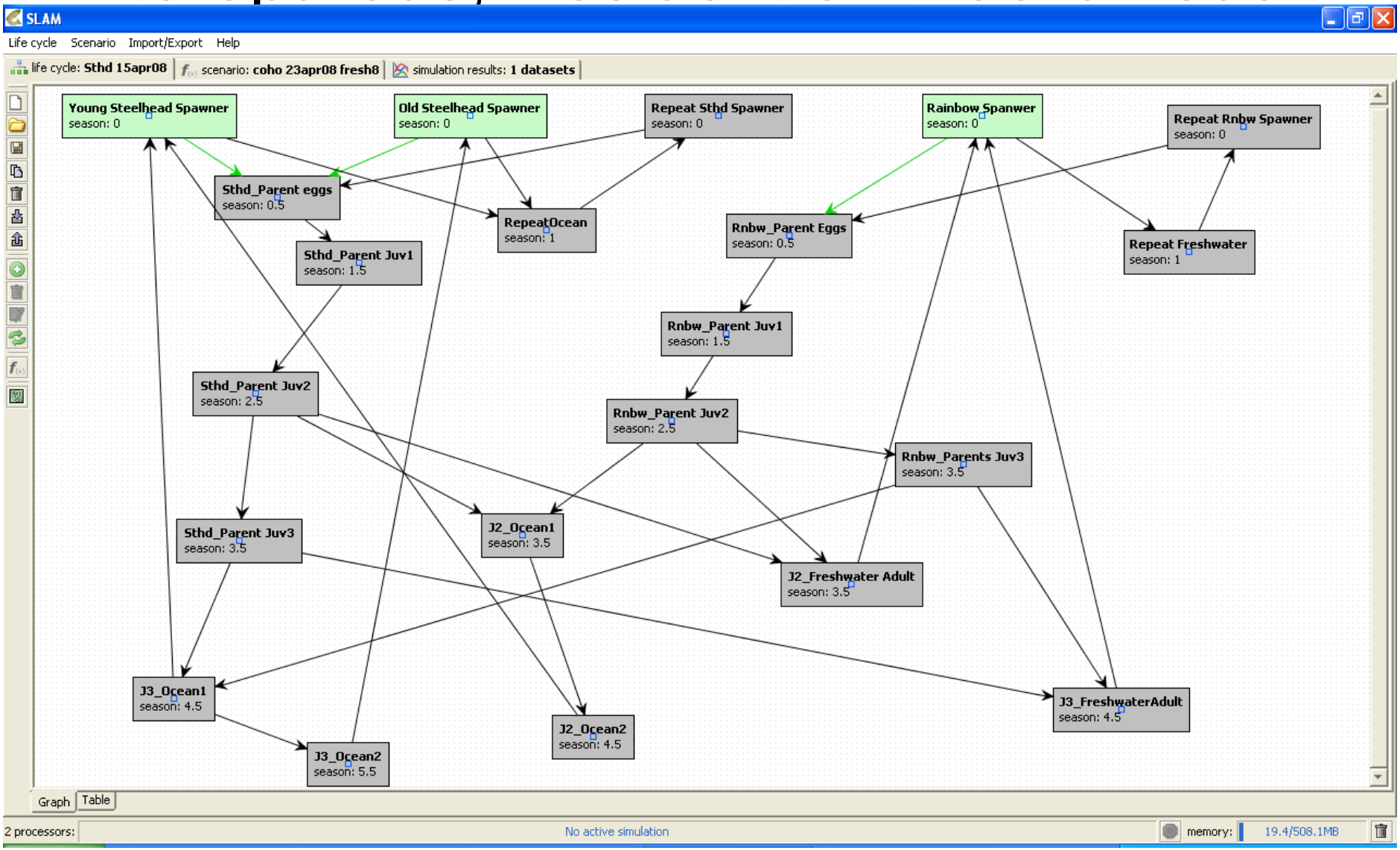
Very Simple Life-cycle Structure



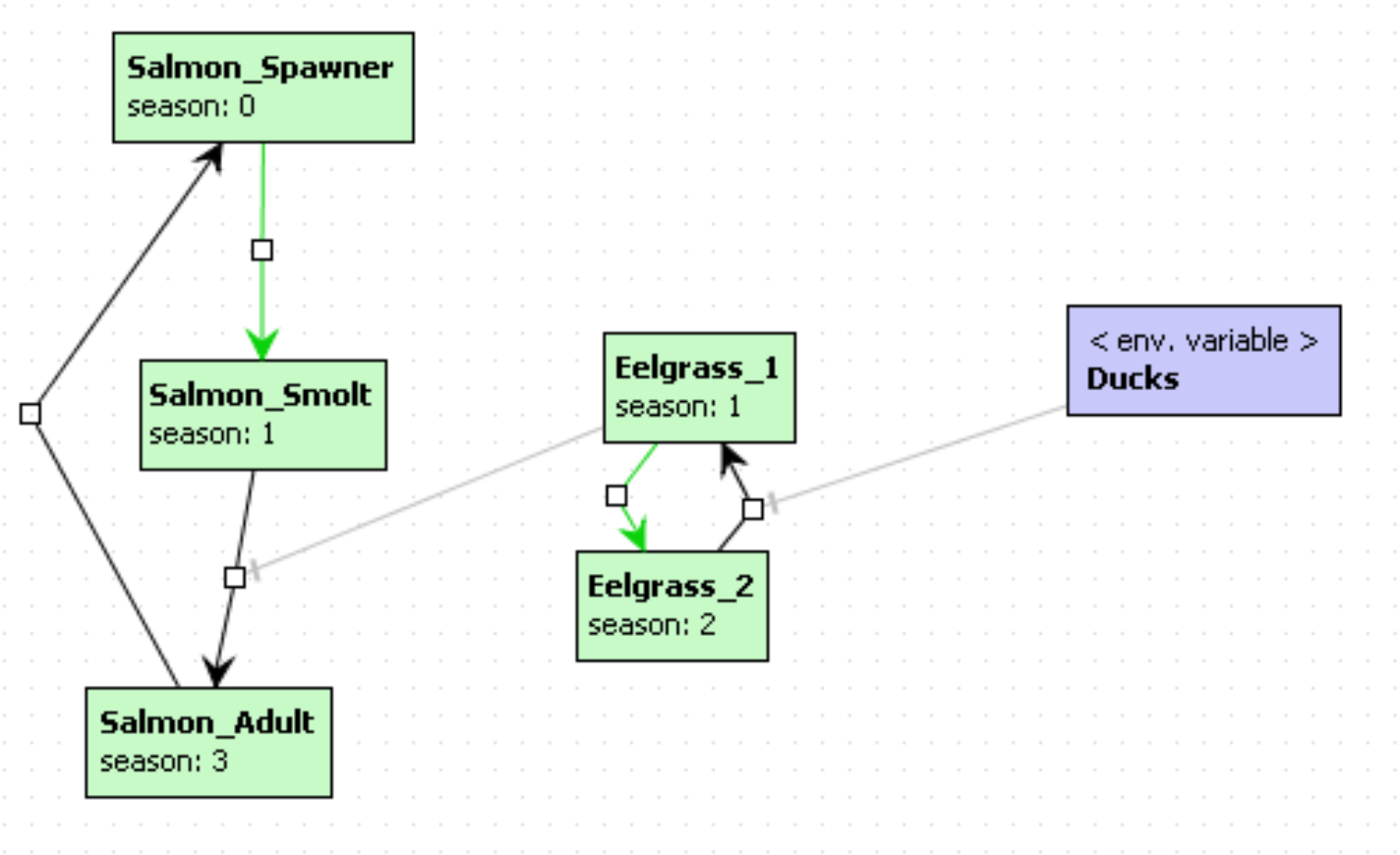
Coho with Hatchery



Steelhead/Rainbow: Iteroparous, Resident & Anadromous



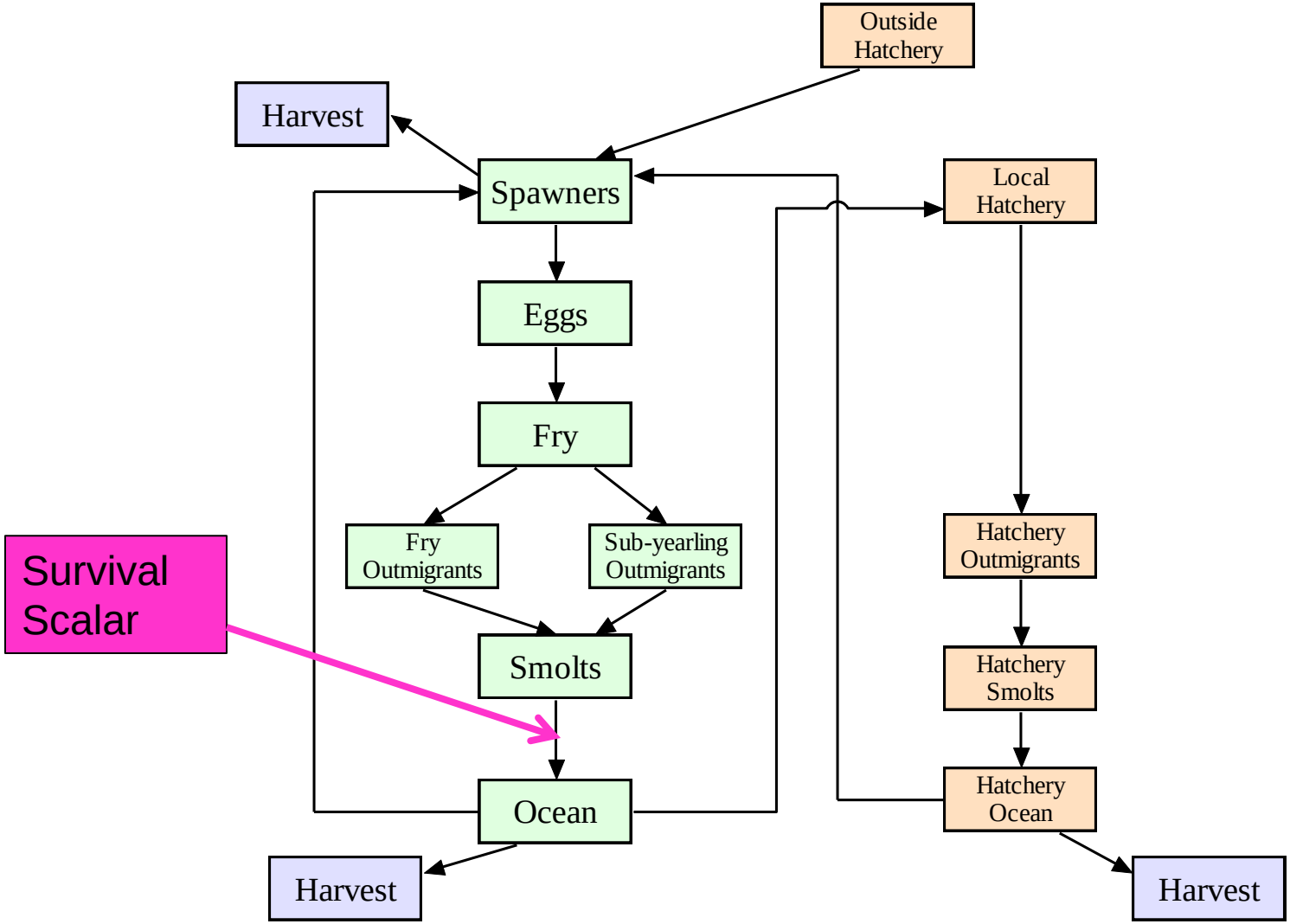
Influence Functions, Multiples Species, and Environmental Factors



How to Parameterize for Salmon

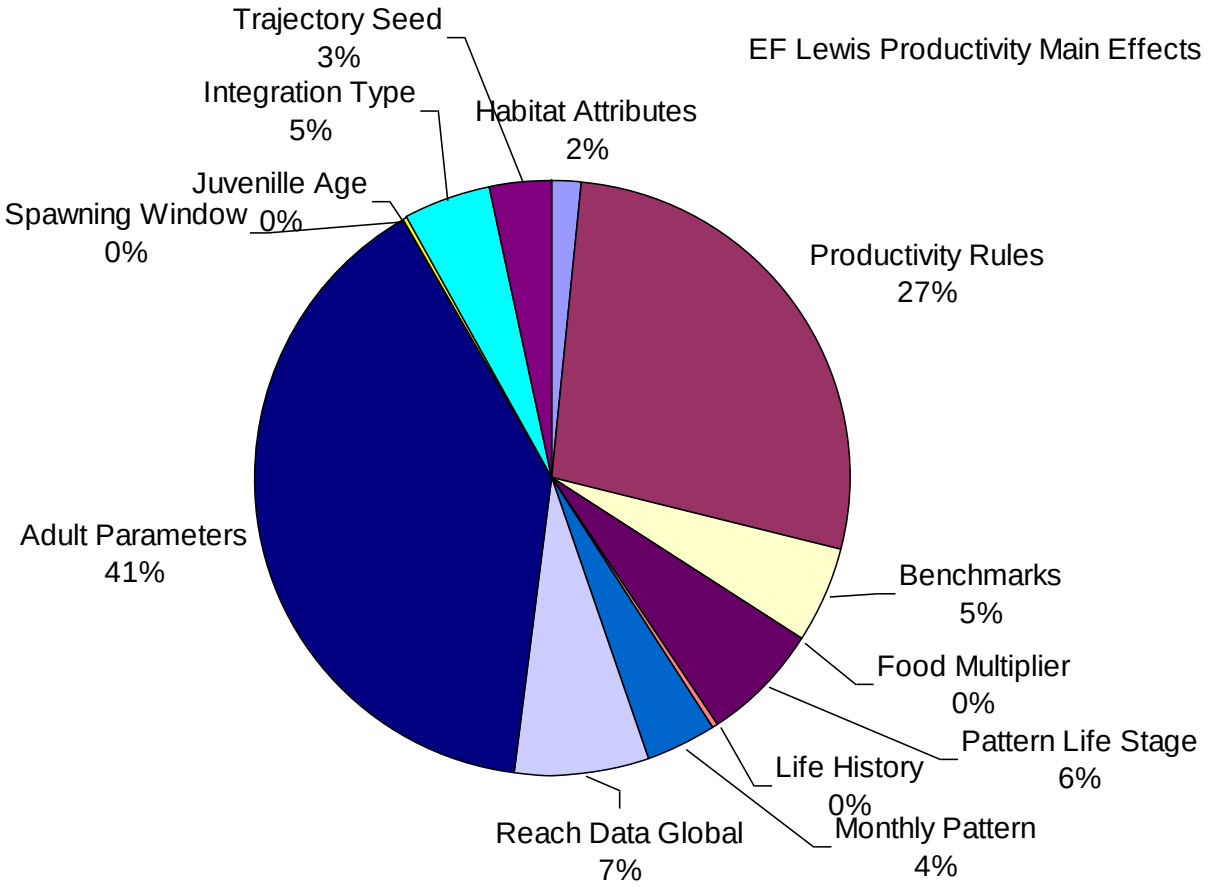
- Life-stage **survival studies** (e.g. fish counts, smolt traps, mark-recapture, pit tags, acoustic tags)
- Abundance studies for capacity
- Predictions from **habitat** –usually for capacity (e.g. Intrinsic potential, smolt production models, EDT, Shiraz)
- **Harvest** estimates, **hatchery** production records
- Studies relating **management actions** to survival or capacity changes (studies of buffer size, flow regulation, predator control, harvest changes, etc.)
- **Alternative methods** (reading chicken entrails, Ouija boards, magic 8 ball, etc.)

Calibration with a scalar



Switch to running SLAM…

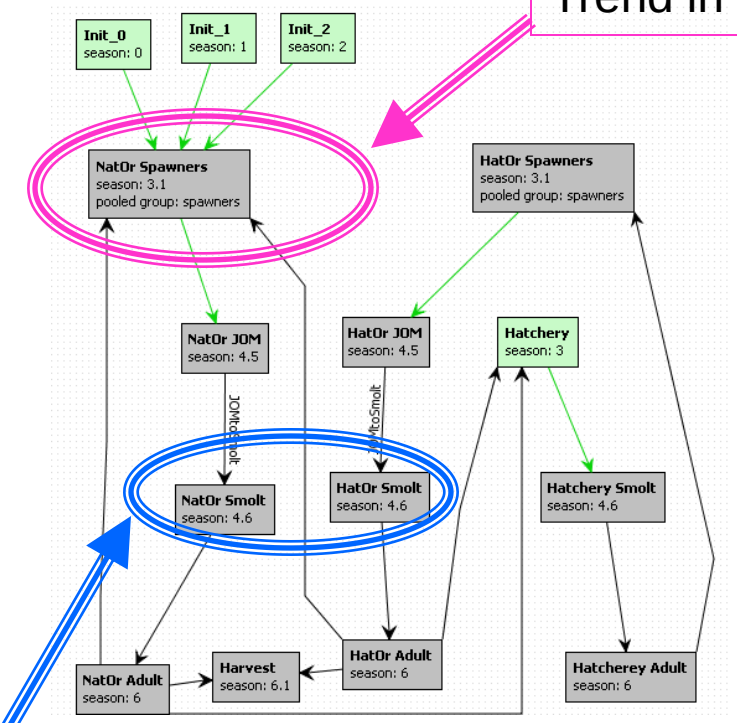
SLAM Harder:
Global Sensitivity Analysis



Example from Sensitivity Analysis of EDT model (McElhany et al. in review)

SLAM Harder: Data Fitting

Trend in Spawner Abundance

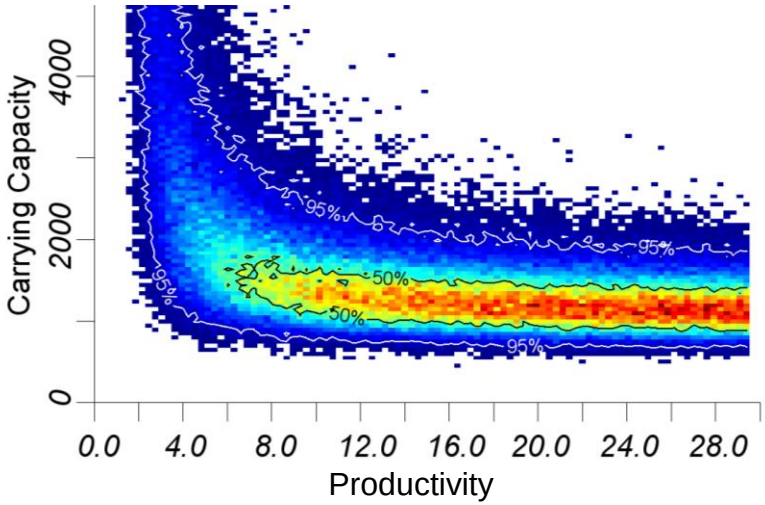


Average number of Juv. Out-migrant's

The Problem:

2 bits of data

~40 possible free parameters



SLAM Summary

- Very flexible – easy to change structure, functions and parameters
- Easy to compare and display alternative management scenarios
- Explicit consideration of uncertainty
- Parameterization – flexible, can compare methods, but requires some other model