InSTREAM / InSALMO Simulation Experiments

- How to use InSTREAM / InSALMO to understand and manage a river
- Two kinds of experiment:
  - Scenario comparison
  - Sensitivity analysis
- BehaviorSpace: NetLogo's tool for running experiments

Two kinds of annoying people...

- Those who will never believe the model because:
  - it's too complex, with too many parameters, *and*
  - it's not realistic because it doesn't include _____ (my pet mechanism)
- Those who believe the model without question

Instead:

- Treat initial results as hypotheses and then investigate:
  - Why did they occur? What mechanisms caused them?
  - Do you believe those mechanisms?
  - Are there alternatives to explore?
  - How robust are the key results?
  - What is the model telling us about the real river?

Example analysis conclusions

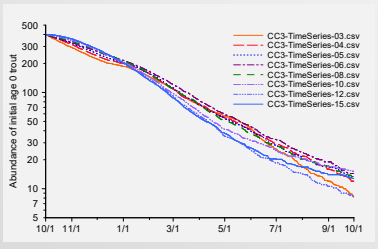
- Higher flows would be better in mid-late summer but not winter
- Temperature is/not more important than flow (at what times of year?)
- Higher spring flows benefit Rainbow but not Brown Trout
- Redd scour is important but not controllable
- More spawning gravel would/not increase abundance

Tricks for understanding mechanisms

- Confine the possibilities to mechanisms in the model
  - Low spawning success cannot be caused by redd siltation because redd siltation is not in the model

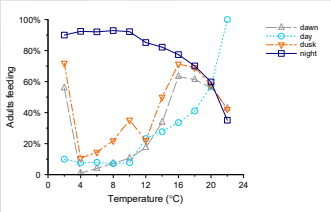
Tricks for understanding mechanisms

- Look at time series: do different things happen at different times of year?



Tricks for understanding mechanisms

- Look at what time of day fish feed
  - ➢A shift from day to night indicates better growth conditions or higher predation risk
  - ➢Remember competition



Tricks for understanding mechanisms

- Turn stuff off (be unrealistic)
  - ➢To see if egg mortality is important, turn it off and see if you still get the same general trends

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to go
  ; The main model schedule
  ; ...
  ; Redd survival
  ; ask redds [ redd-survive ]
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Tricks for understanding mechanisms

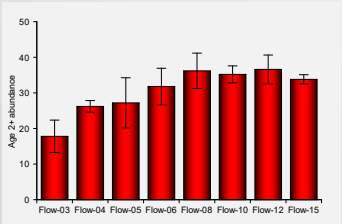
- Use sensitivity experiments
  - ➢How do results change as you vary:
    - Summer, winter flow
    - Summer, winter temperature
    - Fecundity
    - Fish predation
    - Terrestrial predation
    - ... ?

Tricks for understanding mechanisms

- Remember competition, adaptive tradeoff behaviors, and other complexities
  - ➢More mortality can result from higher abundance
  - ➢Smaller size can result from higher abundance
  - ➢Worse growth conditions can lead to higher predation mortality

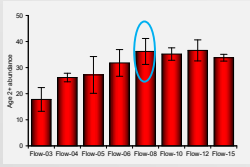
Kinds of simulation experiment 1) Scenario comparisons

- Compare predicted fish populations under several discrete scenarios (e.g., management alternatives)



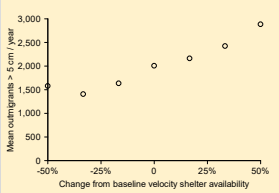
Replication in scenario comparisons

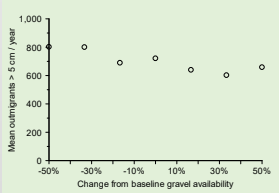
- By random numbers, to evaluate effects of the model's stochasticity, e.g.:
  - ➢How many females spawn, and when
  - ➢Individual survival
  - ➢Redd survival (scour, superimposition)
- By year shuffling, to evaluate effects of the sequence of hydrologic years
  - ➢InSTREAM's year shuffler randomizes the water years



Experiment type 2: Sensitivity analyses

- Examine how simulated fish populations respond to parameter / input values
- Purposes:
  - ➢Calibration
  - ➢Identifying important processes and management actions



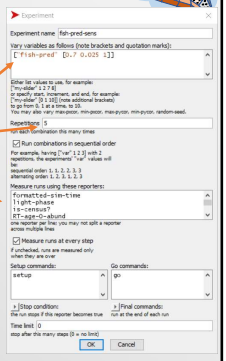


Running simulation experiments: BehaviorSpace

- BehaviorSpace is a software tool in NetLogo for automating simulation experiments
- It is extremely useful but requires simple, careful changes to the software
- I introduce it but see the User Manual and NetLogo documentation

BehaviorSpace

- You define an experiment
  - ➢Which parameters/inputs to vary and what values they will have
  - ➢How many replicates of each scenario
  - ➢What results to output
- BehaviorSpace automatically creates and executes all the model runs, in parallel on all available processors
  - ➢All combinations of all parameter/input values
- Output is written to one file, ready for analysis
  - ➢Or you can use InSTREAM's standard output files



Let's try it

- Suggest something to vary
- We will set up and run the experiment