**FAS6337C Fish Population Dynamics**

**Lab #8 Time Dynamic Population Model**

In this laboratory you are going to adapt the Striped Bass *Morone saxatilis* yield per recruit model to make it time dynamic, include estimates of stock recruit parameters, and impart inter-annual variability in recruitment. Anglers are asking the state fisheries agency to reduce the **minimum size limit of 550 mm TL** so they can keep more fish, but also show interest in catching trophy fish.

The objectives of this laboratory are:

1. Build an age-structured model time dynamic to predict Spawning Potential Ratio, Yield, Total Harvest, and Trophy Catch of Striped Bass for a range of minimum size limits and harvest windows,
2. Identify levels of fishing mortality, minimum size limits, and harvest windows that would cause growth and recruitment overfishing,
3. Explore how likely managers and anglers would be to detect impacts to the fishery if regulations are changed, given highly variable recruitment.

State biologists have measured a wide range of parameters for this (and other east coast) Striped Bass fisheries. The estimates include:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Estimate** | **Notes** |
| ***Miscellaneous*** |  |  |
|  | 35 years |  |
|  | 450mm | Length at 50% maturity |
|  | 350mm | Length at 50% capture |
|  | 800mm | Length at 50% trophy |
| ***von Bertalanffy*** |  |  |
|  | 1032 mm |  |
|  | 0.11 |  |
|  | 0 | Assume it is zero |
| ***Length-weight*** |  |  |
| *a* |  |  |
| *b* | 3.17 |  |
| ***Mortality*** |  |  |
| *M* |  | Use Jensen’s surrogate equation |
|  | 0.2 | Fraction harvested |
|  | 0.1 | Fraction of fish caught |
|  |  | Fraction of fish harvest + fraction caught |
| *D* | 0.15 | Discard mortality |
| ***Recruitment*** |  |  |
|  | 1000 |  |
|  | 18 | from Myers et al. (1998) |
|  | 0.0001, 0.2, 0.4, 0.6, 0.8 | Trial values for SDrec |

Build the model as a time-dynamic simulation and evaluate the objectives above.

**QUESTIONS**

**Please conduct the following analyses in *Excel* and answer the questions regarding this population. Each question or bullet point should be responded to either with text, a table, or a plot.**

**NOTES:**

* Monitor these population metrics: SPR, Yield, Total Harvest, and Trophy Catch
* Use the last 10 years of the simulation to calculate the mean and standard deviation for each population metric.
* Use a of 0.0001 for questions 1–3.
* Assume the for the slot limits, capture vulnerability, and trophy catch is 0.1 \* length (e.g. .

1. Is growth or recruitment overfishing occurring at the current minimum length limit and harvest rates?

A graph with a line

Description automatically generated

Given our MSY is at U=0.15 and our current U=0.2 there is growth overfishing occurring. Likewise given our target for SPR is 0.35 and our mean SPR in the last 10 years is 0.21 our stock is also experiencing recruitment overfishing.

1. Using the current minimum length limit, explore the effect of recK on the population metrics.

* How do the population metrics change as a function of recK? Generate a plot for each metric.

A graph of a graph

Description automatically generated with medium confidence

All population metrics start really low (near zero) with low recK, rise relatively rapidly and then asymptote at high values of recK (30-50 and higher)

1. Using a slot limit of 400 mm to 650 mm, explore the effect of recK on the population metrics.

* How do the population metrics change as a function of recK? Generate a plot for each metric.

A graph of a graph

Description automatically generated with medium confidence

* How does the maximum length limit of the slot limit change across recK values when seeking to maximize only Total Harvest?A table with numbers and a green and yellow background

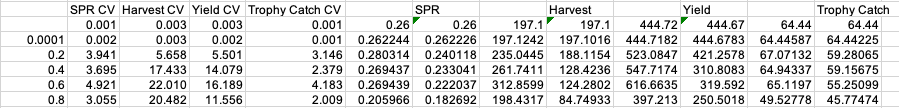
  Description automatically generated

As we change recK values higher the MaxLL that provides the maximum harvest increases as well. Once we get to recK~>34 there really is no MaxLL.

* At the current recK and minimum length limit, what is the maximum length limit of the slot limit that would generate the most total harvest?

MaxLL = 800 would maximize our total harvest.

1. Using a slot limit of 400 mm to 650 mm, explore the effect of at the provided recK (see table above).

* Report in a table the population metric percent coefficient of variation for each trial value of . Go to Formulas > Calculate Now to do a couple of runs of the random number generator to get a feel for the variability.
* How do changes in affect the ability of managers to see changes in SPR?

As increases the chances for SPR-CV to increase becomes higher. However there is a lot of variability in SPR-CV run to run and the SPR-CV per run is not necessarily ordered by . I’ve seen SPR-CV=10. I’d guess from what I’m seeing that is affecting the variance of SPR-CV, with higher resulting in higher SPR-CV variance across runs.

* How do changes in affect the ability of anglers to see changes in Total Harvest and Trophy Catch?

Harvest and yield behave more nicely than SPR-CV. While there can still be switches in ordering, by and large across my runs Yield-CV or Harvest-CV increases with increasing and does so quite dramatically. It should also be noted the CV’s for both of these are usually always far higher than for SPR-CV (sometimes 10x higher). For the higher values (0.6 and 0.8) yield and harvest end up having confidence intervals varying in some runs from effectively 0 to multiples of MSY in the case.

For trophy catch we see results quite like SPR-CV. Ordering is not necessarily preserved and the Trophy-CV for trophy catch is much more similar to SPR-CV in magnitude than to Harvest-CV or Yield-CV.

1. In your opinion, justify whether recK or has a greater effect on the population metrics and the performance of a slot limit of 400 mm to 650 mm in generating Total Harvest and Trophy Catch.

There’s no question that it’s . Changes due to recK in the vicinity of recK=18 does create change but it’s relatively small - . However once gets up to even 0.4 the amount of variability is comparable whereas at 0.6 or 0.8 the variability is insane. In one run I got for . It’s also worth pointing out that run-to-run the statistics change dramatically across the levels. This then is yet another contributing factor to ’s ability to obscure the expected performance of the proposed slot limit.