**FAS6337C Fish Population Dynamics**

**Lab #6 Yield Per Recruit Model**

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Data for this laboratory are from Striped Bass *Morone saxatilis* on the Roanoke River, North Carolina. This is an extremely popular fishery in March-May each year, where thousands of anglers target fish during the spawning run. The 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 to:

1. Build an age-structured model to predict Spawning Potential Ratio and Yield-per-Recruit of striped bass to a range of minimum size limits,
2. Identify levels of fishing mortality and size limits that would cause growth and recruitment overfishing,
3. Evaluate the sensitivity of the model output for SPR and yield to changes in , , , and (discard mortality).

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

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Interpretation |
|  | 35 y | Maximum age |
|  | 1032 mm | Asymptotic maximum length |
|  | 0.11 y-1 | Brody growth coefficient |
|  | 5.25x10-6 | Length-weight scaling |
|  | 3.17 | Length-weight allometry |
|  | 450 mm | Length at 50% mature |
|  | 0.2 | Harvest Rate |
|  | 0.15 | Discard Mortality |
|  | 350 mm | Length at 50% vulnerable to capture |
| MinLL | 550 mm | Minimum length limit |

For all vulnerability or selectivity relationships, assume the .

**QUESTIONS**

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

**(You can use Excel to answer the questions below, but students must attach an Excel spreadsheet in their submission for full credit). There is a Shiny app you may find useful to consult as well (**[**https://zsiders.shinyapps.io/Lab\_5/**](https://zsiders.shinyapps.io/Lab_5/)**).**

1. Using the provided parameter estimates, answer the following in Excel:

* Does this population appear to be undergoing growth overfishing? How did you determine your conclusion? A graph with a line and a line

  Description automatically generated with medium confidence

Given a U=0.2 is close to but just slightly under the maximum yield achieved at ~0.25 I would say that this population is not undergoing growth overfishing. That would require we were to the right of the maximum yield.

* What about recruitment overfishing? How did you determine your conclusion?

According to my calculations the SPR for the population given the parameters is 0.27 which is below the desired 0.35. Therefore, this population is experiencing recruitment overfishing.

1. Using the provided parameter estimates, answer the following:

* How sensitive is the model to changes in , , , and ?A graph with a line and a line

  Description automatically generatedA graph with blue and orange lines

  Description automatically generatedA graph with a line

  Description automatically generatedA graph of a graph showing the value of a stock market

  Description automatically generated
* Which parameter would you recommend for future research to reduce uncertainty?

M is very important to both yield and SPR. K is also important to both but has a much smaller impact that M does. Lmat requires pretty large changes in order to affect SPR dramatically and has no effect on yield (which makes sense given how we’ve setup the model). D has some impact on yield and little to know impact on SPR.

I would recommend future research on mortality especially given that it wasn’t measured in this study but was simply computed from K.

1. Given that various anglers want high harvest and others want catch of large fish:

* Using the Structural Indices PDF from Lab #1, what is considered a “Memorable” size Striped Bass in millimeters?

>=380mm

* What is the minimum length limit that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?
* A graph of a graph with numbers and lines

  Description automatically generated with medium confidenceA graph of a number of different colored lines

  Description automatically generated with medium confidence

Multi-objectives are always difficult to compute unless you have a comparable metric for each objective. Therefore I created a dissatisfaction index:

The idea behind this index is that dissatisfaction is lowest when the maximum has been achieved and is infinite when nothing is achieved. This unitless and normalized quantity allows us to compare the dissatisfaction in distance from maximum yield or maximum memorable catches together. Therefore I can pick the parameters that minimize the sum of dissatisfaction across all groups (assuming even weighting between groups). In this case minimum dissatisfaction was achieved with a minimum length limit of 650.

* What is the maximum length limit that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?
* A graph of a graph with numbers and lines

  Description automatically generated with medium confidenceA graph with numbers and lines

  Description automatically generated

Dissatisfaction decreases with increasing MaxLL so no MaxLL should be imposed.

* What is the minimum and maximum length limit (slot limit or harvest window) that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?A table with numbers and a number of numbers

  Description automatically generated with medium confidence

From our Total\_Dis we can see that the 650 MinLL with the largest MaxLL slot limit minimizes the total dissatisfaction.

* Which regulation (MinLL, MaxLL, or slot) would you suggest? Why (justify with Yield and “Memorable” catch metrics)?

Based on the above I’d recommend increasing the MinLL to 650 as it minimizes the dissatisfaction index amongst groups.

**GRADUATE STUDENTS ONLY:**

1. Given that various anglers want high harvest, others want to catch of large fish, and the managers want the SPR to be greater than 0.35:

* What is the minimum length limit that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?

This is the same conclusion as above because the 0.35 SPR is met with a MinLL of 650

* What is the maximum length limit that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?
* This one actually does change because so long as we fix the 550 MinLL in place and only vary MaxLL we need a MaxLL of 750 or lower just to hit our SPR. Therefore the appropriate MaxLL all else held equivalent would be 750 as dissatisfaction decreases with increasing MaxLL and this is the largest MaxLL allowable by SPR.
* What is the minimum and maximum length limit (slot limit or harvest window) that best allows for a high Yield and a high catch of “Memorable” or larger sized Striped Bass?

This is the same conclusion as above because the 0.35 SPR is met with a MinLL of 650

* Which regulation (MinLL, MaxLL, or slot) would you suggest? Why (justify with Yield and “Memorable” catch metrics)?

This is the same conclusion as above because the 0.35 SPR is met with a MinLL of 650