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FISH 558

Lab 9 HW

3/25/2024

1. **Describe the concept of catch curves. Include assumptions and discuss multiple situations where the assumptions might not be valid.**

Catch curves estimate total mortality by looking at the decline of fish through time, analyzing abundance and time/age. This uses catch-at-age data. A year-specific approach uses one year of data to estimate mortality by comparing the relative abundances of age classes. Assumptions and possible cases that would violate those assumptions are listed below:

* Constant recruitment: will not be valid if variable environmental factors influence recruitment or if multiple cohorts exist with different recruitment rates between them.
* No error in age estimates: can be violated if those gathering data aren’t sufficiently trained.
* Constant mortality: can be violated in species that have significant differences in mortality throughout their lifespan. For example, fish that achieve large body sizes may experience lower mortality rates in old age, or fish that develop cryptic coloration after the larval stage may experience lower mortality afterward. Conversely, male fish that develop flashy, conspicuous coloration during mating season may experience higher mortality during that period than females.
* Constant catchabilty: can be violated in species where certain age classes are more prized commercially or recreationally, such that gear is largely developed to target that age class. It’s not hard to imagine small, cryptic, or shy young fish being less catchable than their large older counterparts.

1. **Use one a catch-at-age dataset from FSAdata and catc curve methods to estimate total instantaneous mortality.** 
   1. **Identify the dataset used and what the data are from (species, location, study, etc).**

For Question 2, I used the “FHCatfishATL” dataset from the FSAdata package. This is catch-at-age data for flathead catfish. It was sourced from a study published in 2006 by Kwak, Pine, and Waters that examined growth and mortality from introduced populations of flathead in three rivers on North Carolina’s Atlantic slope. Ultimately, the study found that these fish had higher growth rates than comparable native populations.

I found that this dataset was pretty data-poor for this analysis (generally, single-digit numbers of fish for each age class in each of the three rivers, with many zeroes). As a sort of “stop-gap” to help with this assignment, I decided to combine these three populations by adding together the catches for each age class across the three sites. The analysis is therefore of a sort of informal “meta-population” of the three river populations. I’m not sure whether there’s any scientific value in this case (the rivers don’t seem to be in the same watershed), but there is academic value for this assignment!

* 1. **Provide a table of Z estimatesand 95% CI using a basic catch curve and the Chapman-Robson method.**

The model ouput indicates that, when limiting F to two decimal places, it is closest to 40% MSP at F = 0.36 (39.77%).

To express this clearly as an annual rate, it must be converted with the following equation:

Where u is the annual fishing mortality rate and Z = instantaneous mortality, calculated as F+M. In this scenario, natural mortality is set to M = 0.4

For this scenario, at F = 0.36 (40% MSP), the annual fishing mortality rate is 0.252. This means that 25.2% of fish are harvested annually.

This can be compared to the current scenario, where F = 0.55, and the annual fishing mortality rate is 0.355. Taking the management action to achieve 40% MSP would result in the percentage of the population being harvested annually to fall from 35.5% to 25.2%.

* 1. **Plot log(catch) vs. age for the dataset, with a fit of the basic catch curve:**

*Spawner per recruit:*

A measure of the potential of an individual recruit to contribute to the spawning population. Typically, this is the recruit’s contribution to future spawning stock biomass, or the number of eggs it produces.

*40% MSP:*

The maximum spawning potential (MSP) occurs when there is no fishing pressure, since spawning will always be highest. %MSP refers to the spawning potential ratio, the percentage of MSP that is achieved at some fishing mortality rate. 40% MSP is a common benchmark.

*Recruitment overfishing:*

Recruitment overfishing occurs when a population has been overexploited until recruitment is reduced and there are fewer young fish.

1. **Choose a species with different studies from fishbase to develop instantaneous natural mortality estimates for.**
   1. **State the species, brief description of it (distribution, life history, etc.). Provide estimates for at least two important parameters. Include screen shot of fishbase parameters table.**
   2. **Use 1 study to generate many estimates of M using different empirical methods. Include the annual rate v in the table as well.**
   3. **Table of mean, standard deviation, min, and max for M and v**
   4. **Select one method and generate M estimates from different studies on fishbase. Also describe central tendency and variability as in 3c.**
   5. **Based on 3c and 3d, discuss and compare sources of uncertainty for empirical estimates of M.**
   6. **Describe why these M estimates make biological sense. Why would M be related to K, Linf, or T?**
2. **Additional questions**
   1. **How many hours?**
   2. **Group work?**
   3. **Particular struggles?**
3. **Grad student question**
   1. **Spend time working on research project, briefly describe what you did.**
4. **Grad student question**
   1. **Create a contour plot to represent how YPR changes as a function of F and tc and include code.**

A chart of different colors

Description automatically generated

Figure 4: Contour plot demonstrating the effects that age at first catch and fishing mortality have on yield per recruit for a population of haddock. The y-axis is age at first catch (tc), and the x-axis is the instantaneous fishing mortality rate (F). The z-axis is the yield per recruit, represented by bands of color. Cooler colors represent lower yield per recruit, while warmer colors represent greater yield per recruit.

The code for Figure 4 is included in the code appendix on this assignment. The section corresponding to this question is clearly commented as “GRAD STUDENT QUESTION.” The y-axis has a shorter range than asked. Models for ages 9 and 10 froze R, troubleshooting notwithstanding. Since the rest of the plot was correct, I elected to leave off those ages.

* 1. **Use figure to discuss relationship between F, tc, and YPR**

Figure 4 shows the effects of parameters F (fishing mortality) and tc (age at first catch) on the yield per recruit of a haddock fishery. It shows that, generally, yield per recruit increases at lower ages at first catch, and increases at higher levels of fishing mortality. In question 1c, I made a management recommendation: tc = 4, F = 0.546. However, identifying that point on Figure 4 shows that yield per recruit can be increased by lowering tc and raising F further.

**Appendix: CODE pasted below**