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Host Organization: Alaska Fisheries Science Center (NOAA)
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Project title: Evaluating Survey Design in the Eastern Bering Sea
Thesis or Question(s):

1) What aspects of survey design give our models the most predictive power?
2) What challenges stand in the way of implementing new sampling methods in the eastern Bering Sea?

Context and Background

I. Fishery populations are shifting their ranges in the Bering Sea as climate conditions change.
    A. "The Arctic ice pack reached its lowest point in 2012 relative to 1979-2000" (Rohan, Barnett and Charriere, 2022).
    B. "Warmer waters can expand the habitat ranges of more temperate species."(Oyafuso Z.S., Barnett L.A.K., Siple, M.C., 2023)
II. Fixed Grid Systematic Sampling
    A. Most Bering Sea monitoring relies on:
        1. Fixed-location sampling (Barnett, L.A.K, Oyafuso, Z., 2023).
            a) Sampling at fixed points like monitoring stations.
III. Data is not consistent across oceans
    A. Different fisheries employ different sampling strategies that make data inconsistent.
        1. The Gulf of Alaska and Aleutian Islands bottom trawl surveys employ stratified random sampling.
        2. The East Bering Sea employs a systematic sampling design with fixed index site locations (Barnett, L.A.K, Oyafuso, Z., 2023)
        3. Both types (and nearly all surveys) suffer from variation over time in the amount of samples they can collect. However, systematic (particularly fixed-station designs) are more vulnerable to this as failure to sample all planned stations can lead to biased population estimates.
            a) Time and money can be limiting factors when conducting surveys so the surveys that can be most accurate in their biomass and abundance estimates despite variation in sampling effort may be the best fit for a fishery.
IV. More flexible sample designs can allow us to better track moving populations.
    A. Adaptive sampling (Yu 2012)
    B. Stratified random sampling (Oyafuso, Z.S., Barnett, L.A.K., Siple, M.C., 2023)

1. Static strata (but dynamic sample allocation among strata)
2. Dynamic strata (spatial boundaries of strata change according to predicted environment)
    a) May be more effective for tracking populations moving North.

V. Consistent and uniform sampling across Oceans can help us monitor moving populations.
   A. Freedom of information
      1. Open Science Framework. (Foster ED, 2017)
   B. Survey design built for dynamic populations.
      1. If static sampling continues, smaller proportions of populations will be observed in surveys and population estimates will become more and more biased.

Researchable Questions

1) What aspects of survey design give our models the most predictive power?
2) What challenges stand in the way of implementing new sampling methods in the eastern Bering Sea?

Responsibilities and Methods

I. Create a model that tests the predictive power of different sampling designs and/or different sampling effort, given historical data.
   A. Github repository of R code that can compare the effectiveness of different sampling methods.
   B. See which aspects of varying sampling methods help us to best estimate the population abundance of a given species.
      1. The accuracy of abundance and uncertainty estimates are important to evaluate the strength of a model.
   C. What explanatory variables are most useful for fitting the model and predicting abundance.
      1. Temp, salinity, ph, etc. (Goethel 2011)
      2. Important for having dynamic strata that can track populations as ocean conditions change.
   D. How can mixed survey design be captured in a predictive model?
      1. Fixed vs random monitoring stations. (DeFilipo et al. 2023)

II. Upload code to github
   A. Collaborate on code using github.
   B. Upload scripts to a shared repository.
   C. Keep a well organized file directory.
   D. Accurately report all Issues in the code.

III. Deliverables
   A. R model comparing the predictive accuracy of different sampling methods.

1. Turn into an open-source package in R which can be used to test the strength of different survey designs in other fisheries. (Kim 2018)

B. Literature review documenting the challenges of changing sampling methods in the East Bering Sea.
C. A Capstone journal documenting my hands-on work and progress
D. An annotated bibliography of sources to be used in my analysis paper

Significance

I. I'll be learning how to create a predictive model that works with a large data set. Then I will be using that model as the basis for an R package that I will upload on GitHub. Along the way I'll be referencing other NOAA packages the likes of which I have not yet worked with.
   A. Aside from future career possibilities, I find this project to be both incredibly challenging and interesting and I look forward to the process.
   B. This is my first opportunity to work with fisheries management so I get to see if I fit with this kind of work.

II. The Alaska Fisheries Science Center manages fisheries for The Chukchi Sea, The Eastern Bering Sea, and The Gulf of Alaska and Aleutian Islands.
   A. These fisheries are seeing some of the most intense ocean warming, and will thus see populations shifting their normal ranges.
   B. The Eastern Bering Sea has a number of fixed index site locations and these need to be built into the predictive model.
      1. Accounting for existing infrastructure in a predictive model is crucial to calculating bias and uncertainty for a survey design.

III. Different fisheries use different survey designs.
   A. Even within the purview of the Alaska Fisheries Science Center, there are different fisheries using different methods of sampling.
      1. While unifying sampling methods could make data more continuous, there are also often reasons constraining certain methods of sampling in certain locations.
      2. Ideally, my R package would allow any fishery anywhere in the world to weigh their survey design options.

Works Cited

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