**Question 1**

Olmos (2023; *Progress in Oceanography* [215: 103035](https://www.sciencedirect.com/science/article/pii/S0079661123000782)) used a GLMM to study the distribution and abundance of Yellowfin Sole in the Bering Sea. They found that the availability of the population to the fishery-independent survey varies based on annual variation in the extent of cool water. Fish are more available to the survey during warm years than cold years.

However, the data had a large number of zeros. A common index standardization technique that is used for species that are infrequently caught and have many 0 hauls is called a “delta” or “hurdle” model. Where first the presence and absence are modeled (CPUE > 0) using a binomial GLM. Then the non-zero CPUE are modeled using a Poisson, gamma, etc GLM. The resulting index in the multiplication of both.

A computer screen shot of a code

AI-generated content may be incorrect.

Develop a delta index standardization model that accounts for temperature or cold pool extent for Yellowfin Sole.

The data are stored in the file EBS\_YellowFin\_CPUE.csv

**Question 2**:

One method for model selection is evaluating out of sample predictive performance. This can be done by:

1. Divide the data into 10 equal sized groups
2. Fit the model to all groups except one.
3. Predict the CPUE using the data from the left out group
4. Repeat for all 10 groups.
5. Calculate root mean squared error.

Compare an index out of sample predictive performance with and without the cold pool extent or bottom temperature.

Extra credit: Traditionally uncertainty was derived via a non-parametric bootstrap. Fit a delta model in RTMB and derive the CI of the index using the delta-method. Compare it with the bootstrap estimates.