Disentangling density, climate, and fishing effects on Bering Sea crab

Episodic events drive Bering Sea crab population dynamics

Should I farm each of these simple models out to a student to get some experience?

History—volatile but valuable stocks, questions about what drivers are, have needed to add additional mortality periods to fit model.

Retrospective biases associated with assuming constant other mortality. If there are mortality events, we will overharvest at the worst time (snow crab 2020)

What is the relative risk of missing a mortality event vs. chasing noise? How do we strike that balance?

Methods—fit simple models that estimate fishing mortality, other mortality, and recruitment. Why is this useful for our question rather than a full stock assessment model?

Results—

* Are there correlations between estimated processes for stocks?
* Are there correlations to the environment?
* Can a story be told for the history for each stock based on the correlations and fishing mortality? What has driven the dynamics of the stock?
* What generalizations can be made across stocks?
  + At best, a weak stock recruitment relationship seems to be the rule.
  + Variability in mortality with punctuated events seems to be common.

What do these generalizations mean for the management of the stocks? Discuss current and potential management levers. What can we actually do?

Importance of the NBS.

When to give up on a stock (BKC)

Usefulness of stock enhancement?

Explain punctuated events in fishing, other M, and recruitment?

What are the main drivers of each stock?

What accounts for punctuated

How does this methodology fit in the bigger picture of models? Explicitly incorporating a bunch of drivers vs. modeling ‘buckets’ of dynamics drivers, then looking for correlations between outside covariates and the buckets?

Set this up for talking about risk-based management instead of maximizing yield

It looks like mortality is positively correlated to abundance for king crabs?

Relationship between density, recruitment, and mortality by stock.

Relationship between recruitment among stocks.

Relationship between mortality among stocks.

Relationship between bottom temperature, SST, etc. and mortality, recruitment.

Look at a relationship between other mortality and average size.

Figure 1. Map with different stock distribution by color + catches + value

Figure 2. Snow + tanner time series of abundance with key points in the stock’s history linked to the time series of estimated population processes. Label important points with “R, F, M” to indicate recruitment, fishing, or mortality.

Figure 3. King crab time series of abundance with key points in the stock’s history linked to the time series of estimated population processes. Label important points with “R, F, M” to indicate recruitment, fishing, or mortality.

Figure 4. Relationships to environmental variables

Fig S1. Show a figure of the number of crab used to make the estimates + stations observed

Fig s2. Stock recruit relationships.

CORRELATE THE ESTIMATED MORTALITY WITH AVERAGE SIZE IN THE POPULATION!!! Maybe those peaks and troughs are a signal of a u-shaped mortality by size for RKC?

Non-stationary drivers means maximums sustainable yield is non-sensical.

Population dynamics are the sum of many processes and some events have outsized influence on dynamics.

Confluence of environmental conditions, introduction of a competitor, direct fishing effects, indirect fishing effects….

Punctuated events drive the dynamics of Bering Sea crab

What can we do?

INTERESTING OBSERVATIONS

* BBRKC and PIBKC would be hard to tell apart with no label
* Mortality seems to be related to density for several stocks
* Pulsed recruitments are the norm
* BBRKC was on the way up again until 2000…then whomp
* Fishing mortality and other mortality area correlated for BBRKC and snow (only stocks with consistent and intense fishing)