Oyster Modeling Overview

ABSI CAB 01/08/2020

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What I want to tell you about:

1. How this work fits in the broader project
2. My task
3. CAB role
4. Model in a nutshell
5. Model objectives
6. Model structure
7. Model data
8. Model outputs

1. How this fits in the bigger picture

- Hydrologic model
  - Climate, water use & mgmt. → water, nutrients entering bay
- Hydrodynamic model
  - Water entering bay → water qual. throughout bay
- Oyster model
  - Water, mgmt., restoration → oyster populations and fisheries

2. My Task

- Guide development of oyster model
  - Oyster populations, fisheries
  - Scientifically rigorous and CAB-approved

3. CAB role

- Skepticism
- Input and help
- Discussion

4. Model in a nutshell

```
for (i in 2:years){
      for (k in 2:(nsites+1)) {                                                  #open site loop back up again
        #actual effort
#         et[i,k] <- total_et * eff[k]                                             #assuming fixed effort, so just a function of total state-wide ef
        et[i,k]=0;       if(i>=fish_strt) et[i,k] = total_et * eff[k]              #not stocking for first 30 years, then stocking at number stock,
        et[i,1]=et[i,2]; et[i,nsites+2]=et[i,nsites+1];                           #mirrors
        hr[i,k] <- fishing * (1-exp(-et[i,k]*qt))                                 #fishing is just a flag, then harvest rate per ususal
        hr[i,1]=hr[i,2]; hr[i,nsites+2]=hr[i,nsites+1];                           #mirrors

       #Set up stocking, no stocking for 30 years, then start stocking at a constant rate#
       st[i,sites]=0;      if(i>=30) st[i,sites] = stock[k]*(1-ism)               #not stocking for first 30 years, then stocking at number stock, r

       #recruitment unpacking
       ssb_tot[i,k] = eggs[i-1,k] + eggs_hat[i-1,k]                               #total wild and hat eggs
       ssb_tot[i,1]=ssb_tot[i,2]; ssb_tot[i,nsites+2]=ssb_tot[i,nsites+1];       #do i need this?

       #dispersal
       larv[i,k] = sum(eggs[i-1,sites] * prob_mat[k,sites])                      #Use this dispersal to account for dispersal, but recognize the mod
#        larv[i,k] = eggs[i-1,k]                                                   #Use this dispersal to check on null model, but reocnize that thi
       larv[i,1]=larv[i,2]; larv[i,nsites+2]=larv[i,nsites+1];                   #mirrors

       larv_hat[i,k] = sum(eggs_hat[i-1,sites] * prob_mat[k,sites])
#        larv_hat[i,k] = eggs_hat[i-1,k]
       larv_hat[i,1]=larv_hat[i,2]; larv_hat[i,nsites+2]=larv_hat[i,nsites+1];  #mirros
       larv_tot[i,k] = larv[i,k] + larv_hat[i,k]                                  #total wild and hat eggs
       larv_tot[i,1]=larv_tot[i,2]; larv_tot[i,nsites+2]=larv_tot[i,nsites+1];  #mirros

       #first stage of density dependence
       N1_hat[i,k] = (larv_hat[i,k]*(1-hert_hat)) * f[i,k]*a1_hat[k]/(1+b1[i,k]*larv_tot[i,k])
       N1_w[i,k] = (larv[i,k] + (hert_hat*larv_hat[i,k])) * f[i,k]*a1[k]/(1+b1[i,k]*larv_tot[i,k])

       #second stage of density dependence
       N2_tot[i,k] = N1_hat[i,k] + N1_w[i,k] + st[i,k]                            #total N1's entering N2 stage,
       R_hat[i,k] = N1_hat[i,k]*a2_hat[k]/(1+b2[i,k]*N2_tot[i,k])                 #hatchery recruits
       R_st[i,k] = st[i,k]*a2_st[k]/(1+b2[i,k]*N2_tot[i,k])                       #stocked recruits
       R[i,k] = N1_w[i,k]*a2[k]/(1+b2[i,k]*N2_tot[i,k])                           #wild recruits

       #subjecting recruits to some mortality before they become age 1's
       nage[i,1,k]= R[i,k]*So.5                                                    #So.5 is set to 1, so this isn't operational here (used for when c
       nage[i,1,1] = nage[i,1,2]; nage[i,1,nsites+2] = nage[i,1,nsites+1]         #mirrors
       nage_hat[i,1,k] = R_hat[i,k]*So.5
       nage_hat[i,1,1] = nage_hat[i,1,2]; nage_hat[i,1,nsites+2] = nage_hat[i,1,nsites+1] #mirros
       nage_st[i,1,k] = R_st[i,k]*So.5                                                       #note here is where you would have added post recruit st
       nage_st[i,1,1] = nage_st[i,1,2]; nage_st[i,1,nsites+2] = nage_st[i,1,nsites+1]      #mirrors
```

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1. Oysters and fisheries assumptions

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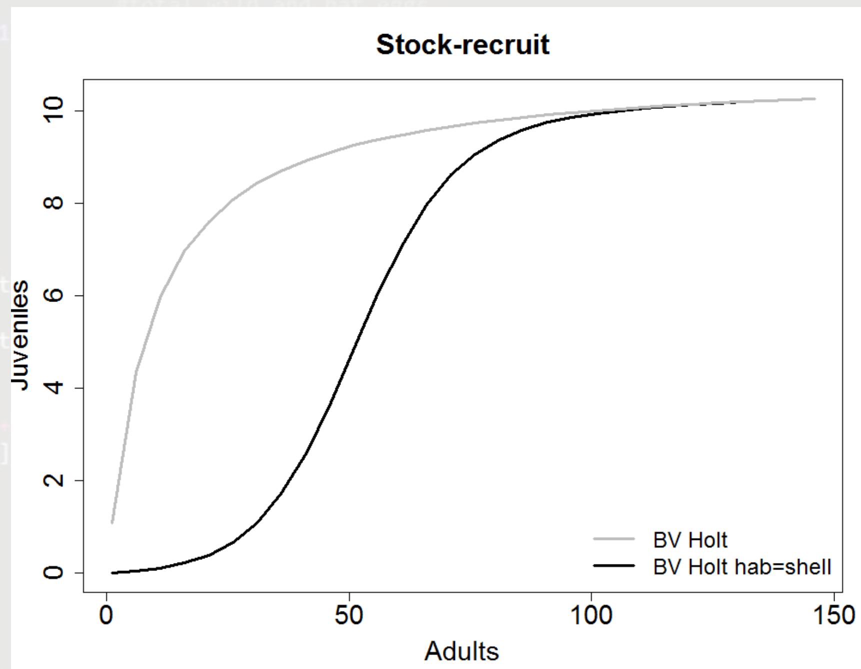
2. Translate to math and statistical equations



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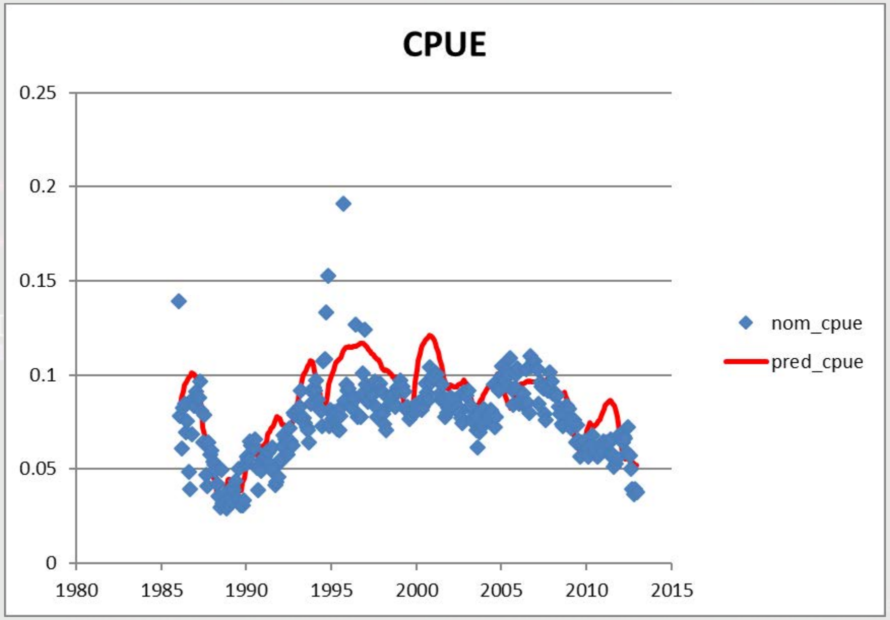

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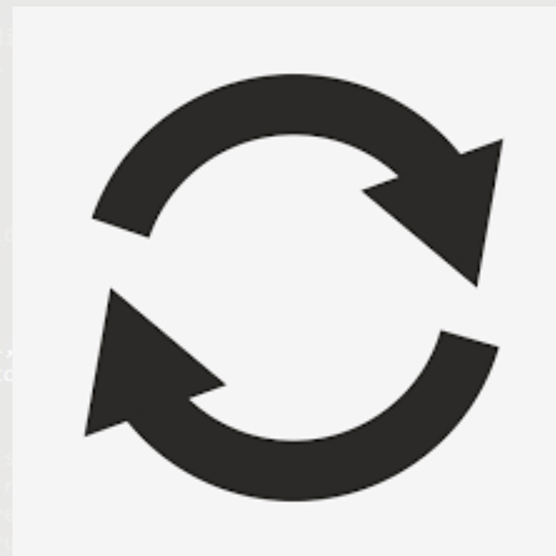
5. Repeat 3-4



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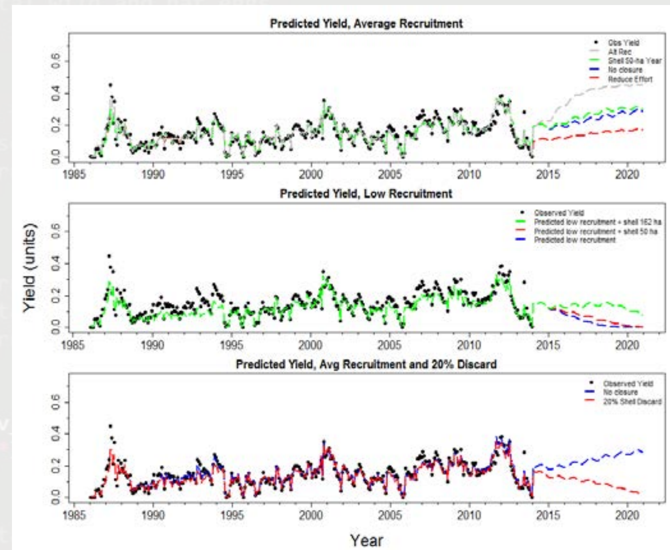
6. Make predictions
   - -Environment
   - -Management
   - -Restoration



5. Model Objectives

1. Make discussions easier/more fruitful
2. Predict likely and unlikely outcomes of action
3. Increase understanding of oysters & fisheries
4. ~~Be a perfect representation of reality~~

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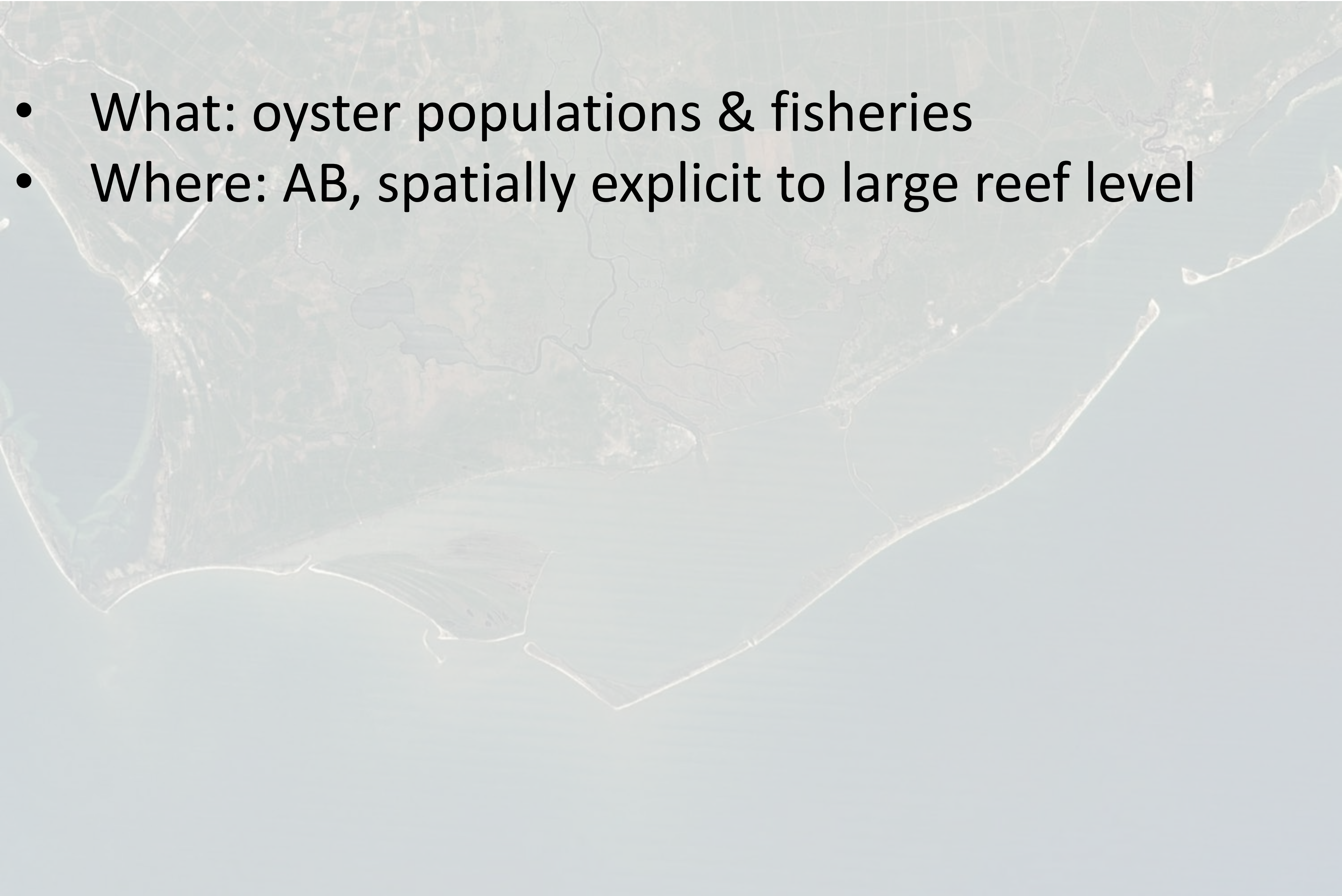

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- When: Future simulation based on past
- “Structure”: Age- and stage-structured, so:
  - Oyster larvae
  - Oyster recruits
  - Oyster populations in monthly ages
  - Oyster harvest
  - Oyster shell

7. Model Data

- Prior oyster/fishery information
  - Natural mortality, growth, env. relationships
- Fisheries data
- Fisheries independent data
- *Perfect data is not expected*

8. Model Outputs

- Oyster population metrics
  - Recruits
  - Adults
  - Shell

- Fishery Metrics
  - Fisher behavior?
  - Harvest
  - Yield
  - Price/revenue?

8. Model Outputs: what's the point?

- "What if" analyses
  - Harvest
  - Restoration
  - Water use/mgmt.

- Outcomes
  - Expected
  - Unexpected
  - Ranges probable


Questions and concerns
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