Oyster Stock Assessment Check In

May 15, 2017

Annapolis, MD

Current Status of Oyster Assessment

Completed:

- ✓ Develop a presentation about assessment
- ✓ Develop a timeline for completing the assessment

Completed for Presentation Tonight:

- ✓ Hire a post-doctoral researcher through UMCES to develop the stock assessment model
- ✓ Assemble a science team of DNR and UMCES to conduct the assessment.
- ✓ Provide background information on stock assessments for OAC
- ✓ Develop Stock Assessment Objectives and Terms of Reference
- ✓ Develop an inventory of available data sources for the assessment
- ✓ Address constituent questions / concerns about stock assessments

UMCES = University of Maryland Center for Environmental Science

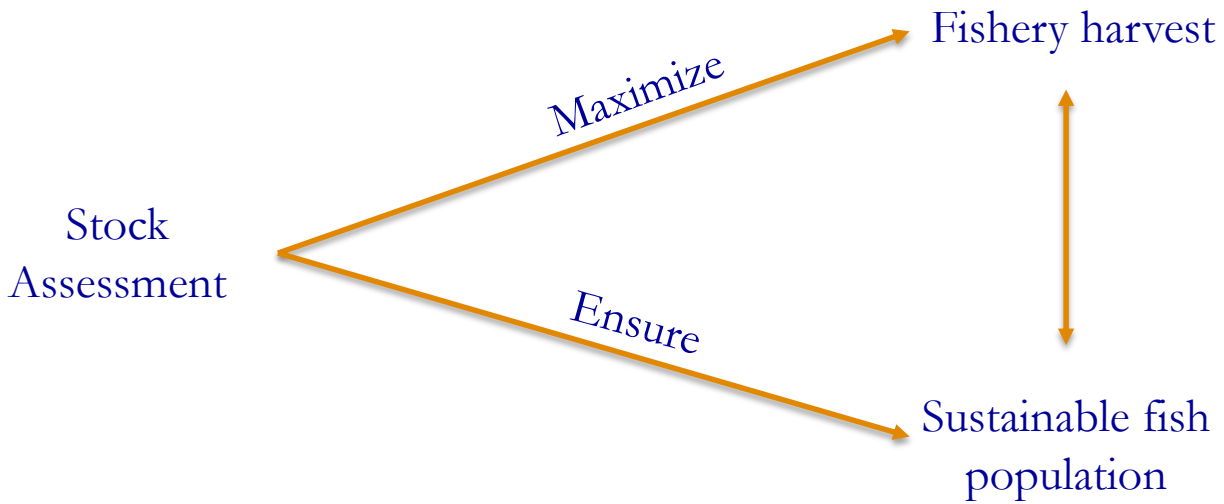
Stock Assessment Background

What are the goals of a stock assessment?

Stock assessments :

1. Estimate current fish stock status relative to relative reference points
2. Estimate current abundance and harvest rates
3. Estimate past abundance and harvest rates

Stock assessments support sustainable fisheries by providing fisheries managers with the information necessary for sound management actions.



Stock Assessment Background

What is a stock assessment?

A Math Exercise That Uses Available Data:

- Commercial catch reports (harvest and effort)
- Survey data
- Biological information about species: growth, mortality, etc.

According To National Marine Fisheries Service:

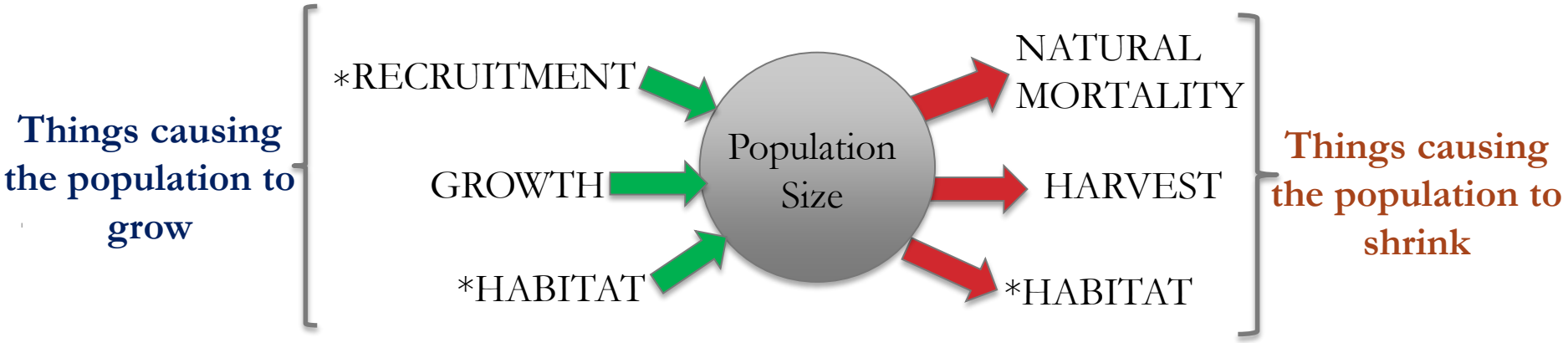
- Stock assessment models represent the processes of birth, natural death, growth, and fishery catch that affect the stock over time.
- Scientists calibrate the model by using observed data from fishery catch, abundance surveys (fall survey), and biological information.

Stock Assessment Background

What is a model?

A model uses data and information describing things that make the population grow and shrink to estimate population size, harvest rates, and recruitment over time.

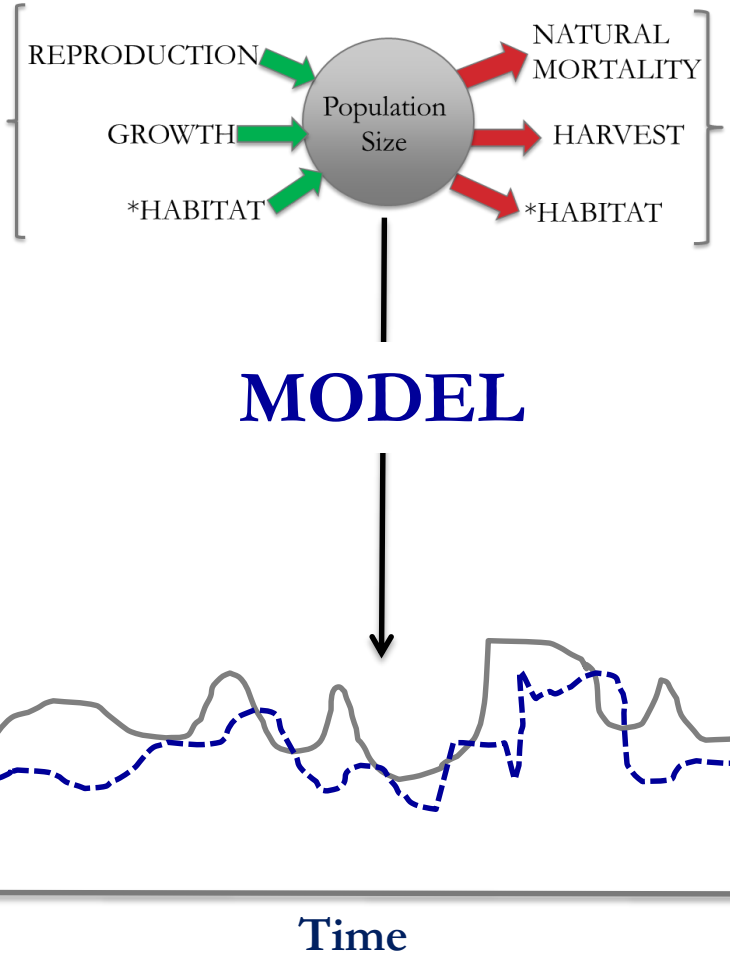
Survey data reflecting trends in population size are used in the model to calibrate the estimates and help us understand how well the model is working.



** Recruitment refers to the size of the spat fall each year. Habitat refers to shell and is unique to oysters since they create their own habitat.*

Stock Assessment Background

What is a model?



— Survey data used to calibrate model estimates: fall survey, patent tong surveys, commercial catch per unit effort.

--- Model-estimated population size

Stock Assessment Background

Why not just use survey data? Why use modeling?

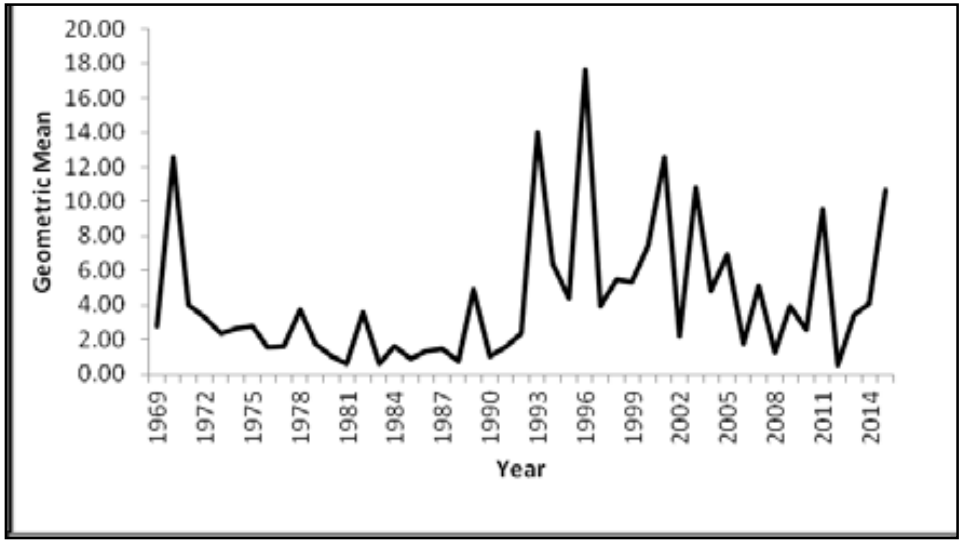
- Survey data are helpful for understanding trends and validating model estimates.
- Survey data do not provide estimates of population size and harvest rates.

- Models combine survey data with other information (e.g. growth rates, reproductive potential, age structure, rates of death) to simulate how a population behaves.
  - Models can provide estimates of population size and harvest rates over time
  - Models can help us understand how management changes impact the population
  - Models can be used to develop Biological Reference Points

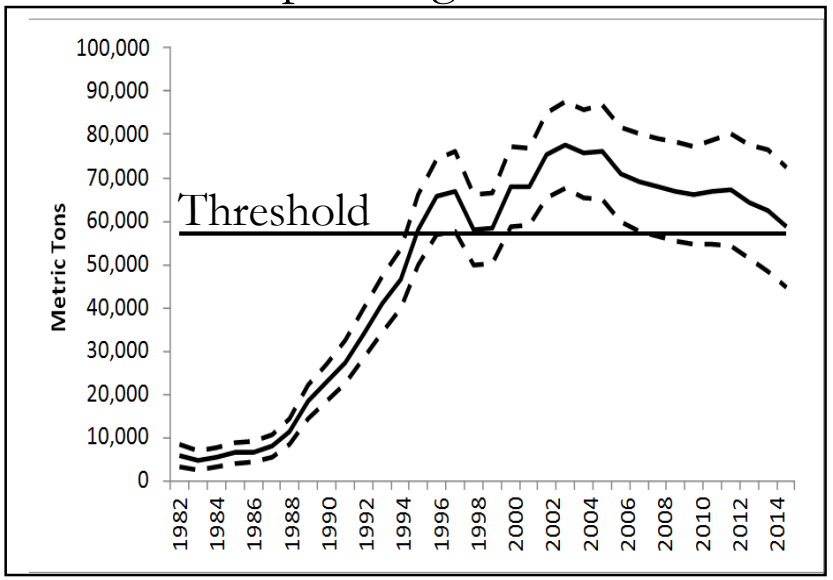
Stock Assessment Background

Example of Survey Data and Modeling

Maryland Striped Bass Juvenile Index (JI)
SURVEY DATA



Model estimate of striped bass female spawning biomass.



It would be difficult to manage from this index alone. The JI does not provide a complete picture of how the coast wide population is behaving, but it does provide critical information.

Maryland's JI is combined with many surveys and used in a model to estimate coast wide female spawning biomass AND a **biological reference point.**

Stock Assessment Background

What are biological reference points?

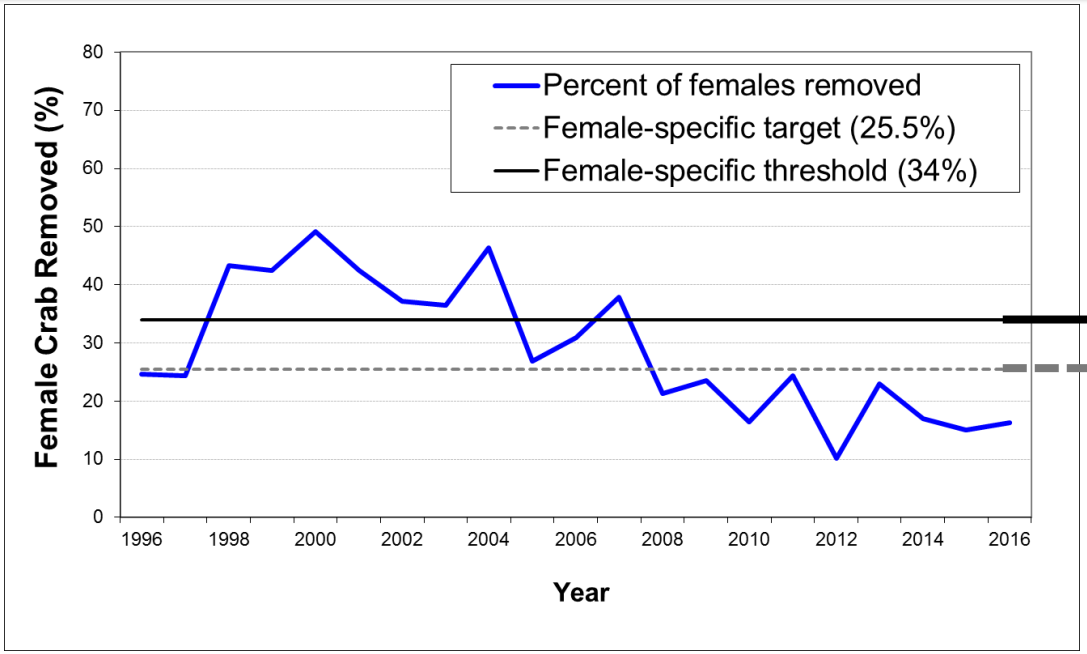
- Stock assessment models help us understand if an oyster population is shrinking or growing and how the population reacts to fishing over time.

- Stock assessment models can help us **identify** levels of fishing that will maintain the population abundance at a desired level. These levels of fishing and desired abundance are called **biological reference points.**

- Two types of biological reference points:
  1. Target reference point defined by managers through the public process
     Where we want to be
  2. Threshold reference point defined by the stock assessment
     Where we do not want to be

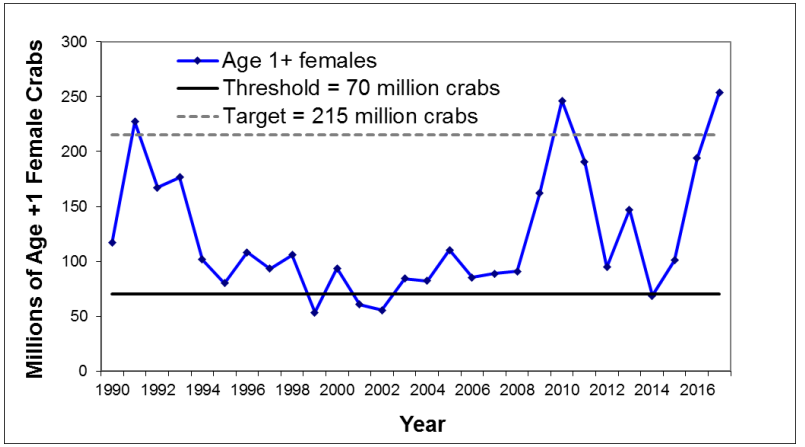
Stock Assessment Background

Example of a biological reference point



Where we DO NOT want to be

Where we want to be



Stock Assessment Background

Stock Assessment Approaches

Index-based approach (Uses survey data without a complicated model)

- Often used when there is not a lot of data.
- No estimate of population size but can show population trends over time
- Limited information about the population and how it reacts to fishing.
- When using an index approach, the goal is to keep some population measure (e.g. oyster density) within a given range. Fishing harvest rules are loosened or tightened to keep it within range.
- Can be used as a cross-check for model-based approaches.

Model-based approach

- Can estimate population size
- More complex models can incorporate data from many sources and allow for exploration of how differing fishing levels may impact the population over time.
- More complex models also allow us to explore how things we are unsure of impact model estimates.

Stock Assessment Background

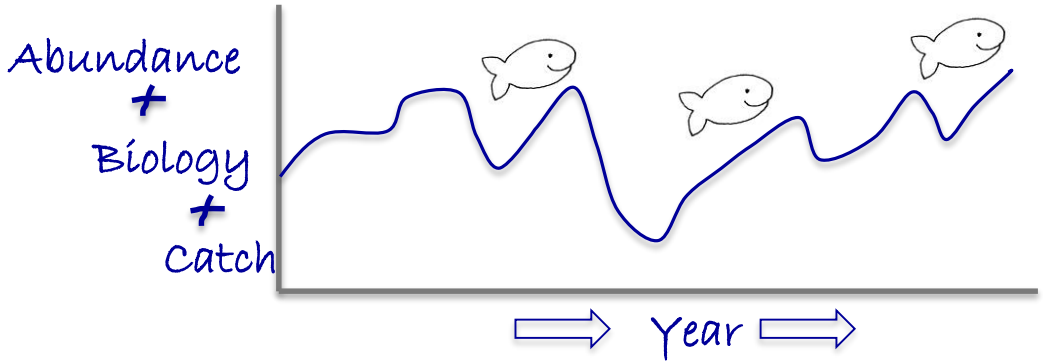
Stock Assessment Approaches

Most stock assessments will develop more than one type of approach in order to compare results.

All approaches are thoroughly **evaluated** by the science team and peer reviewed to make sure results are plausible (consistent with data sources and general knowledge about fishery history and population).

Specific approaches for the oyster stock assessment have not been selected yet.

The approach that is ultimately chosen depends on the data available and the objectives of the stock assessment project.



Stock Assessment Objectives

Based on Statute §4–215 / 2016 House Bill 937:

1) **Analyze** available data to provide index or model based definitions of threshold fishing and/or biomass levels for the Maryland Chesapeake Bay oyster population on a spatial scale that is supported by the available data.
2) **Evaluate and recommend** index or model-based biological reference points for oysters in the Maryland portion of Chesapeake bay that are based on the biological characteristics of the oyster population and other appropriate factors that affect the oyster population including shell dynamics.
3) **Identify** currently available field surveys or data gathering efforts that can be employed to monitor stock status relative to recommended biological reference points.
4) **Develop** estimates of oyster abundance and fishing levels over time on a spatial scale that is supported by available data.
5) **Ensure** that the assessment approach allows for the eventual evaluation of an array of management tools (e.g.) season and vessel limits that could be employed for the fishery on a spatial scale that is supported by available data.

Terms of Reference (TORs)

What are Terms of Reference?

- Developed to ensure that everyone has the same expectations from the assessment
- Details the items that should be included in the assessment
  - Questions to address
  - Approaches to explore
- Defines protocols and responsibilities when developing a stock assessment
- Used as guidelines during the peer review of the assessment

Draft Oyster Assessment Terms of Reference :

1) Complete a thorough data review: survey data, reported harvest and effort data, studies and data related to population rates (growth, mortality and recruitment), available substrate, shell budgets, and sources of mortality.
   a) List, review, and evaluate the strengths and weaknesses of all available data sources for completeness and utility for stock assessment analysis, including current and historical fishery-dependent and fishery-independent data.
   b) Identify the relevant spatial and temporal application of data sources.
   c) Document changes in data collection protocols and data quality over time.
   d) Justify inclusion or elimination of each data source

Terms of Reference

2) Develop stock assessment model or index based approach that estimates biological reference points and documents status of the stock relative to estimated reference points. To the extent possible, quantify sources of uncertainty within model.

3) Compare estimates of stock status generated by index and model-based approaches. Justify selected approach.

4) Include sanctuaries and restoration efforts in sanctuaries in the development of stock assessment approaches.

5) Examine how hatchery plantings (aquaculture and public fishery) impact spawning potential in fishery.

Inventory of Available Data

Terms of Reference #1

Data describing Maryland oysters will be prioritized in the assessment

Input category	Data Source
Growth Age/Size Structure	Fall survey, Peer reviewed studies, DNR and other analyses
Recruitment	Fall survey, Patent Tong surveys, Peer reviewed studies
Habitat	Yates Survey, Bay Bottom Survey, Current sonar surveys, Shell plantings
Harvest	Dealer buy tickets, Monthly harvester reports, Bushel tax forms
Natural mortality	Fall survey, Peer reviewed studies, DNR and other analyses
Abundance	Fall survey, Patent Tong surveys

Inventory of Available Data

What kinds of data are useful?

- Research studies describing vital rates (growth, fecundity, mortality)
- Covers long period of time over differing environmental conditions
- Data collection methods are consistent over time, or we understand exactly what changed and when.
- Spatial scale matters

What kinds of data are not useful?

- Not sure – we'd have to see it.
- Generally very short, very local observations are difficult to use

Call for data - Contact us if you think you've got data we can use.

Concerns We Have Heard

MARYLAND DEPARTMENT OF NATURAL RESOURCES

What is the purpose of this oyster stock assessment?

- To develop biological reference points (directed by law)
- To examine the effects of fishing and other factors on the past and current status of an oyster population in order to guide future management decisions.

Why will the stock assessment take so long?

- First time conducting an assessment for Maryland oysters
- Gathering multiple large data sets
- Research – getting all the data sources covered
- Model selection - examining all possible approaches
- Coding and code-proofing
- Diagnostics – do the results make sense?
- Documentation and writing a report
- Review process (internal and external)
- The review panel will prepare a report

Parameter values

```
a = 60  #alpha for Beverton-Holt stock-recruitment curve
0.00017b =   #beta for Beverton-Holt
tf = 2000  #number of time steps
N0 = c(100, 0, 0, 0, 0)  #initial population vector for 5
age classes
0.28s =   #survival rate with fishing
0.1056e =   #fraction of age 3 fish that spawn early (age 4
is mean spawner age)
0.10561 =   #fraction of age 4 fish that spawn late as age
5 fish
sx = c(s, s, (s * (1 - e)), (s * (1)))  #survival vector
for all ages with fishing, spawners die after spawning
t <- 1  #start off at time=1
```

Make a function for the age-structured matrix

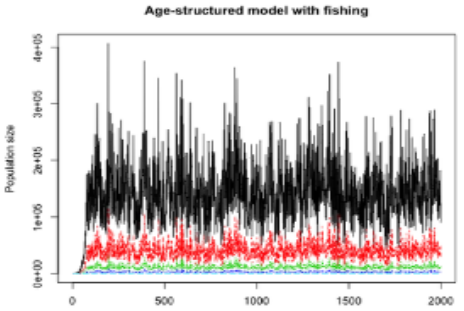
```
# Make a function for the age-structured matrix with
fishing
AgeStructMatrix_F = function(sx, a, b, tf, N0) {
0.3    sig_r =
    ncls = length(N0)  #Number of age classes
    Nt_F = matrix(0, tf, ncls)  #Initialize output matrix
with time steps as rows, age classes as columns
    Nt_F[1, ] = N0  #put initial values into first row of
output matrix
    for (t in 1:(tf - 1)) {
        #for time step t in 1:1999
        Pt = (e * Nt_F[t, 3]) + ((1 - 1) * Nt_F[t, 4]) +
Nt_F[t, 5]  #number of spawners
        Nt_F[t + 1, 1] = ((a * Pt)/(1 + (b * Pt))) *
(exp(sig_r * rnorm(1, mean = 0,
            sd = 1)))  #number of recruits with
environmental stochasticity
        Nt_F[t + 1, 2:ncls] = sx * Nt_F[t, 1:(ncls - 1)]
#number of age classes 2-5
    }
    return(Nt_F)
}
```

Run model by calling function

```
Nt_F = AgeStructMatrix_F(sx, a, b, tf, N0)
```

Plot of time series with all 5 age classes

```
matplot(1:tf, Nt_F, type = "l", xlab = "Time", ylab =
"Population size", main = "Age-structured model with
fishing")
```



Concerns We Have Heard

What could the results mean for the public fishery?

- A stock assessment does not provide specific management strategies. Whatever the result of the assessment, any management actions will be determined in a subsequent public process.

What if the stock assessment finds the population is overfished and fishing levels are way too high?

- We cannot pre-suppose the results of the assessment. But whatever the result, how we deal with that will be a separate process with lots of public input.

Are we stuck with the assessment results forever?

- Stock assessments generally get updated periodically as new data and new information become available.
- Between stock assessments, the effects of management actions can be tracked and adjustments to harvest rules can be made as long as reference points are maintained.

Concerns We Have Heard

Are you going to count every oyster?

- No. It would be impossible and impractical to count all oysters in Maryland waters. Data already collected will be used in the assessment.

Are you going to determine an oyster population estimate?

- Maybe. If the available data support this type of model, and if the model assumptions are valid.

Are you going to account for all oysters in the assessment?

- Information on oysters in both sanctuary areas and public fishery areas will be used in the assessment.

Concerns We Have Heard

How would shell availability and shell planting be incorporated into the assessment?

- The science team will explore the use of habitat data in the model to describe population growth and decline. Habitat data will include shell plantings and the shell budget.

What is the difference between the stock assessment and the Five Year Oyster Review Report?

- The report was a comprehensive presentation of data and information on both public fishery areas and sanctuaries.
- The report was used to gauge if the 2010 objectives were being met.
- The report did not develop biological reference points. It made no attempt to identify target limit of abundance or fishing.

Concerns We Have Heard

MARYLAND DEPARTMENT OF NATURAL RESOURCES

Are models trustworthy and can they produce reliable results?

- Generally – Yes. BUT **models always contain uncertainty.** Fisheries models, like weather models predicting hurricane tracks, need to be interpreted with a knowledge of model assumptions. Model results are trustworthy as long as assumptions and uncertainty are thoroughly described and recognized.
- Models are only as good as the input data

How can models be helpful and valuable?

- Models provide a cohesive picture of an entire system.
- Models allow the exploration of how various factors (fishing) may impact that system over time.
- A fisheries model can provide a platform for transparent and predictable management.

Concerns We Have Heard

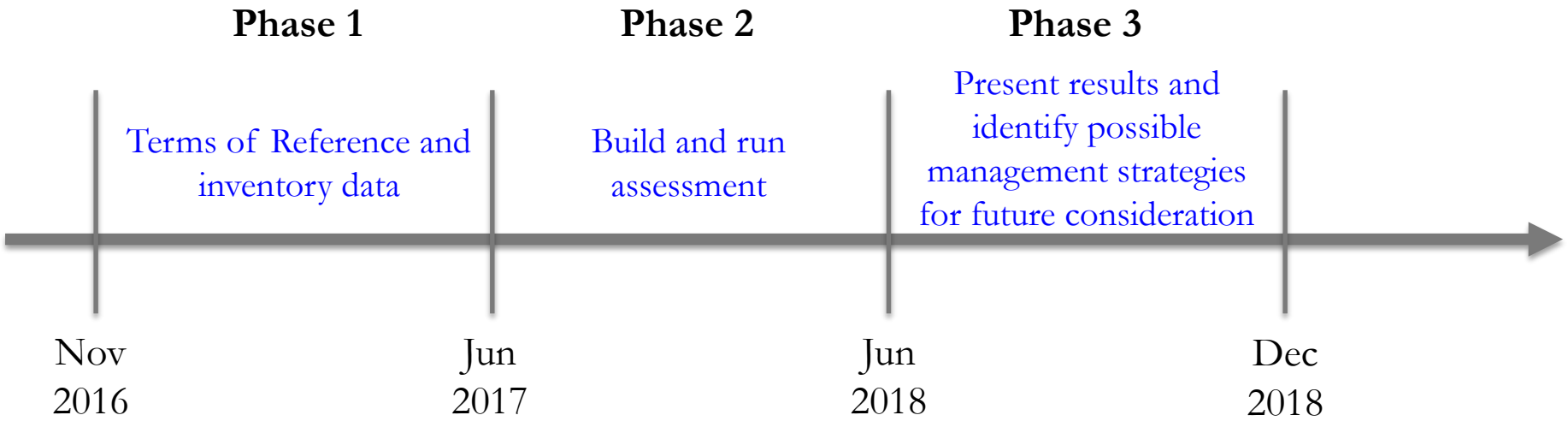
How far back in time will the assessment go?

- The assessment will go back in time as far as there is available data.
- Most likely the assessment will start in the 1980s or 1990s due to limited data prior to those years.

What happens after the stock assessment and how do we use the stock assessment in the future?

- The next step after the assessment will be to identify a laundry list of **general** management strategies for inclusion in the legislative report due in December 2018. (e.g. bushel limits, seasons)
- The results of the assessment will be used in a future process to help determine the specifics of identified management strategies (e.g. actual number of bushels).
- The process of selecting and developing a management approach based on assessment results will require intensive public input.

Timeline


Phase 1
Phase 2
Phase 3
Terms of Reference and inventory data
Build and run assessment
Present results and identify possible management strategies for future consideration
Nov 2016
Jun 2017
Jun 2018
Dec 2018

Homework

Homework Assignment #3 for Commissioners

- Review the Terms of Reference
- Send comments about the Terms of Reference by June 5th
- Review the data inventory
- Report any potentially useful data by June 5th

Fish are born, they grow, they reproduce and they die – whether from natural causes or from fishing. That's it.

Modelers just use complicated (or not so complicated) math to iron out the details.

For more background information on stock assessments:
https://www.aboutseafood.com/sites/all/files/stockassessmentguide.pdf