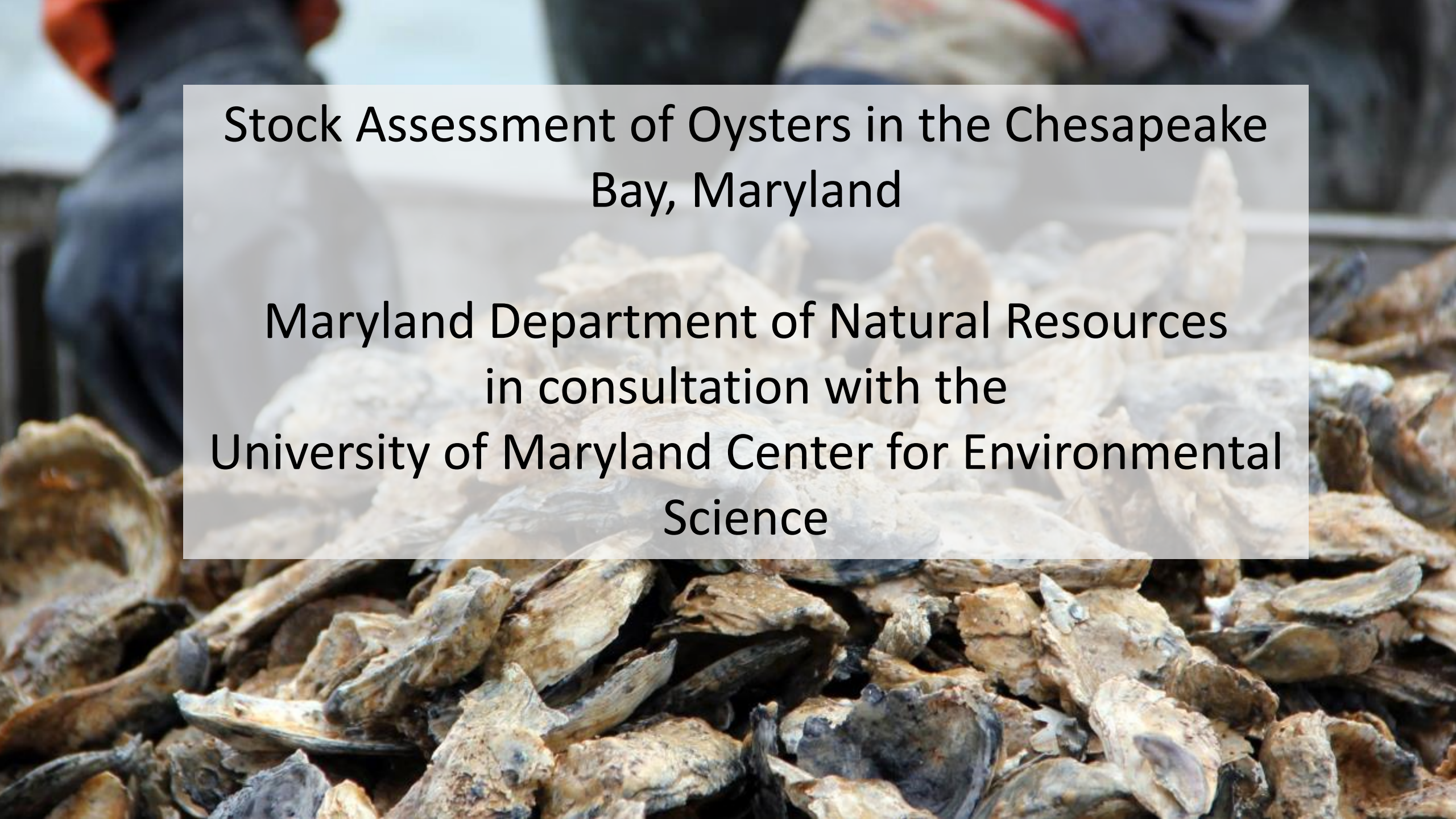


Stock Assessment of Oysters in the Chesapeake Bay, Maryland

Maryland Department of Natural Resources
in consultation with the
University of Maryland Center for Environmental Science

300 year plan for lumber for renovations

Sustainable Oyster Population and Fishery Act of 2016

Statute §4–215

To be Completed On or Before December 1, 2018

Requires DNR in consultation with University of Maryland Center for Environmental Science (UMCES) to:

- Conduct an oyster stock assessment
  - Reviewed by an independent panel of fisheries stock assessment experts
- Develop biological reference points to manage the public fishery
- Identify oyster management strategies to achieve a sustainable oyster population and fishery
- Provide opportunity for stakeholder engagement

Terms of Reference #1 (TORs)

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

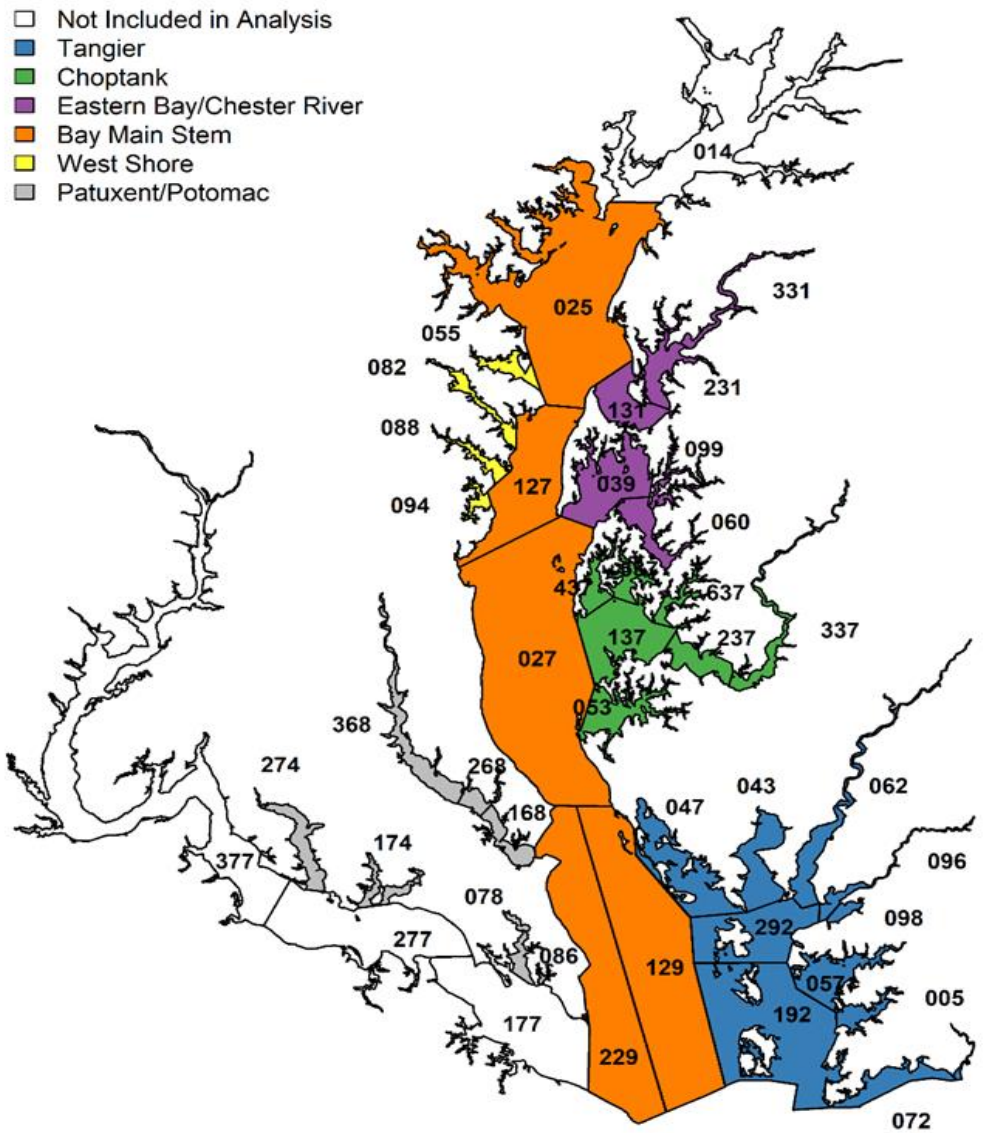
Inventory of Available Data

Data Source	Process: Recruitment	Habitat	Harvest	Nat. mortality	Fish. Mortality	Abundance trends	Growth	Catchability
Dealer buy tickets			√		√			
Harvester reports			√		√			
Bushel tax forms								
Fall dredge survey	√			√		√		
Patent tong survey						√		
Hatcher-reared spat	√							
Natural seed	√							
Shell plantings		√						
Artificial substrate plantings		√						
MD Bay bottom survey		√						
Yates bar survey		√						
Current sonar surveys								
DNR and other analyses				√				
Peer-reviewed studies		√					√	√

We are using data for 1999-present.

(√) indicates primary role in the analyses
No check mark indicates primarily used for qualitative comparison

Harvest reporting “NOAA codes”



<u>Conducted individual analyses for 36 NOAA Codes organized into 6 Regions</u>

Tangier Sound
Choptank River
Eastern Bay
Bay Mainstem
Patuxent and Potomac
Western Shore

Excluded from assessment due to lack of data:

094 (Rhode/West Rivers)
055 (Magothy River)
098 (Monie Bay)

Terms of Reference #2

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.

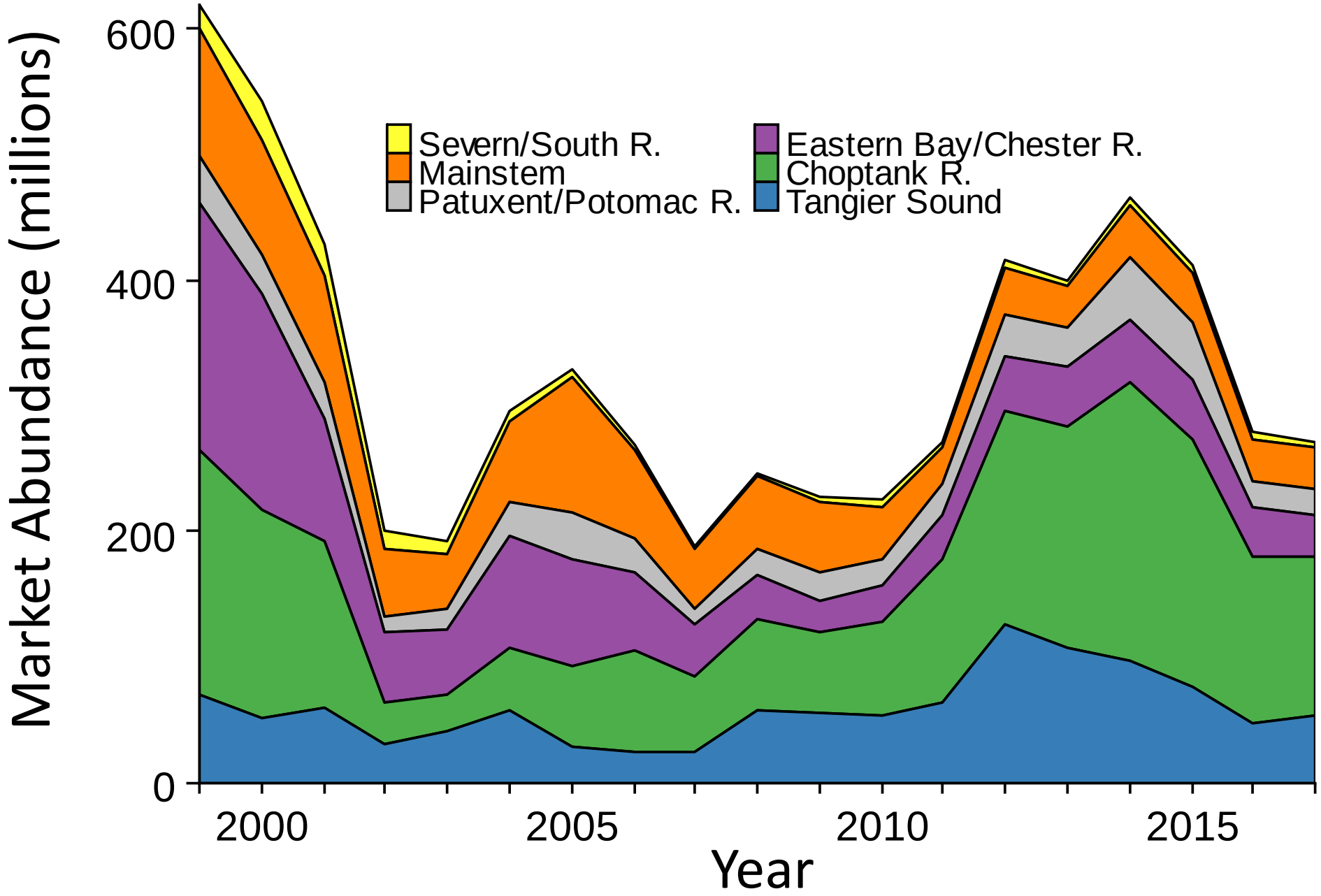
   a. Depletion analyses – Buy ticket data
   b. Trend analyses – Fall dredge survey
   c. Population dynamics stock assessment model

Stage-structured Assessment Model Results

Types of results estimated in model:

- Number of spat (<1 year old), small (>1 year old, < 3 inches), and market-sized oysters (>3 inches)
- Natural mortality rates (Fraction that die to causes other than harvest)
- Fishing rates (harvest fraction)
- Habitat relative to 1980

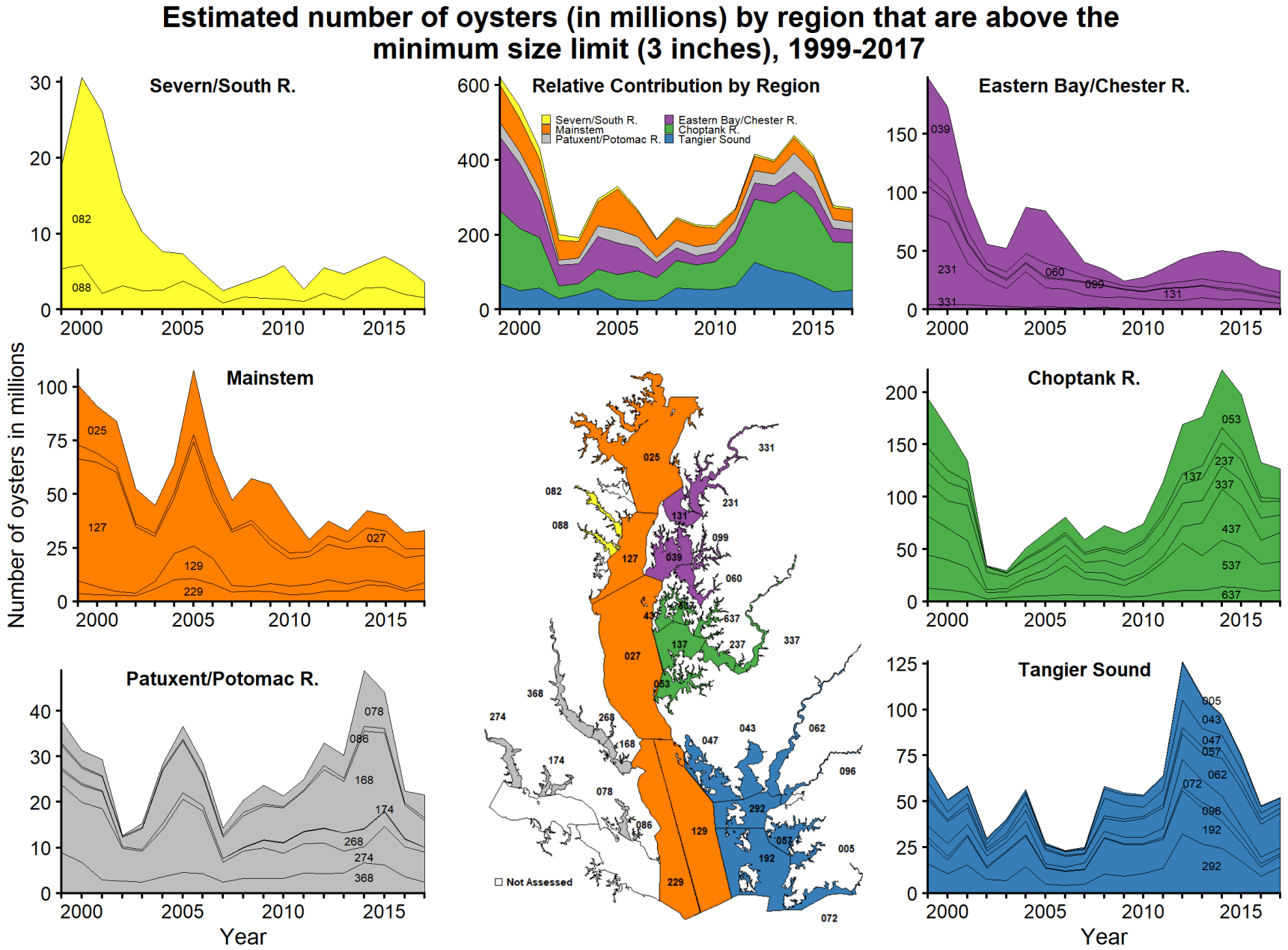
Estimated Number of Market-sized Oysters per Region



Shows estimates of number of market-sized oysters (individuals) over time.

No region is doing as well as in 1999.

Some regions, like the Choptank are increasing while others, like Eastern Bay, are not.

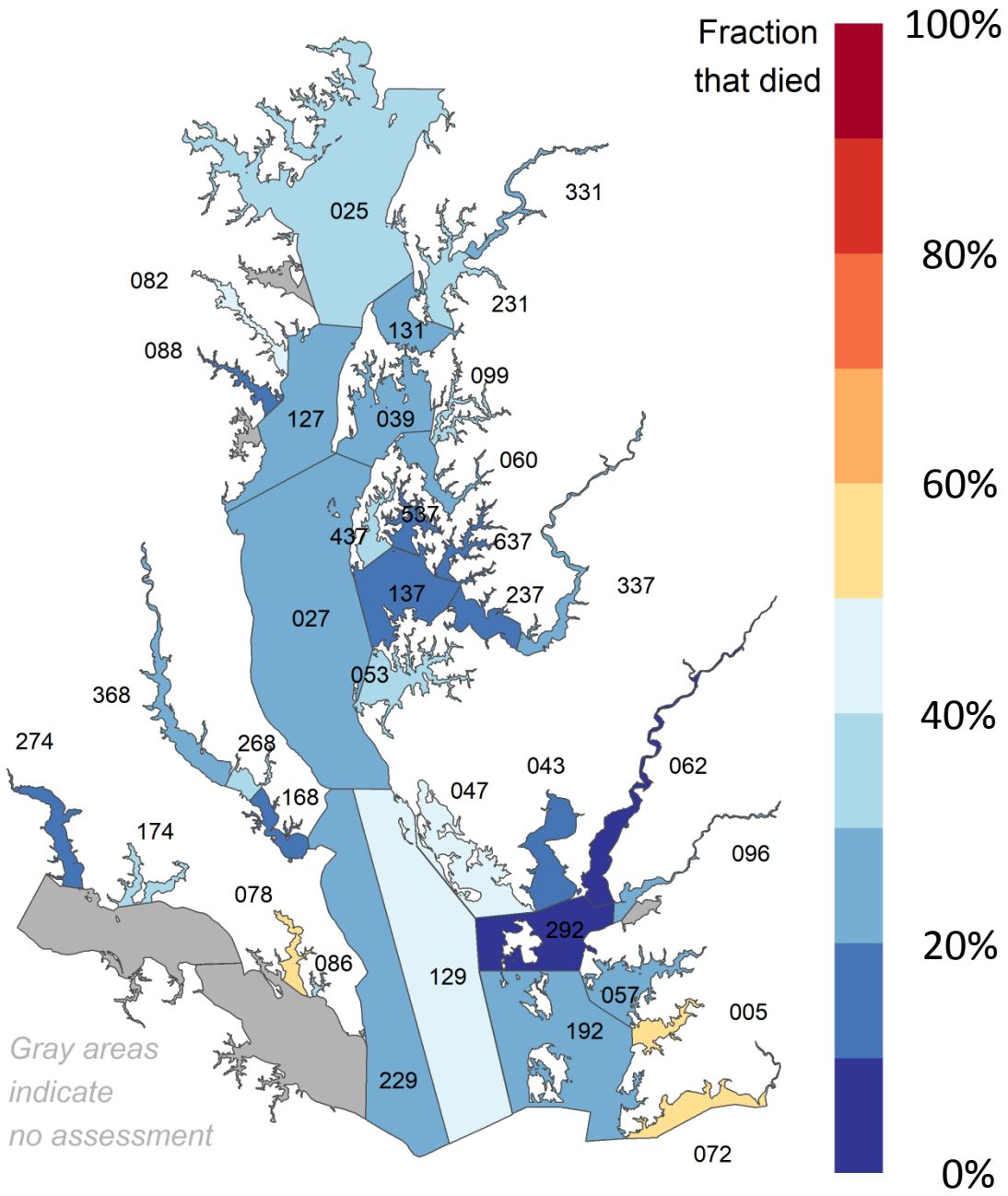


Shows estimates of number of market-sized oysters (individuals) over time.

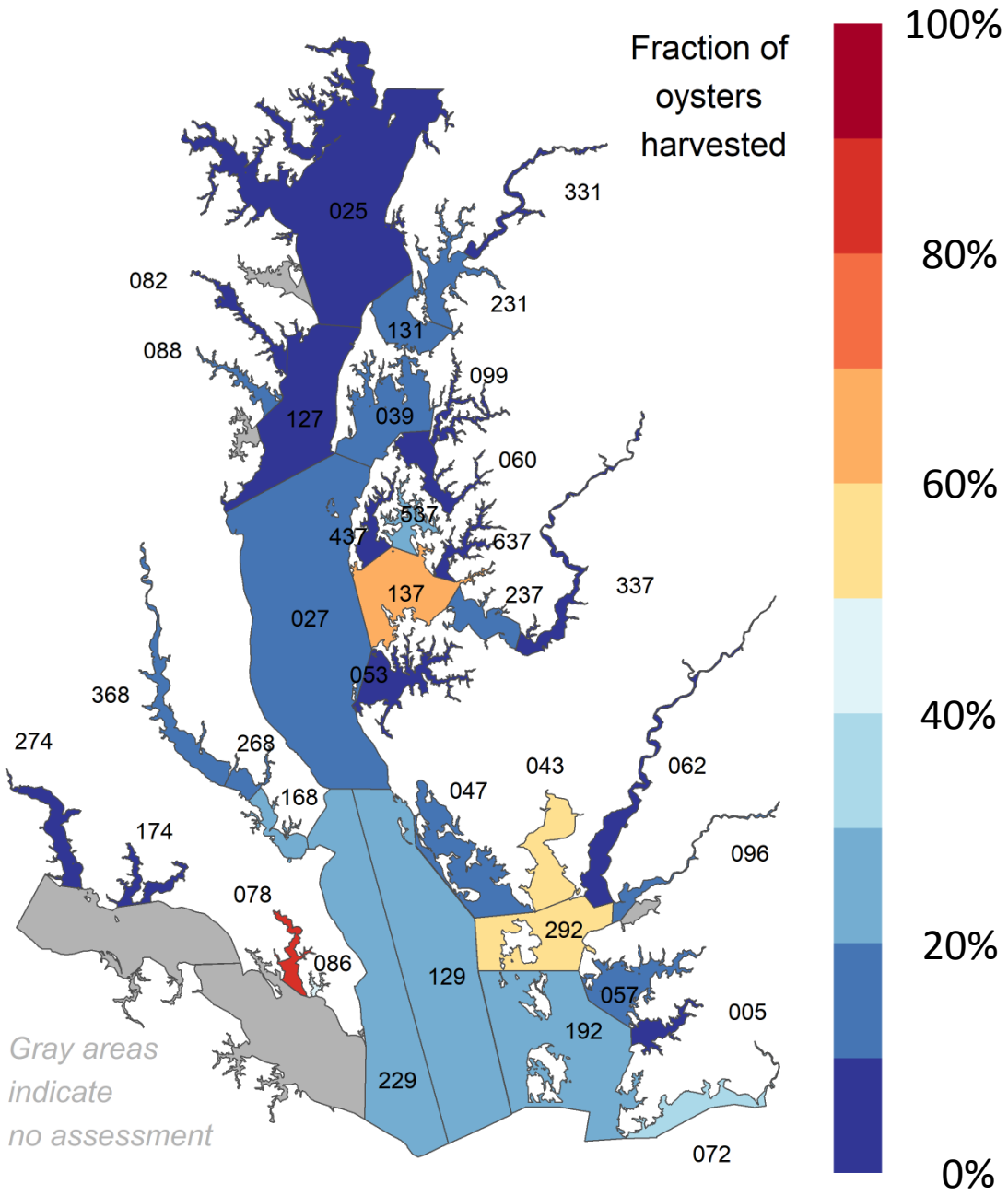
No region is doing as well as in 1999.

Some regions, like the Choptank are increasing while others, like Eastern Bay, are not.

Fraction of adult oysters that died from natural mortality and disease in 2017



Fraction of oysters larger than the minimum size limit (3 inches) that were harvested in 2017



Stock Assessment Background

What are biological reference points?

- Biological reference points **identify** fishing rate and abundance that will achieve the management objectives.

- Two types of biological reference points:
  1. Target reference point defined by managers through the public process
     Benchmark that identifies our goal
  2. Threshold reference point defined by the stock assessment
     Benchmark that identifies where we do <u>not</u> want to be

Biological Reference Points

Fishing Rate (target and upper threshold)

- Target rate is estimated as the fraction of market-sized oysters (harvest ratio) that maximizes harvest while resulting in a stable or increasing oyster population
- Threshold rate represents the absolute maximum harvest rate that can be sustainable, which will result in eventual disappearance the population if it is regularly exceeded
- Estimated using a model that includes oyster's reliance on shell for habitat and their production of shell
- Goal: Not allow the fishing rate to exceed the threshold

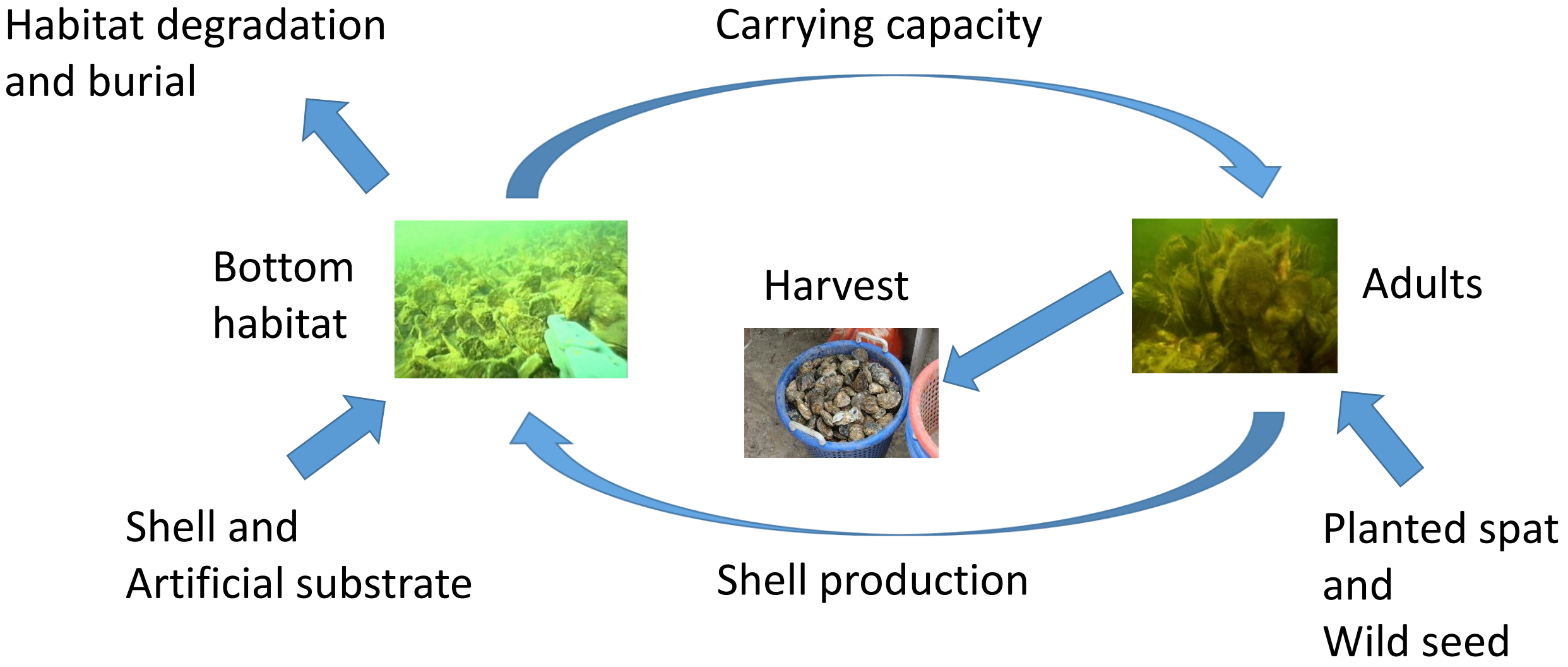
Abundance (lower threshold only)

- Goal – not allow abundance to decrease below the lowest levels observed
- Set to the minimum abundance estimated during 1999-2017

Statute §4-215 requires:

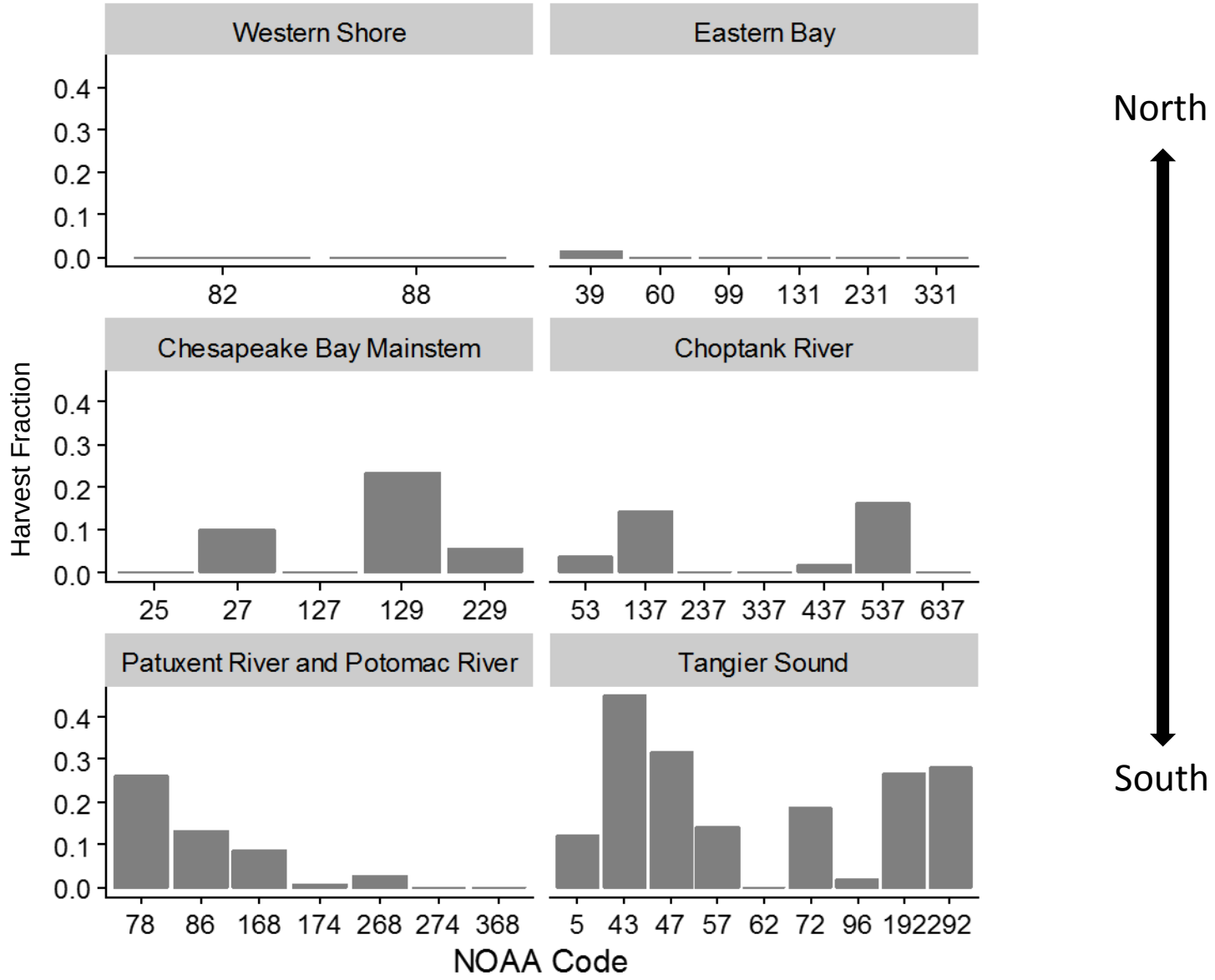
1. Develop biological reference points
2. Determine if population is overfished (lower threshold abundance)
3. Determine if there is overfishing (upper threshold fishing rates)
4. Identify sustainable harvest rates (target fishing rates)

Reference Point Model

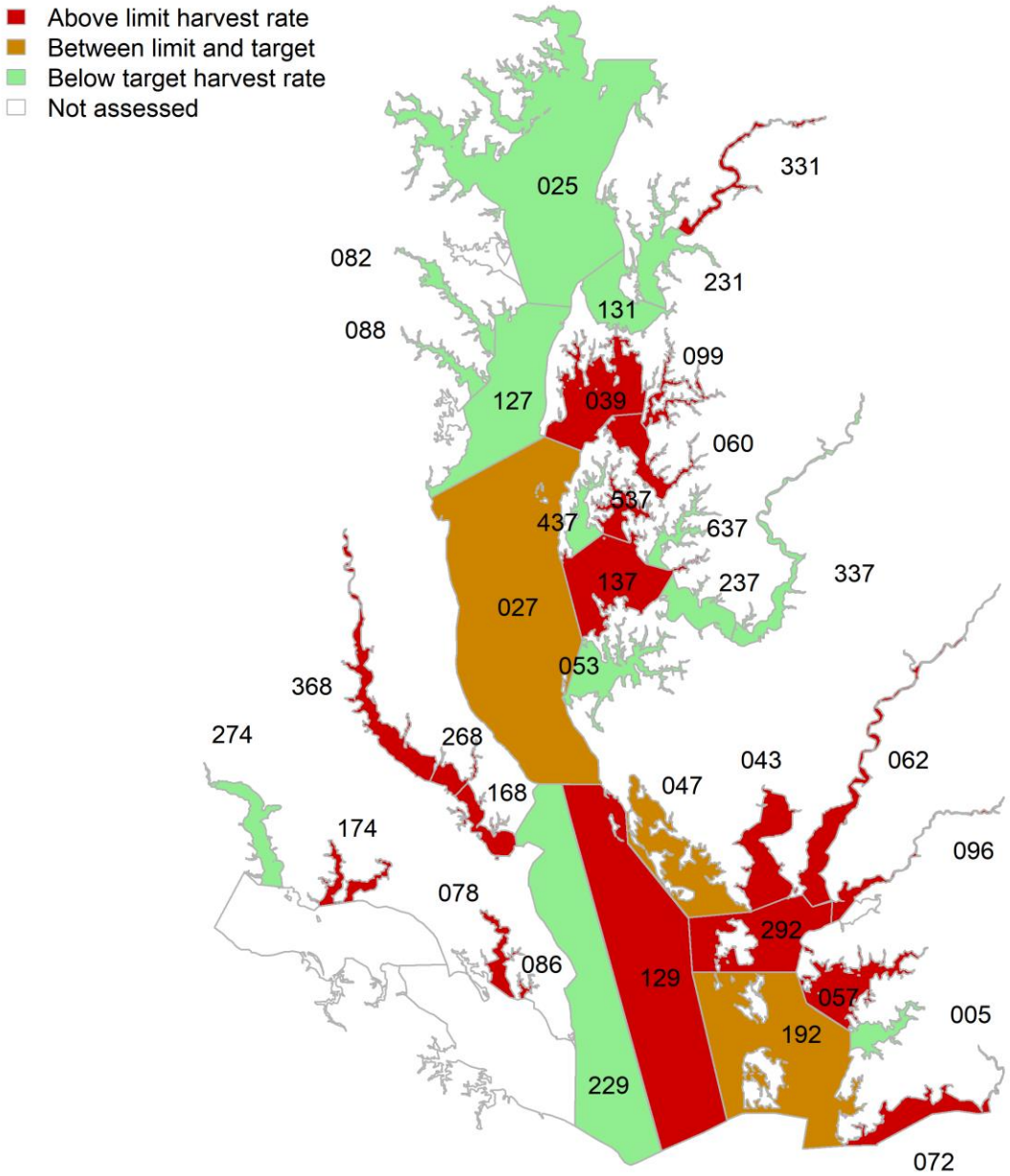


Based on Wilberg et al. 2013

Estimated Threshold Fishing Rates for Market-sized Oysters from Model Results



Harvest rate (corrected for spat plantings) in the 2017-2018 fishing season relative to target and limit harvest rates



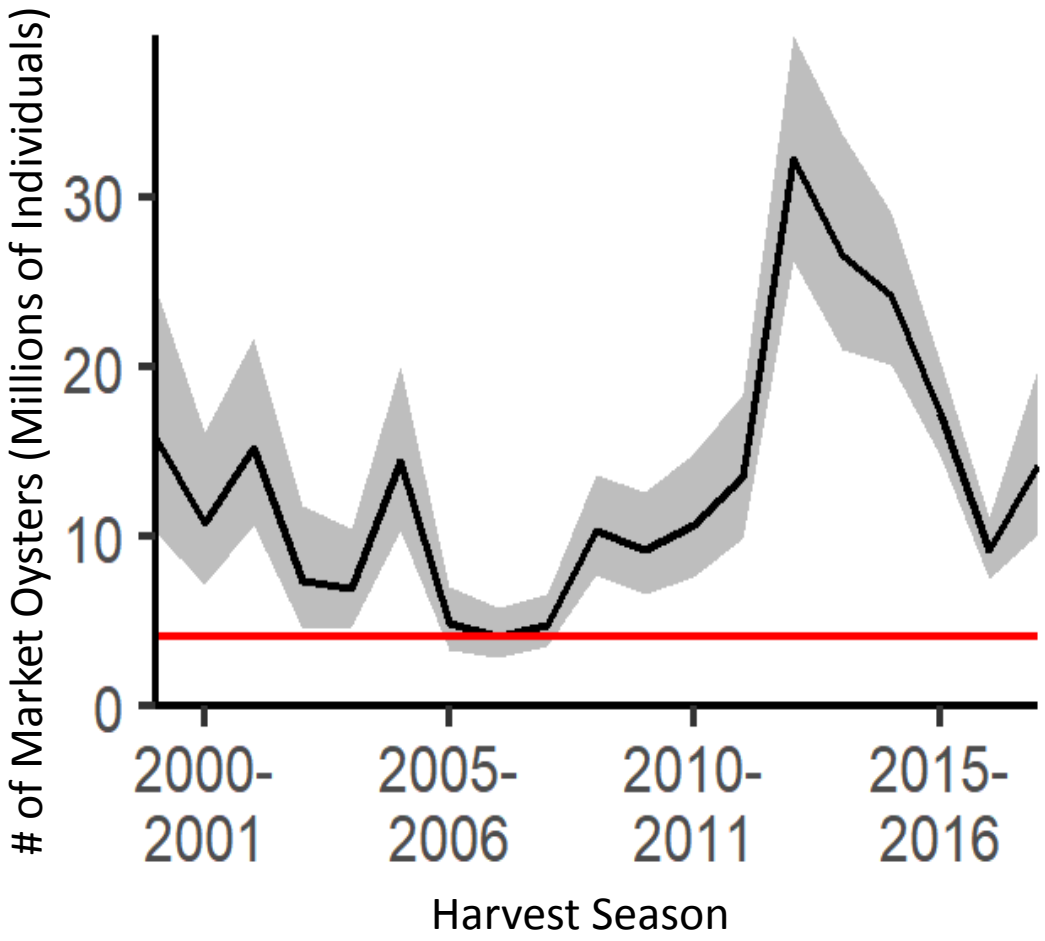
Red shading indicates fishing over the upper threshold rate.

Orange shading indicates fishing over the target rate and under the threshold rate.

Green shading indicates fishing at or below the target rate.

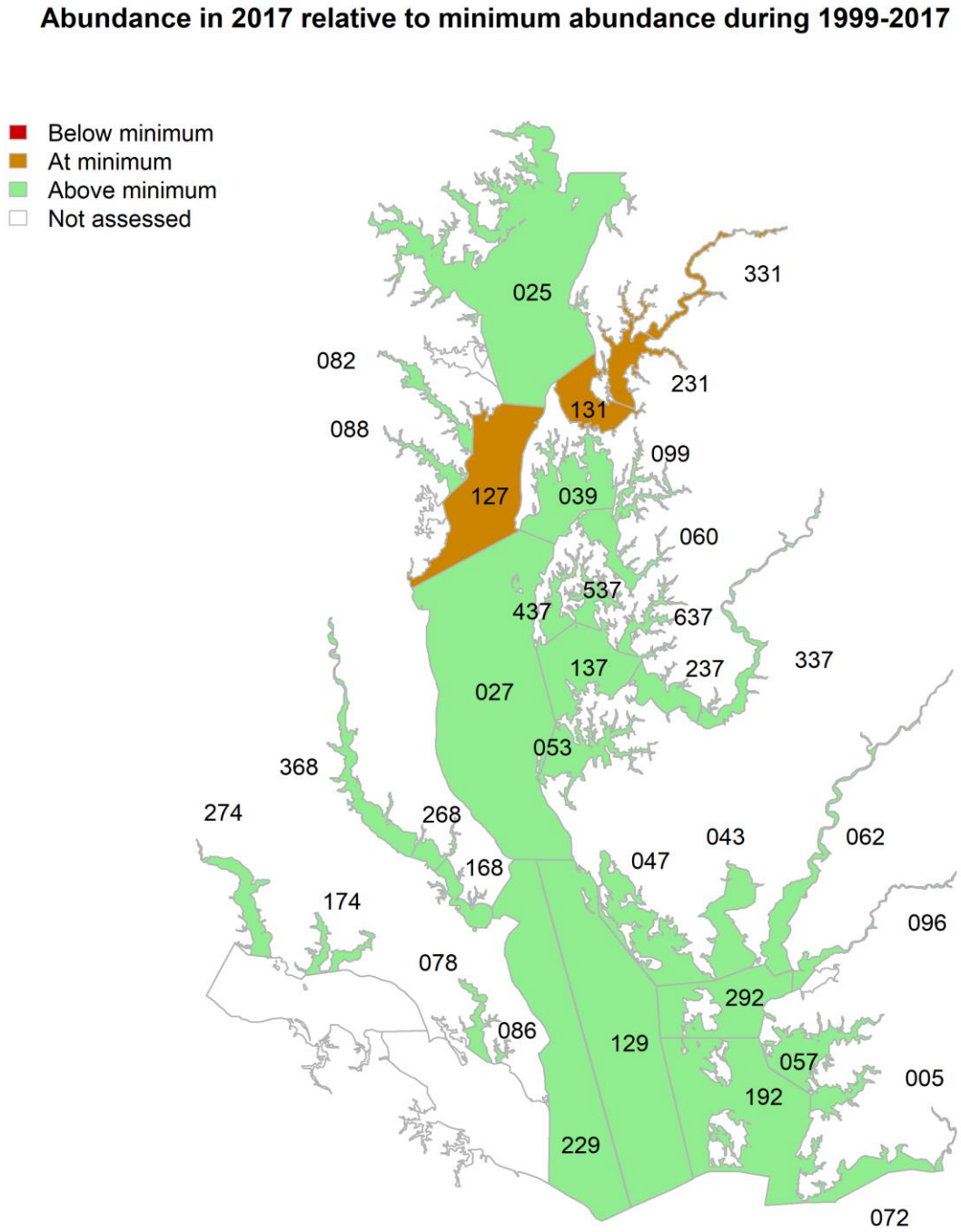
Example of Abundance Biological Reference Points

Abundance Biological Reference Point
Threshold Only



Red line represents the lower threshold reference point which is set to the minimum abundance estimated during 1999-2017

Goal: Not allow abundance to decrease below red line



Red shading indicates abundance below the lower threshold.

Orange shading indicates abundance at the lower threshold.

Green shading indicates abundance above the lower threshold.

Summary Findings from Model Assessment Results and Biological Reference Points

- A majority of the NOAA Codes are estimated to be over the threshold fishing rate.
- If conditions stay constant will expect more of the NOAA Codes to go under the abundance threshold.
- In some NOAA Codes, seed plantings kept fishing rates under the threshold.

Terms of Reference #3

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

- We compared the results of the different approaches and how well their assumptions are met
- We recommend using the stage-structured assessment model to evaluate status of the population relative to the reference points
- Limitations with the data available for the depletion analyses led us to conclude that they should not, on their own, currently be used for comparisons with the exploitation rate reference points although depletion estimates could be used in a limited number of NOAA codes with consistently high harvest – especially if improvements to harvest reporting occur.
- The fall dredge survey catch per bushel agreed well with abundance in some NOAA codes and less well in others. Alternative ways of analyzing the fall dredge survey data (e.g., number per area swept) may be useful for monitoring abundance relative to its reference points.

Terms of Reference #4

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

- We conducted analyses and assessments for almost all NOAA codes in Maryland, including ones with sanctuaries
- Repletion and restoration efforts are included in the population dynamics assessment model (hatchery-reared spat, natural seed, shell plantings, artificial substrate)
- Abundance of oysters in sanctuaries is included when comparing abundance to the limit (threshold) reference point
- We would need more information about available habitat and larval dispersal to estimate effects of sanctuaries on harvest fraction reference points. These are described in the research recommendations.

Term of Reference #5

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

Challenging TOR to address because:

- Planted oysters cannot always be distinguished from wild oysters
- Aquaculture plantings include triploid oysters which are specifically bred not to spawn
- Cultured oysters are harvested year-round, sometimes at a smaller size than wild harvest, so quantifying which oysters stay in the water long enough to spawn is difficult

What we did:

A simple comparison of: 1) estimates of market-size oysters from the assessment model, 2) the estimated number of market-size oysters generated from hatchery plantings, and 3) the harvest of oysters from lease grounds, where harvest is considered a proxy for abundance.

What we found:

- Market-size oysters from non-lease planting, which are nearly all diploid, can potentially contribute a substantial larval subsidy to the wild population in some NOAA codes and some years.
- Spawning potential of market-sized oysters on leases is likely negligible relative to the population outside of leases at the Maryland-wide scale.

Further reading

- https://dnr.maryland.gov/fisheries/Pages/oysters/Oyster_Stock_Assess.aspx