The background of the slide shows a close-up of numerous oyster shells, some open and some closed, piled together. In the upper left corner, a person wearing a white protective suit and a red cap is partially visible, likely working in an oyster processing facility. The overall scene is brightly lit, suggesting an industrial or laboratory setting.

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

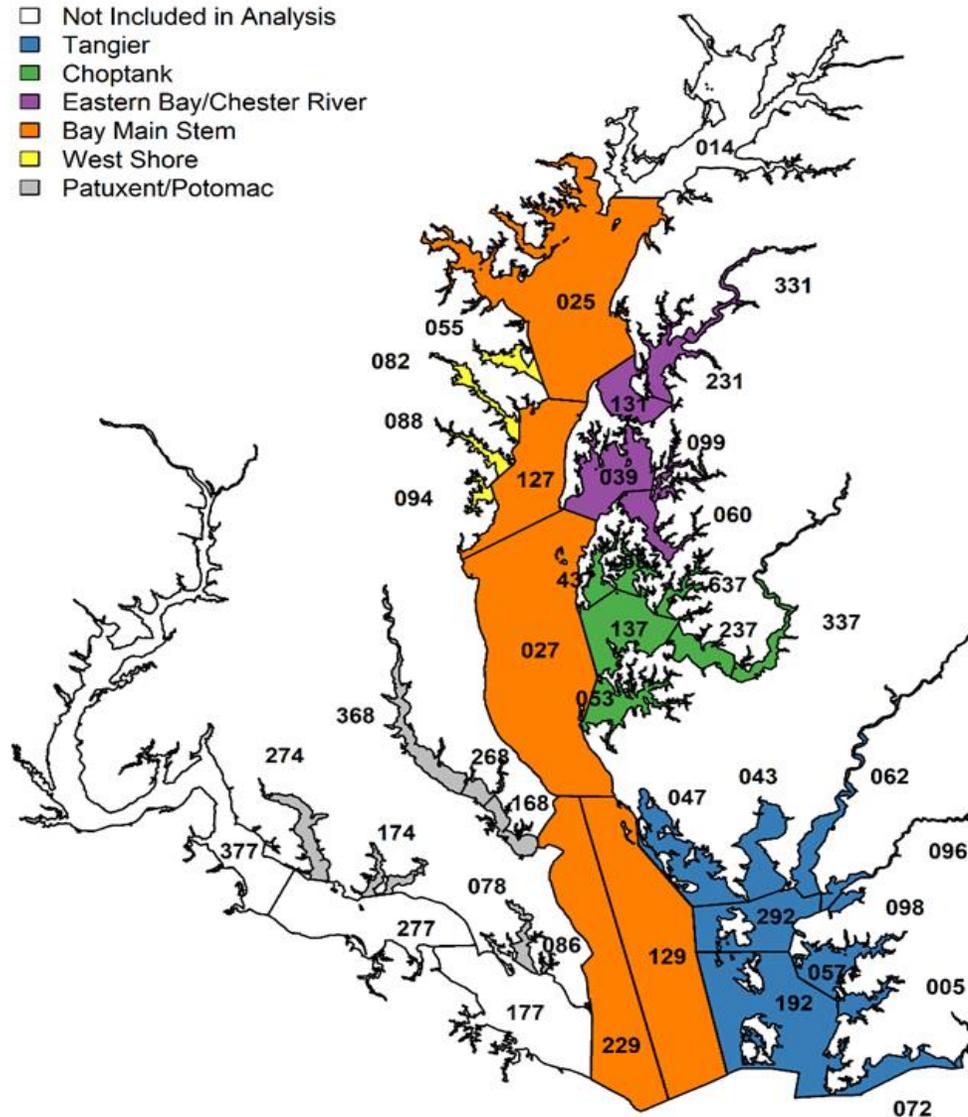
Data Source	Process							
	Recruitment	Habitat	Harvest	Nat. mortality	Fish. Mortality	Abundance trends	Growth	Catchability
Dealer buy tickets			✓		✓			
Harvester reports			✓		✓			
<i>Bushel tax forms</i>								
Fall dredge survey	✓			✓		✓		
Patent tong survey						✓		
Hatcher-reared spat	✓							
Natural seed	✓							
Shell plantings		✓						
Artificial substrate plantings		✓						
MD Bay bottom survey		✓						
Yates bar survey		✓						
<i>Current sonar surveys</i>								
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”



Conducted individual analyses for 36 NOAA Codes organized into 6 Regions

- 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

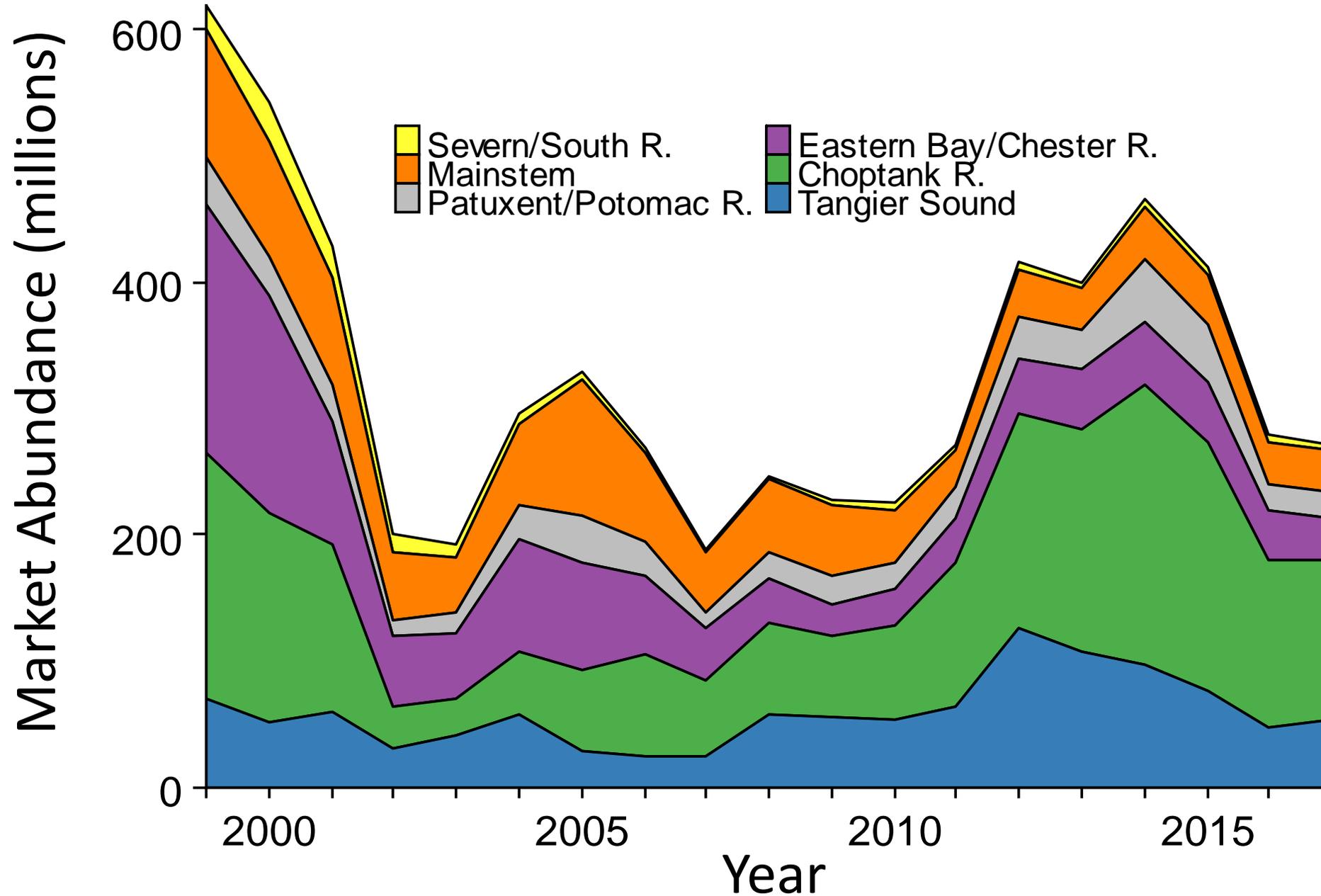
- 2) Develop stock assessment model or index based approach that estimates biological reference points and documents status of the stock relative to estimated reference points. To the extent possible, quantify sources of uncertainty within model.
 - a. Depletion analyses – Buy ticket data
 - b. Trend 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

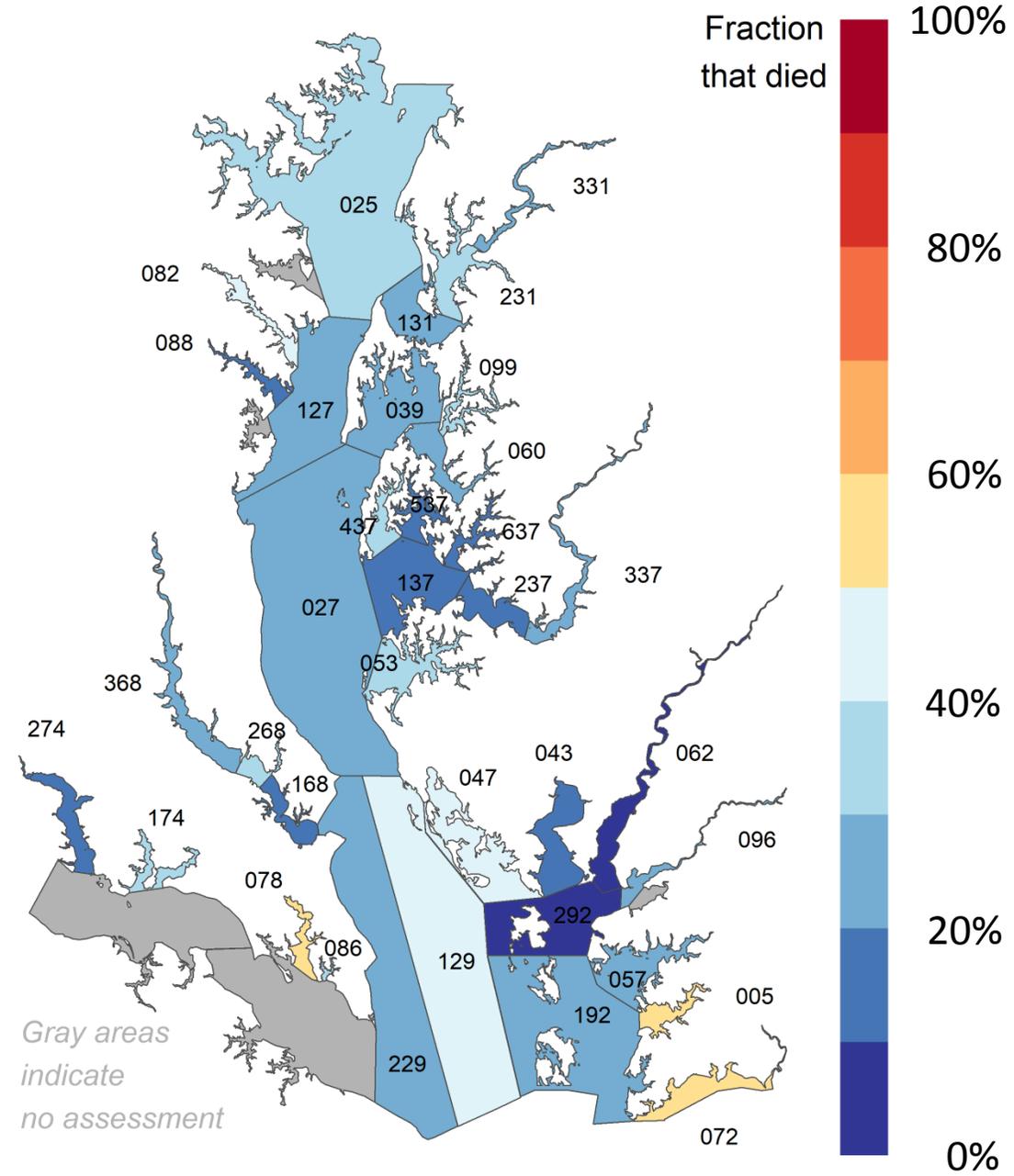


Shows estimates of number of market-sized oysters (individuals) over time.

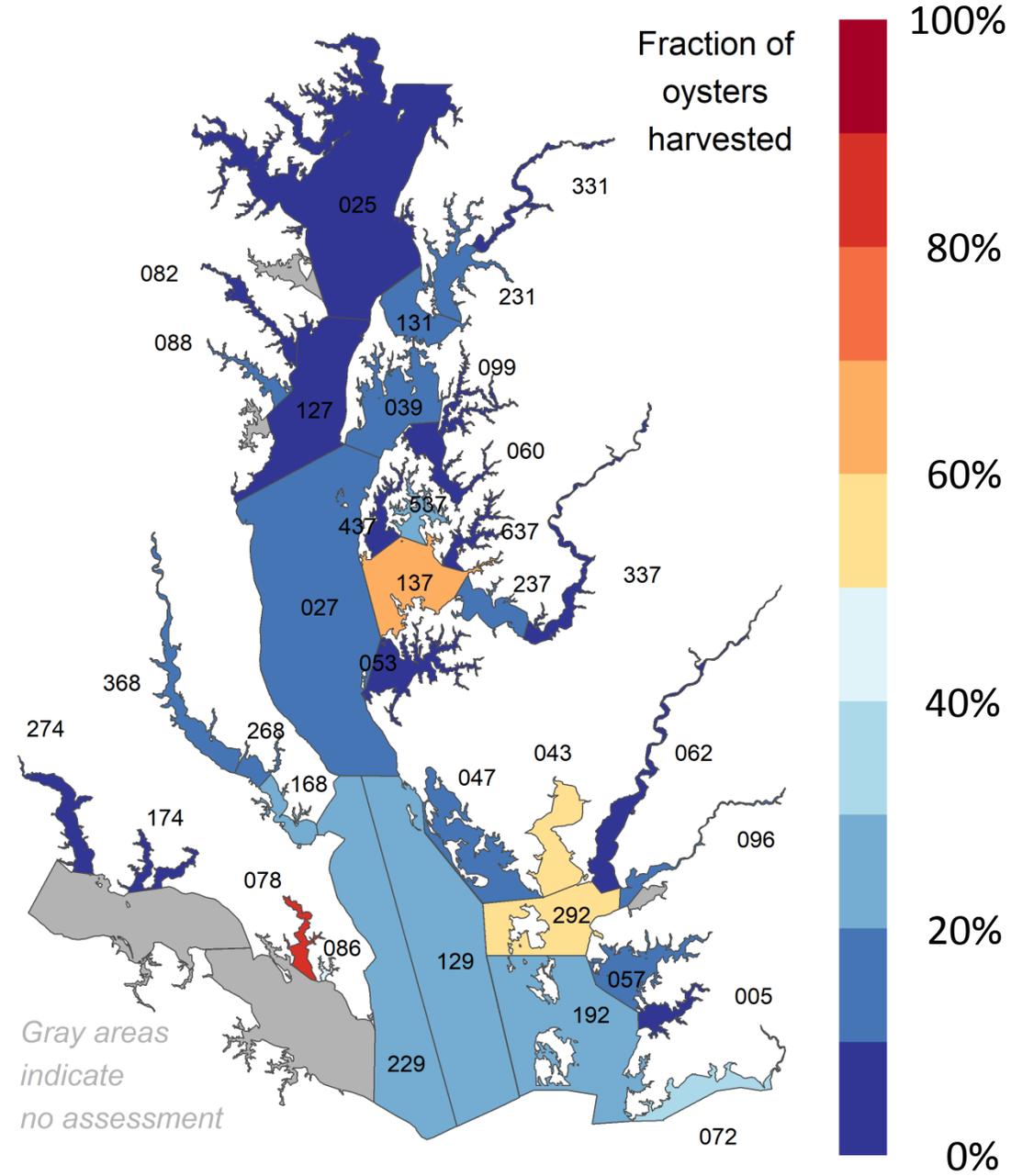
No region is doing as well as in 1999.

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

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 not 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

Habitat degradation
and burial

Carrying capacity

Bottom
habitat



Harvest



Adults

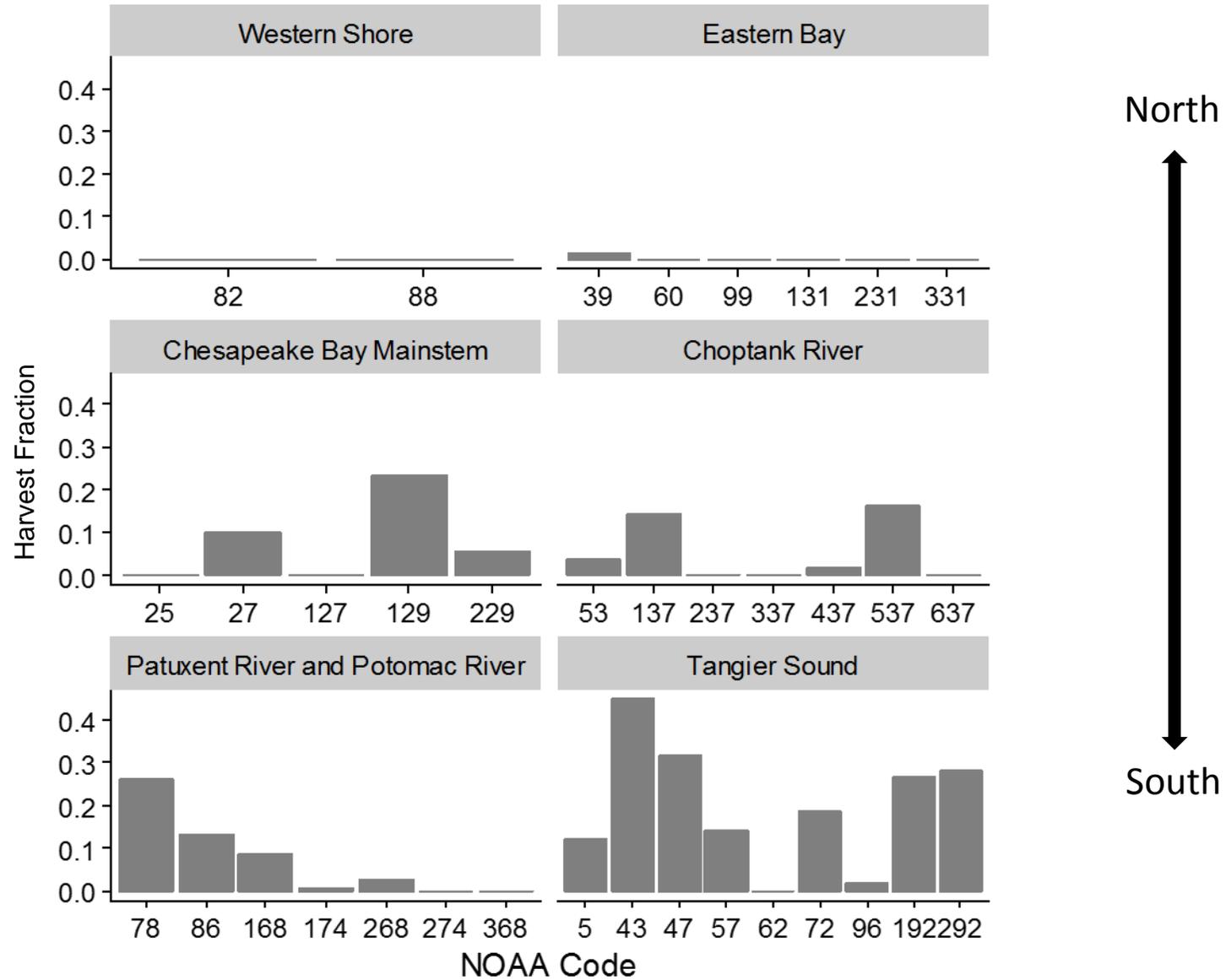


Shell and
Artificial substrate

Shell production

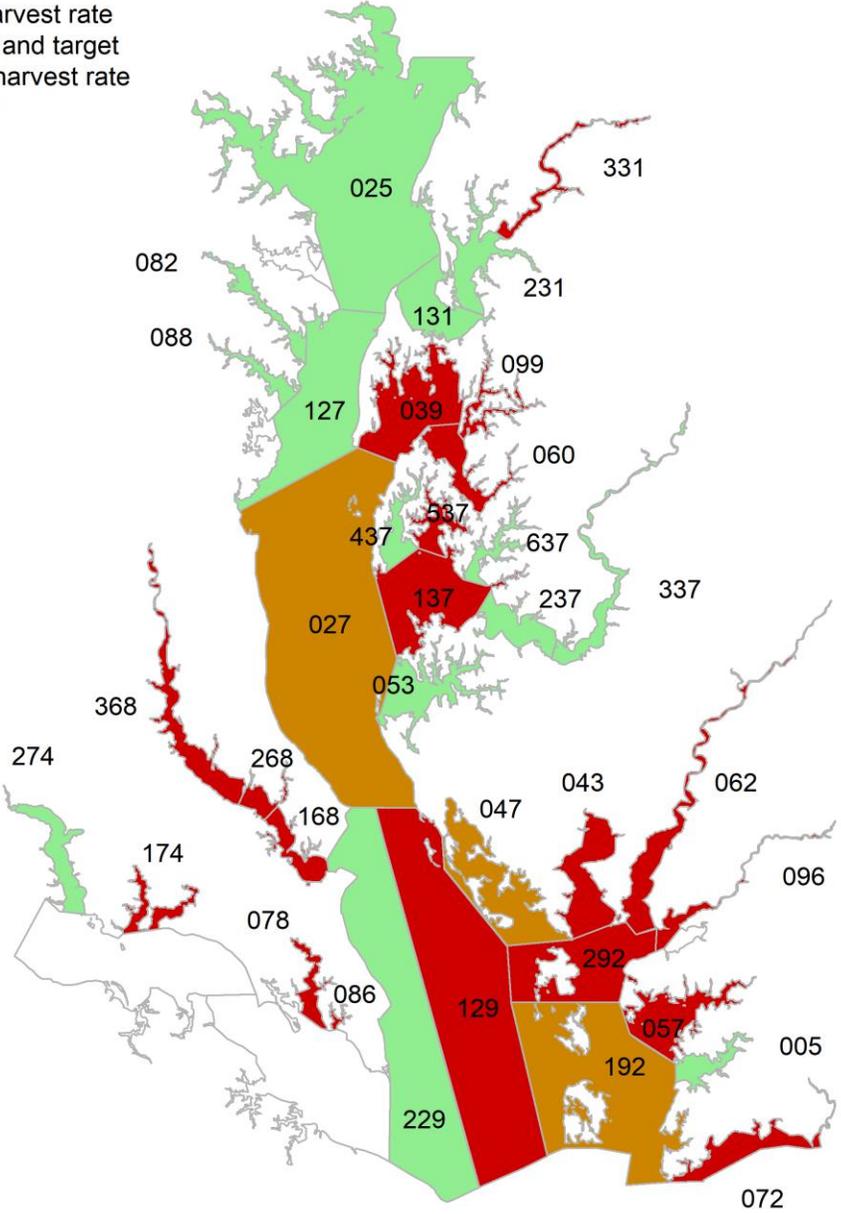
Planted spat
and
Wild seed

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

- Above limit harvest rate
- Between limit and target
- Below target harvest rate
- Not assessed



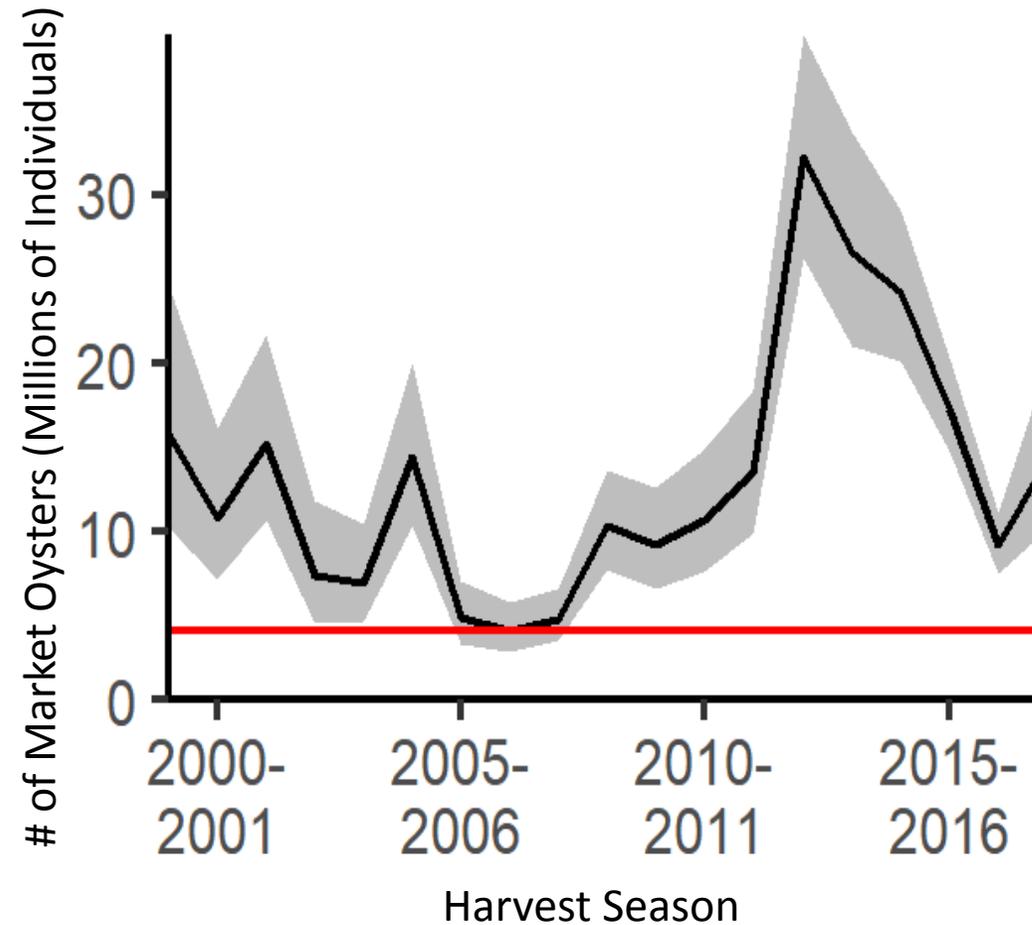
Red shading indicates fishing over the upper threshold rate.

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

Green shading indicates fishing at or below the target rate.

Abundance Biological Reference Point Threshold Only

Example of Abundance
Biological Reference
Points

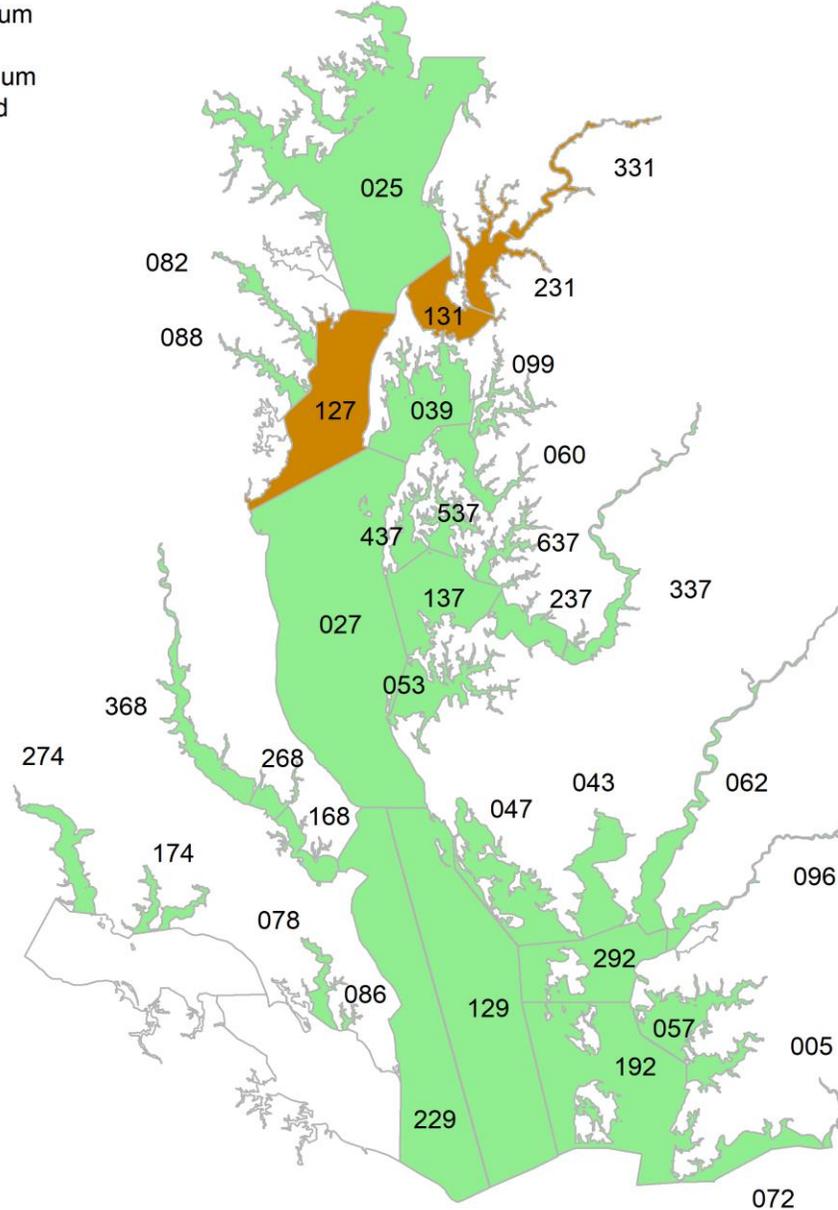


Red line represents the lower threshold reference point which is set to the minimum abundance estimated during 1999-2017

Goal: Not allow abundance to decrease below red line

Abundance in 2017 relative to minimum abundance during 1999-2017

- Below minimum
- At minimum
- Above minimum
- Not assessed



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



The screenshot shows a web browser displaying the URL https://dnr.maryland.gov/fisheries/Pages/oysters/Oyster_Stock_Assess.aspx. The page header includes the Maryland Department of Natural Resources logo and navigation links for Maryland.gov, Phone Directory, State Agencies, Online Services, and a Translate button. A search bar is present with the placeholder text "Enter search term". Below the header is a teal navigation bar with links for FISHING REPORTS, RECREATIONAL, COMMERCIAL, MANAGEMENT, PROGRAMS, and MAPS. The main content area is divided into two columns. The left column, titled "Fisheries", contains a list of links: Fisheries Home Page, Fisheries Regulations, Fishing Licenses, Fishing Report, Tide Finder, and Join Our Mailing List. Below this is a "More Resources" section with links for Public Notices and Fish Facts. The right column features the main article title "2018 Oyster Stock Assessment" and two paragraphs of text. The first paragraph states that the Sustainable Oyster Population and Fishery Act of 2016 (Senate Bill 937/Natural Resources Article §4-215) directs the Maryland Department of Natural Resources, in consultation with the University of Maryland Center for Environmental Science, to conduct a stock assessment and develop biological reference points based on the biological characteristics of the oyster population and other appropriate factors affecting the population. The second paragraph states that as required by the guiding legislation, all analytical approaches involved in the stock assessment model and development of biological reference points were submitted to an independent peer review. The peer review was conducted with the logistical support of the Atlantic States Marine Fisheries Commission and was funded through an Environmental Protection Agency Chesapeake Bay Implementation Grant.