

# Maryland Oyster Stock Assessment

November 19, 2018

*Briefing presentation*

## 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

## *Terms of Reference #1*

Input category	Data Source
Recruitment	Fall dredge survey (✓), Hatchery-reared spat (✓), Natural seed (✓), Patent Tong surveys, Peer reviewed studies
Habitat	Bay Bottom Survey (✓), Yates Survey (✓), Current sonar surveys, Shell plantings (✓), Artificial substrate plantings (✓), Peer reviewed studies (✓)
Harvest	Dealer buy tickets (✓), Monthly harvester reports (✓), Bushel tax forms
Natural mortality	Fall dredge survey (✓), Peer reviewed studies, DNR and other analyses (✓)
Abundance trends	Fall dredge survey (✓), Patent Tong surveys (✓)
Growth	Peer-reviewed studies(✓), Fall dredge survey
Catchability	Peer-reviewed studies(✓), other DNR analyses and studies

We are using data for 1999-present.

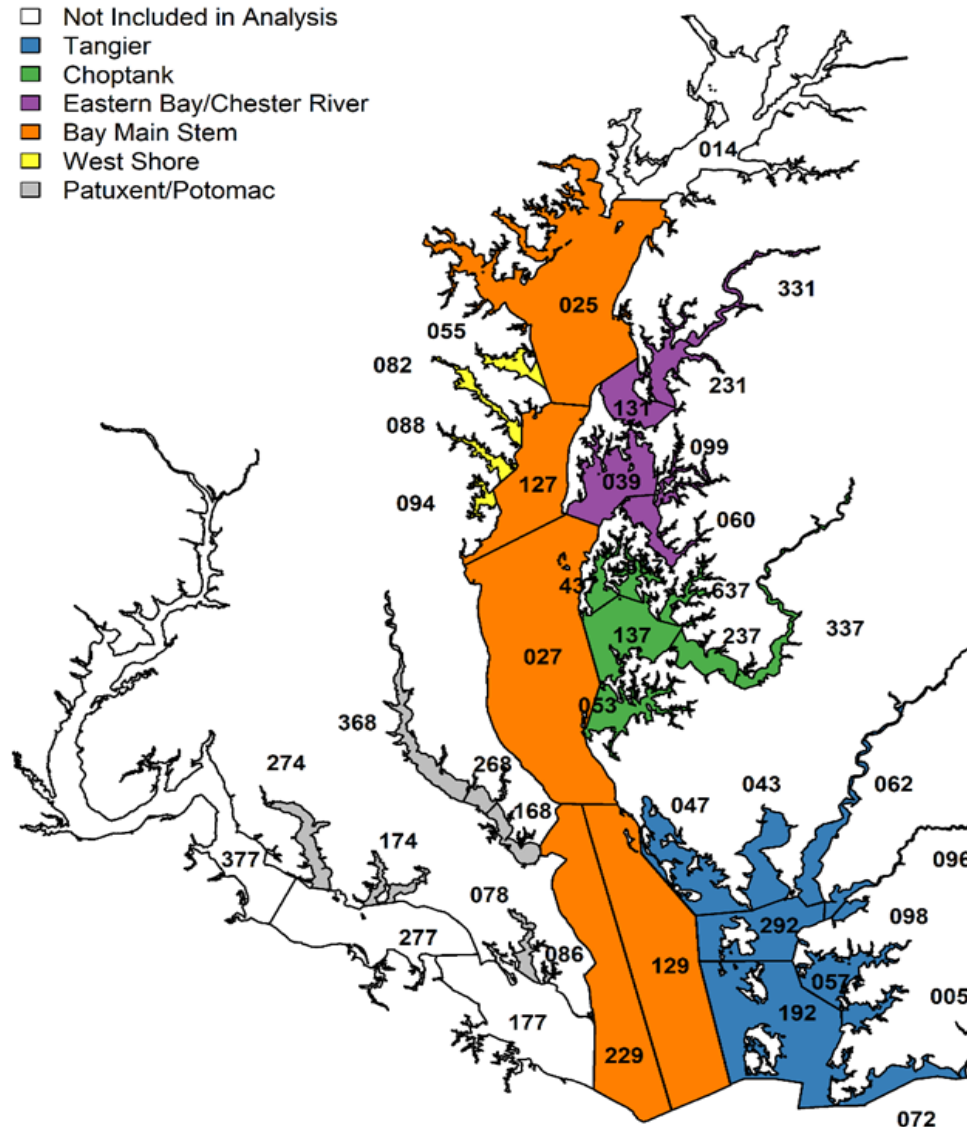
(✓) indicates primary role in the analyses

No check mark indicates primarily used for qualitative comparison

# 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

# 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:

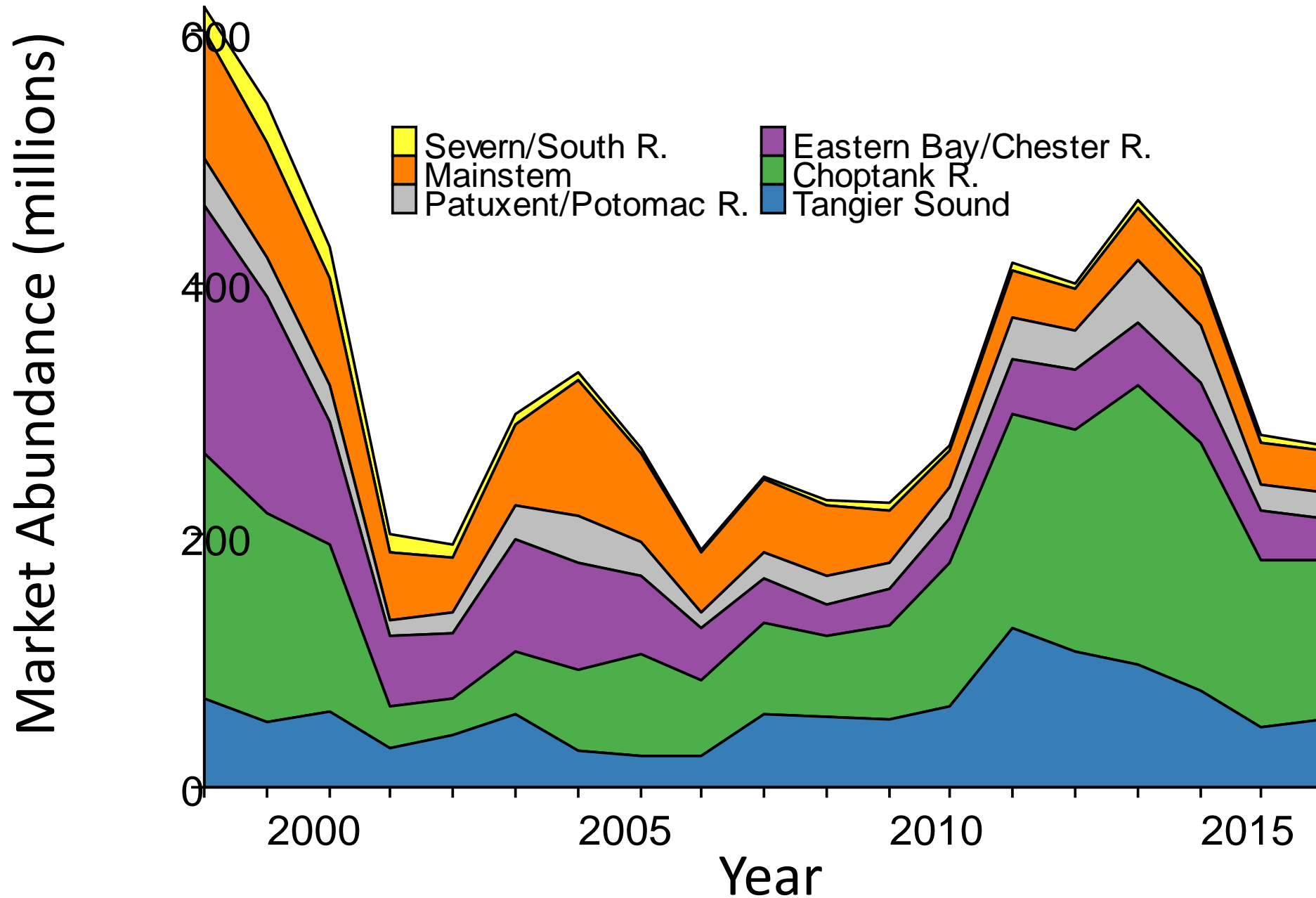
- 094 (Rhode/West Rivers)
- 055 (Magothy River)
- 098 (Monie Bay)

## 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

Total Estimated Number of Market-sized Oysters per Region from Model Results



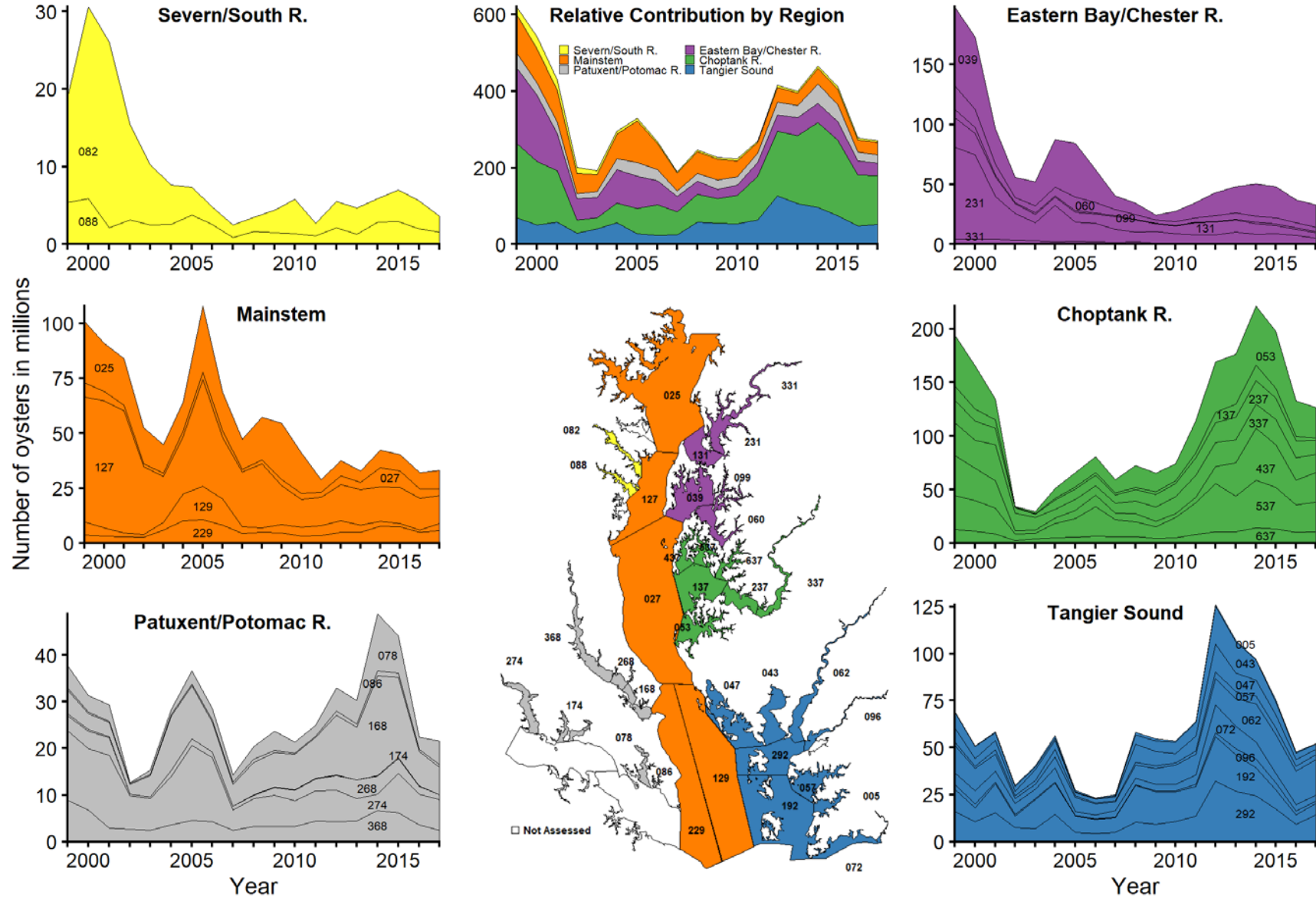
Shows estimates of number of market-sized oysters (individuals) over time.

No region is doing as well as in 1999.

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



### Estimated number of oysters (in millions) by region that are above the minimum size limit (3 inches), 1999-2017

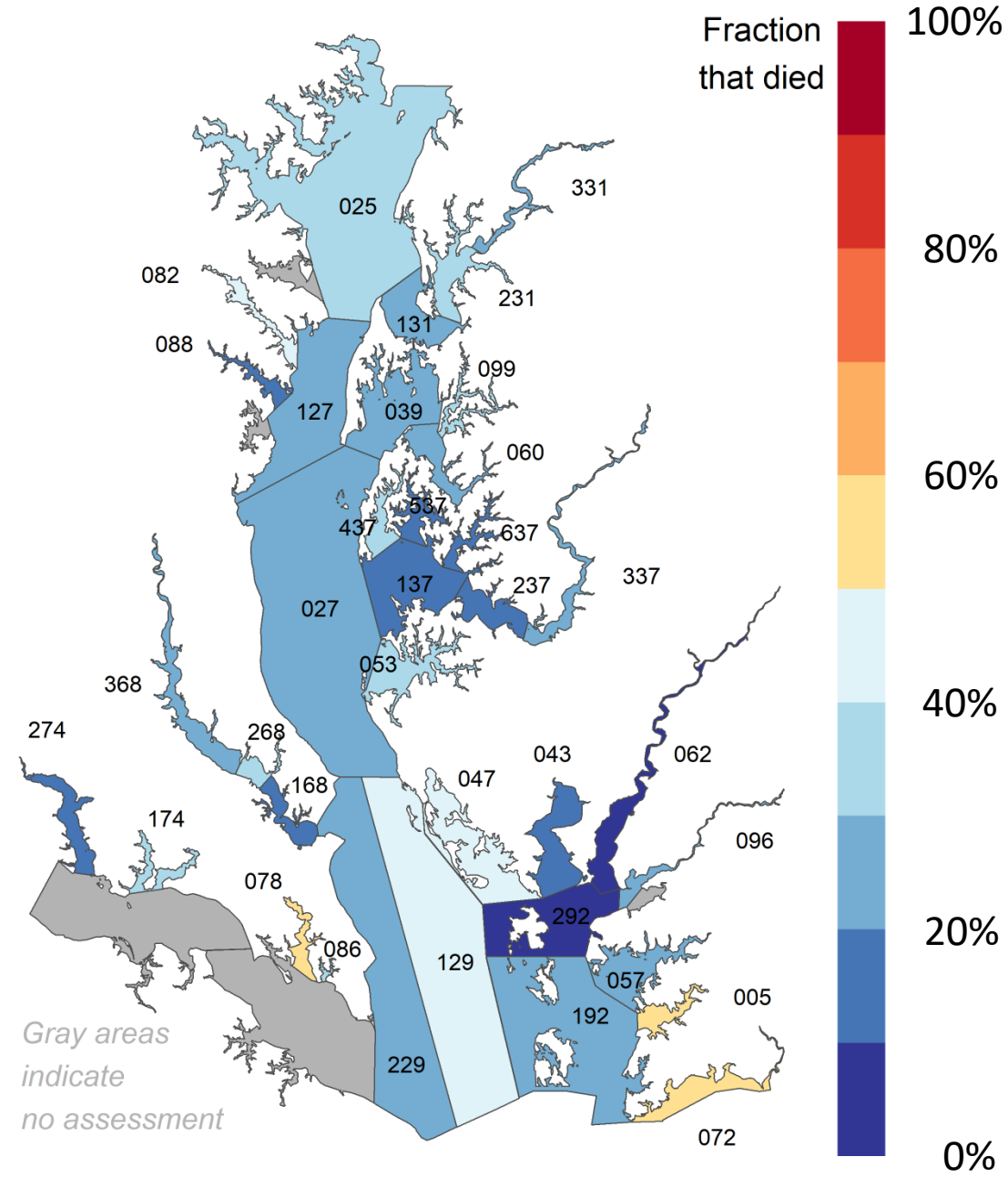


Shows estimates of number of market-sized oysters (individuals) over time.

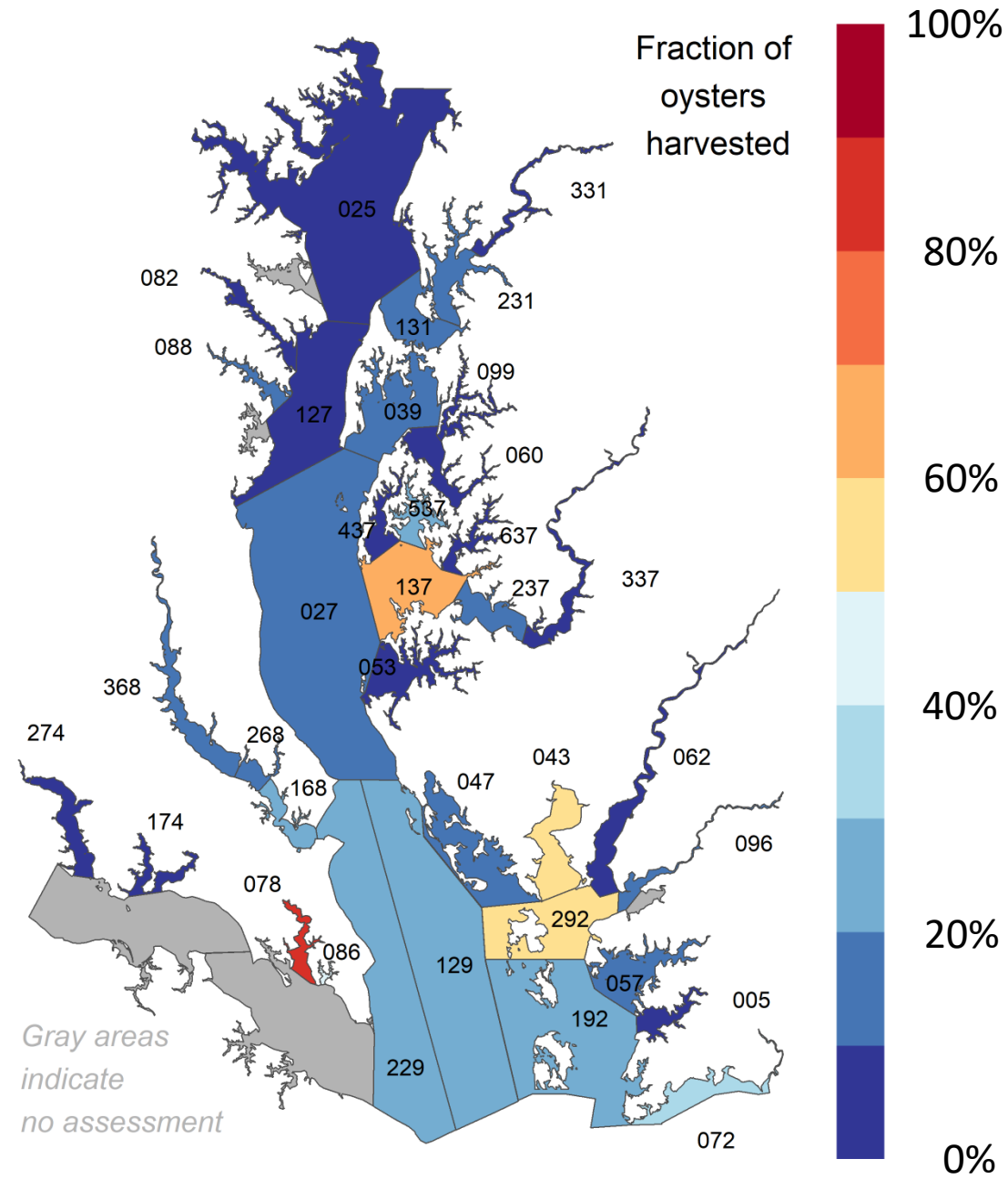
No region is doing as well as in 1999.

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

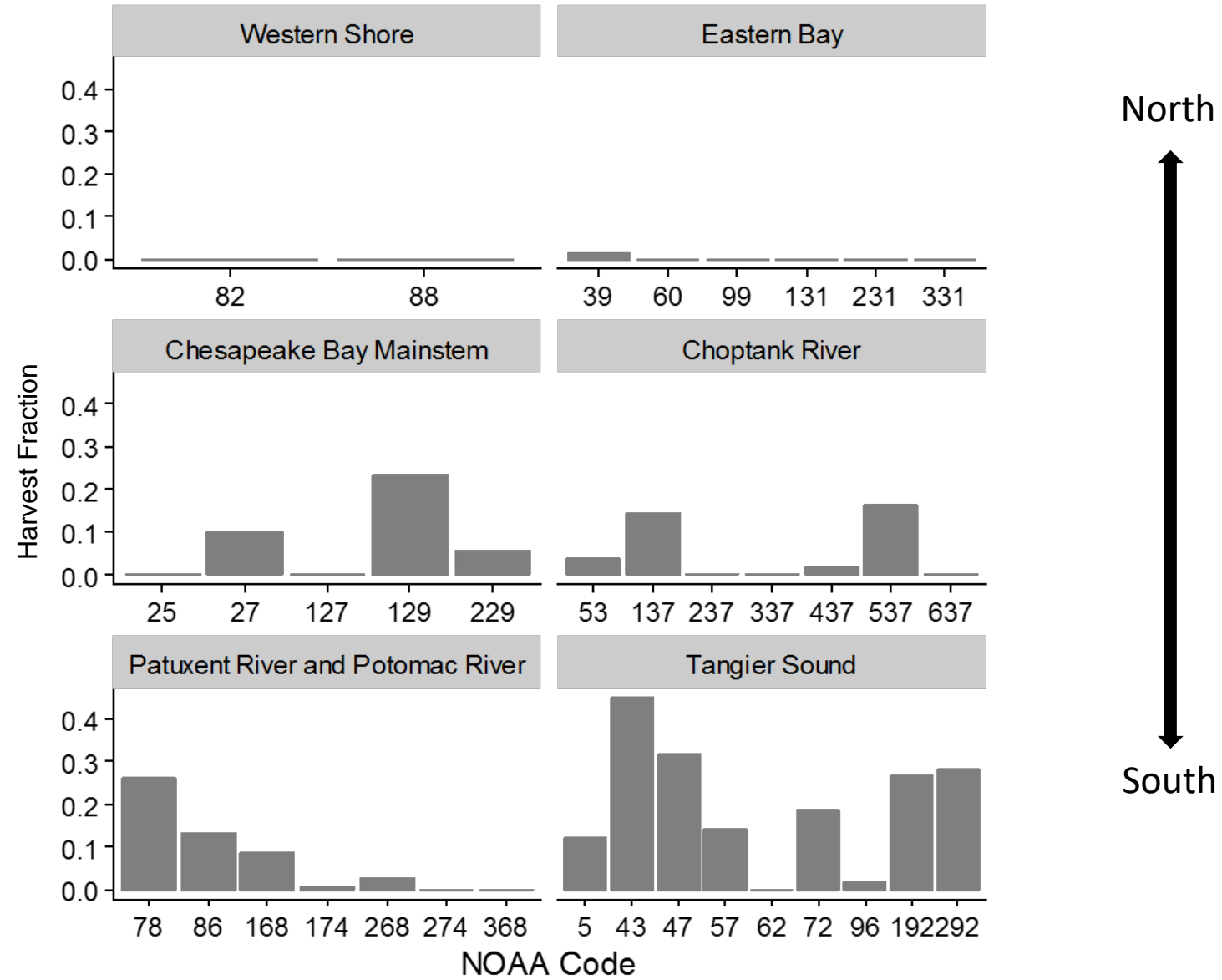
## Abundance (lower threshold only)

- 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)

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



# Summary Results of Biological Reference Points – Fishing Rates per Harvest Season

Region	NOAA Code	Threshold Rate	Target Rate	2015-2016	2016-2017	2017-2018
Tangier	5	0.123	0.061	0.809	0.254	0.001
	43	0.449	0.225	0.667	0.817	0.54
	47	0.318	0.159	0.422	0.737	0.162
	57	0.139	0.069	0.088	0.098	0.161
	62	0	0	0.076	0.049	0.047
	72	0.19	0.095	0.472	0.399	0.373
	96	0.017	0.009	0.492	0.552	0.185
	192	0.265	0.132	0.633	0.358	0.24
	292	0.281	0.141	0.846	0.867	0.506
Choptank	53	0.035	0.017	0.004	-0.023	-0.162
	137	0.142	0.071	0.581	0.636	0.632
	237	0	0	-0.874	-0.547	-0.334
	337	0	0	-2.706	-1.856	-1.535
	437	0.018	0.009	-1.423	-2.718	-5.201
	537	0.161	0.081	0.395	0.285	0.271
	637	0	0	0.069	0.054	-0.068
Eastern Bay	39	0.016	0.008	-0.029	0.156	0.103
	60	0	0	0.137	0.082	0.028
	99	0	0	0.003	0.003	0.006
	131	0	0	-4.245	-2.394	-1.341
	231	0	0	-0.458	-0.419	-0.311
	331	0	0	-0.034	-0.027	0.007
Mainstem	25	0	0	-2.028	-1.077	-1.693
	27	0.1	0.05	0.396	0.323	0.067
	127	0	0	-0.594	-0.483	-0.431
	129	0.232	0.116	0.29	0.112	0.265
	229	0.057	0.029	-0.775	-0.463	0.028
Patuxent and Potomac	168	0.085	0.042	0.504	0.506	0.123
	268	0.026	0.013	0.344	0.291	0.197
	368	0	0	0.022	0.229	0.151
	78	0.263	0.132	0.273	0.625	0.814
	86	0.132	0.066	0.257	0.37	0.404
	174	0.008	0.004	0	0.121	0.076
	274	0	0	0.03	0.006	-0.2
Western Shore	82	0	0	-9.954	-9.217	-6.255
	88	0	0	-6.855	-5.242	-3.008

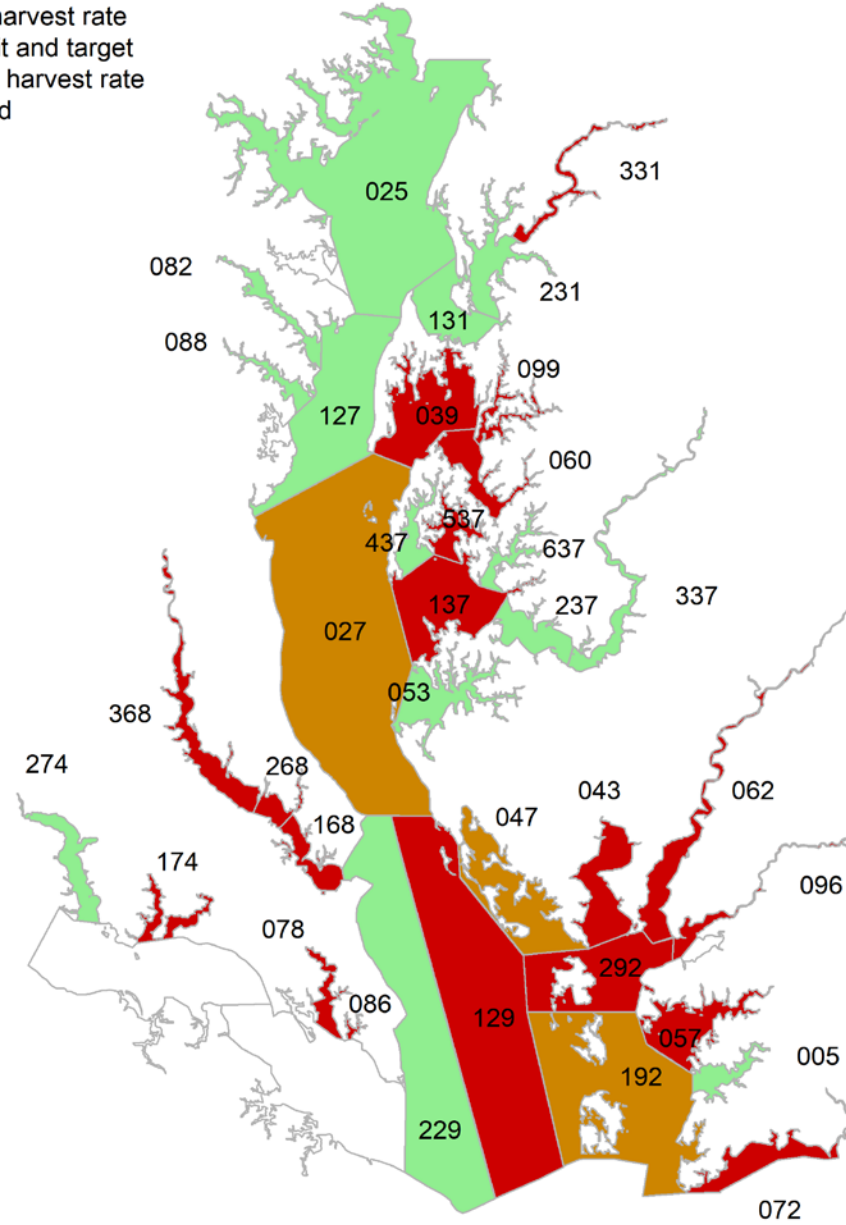
Red shaded boxes indicate fishing over the upper threshold rate.

Orange shaded boxes indicate fishing over the target rate and under the threshold rate.

Green shaded boxes indicate fishing at or below the target rate.

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.

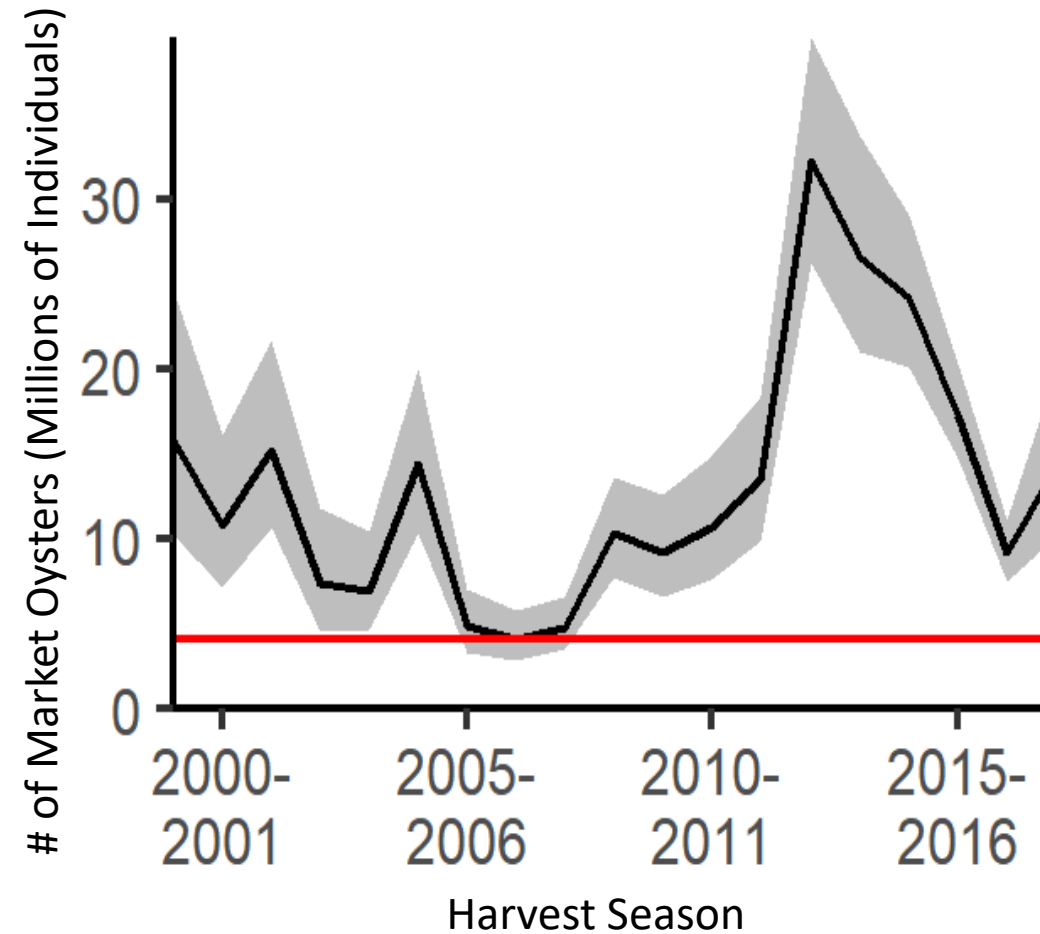
**Orange** shading indicates fishing over the target rate and under the threshold rate.

**Green** shading indicates fishing at or below the target rate.



### Abundance Biological Reference Point Threshold Only

Example of Abundance  
Biological Reference  
Points

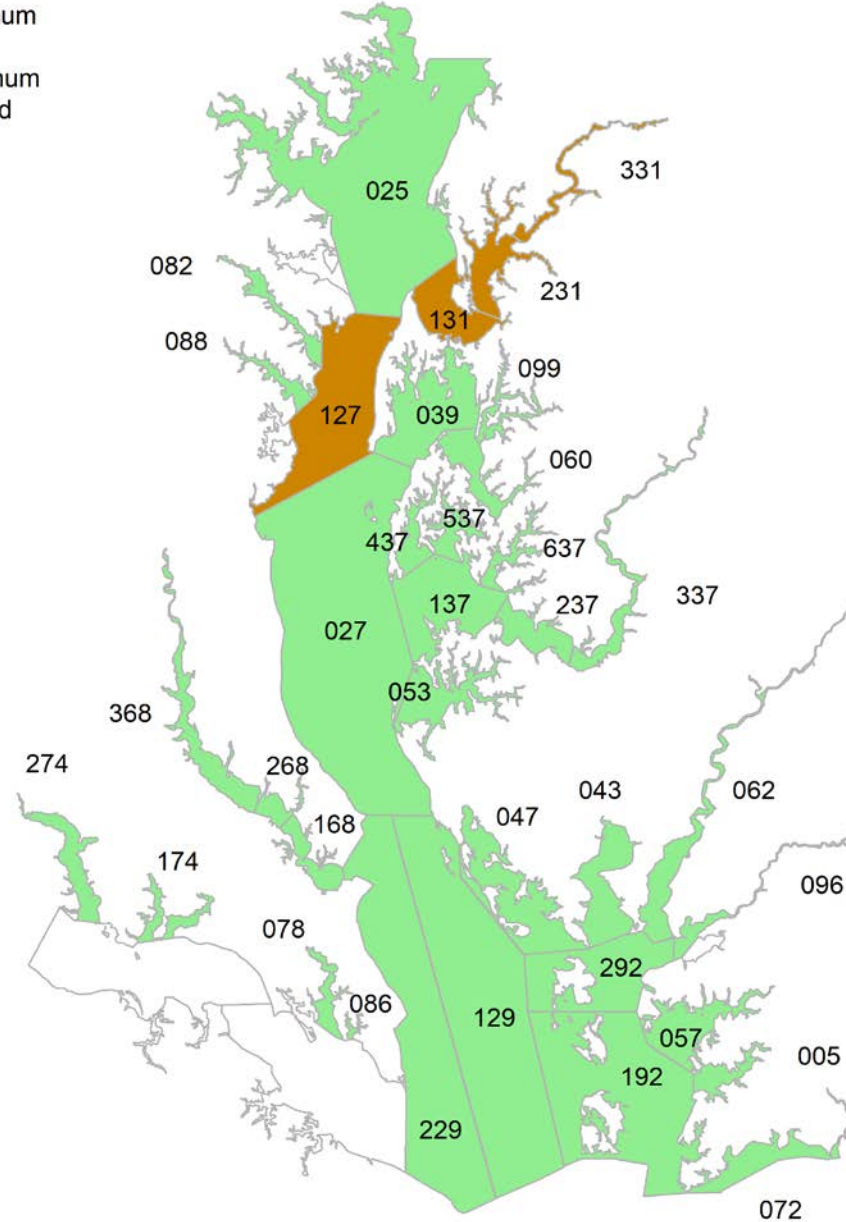


Red line represents the lower threshold reference point which is set to the minimum abundance estimated during 1999-2017

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 all things 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.

# Objective means to monitor fishery and population against biological reference points

## To meet statute § 4-215 requirements:

- Conduct a stock assessment at regularly scheduled intervals (e.g., 2-3 years)
- Use the fall dredge survey to monitor abundance in areas with close correspondence to the assessment results
- Use data from buy tickets or harvest reports with depletion analyses to estimate abundance and harvest fractions for NOAA codes in high harvest areas

# Potential Management Strategies

To meet statute § 4-215 requirements:

## Oyster Management Toolbox

- Output controls
  - Minimum size limits
  - Slot size limits
  - Bushel limits
  - Total allowable catch (TAC)
  - Individual transferrable quotas (ITQs)
- Input controls
  - Season limits
  - Time limits (allowable hours)
  - Gear limits
  - Entry (license) limits
  - Sanctuaries
  - Harvest reserve areas
  - Rotational harvest



# Potential Management Strategies Continued

**To meet statute § 4-215 requirements:**

## **Oyster Management Toolbox**

- Habitat modification
  - Planting substrate
  - Planting dredged or reclaimed shell
  - Seed areas
- Stock enhancement
  - Planting wild, natural seed
  - Planting hatchery-reared spat on shell