



# Opportunities and challenges in blue crab management

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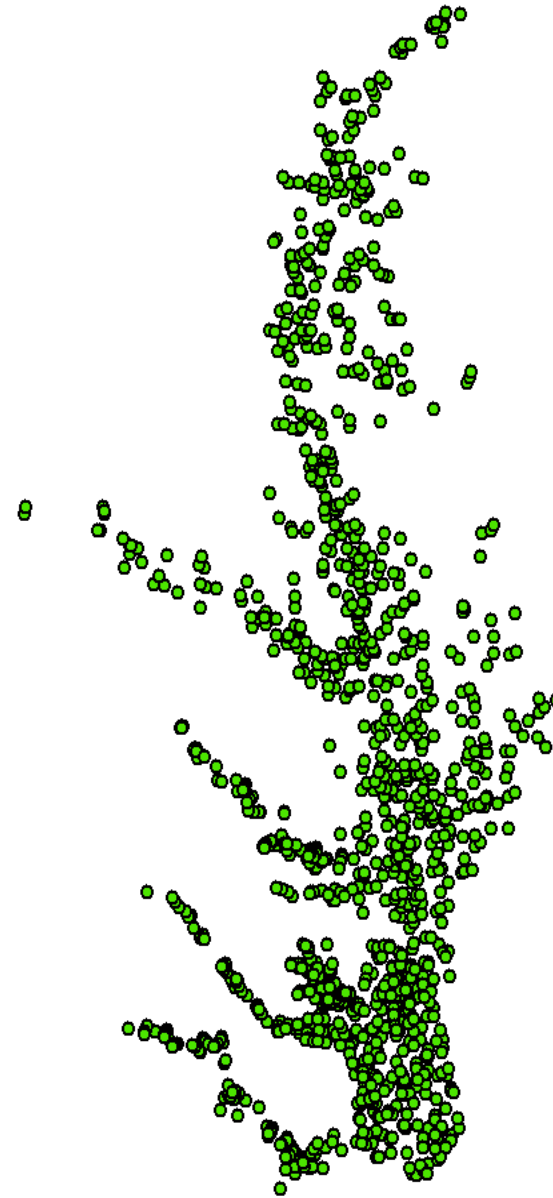
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# History and development of assessment approaches to blue crab

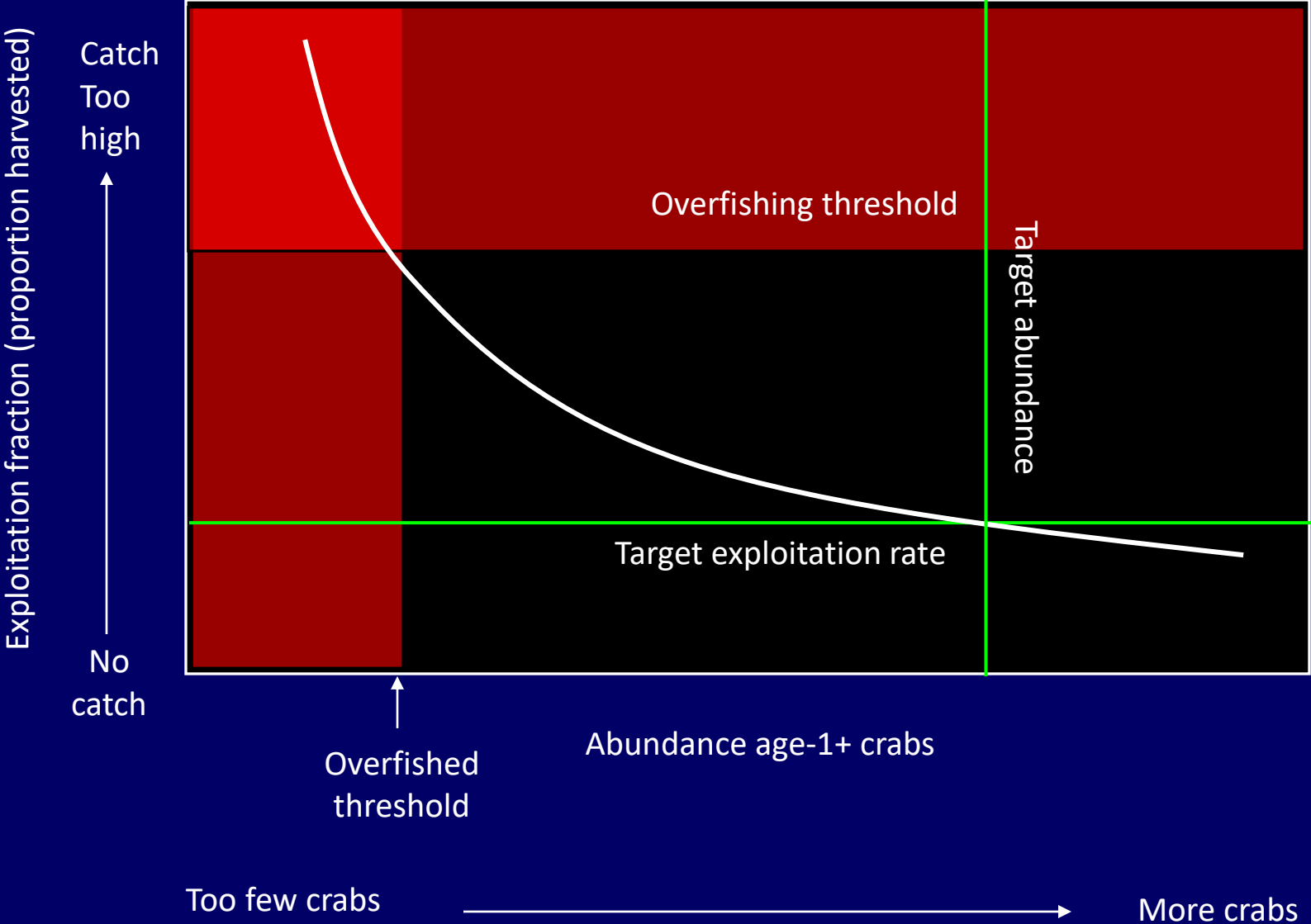
- Historical fishery with harvest records (spotty) back to 19<sup>th</sup> Century
  - *Ad hoc* management by traditional size and season limits
- First assessment in 1997
- Winter dredge survey implemented 1998/1999
- Bi-State Blue Crab Commission - Target and Threshold Framework (1999 – 2001)
- 2005 Baywide, integrated stock assessment
- 2008 Female-based conservation approach
- 2011 Sex-specific stock assessment
  - Female based management
  - Updated in 2017

# The Winter Dredge Survey (WDS)

- Conducted yearly since 1990
- Winter – crabs are dormant, no movement
- 1 minute tow of a crab dredge
- ~1,500 stations per year



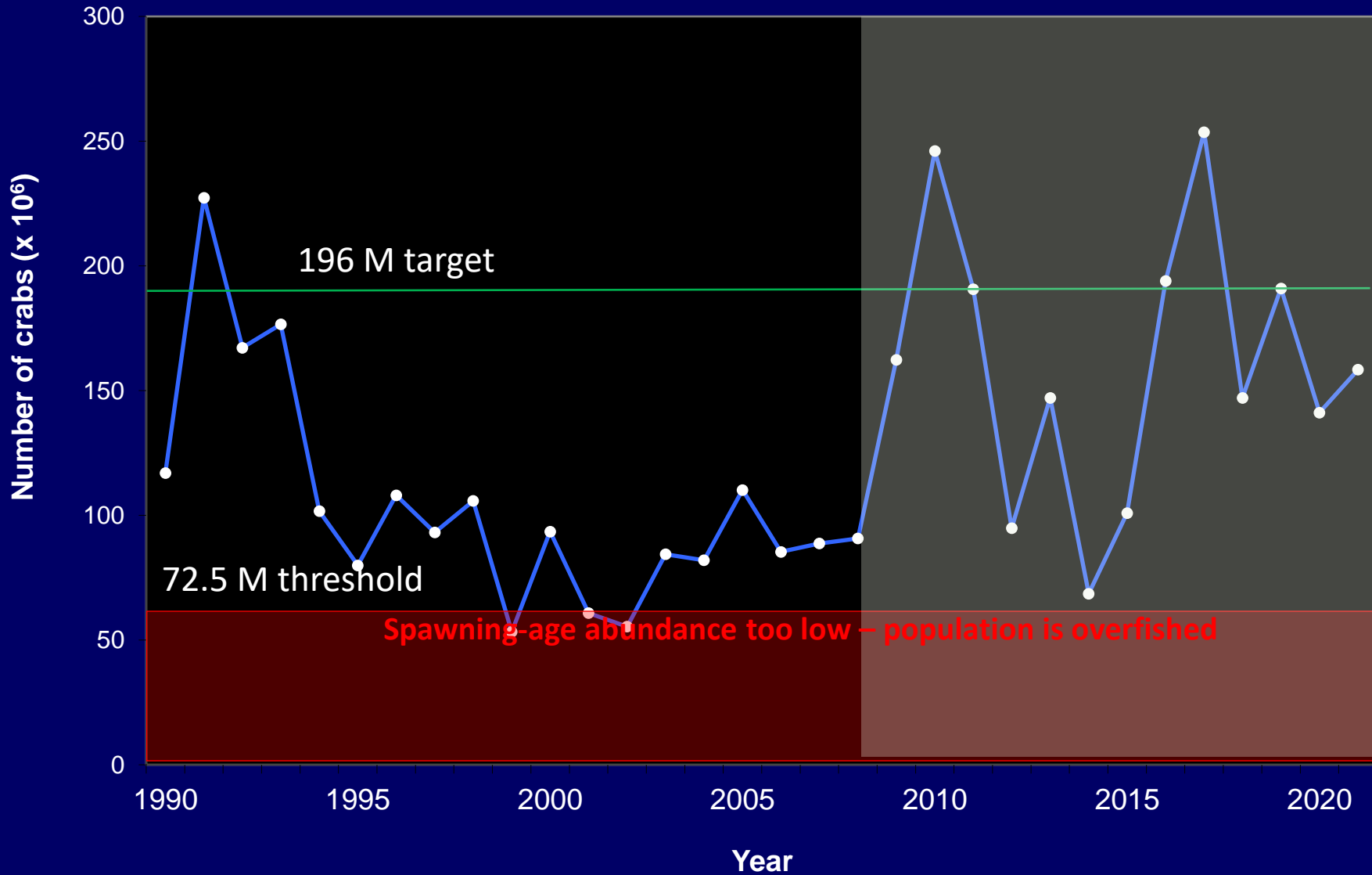
# Biological reference points



# History and development of assessment approaches to blue crab

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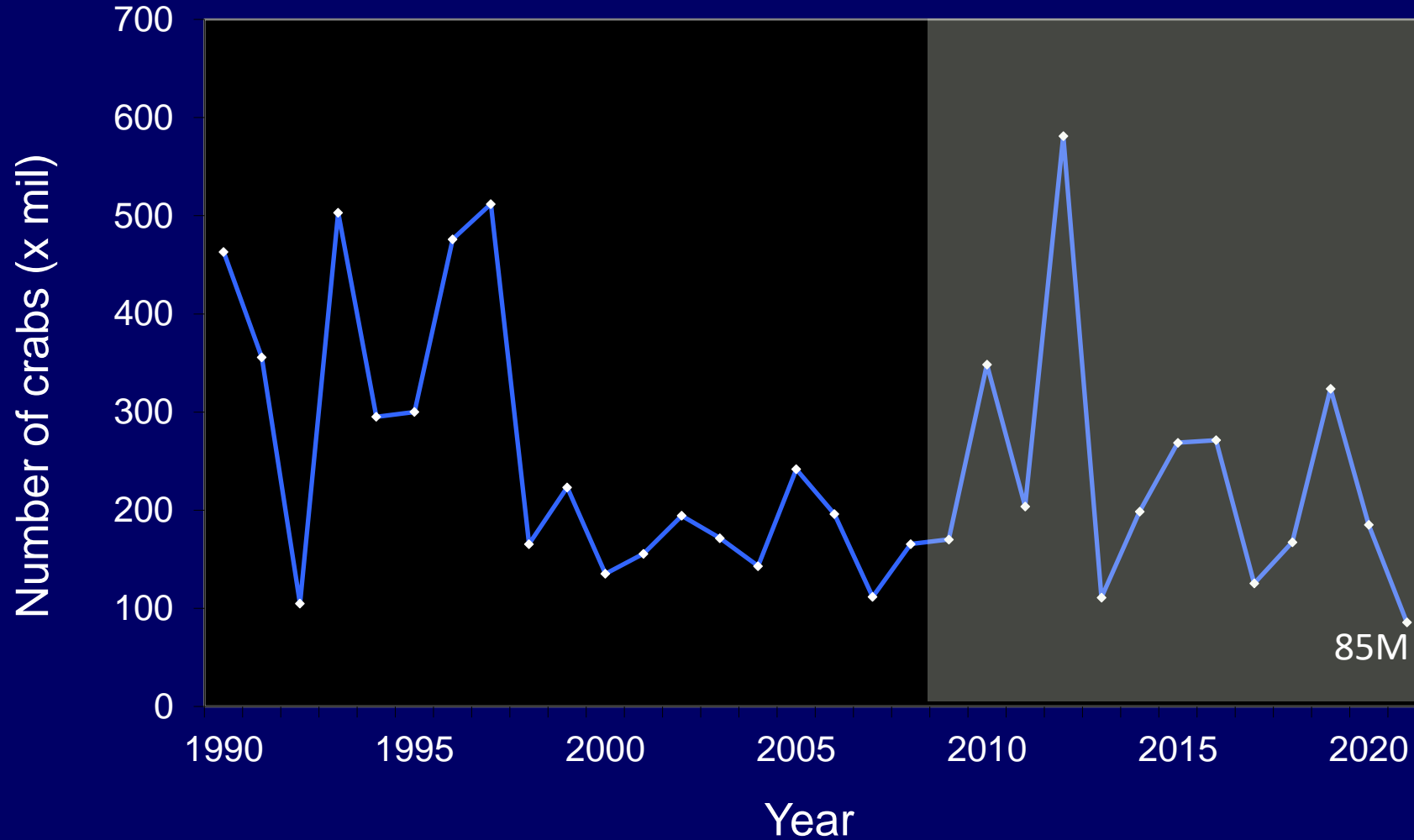
# Age-1+ female abundance (Millions)



# Age-1+ female abundance

- The 2021 estimate of age-1+ female abundance is 80% of the target value, but 2.2x the threshold value
- Management continues to effectively meet objective of avoiding overfishing.
- The average age-1+ female abundance 2008-2021 is 156M, approximately 88% higher than the 1994-2007 average of 85M crabs.

# Age-0 recruit abundance (Millions)

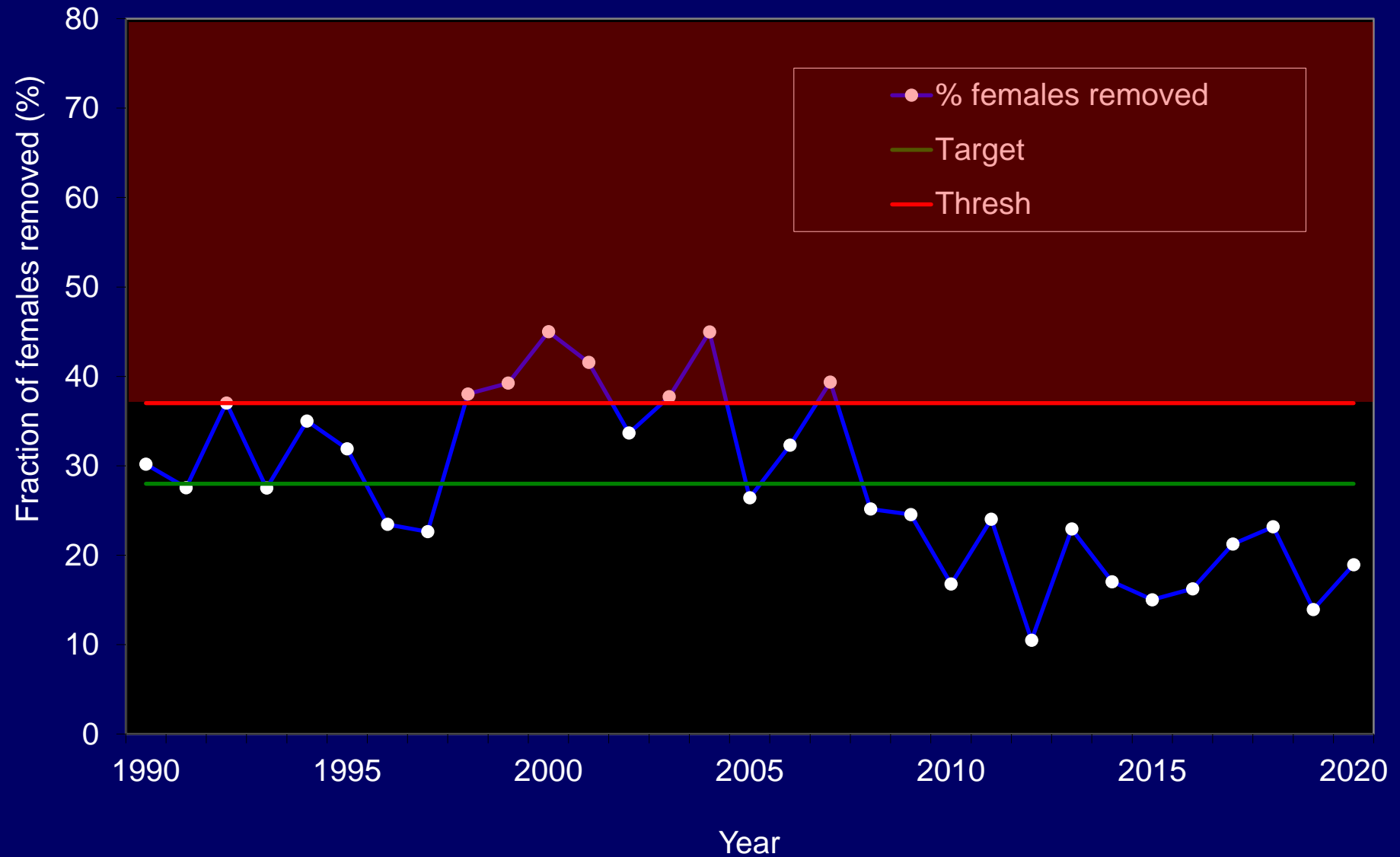




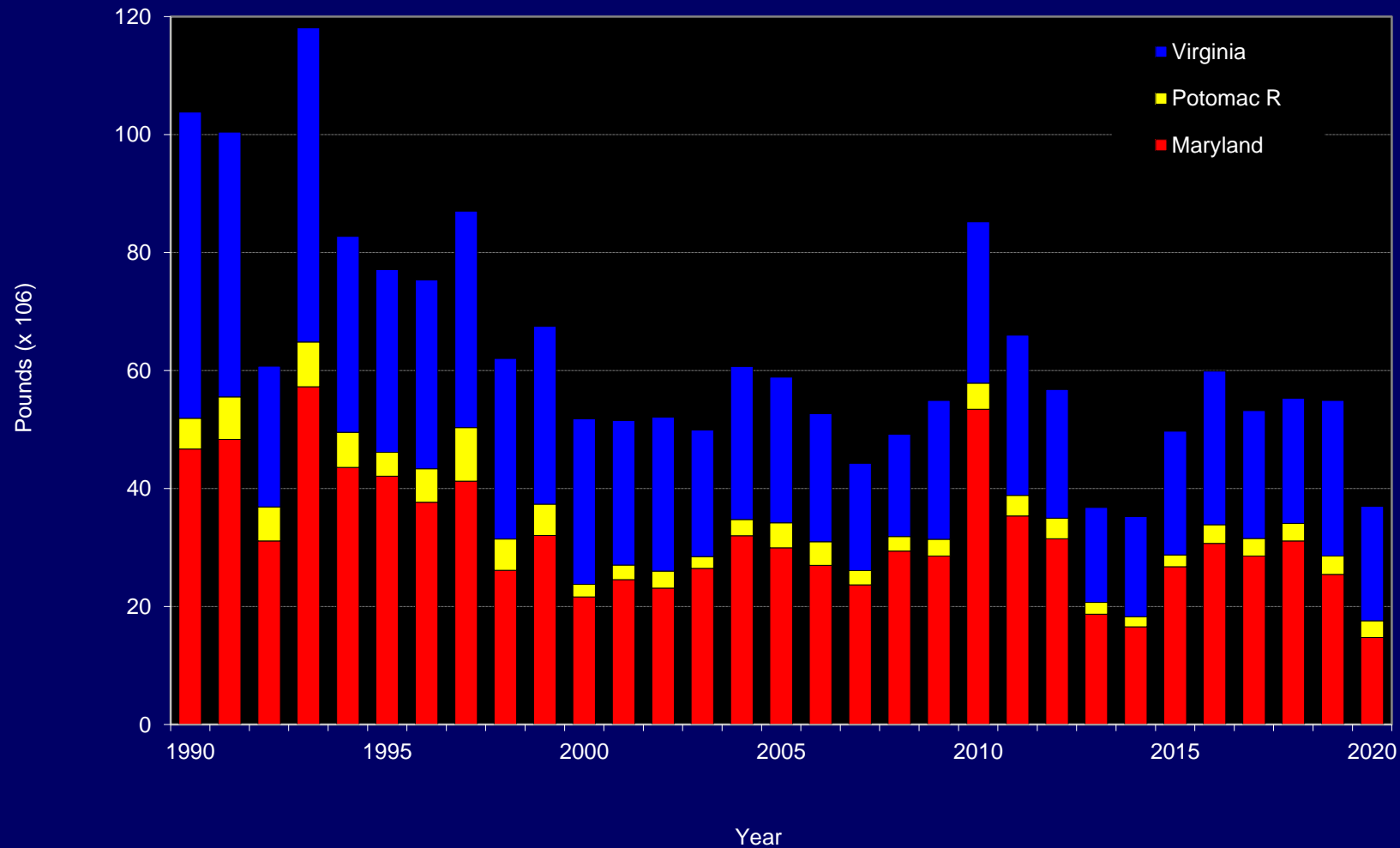
# Age-0 recruits

- Recruitment in 2021 was 85M crabs, the lowest recorded in the WDS time series, and similar to levels in the 1998-2008 that triggered concern.
- Reasons for low recruitment are not known.
  - No disruption or change in distribution of the survey
  - Overwinter mortality normal
  - Environmental conditions normal
- The decrease in recruitment is at odds with the increased spawning stock abundance.
  - Decline in recruits per spawner (more to come)
- Is low recruitment in 2021 an aberration or a return to an old pattern?




# Female exploitation



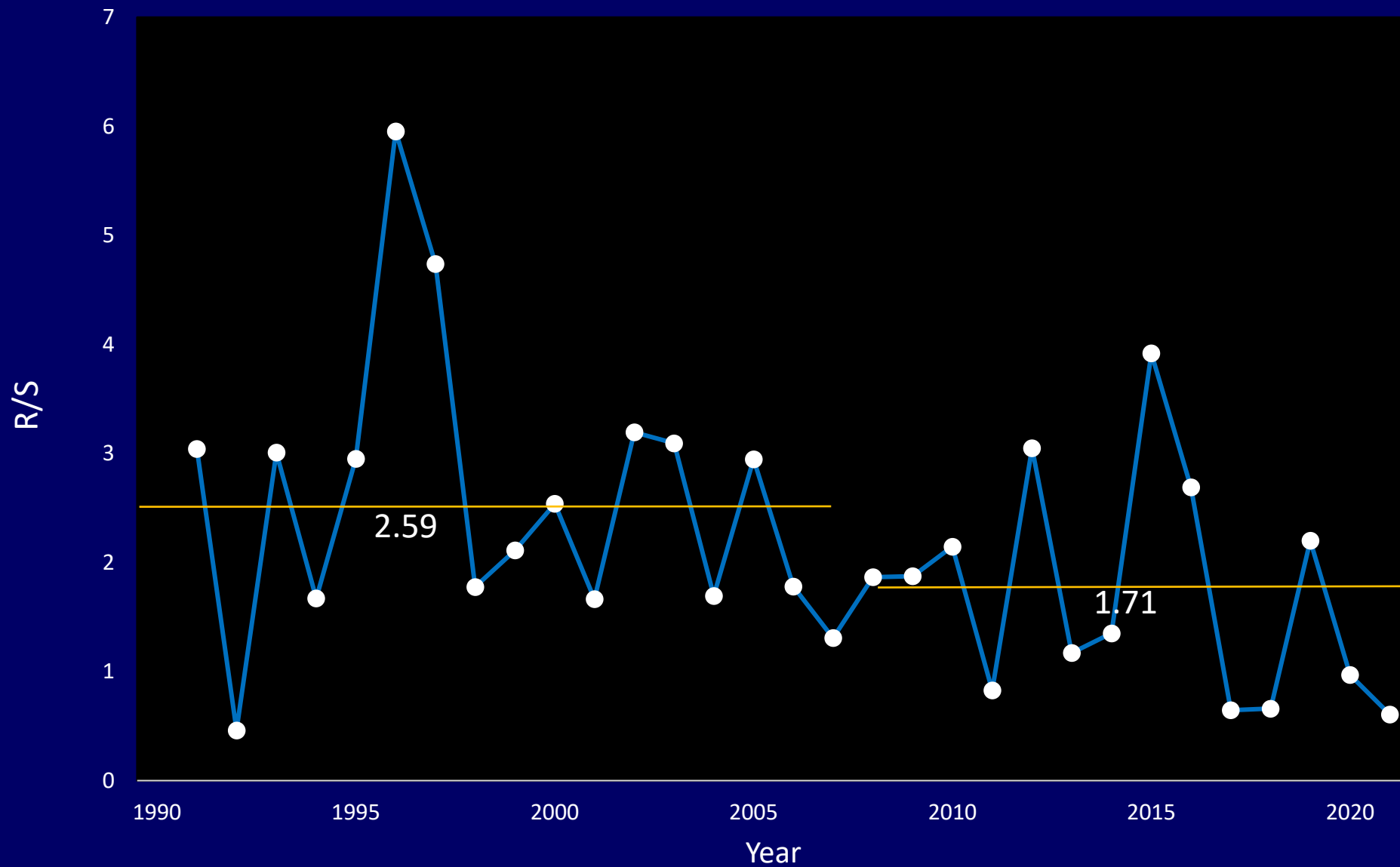
# Total commercial blue crab landings (all market categories) in Chesapeake Bay, 1990-2020



# Take home messages

- Female-conservation measures have worked to conserve female abundance, such that it is consistently higher than 1994-2007, and comparable with earlier levels. 
- Recruitment is not consistently higher than pre - 2007. 
  - Time series low in 2021
- Harvests have not paid dividends. 

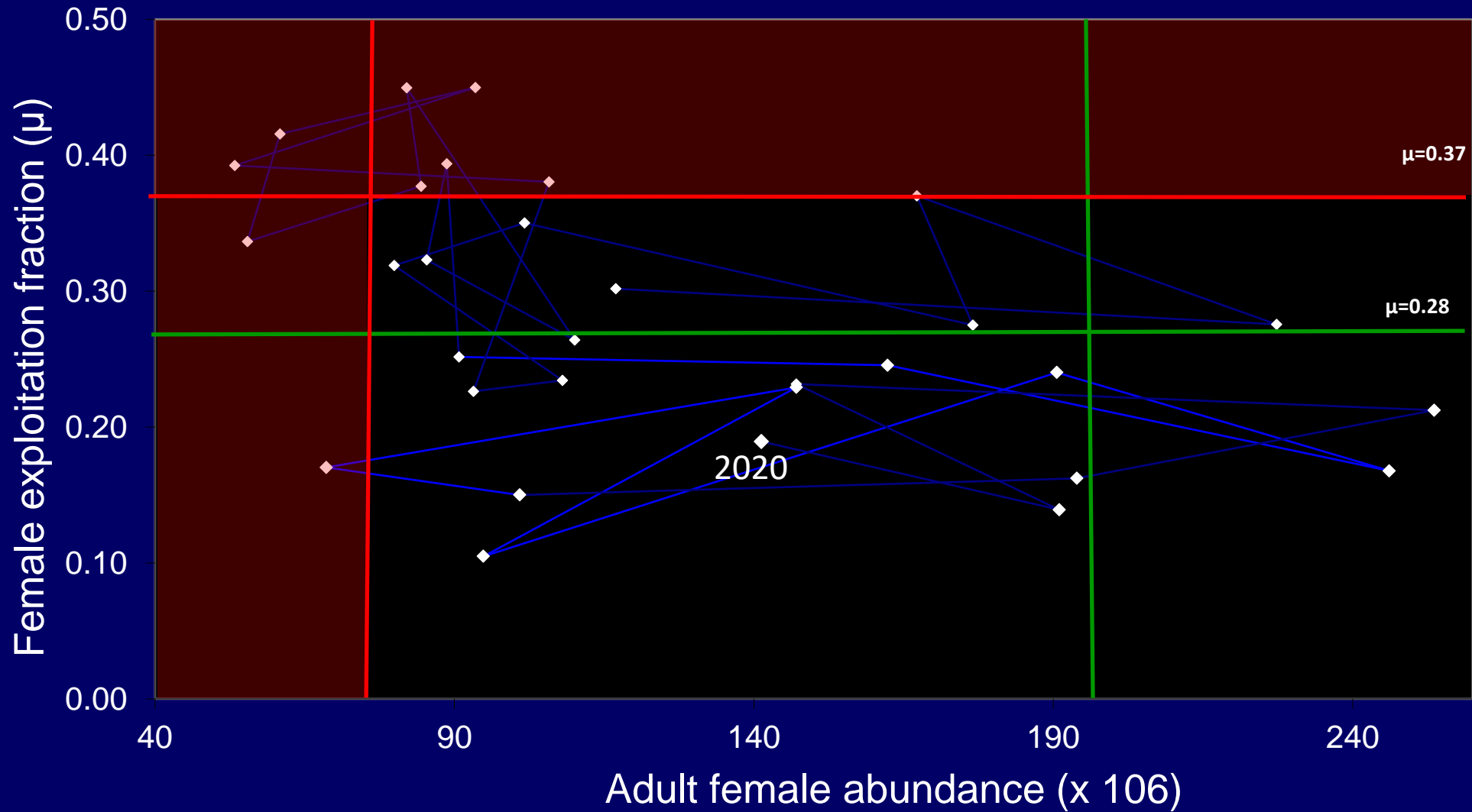
# Stock productivity



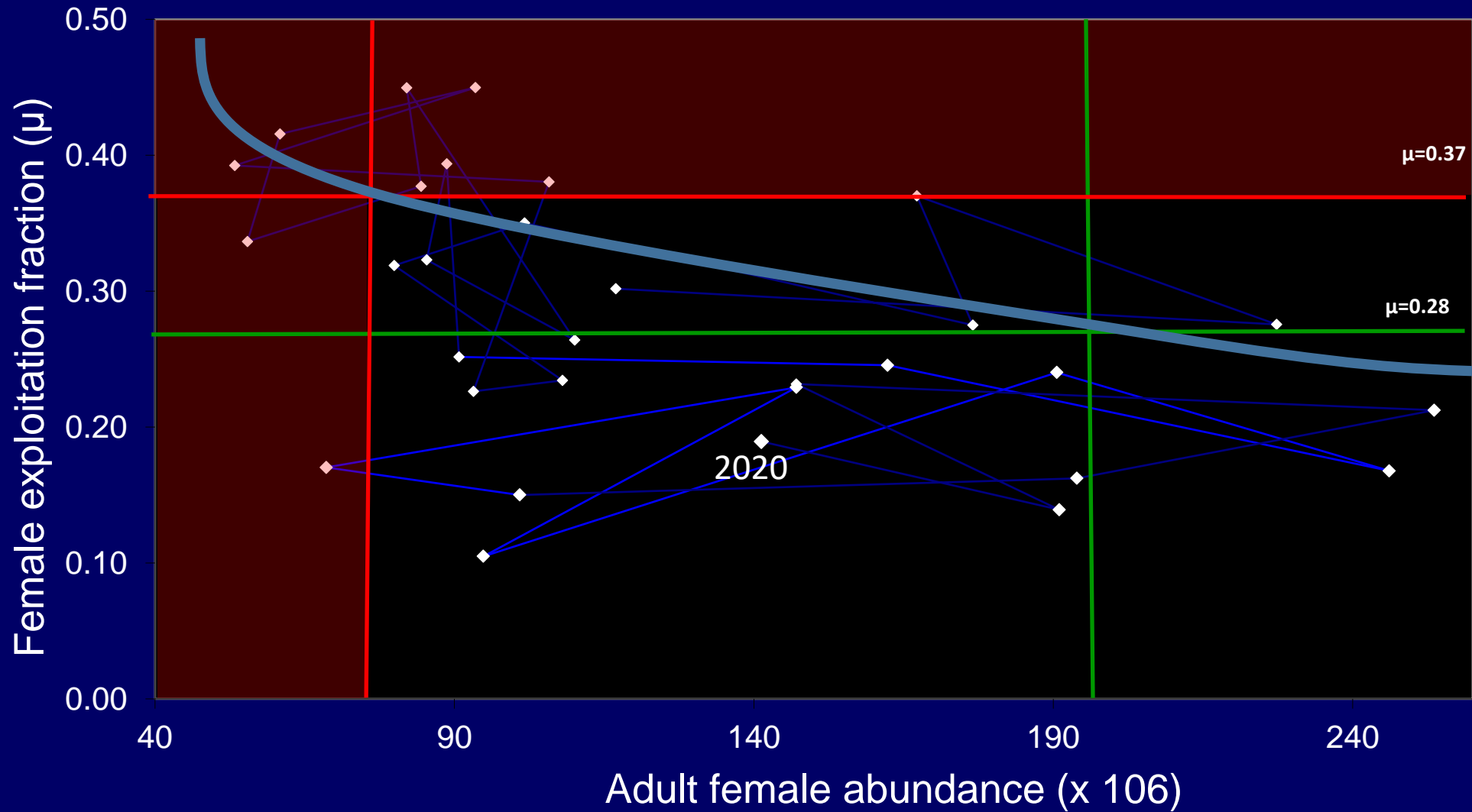
# Recruits per spawner

- Average recruits per spawner have declined by 34% from an average of 2.59 (1994-2007) to 1.71 (2008-2021)
- The blue crab stock is less productive now than it was previously.
- Understanding this change is an important question
  - Is this management-related?
  - Is this stock-related?
  - Is this environment related?

# Control rule



# Control rule





# Control rule questions

- Expected relationship should pass through the limit and target reference points
  - Lack of fit could be explained by incomplete and incorrect understanding of crab population dynamics
  - Lack of fit could be explained by biases and uncertainty in the input data

Actions and explanations

# Management and research actions

- Track abundance of age-0 crabs closely
  - How many
  - Where
  - How reliable
- If continued low abundance persists, move to conserve survivors
- Leverage CBSAC (~ BBCAC TSC) to identify critical analyses and research

# What is needed

- Improved understanding of performance of current and proposed management policies
  - Resilience under uncertainty
  - Impacts of stock productivity
  - Ecological and fishery allocation
- Discussions of societal objectives for blue crab fisheries in a changing world
  - Forecasts of future conditions
  - Stakeholder-centered approach to targets – what do we want?

# It's tough to make predictions – especially about the future

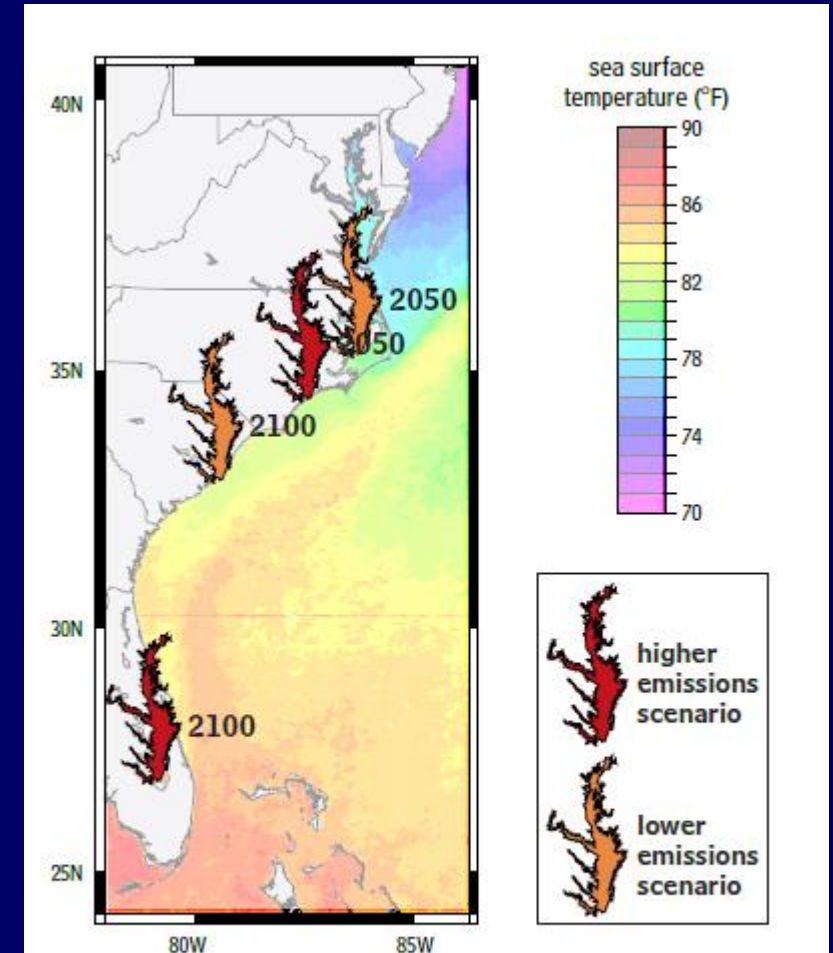
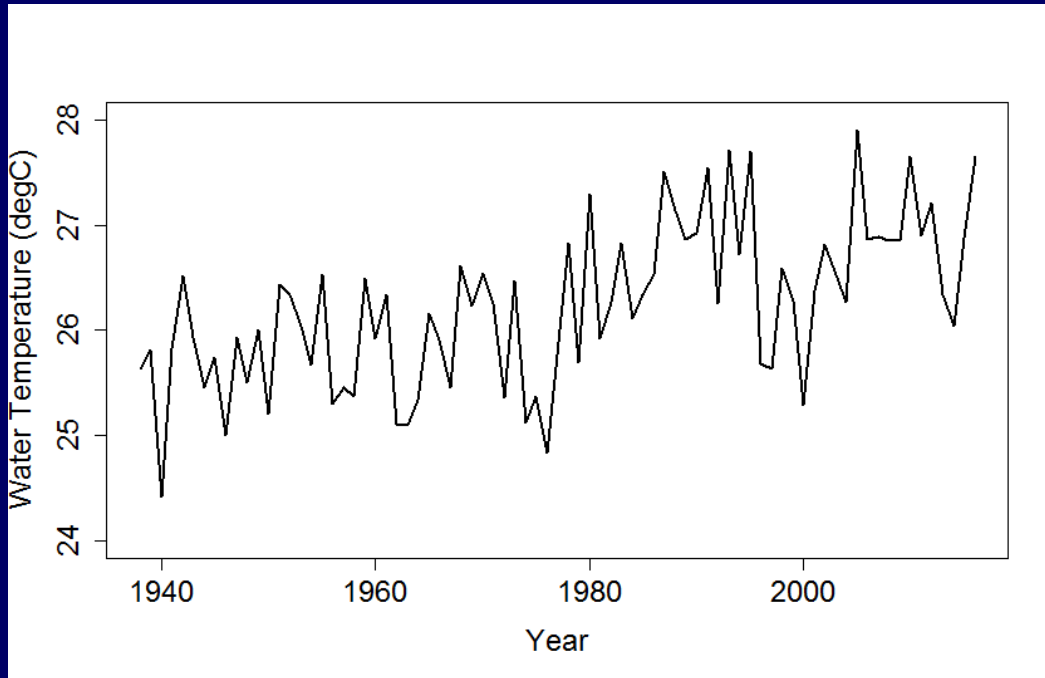
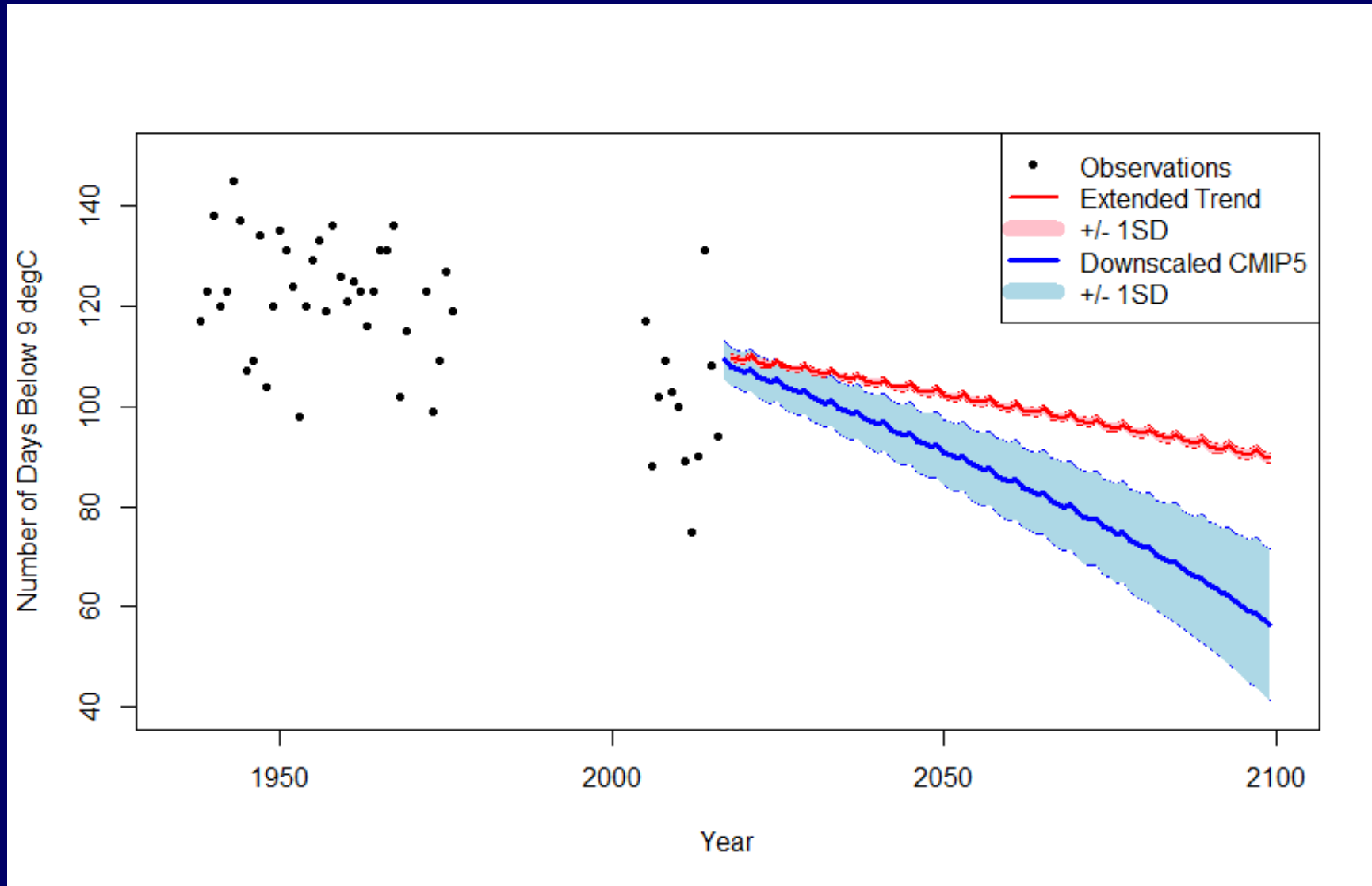


Figure 4.7. Summertime surface water temperatures in the Chesapeake Bay are projected to approximate those of estuaries well down the Atlantic Coast by 2050 and 2100.

# Climate impacts of overwintering



Questions

# Crab distribution maps

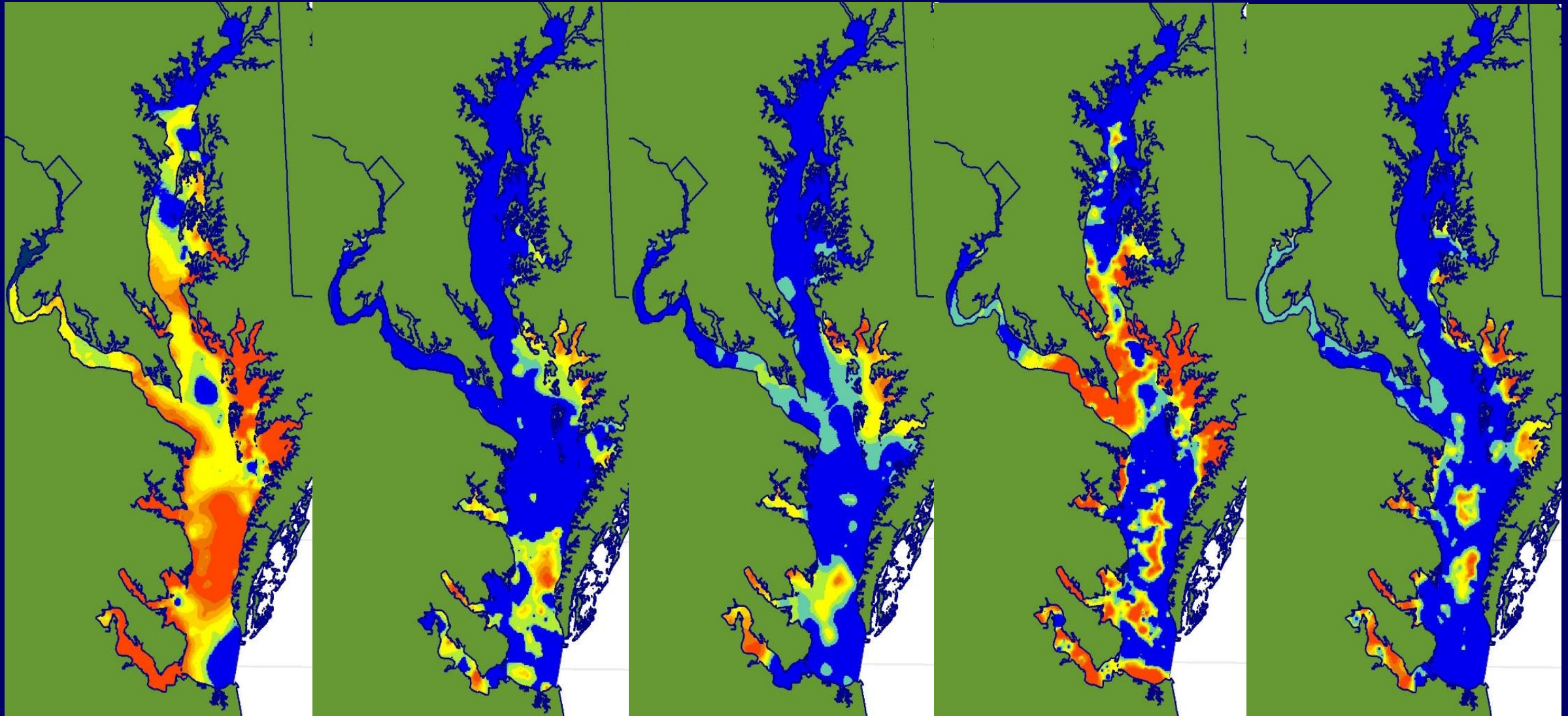
1990

2000

2008

2012

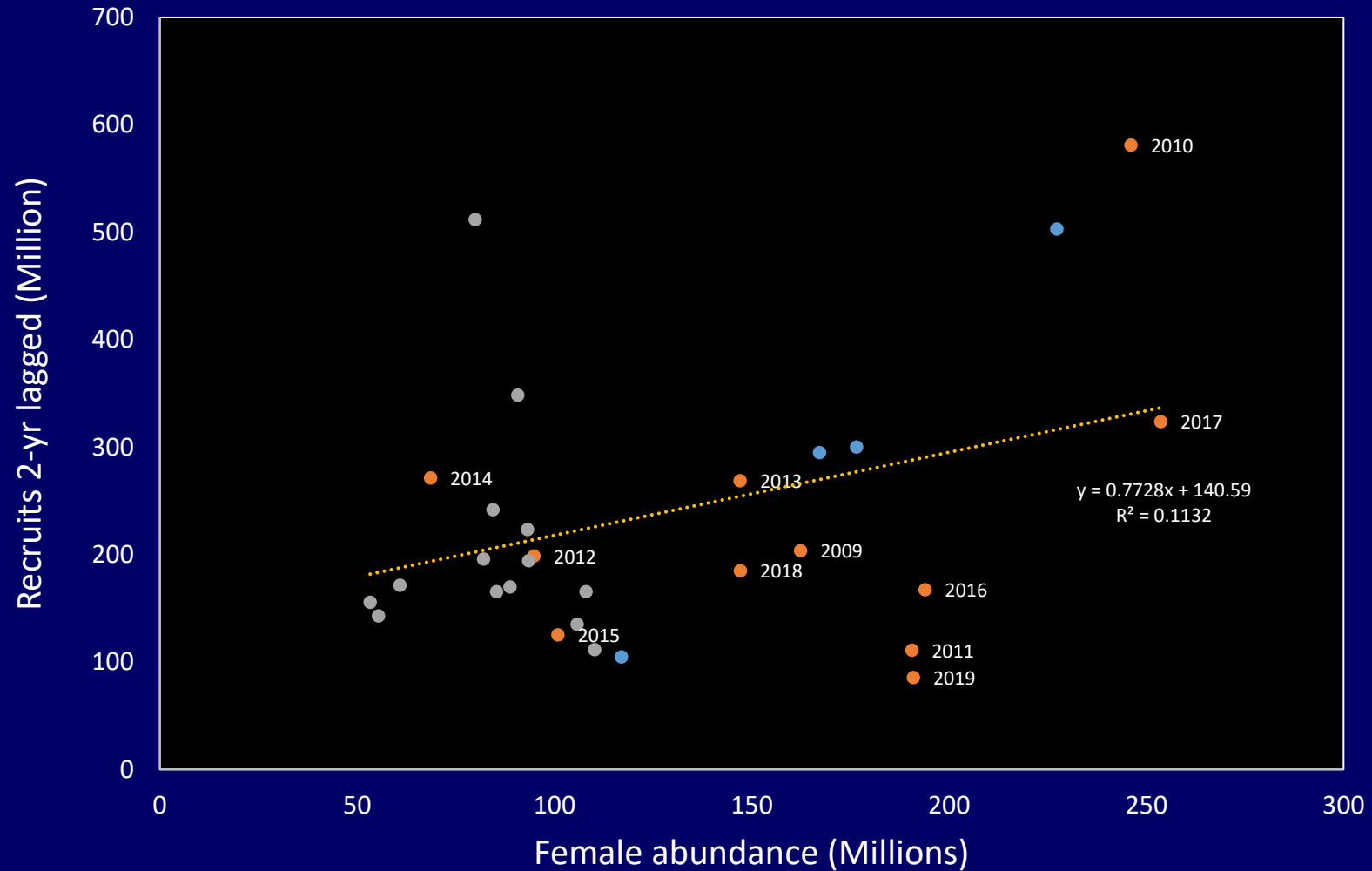
2018



Jensen and Miller 2005



# Stock & recruitment



# Phase shifts (Lipcius et al. – pers.comm.)

