Information Gathering and synthesizing subcommittee:

Oyster Aquaculture Siting Optimization:

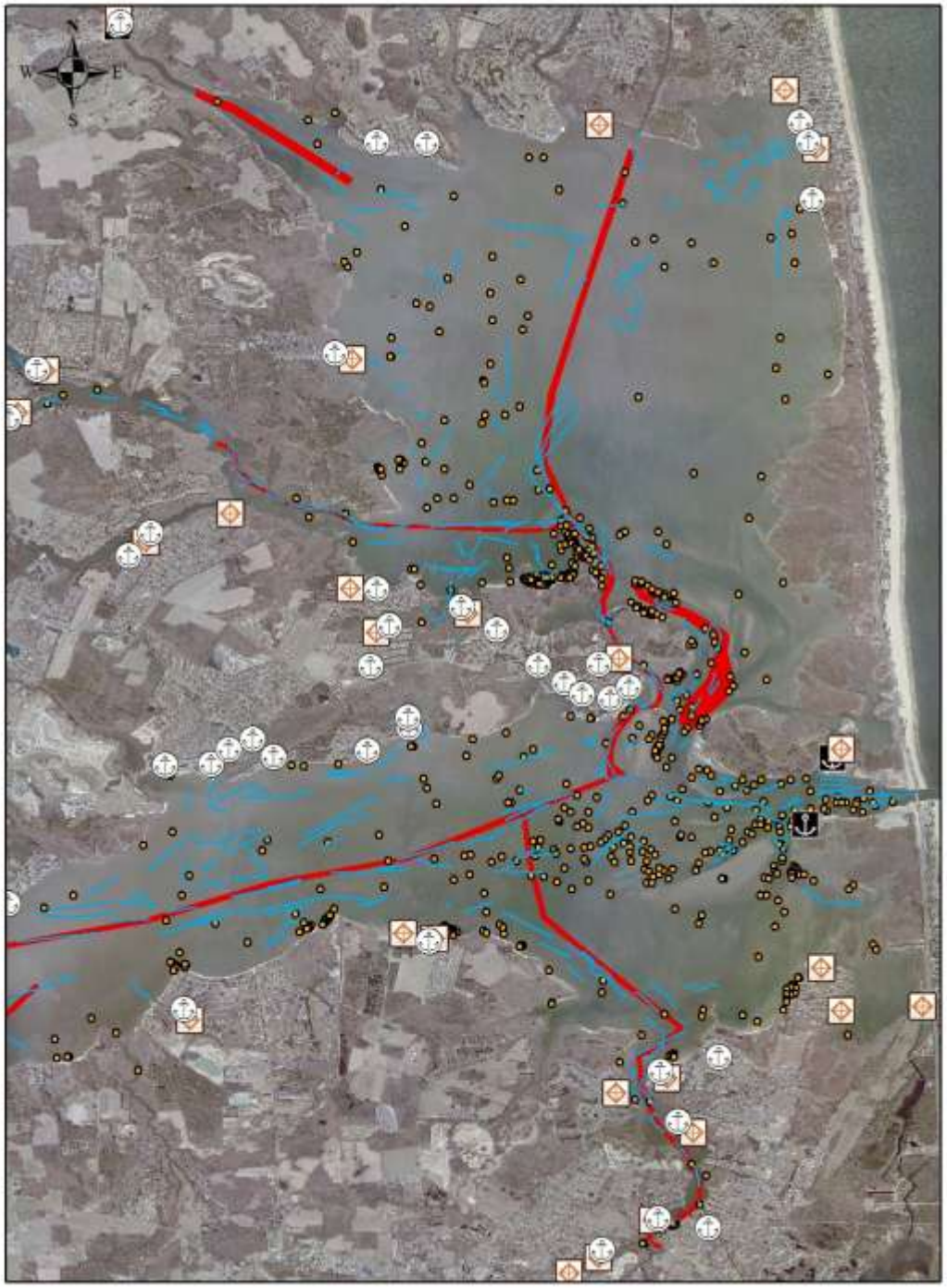
Oyster Aquaculture Tiger Team

GIS Planning Goals

- Decrease user conflicts, improve planning and regulatory efficiencies and decrease costs and delays, and preserve critical ecosystem services
  - Reduce conflicting Interests
    - High Boat use regions and pathways would be primary conflicting use.
    - Conflicting uses would be exclusion areas for aquaculture.
    - Mixed or overlapping uses may be excluded or rated as a low interest area due to the type of uses and conflicts.
    - Optimally aquaculture lease areas would be located in areas with low conflicted interests or highly compatible uses.
- Places science-based information at the heart of decision-making.
- Emphasizes stakeholder and public participation.

Current Data

- Human-Use Considerations
  - Navigational Channels
  - Historic Channel dredging
  - Marinas, public and private boat ramps, high use boat slip regions
- Physical Data
  - Bathymetry
  - Bottom sediment data
    - DNREC Clam Abundance Surveys
    - Chrzastowski (1986)
- Ecological Data
  - Clam abundance and potential habitat
  - Seasonal important Bird Habitat



Human-Use Data

Legend

- High Density Boat Slips
- Public/Private Boat Ramps
- Marinas
- Navigational Channels
- Stationary Boats
- Boats in Motion

2 1 0 2 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team

Data Needs

- Bottom Sediment Data
  - NRCS data for subaqueous soils in bays (Requested, but unknown status)
- Bathymetry
  - DNREC (completed)
  - USACE (Requested, but unknown status)
- DNREC Heritage Program:
  - Species Distribution Update (in the process of being compiled)
- Potential Development areas (Long-term)
  - Marinas
  - Private ramps
  - Coastal development

Data (GIS) collection and synthesizing subcommittee

- Determine what data has been collected and what data is still needed to form a Commercial oyster aquaculture suitability map (GIS layer).
  - Report to team at June 5th meeting
- Synthesize data into a GIS layer showing optimal oyster aquaculture areas.
  - Draft product presented to team at July 3rd meeting

Habitat Parameters

- Virginia
  - depths greater than 5 meters are considered too deep for aquaculture.
  - Average salinity ≥ 7 ppt
  - Optimal, Suitable Unsuitable
    - Shellfish Closure
    - Dominant Land Use
- Suitability Index
  - **Optimal**
    - Optimal growing conditions are present
    - Bathymetry and salinity regimes are appropriate
    - There are no designated shellfish closures at the present
    - Water quality is good.
  - **Suitable**
    - Optimal growing conditions exist (shellfish waters are "opened")
    - Salinity and bathymetric criteria established for the model are met.
    - Land use data reports these areas have some level of development or existing agricultural practices that threaten water quality.
  - **Unsuitable**
    - Does not meet the bathymetry and/or salinity requirements
    - Areas where the Health of the waters as "prohibited" for the taking of shellfish are also unsuitable.

Exclusion Areas

Regulatory Setback Standards

- Virginia
  - Temporary protective enclosures shall not be placed within 100 feet of any shoreline or pier without the agreement of the riparian property owner
- Maryland
  - Shoreline setback of 50 ft and a navigational channel setback of 150 ft.
- Delaware
  - Shoreline setback of 1000 ft

Current Regulatory 1000 ft Exclusionary Shoreline Buffer

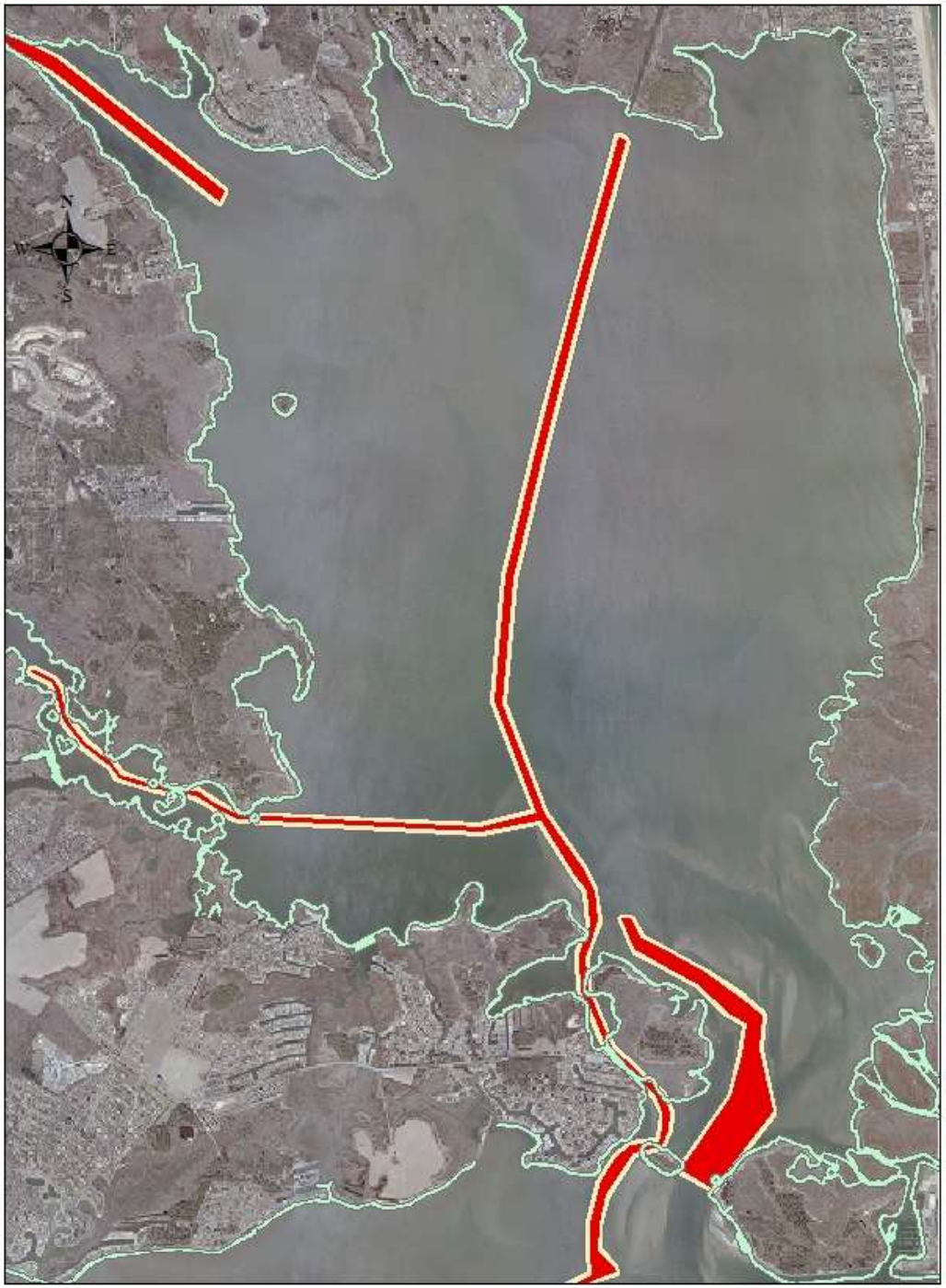
Legend

1000ft Shoreline Buffer

2 1 0 2 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team



Proposed Buffer Regulations (State of Maryland Buffers): Rehoboth Bay

Legend

- Shoreline 50 ft Buffer
- Navigational Channels
- Navigational Channel 150 ft Buffer

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

Oyster Aquaculture Tiger Team

Proposed Buffer Regulations (State of Maryland Buffers): Eastern Indian River Bay

Legend

- Shoreline 50ft Buffer
- Navigational Channels
- Navigational Channel 150 ft Buffer

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

Oyster Aquaculture Tiger Team

Proposed Buffer Regulations (State of Maryland Buffers): Eastern Indian River Bay

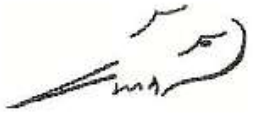
Legend

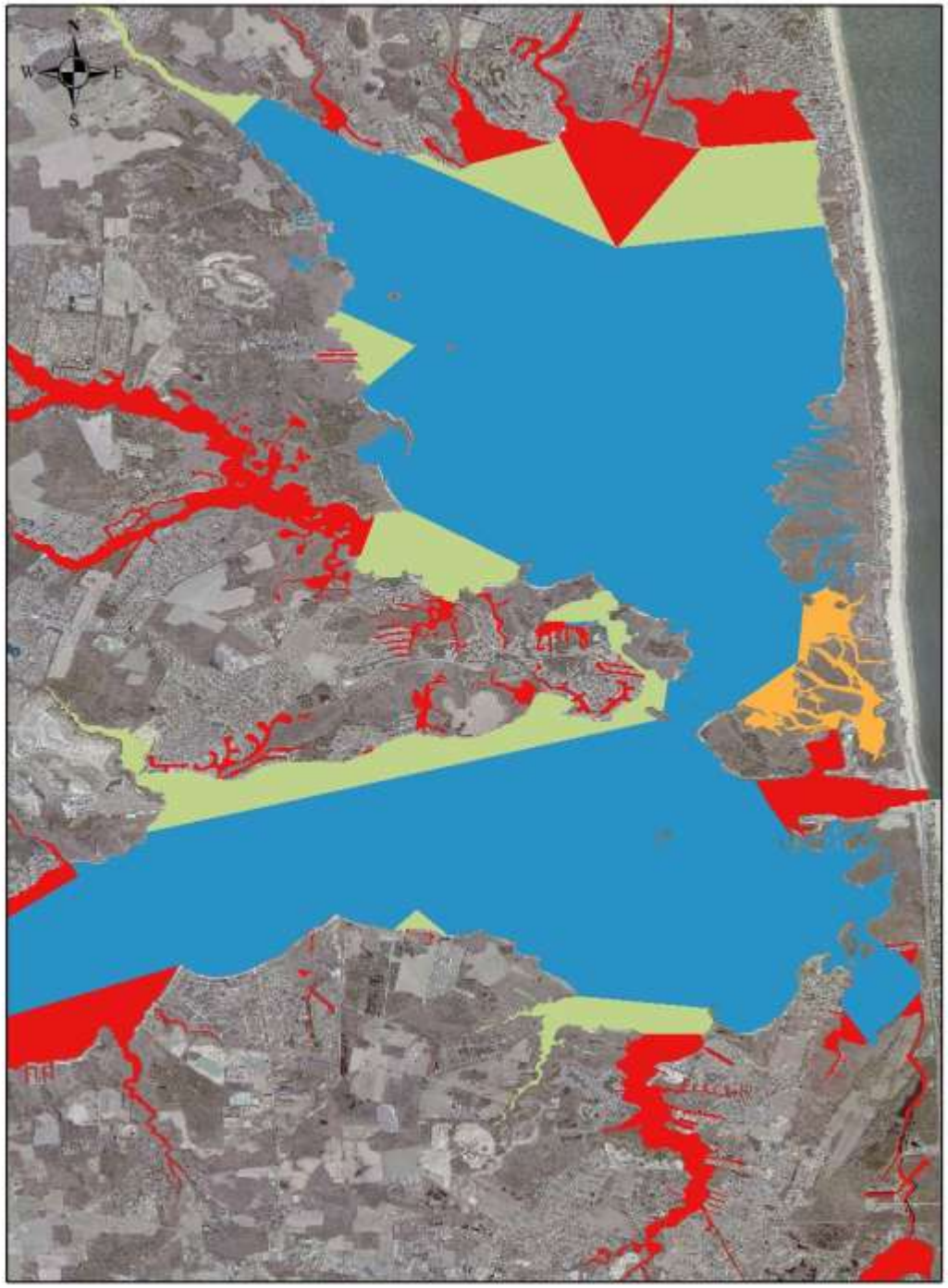
- Shoreline 50 ft Buffer
- Navigational Channels
- Navigational Channel 150 ft Buffer

1 0.5 0 1 Miles

1 0.5 0 1 Kilometers

Oyster Aquaculture Tiger Team





DNREC Clam Harvest Closures

Legend

Working 2010 Shellfish Harvesting Areas

STATUS

- Prohibited
- Prohibited (Hatchery)
- Seasonal Closures
- Open

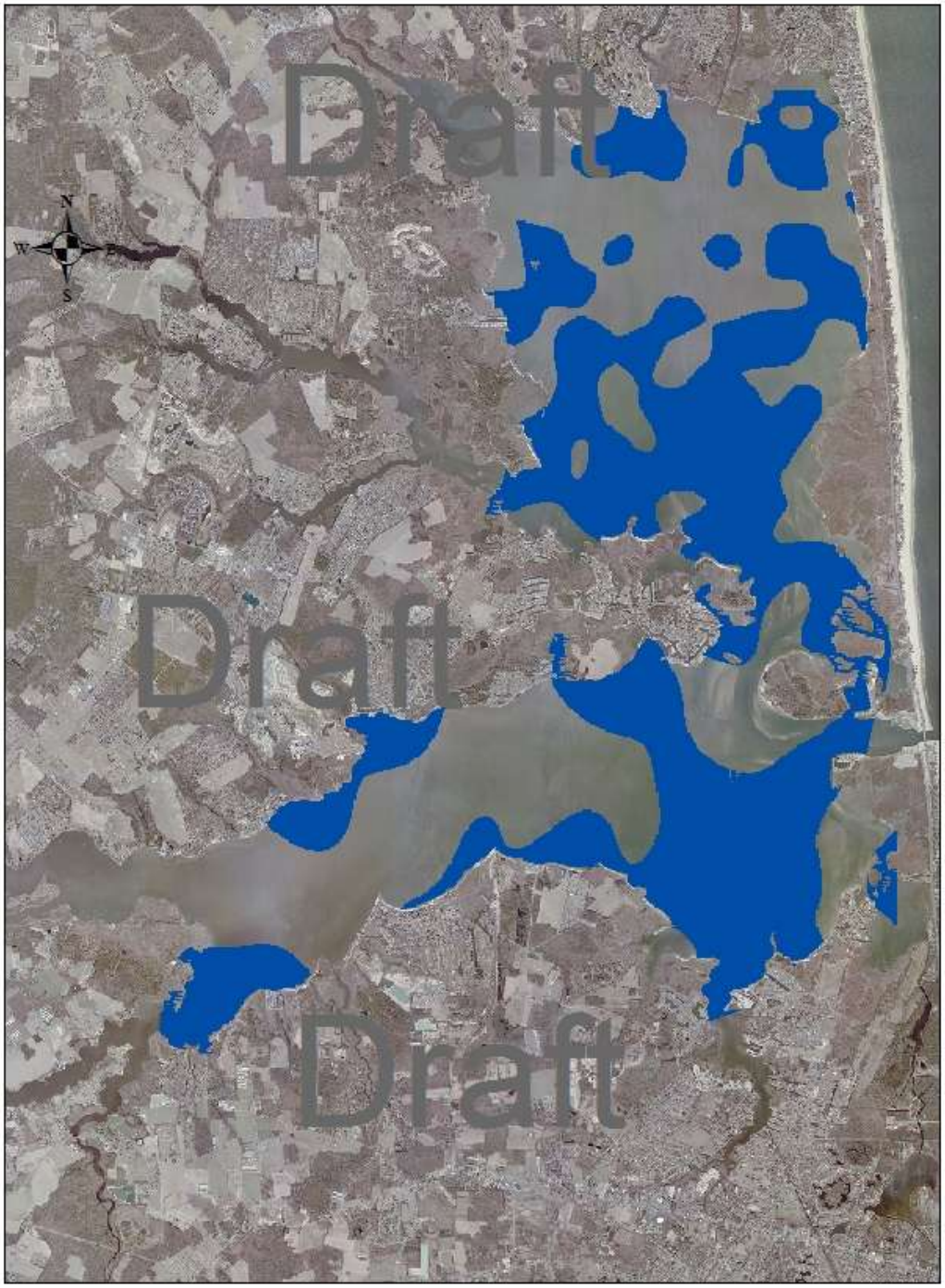
2 1 0 2 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team

Barren Bottom Classification

- Rhode Island considers >3 clams per square meter to be the dividing line between productive vs barren bottom suitable for aquaculture use.
  - Unproductive bottom is also an odd definition but the unwritten criteria that we use is that a commercially viable bottom would have 10 hard clams per square meter.
  - Five per square meter is a recreationally decent area but it could still be leased for aquaculture.
- Virginia does not have any specific shellfish density standard
  - Use public verses lease designation
- Maryland does not have any specific shellfish density standard



Draft

Inland Bay Exclusion Areas Based upon Clam Densities

Legend

Clam Densities of 3 or greater (clam / m sq)

Draft

2.5 1.25 0 2.5 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team

Draft

Inland Bay Exclusion Areas Based upon Clam Densities

Legend

Clam Densities of 5 or greater (clam / m sq)

Draft

2.5 1.25 0 2.5 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team

Draft

Inland Bay Exclusion Areas Based upon Clam Densities

Legend

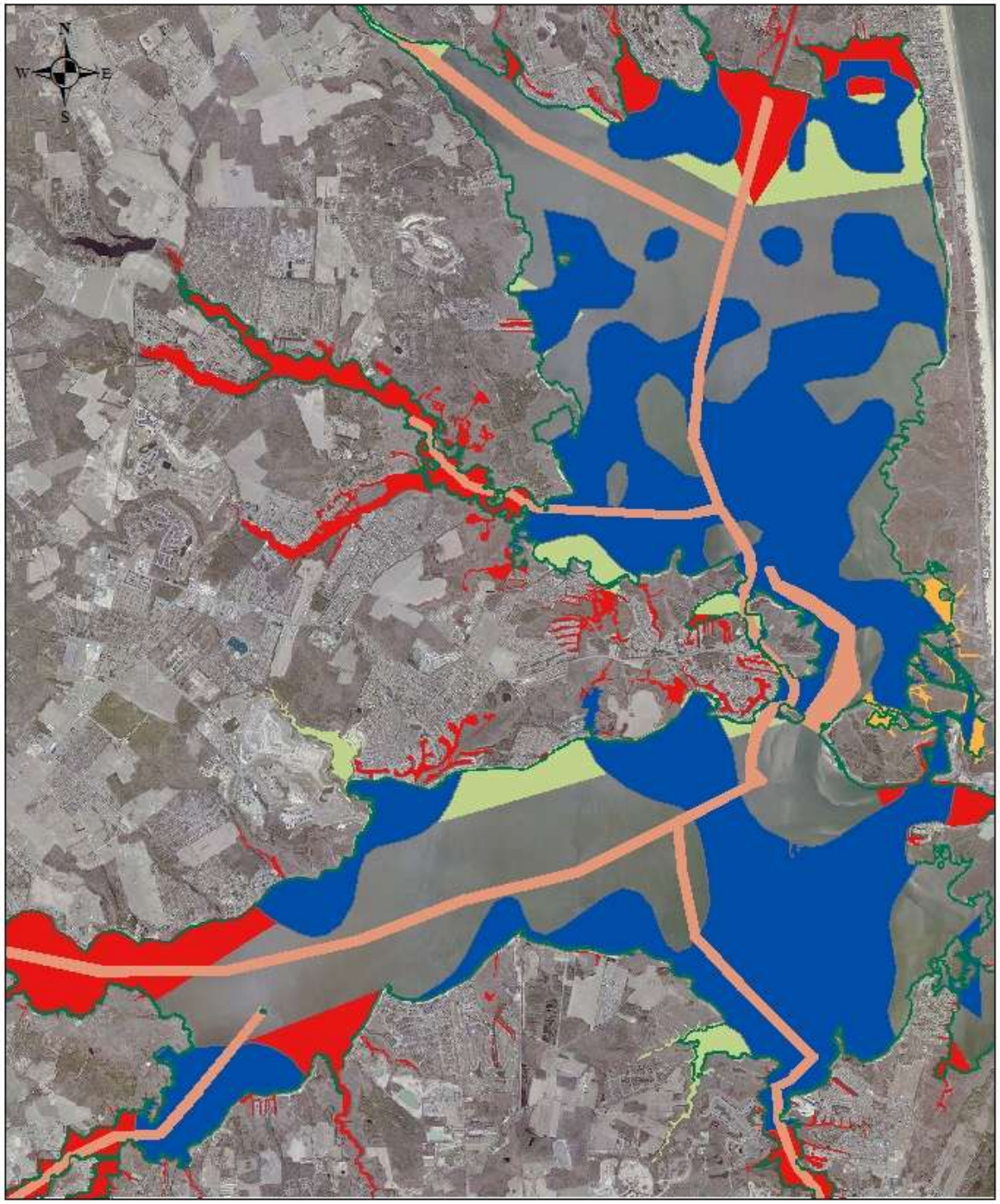
Clam Densities of 8 or greater (clam / m sq)

Draft

2.5 1.25 0 2.5 Miles

3 1.5 0 3 Kilometers

Oyster Aquaculture Tiger Team



Oyster Aquaculture Exclusion Areas

Legend

- Shoreline 50 ft Buffer (Md)
- Navigational Channel 150 ft Buffer
- Clam Densities of 3 or greater

Shellfish Harvesting Areas

STATUS

- Prohibited
- Prohibited (Hatchery)
- Seasonal Closures

Total Area Excluded:

11618 Acres

61.5% of the total Inland Bays area

2 1 0 2 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture

Legend

Areas outside of the OA exclusions

Total Area:

7287 Acres

38.5% of the total Inland Bays area

2 1 0 2 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Areas outside of the OA exclusions

Total Area:

4,299 Acres

45.6% of the total Rehoboth Bays area

1 0.5 0 1 Kilometers

0.9 0.45 0 0.9 Miles

Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Areas outside of the OA exclusions

Rehoboth Bay 2004

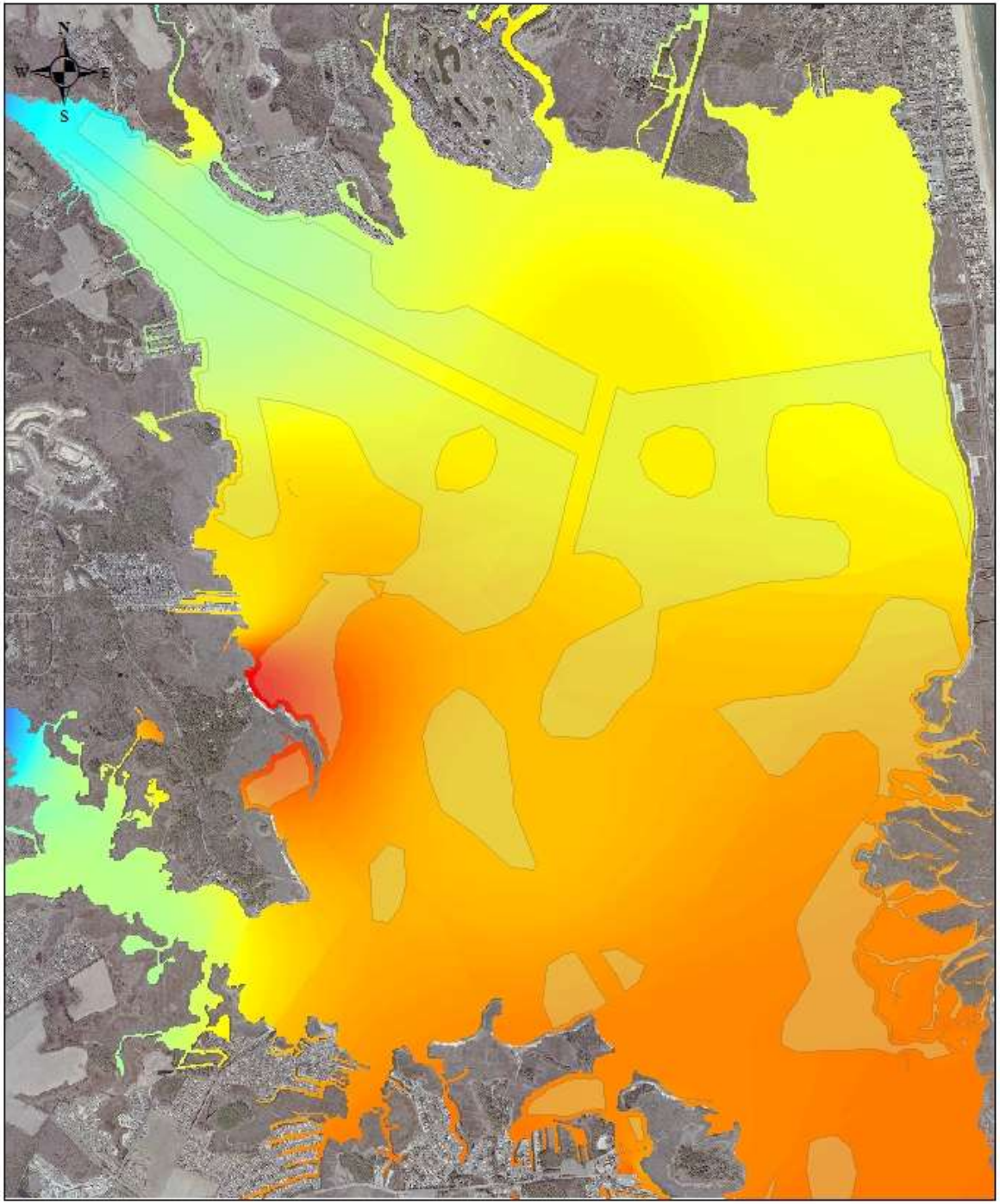
Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

1 0.5 0 1 Kilometers

0.9 0.45 0 0.9 Miles

Oyster Aquaculture Tiger Team



Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Value (ppt)

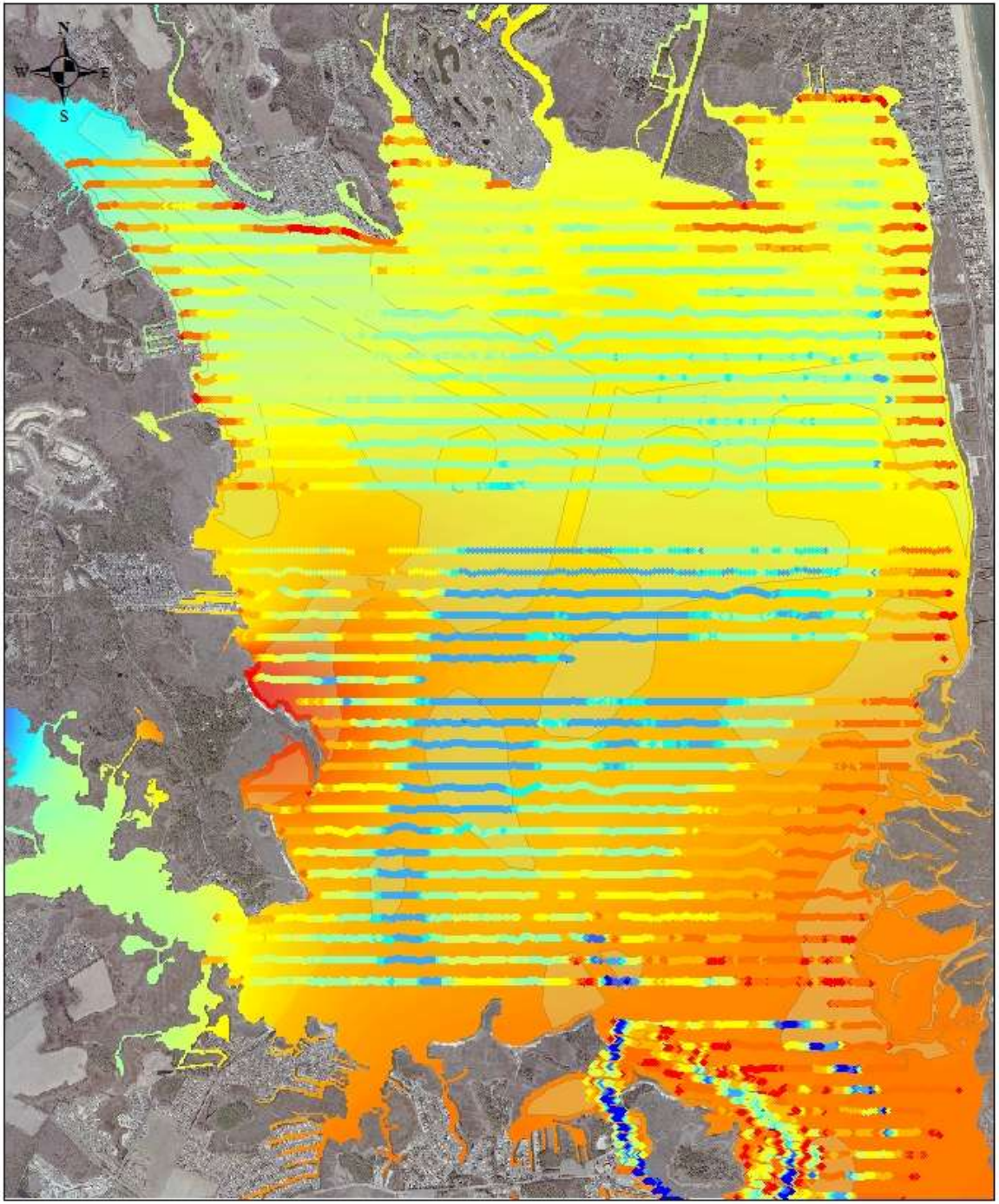
High : 31.5423

Low : 7.24303

1 0.5 0 1 Kilometers

0.9 0.45 0 0.9 Miles

Oyster Aquaculture Tiger Team



Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

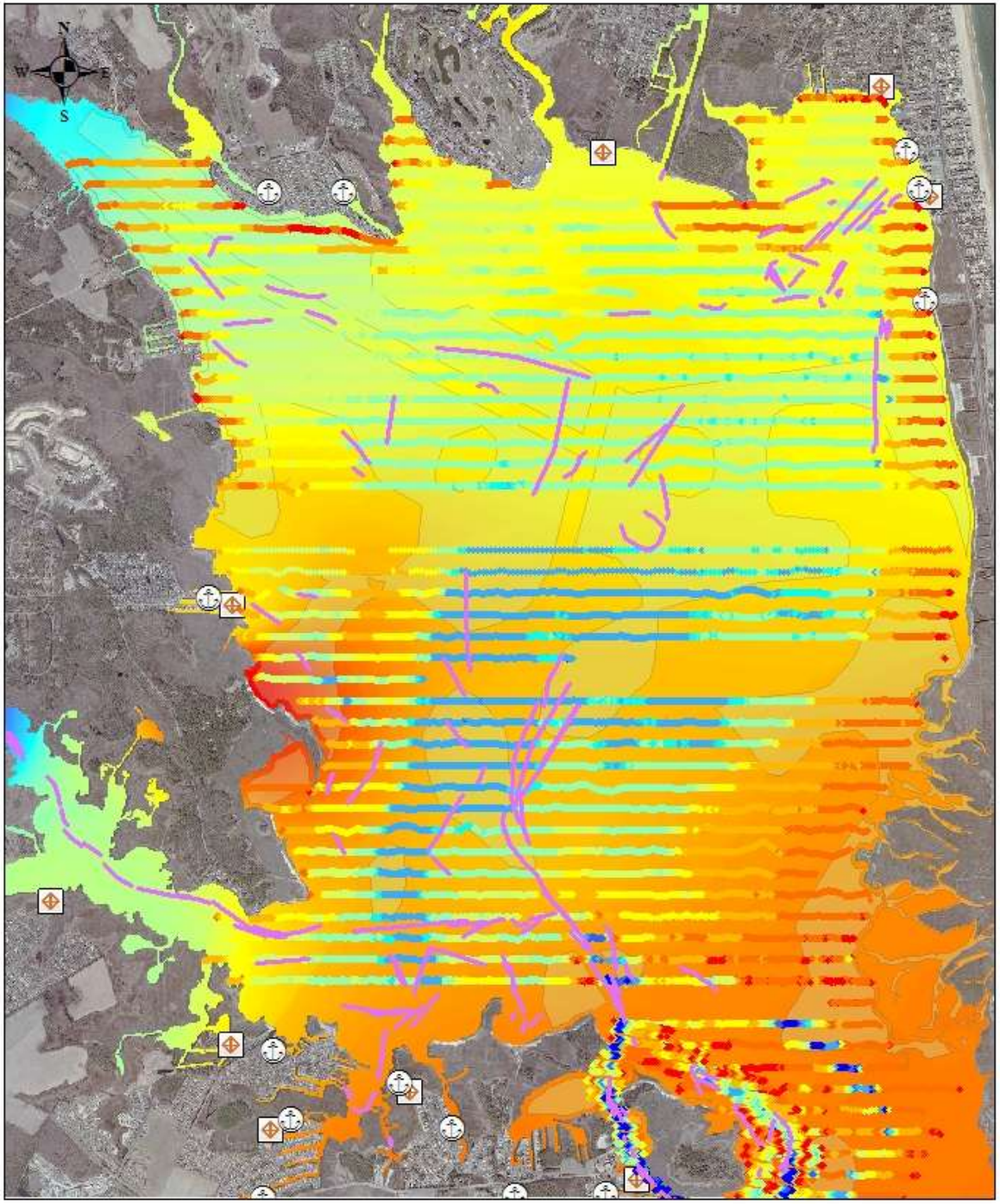
Low : 7.24303

Rehoboth Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Oyster Aquaculture Tiger Team



Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Rehoboth Bay 2004

Depth (ft mlw)

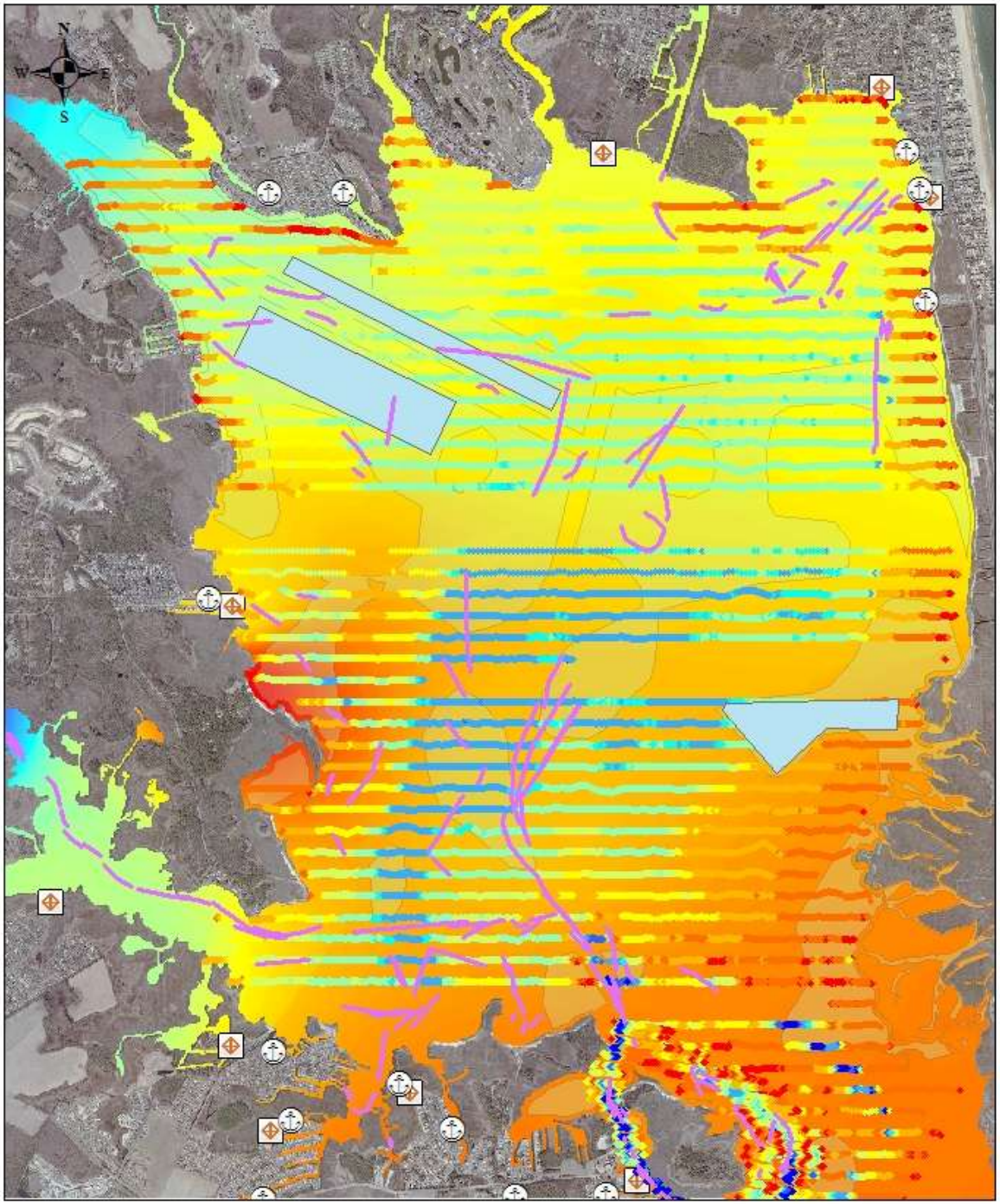
- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0
- Boats in Motion
- Areas outside of the OA exclusions
- High Density Boat Slips
- Public/Private Boat Ramps
- Marinas

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

Low : 7.24303



Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

Potential Oyster Aquaculture Areas

Rehoboth Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Boats in Motion

Areas outside of the OA exclusions

High Density Boat Slips

Public/Private Boat Ramps

Marinas

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

Low : 7.24303

Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Total Area:

319 Acres

3.4% of the total Rehoboth area

1 0.5 0 1 Kilometers

0.8 0.4 0 0.8 Miles

Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

- Example Squares
- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Total Area:

319 Acres 3.4% of the total Rehoboth area

Example Areas:

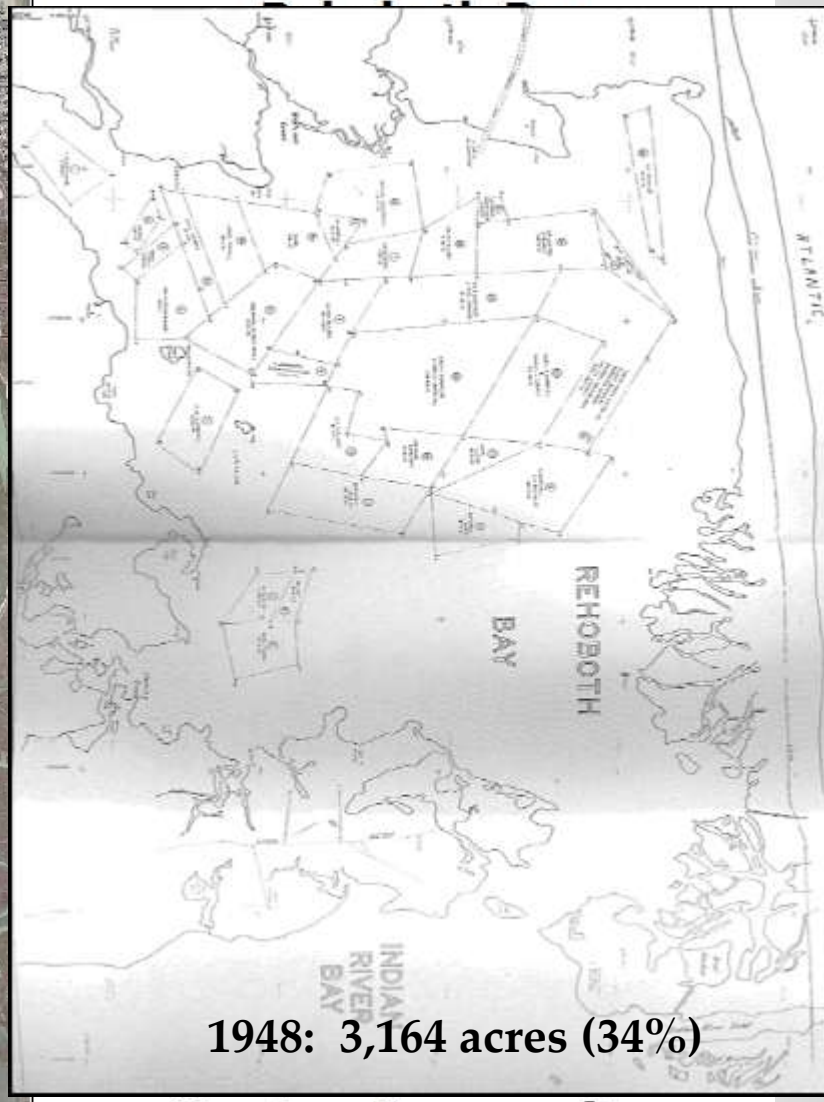
75.5 Acres 0.8% of the total Rehoboth area

1 0.5 0 1 Kilometers

0.8 0.4 0 0.8 Miles

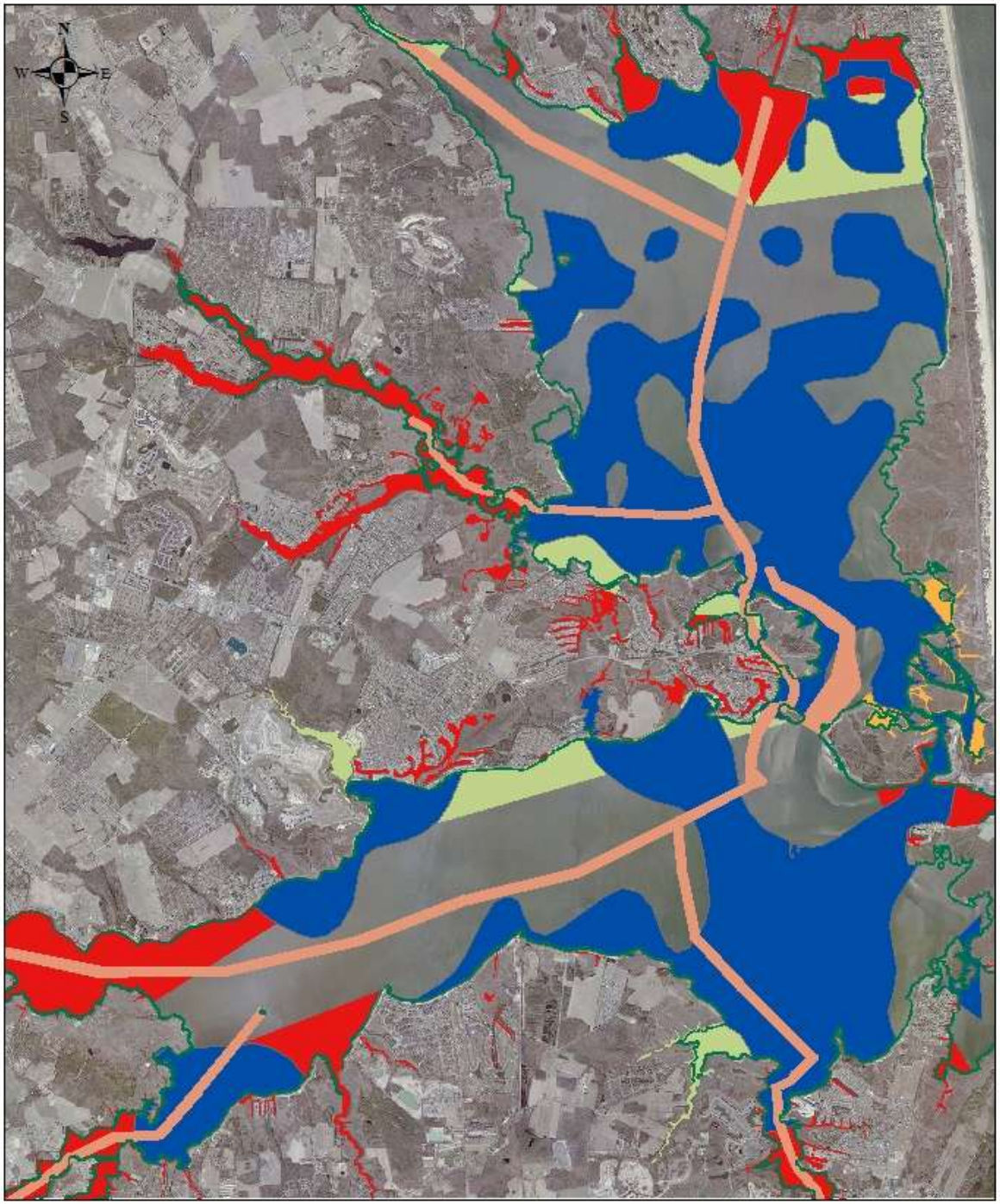
Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture:



1948: 3,164 acres (34%)

Oyster Aquaculture Tiger Team



Oyster Aquaculture Exclusion Areas

Legend

- Shoreline 35 ft Buffer (Md)
- Navigational Channel 150 ft Buffer
- Clam Densities of 3 or greater

Shellfish Harvesting Areas

STATUS

- Prohibited
- Prohibited (Hatchery)
- Seasonal Closures

Total Area Excluded:

11618 Acres

61.5% of the total Inland Bays area

2 1 0 2 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team

Area Available for Oyster Aquaculture: Indian River Bay

Total Area:

2,987 Acres

31.5% of the total Indian River area

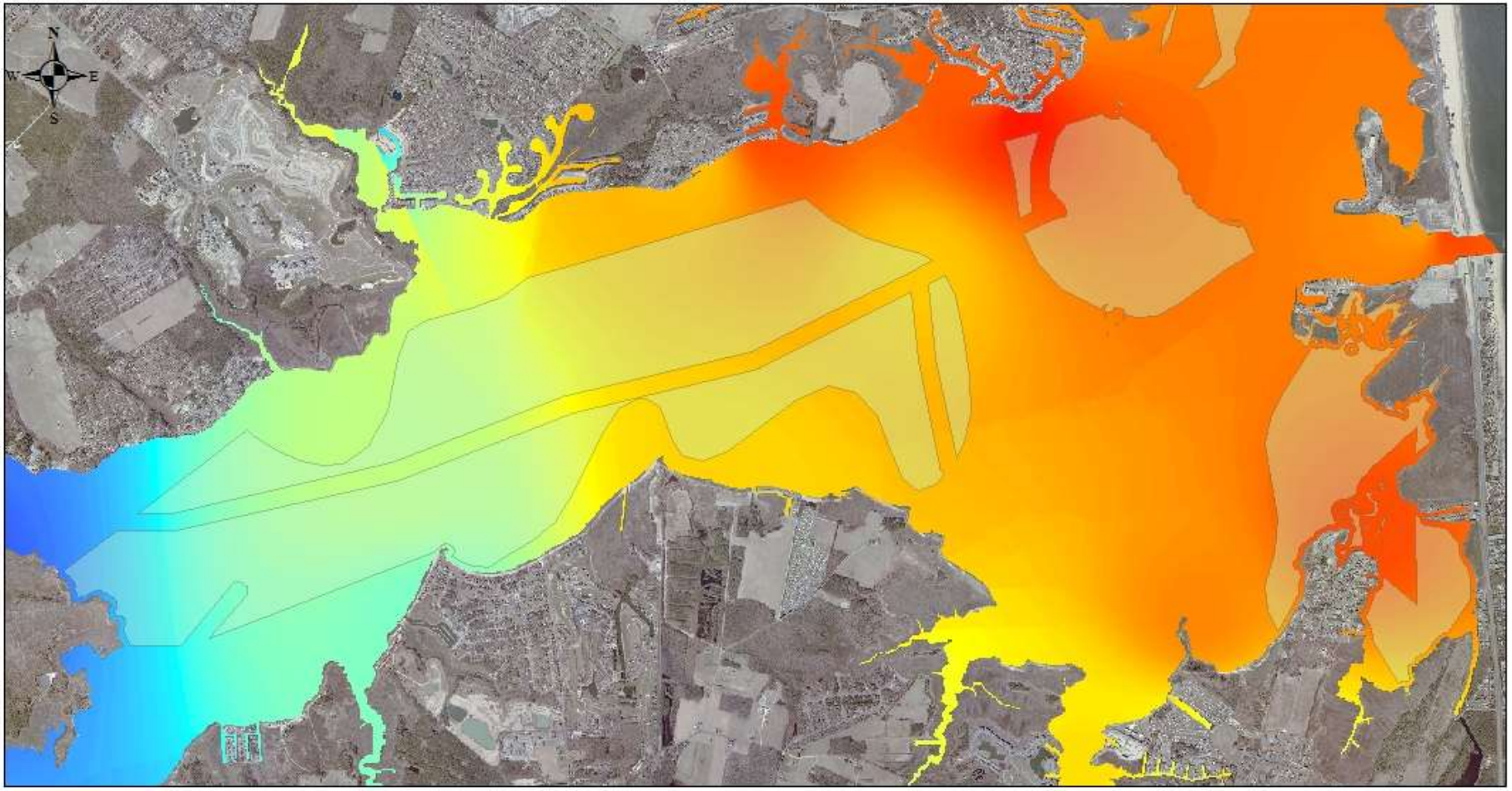
Legend

Areas outside of the OA exclusions

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team



Legend

Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

Low : 7.24303

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

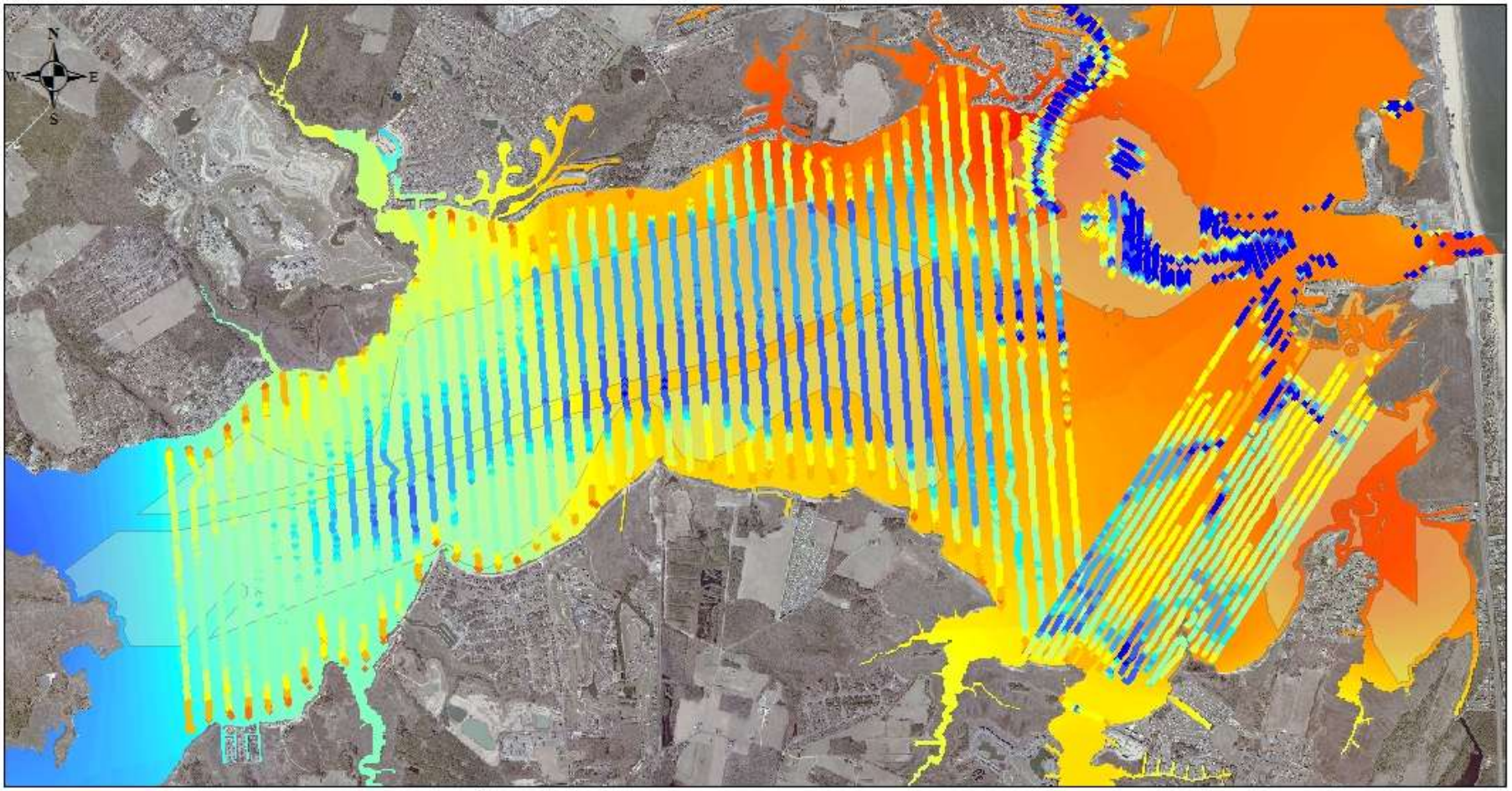
1 0.5 0 1 Miles

Total Area:

2,987 Acres

31.5% of the total Indian River area

Oyster Aquaculture Tiger Team



Legend

Indian_River Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

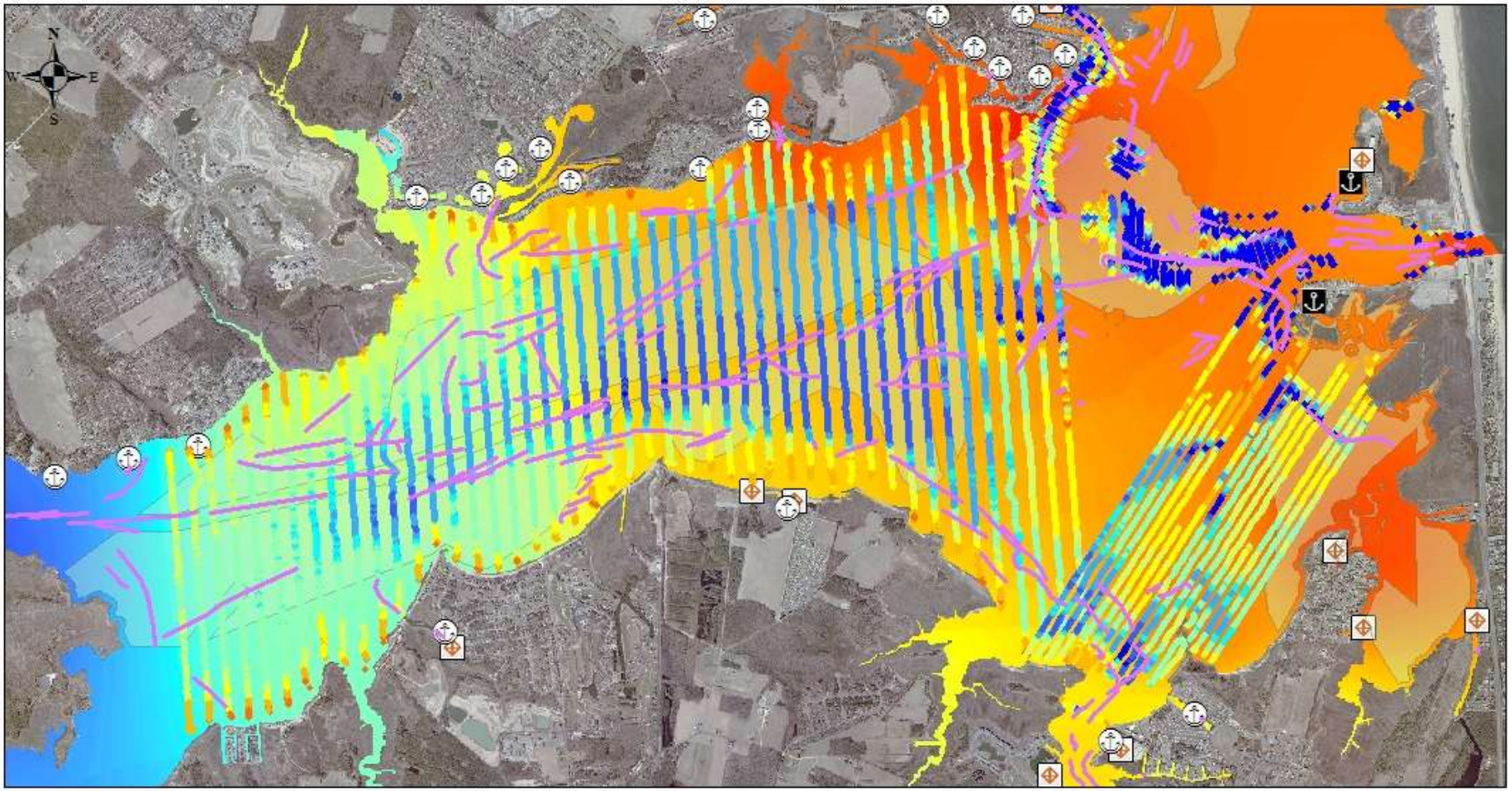
Low : 7.24303

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team



Legend

Indian_River Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Boats in Motion

Areas outside of the OA exclusions

High Density Boat Slips

Public/Private Boat Ramps

Marinas

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

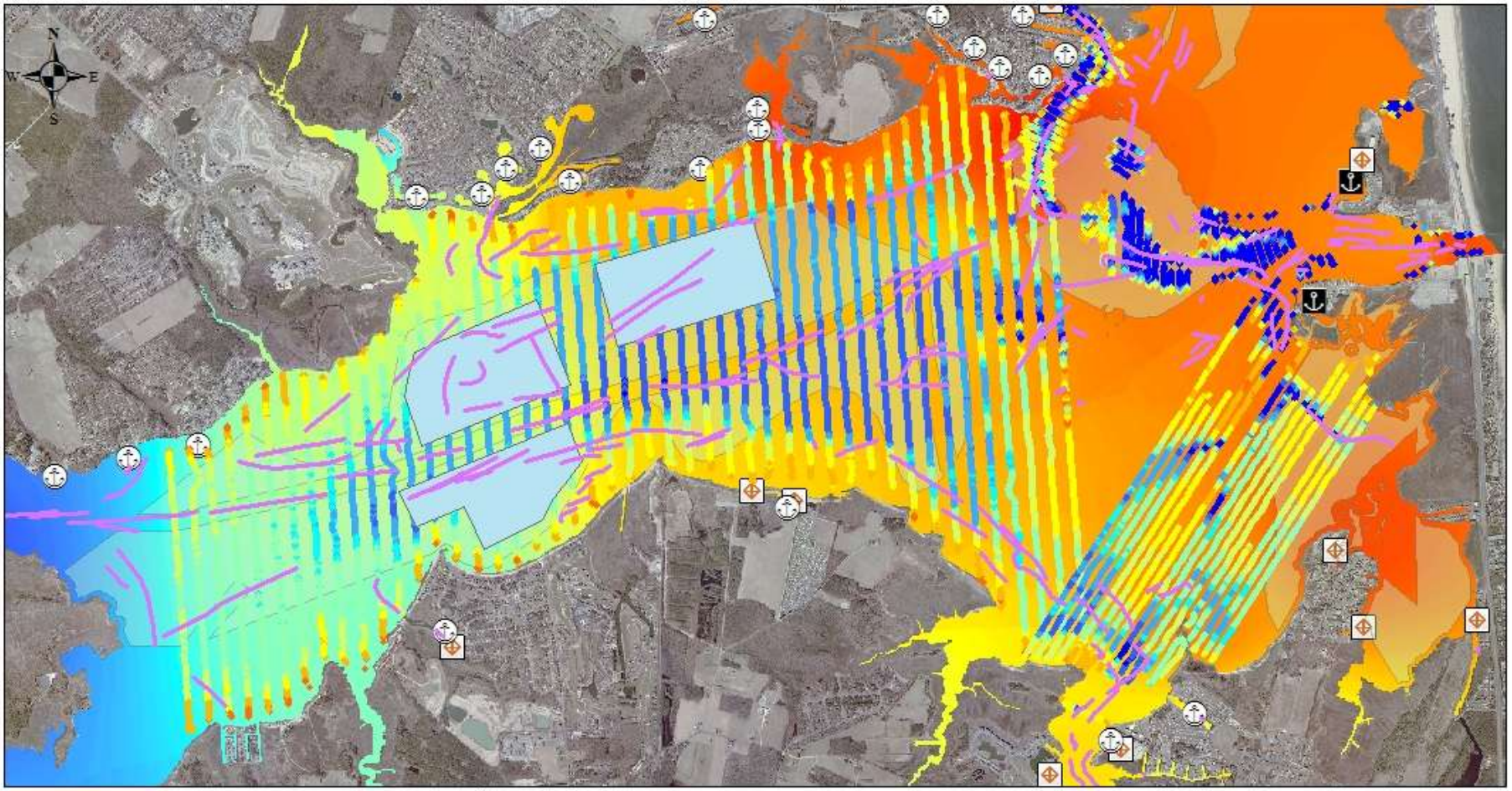
Low : 7.24303

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team



Legend

Indian_River Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Boats in Motion

Potential Oyster Aquaculture Areas

Areas outside of the OA exclusions

High Density Boat Slips

Public/Private Boat Ramps

Marinas

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

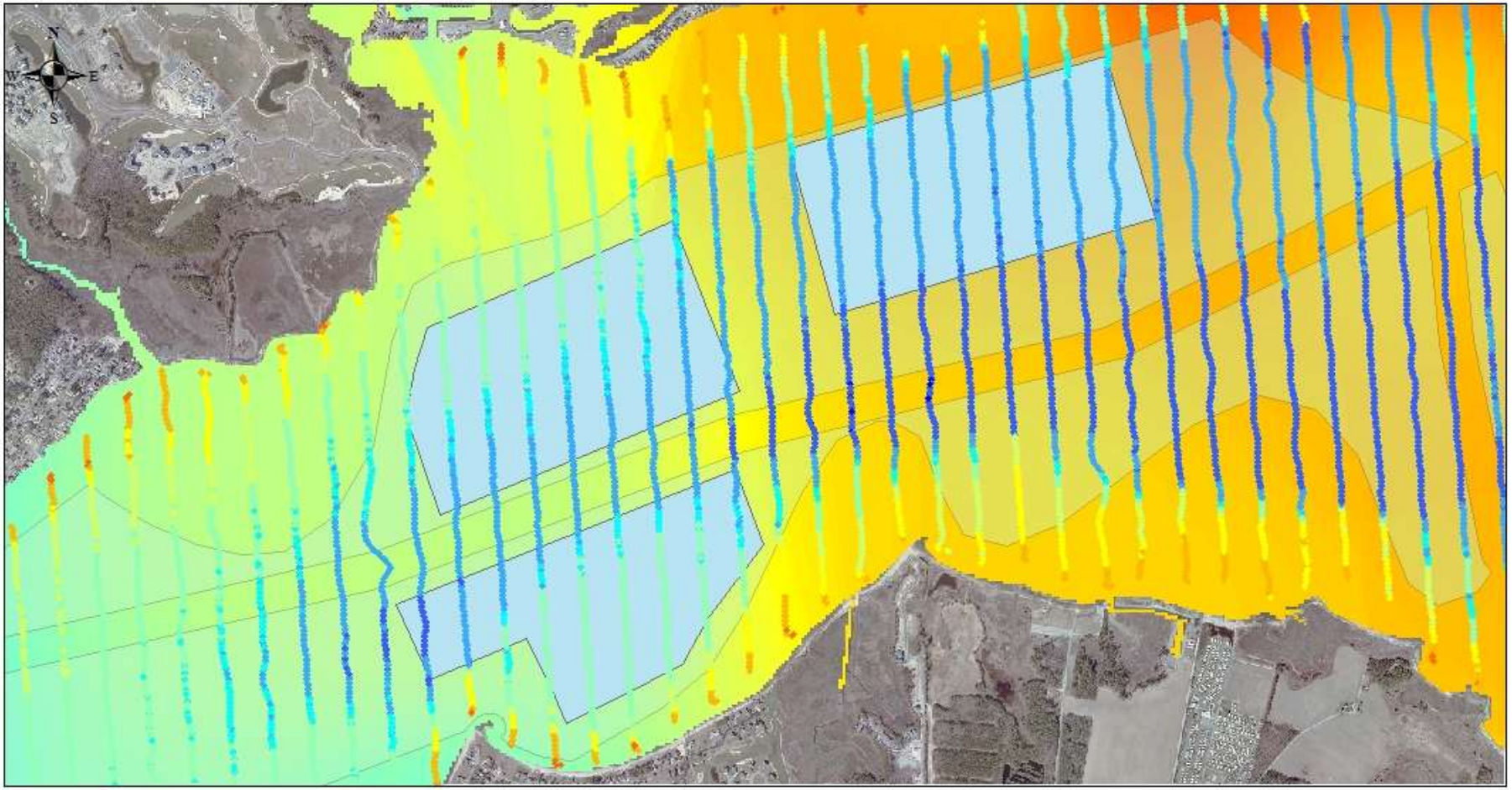
Low : 7.24303

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles

Oyster Aquaculture Tiger Team



Legend

Indian_River Bay 2004

Depth (ft mlw)

- -0.9 - 0.0
- -1.9 - -1.0
- -2.9 - -2.0
- -3.9 - -3.0
- -4.9 - -4.0
- -5.9 - -5.0
- -6.2 - -6.0
- -6.9 - -6.3
- -7.9 - -7.0
- -14.9 - -8.0

Potential Oyster Aquaculture Areas

Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Value (ppt)

High : 31.5423

Low : 7.24303

Area Available for Oyster Aquaculture: Indian River Bay

0.4 0.2 0 0.4 Kilometers

0.4 0.2 0 0.4 Miles

Oyster Aquaculture Tiger Team

Legend

- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Area Available for Oyster Aquaculture: Indian River Bay

0.4 0.2 0 0.4 Kilometers

0.4 0.2 0 0.4 Miles

Total Area:

560 Acres

5.9% of the total Indian River area

Oyster Aquaculture Tiger Team

Legend

- Example Squares
- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Area Available for Oyster Aquaculture: Indian River Bay

0.4 0.2 0 0.4 Kilometers

0.4 0.2 0 0.4 Miles

Total Area:

560 Acres 5.9% of the total Indian River area

Example Areas:

86.5 Acres 0.9% of the total Indian River area

Oyster Aquaculture Tiger Team

Legend

- Example Squares
- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles

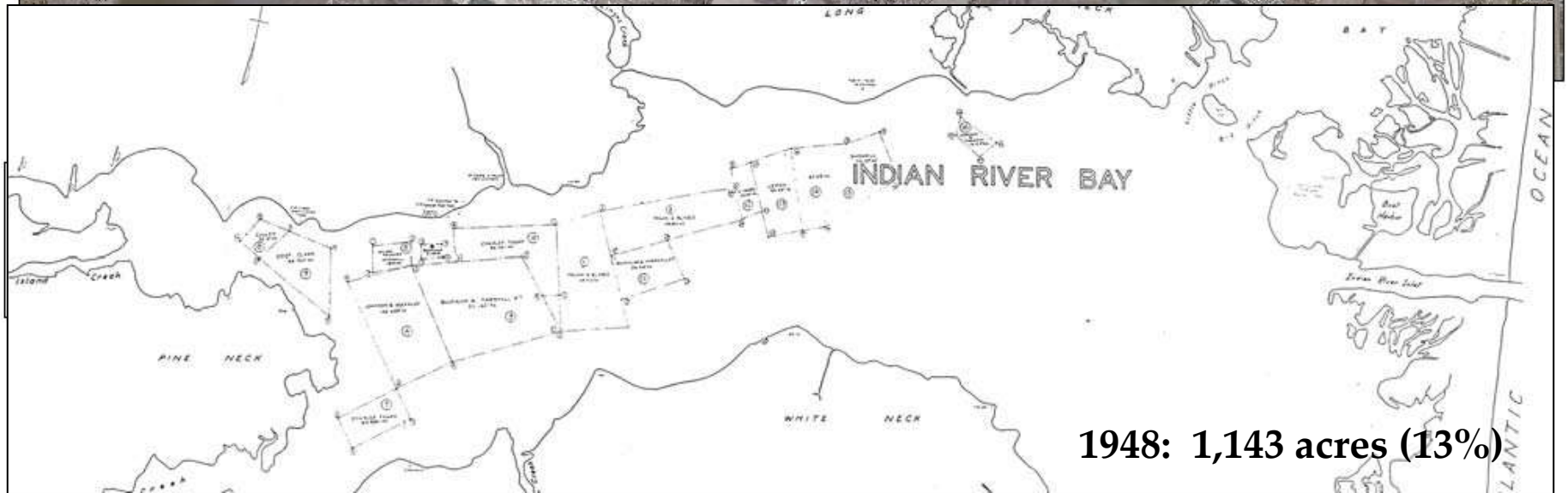
Total Area:

560 Acres 5.9% of the total Indian River area

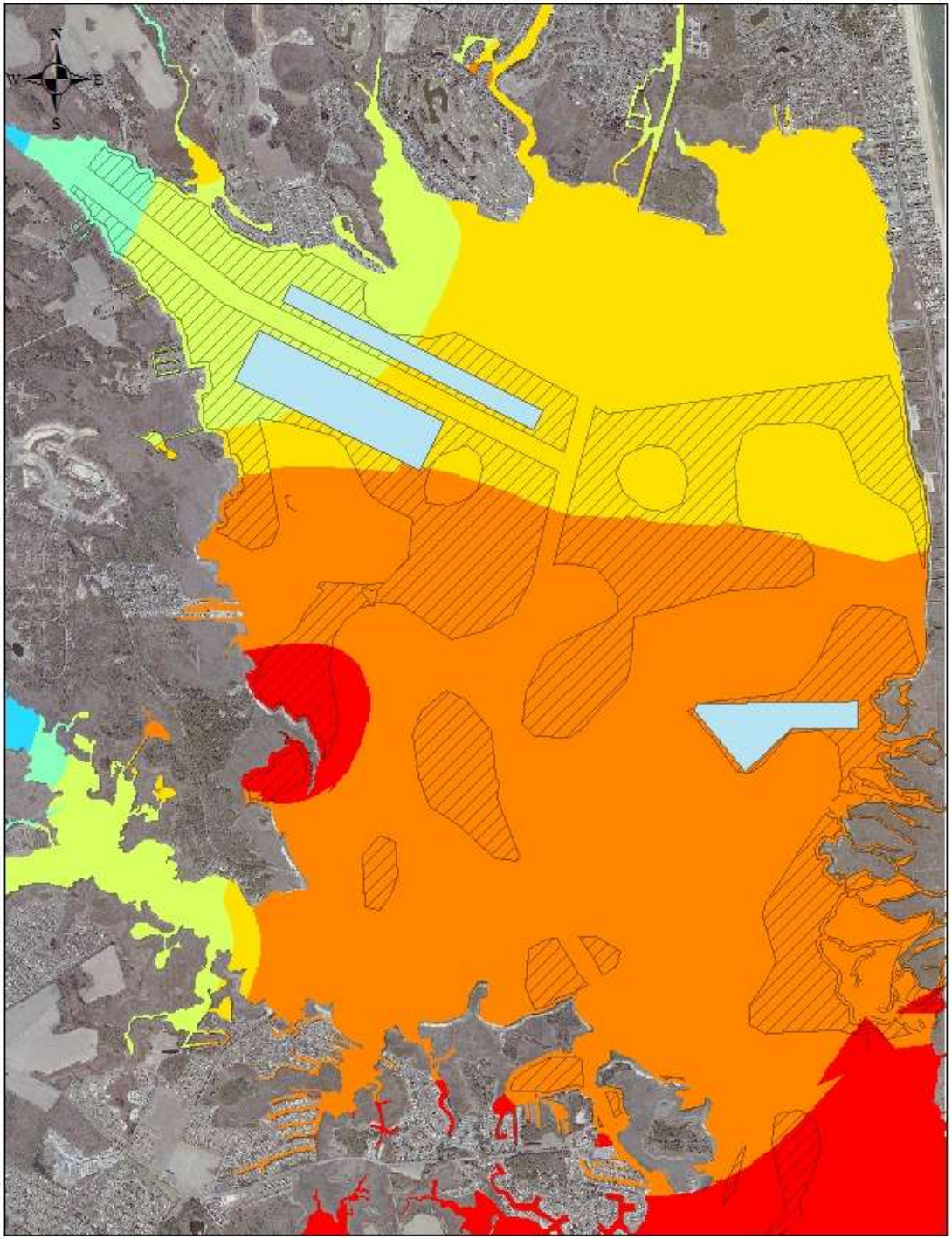
Example Areas:

86.5 Acres 0.9% of the total Indian River area

Oyster Aquaculture Tiger Team



1948: 1,143 acres (13%)



Area Available for Oyster Aquaculture: Rehoboth Bay

Legend

- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Parts Per Thousand (ppt)

- 7.2 - 14.5
- 14.6 - 18.8
- 18.9 - 22.3
- 22.4 - 24.6
- 24.7 - 26.7
- 26.8 - 27.6
- 27.7 - 29.8
- 29.9 - 31.5

1 0.5 0 1 Kilometers

0.8 0.4 0 0.8 Miles

Oyster Aquaculture Tiger Team

Legend

- Potential Oyster Aquaculture Areas
- Areas outside of the OA exclusions

Mean Salinity (1998 - 2008)

Parts Per Thousand (ppt)

- 7.2 - 14.5
- 14.6 - 18.8
- 18.9 - 22.3
- 22.4 - 24.6
- 24.7 - 26.7
- 26.8 - 27.6
- 27.7 - 29.8
- 29.9 - 31.5

Area Available for Oyster Aquaculture: Indian River Bay

1 0.5 0 1 Kilometers

1 0.5 0 1 Miles