Preliminary Screening Analysis for Ocean SAMP

Malcolm Spaulding [1], Annette Grilli [1], and Chris Damon[2]
[1]Ocean Engineering and [2] Environmental Data Center, CELS
Grover Fugate, Coastal Resources Management Council

Program Managers Meeting
February 24, 2009

Geology support
Jon Boothroyd, Geosciences and John King, GSO

Rhode Island OCEAN samp

Coastal Federal CZMA

Because of their proximity to and reliance upon the ocean and its resources, the coastal states have substantial and significant interests in the protection, management, and development of the resources of the exclusive economic zone that can only be served by the active participation of coastal states in all Federal programs affecting such resources and, wherever appropriate, by the development of state ocean resource plans as part of their federally approved coastal zone management programs.

The Rhode Island Coastal Resources Management Program

The primary responsibility of the council shall be the continuing planning for and management of the resources of the state's coastal region. The council shall be able to make any studies of conditions, activities, or problems of the state's coastal region needed to carry out its responsibilities.

(ii) The resources management process shall include the following basic phases:

(A) Identify all of the state's coastal resources, water, submerged land, air space, fin fish, shellfish, minerals, physiographic features, and so forth.

(B) Evaluate these resources in terms of their quantity, quality, capability for use, and other key characteristics.

(C) Determine the current and potential uses of each resource.

(D) Determine the current and potential problems of each resource.

(E) Formulate plans and programs for the management of each resource, identifying permitted uses, locations, protection measures, and so forth.

(F) Carry out these resources management programs through implementing authority and coordination of state, federal, local, and private activities.

(G) Formulation of standards where these do not exist, and reevaluation of existing standards.

The Rhode Island Coastal Resources Management Program

Special area management plans.

(I) The council shall adopt such special area management plans as deemed necessary and desirable to provide for the integration and coordination of the protection of natural resources, the promotion of reasonable coastal-dependent economic growth, and the improved protection of life and property in the specific areas designated council as requiring such integrated planning and coordination.

(II) The integrated planning and coordination herein specified shall include, but not be limited to, federal agencies, state agencies, boards, commissions, and corporations, including specifically the economic development corporation, and cities and towns, shall utilize to the extent appropriate and feasible the capacities of entities of higher education, including Rhode Island Sea Grant, and shall provide for the participation of advocacy groups, community-based organizations, and private persons.

(III) The council shall administer its programs, regulations, and implementation activities in a manner consistent with special area management plans.

(IV) Special area management plans and any updates thereto shall be adopted as appropriate as elements of the state guide plan .

SAMPs for Ecosystem Management

- Describe the dynamics of marine ecosystems
- Characterize the salient issues
- Set clear policies and standards for permitting and regulation by federal /state/municipal governments
- Establish an integrated decision-making process
- Build an informed constituency for long term stewardship

The CRMC Has An Extensive Array of SAMPs

Context

- Focus of present effort to establish areas that are suitable for renewable energy development in RI coastal waters (**one portion** of the larger Ocean SAMP planning exercise)
- Sources of renewable energy from ocean: waves , in-stream tidal currents, mean currents, ocean thermal energy conversion, and wind). Wind only viable energy resource for grid scale power production in RI

Overview

Tier #1 Analysis (Hard Constraints)

- Energy Resource (wind, waves, tidal/mean currents, OTEC)
- Exclusions
- Technology Type

Extended (TDI, Visualization, Marine Transportation)

Tier #2 Use conflicts/collaboration and environmental impacts (NOT ADDRESSED IN THIS PRESENTATION TO BE COVERED IN FOLLOW-ON WORK)

Tier #1 Screening (Deal Breakers)

Wind Resource

- Adequate Wind Resources (greater than 7 m/sec at 80 m, hub height)

Exclusions

- Navigation Areas -Regulated (shipping lanes, precautionary areas, preferred routes)
- Vessel tracks (AIS data)
- Ferry Routes
- Regulated areas (disposal site, military areas, unexploded ordnance, marine protected areas)
- Airport buffer zones
- Coastal buffer zone (1 km)
- Cable Areas (?)

Tier #1 Screening (cont'd)

- Water depth
  - Minimum depth – 5 m (access by barge and heavy construction equipment)
  - Maximum depths
    - *Mono-piles*
    - 20 m typical depths in Europe
    - 25 m DNV suggested limit (RI WINDS study choice – 75 ft)
    - 30 m Limit of shallow water (deepest depth in Europe)

Tier #1 Screening (cont'd)

- Water Depths

  Maximum Depths –

  Jacket structures

  50 to 60 m DeepWater Wind

  (45 m for Beatrice Demonstration Project in Scotland)

  Floating

  No depth limit

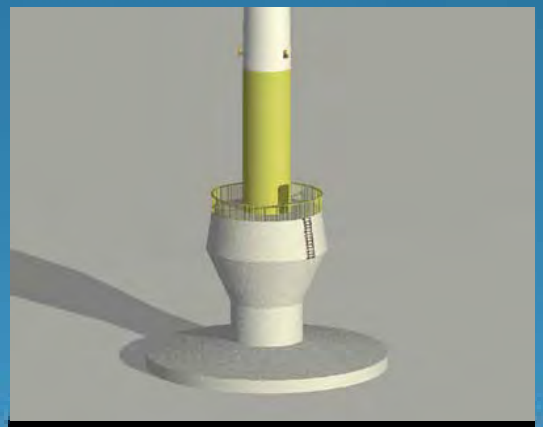
Fixed Bottom Substructure Technology

Proven Designs

Future

Monopile Foundation

- Most Common Type
- Minimal Footprint
- Depth Limit 25-m
- Low stiffness



Gravity Foundation

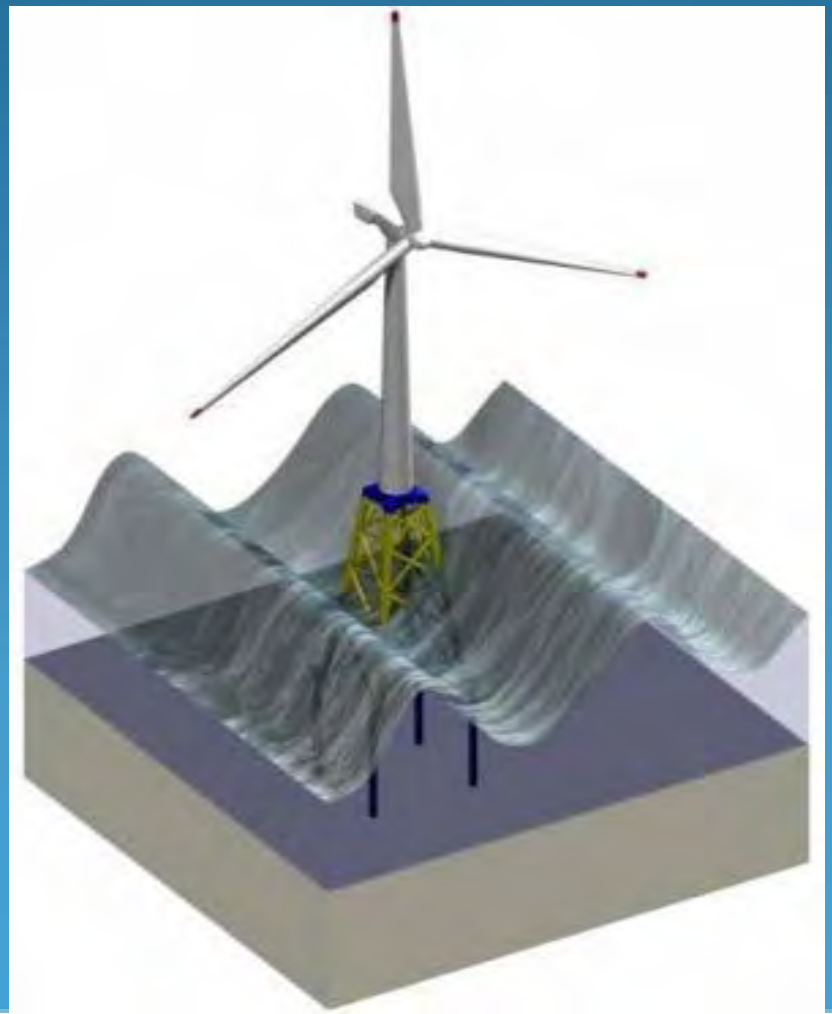
- Larger Footprint
- Depth Limit?
- Stiffer but heavy

Tripod/Truss Foundation

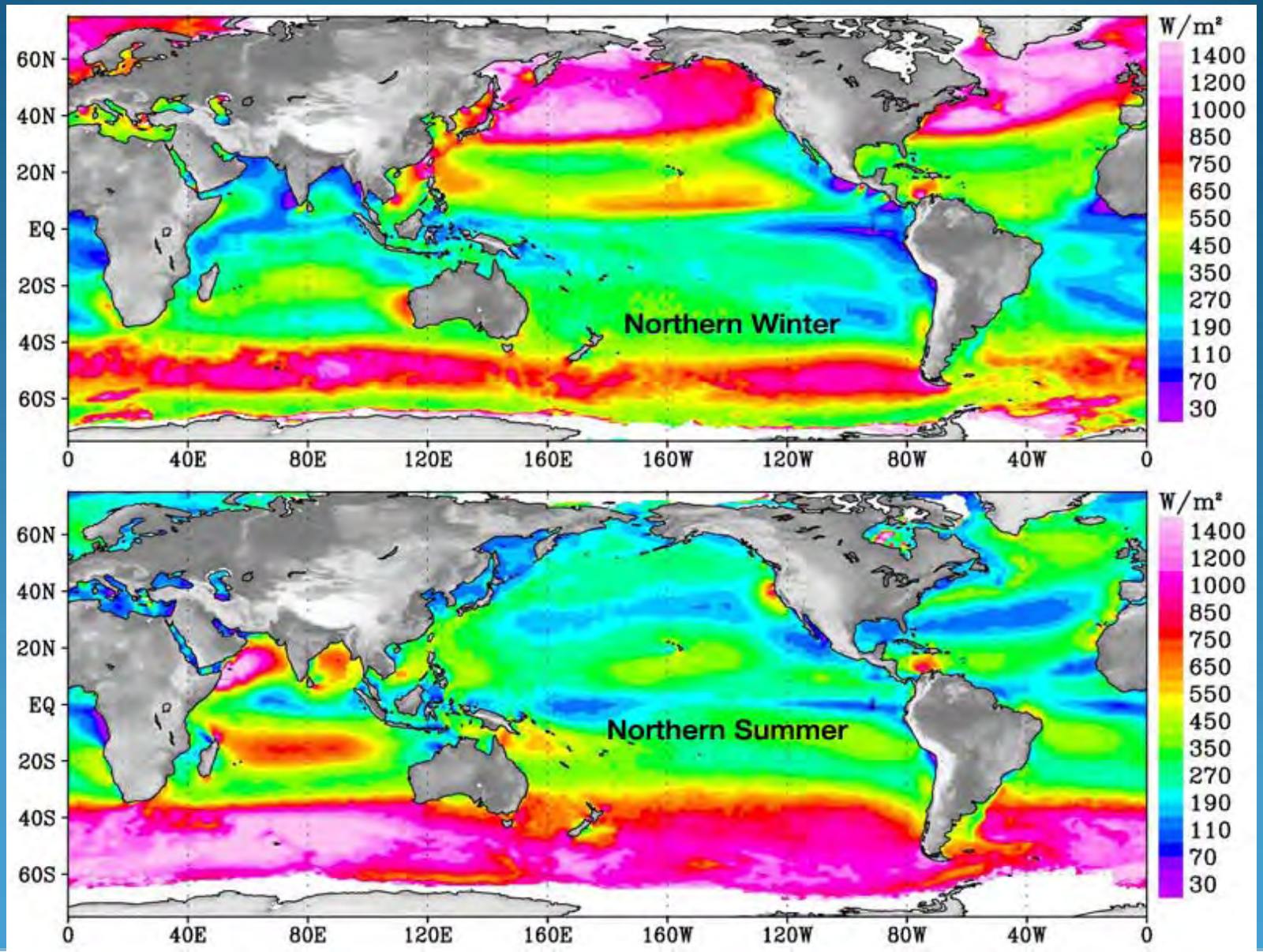
- No wind experience
- Oil and gas to 450-m
- Larger footprint
- Talisman project

Graphics source: http://www.offshorewindenergy.org/

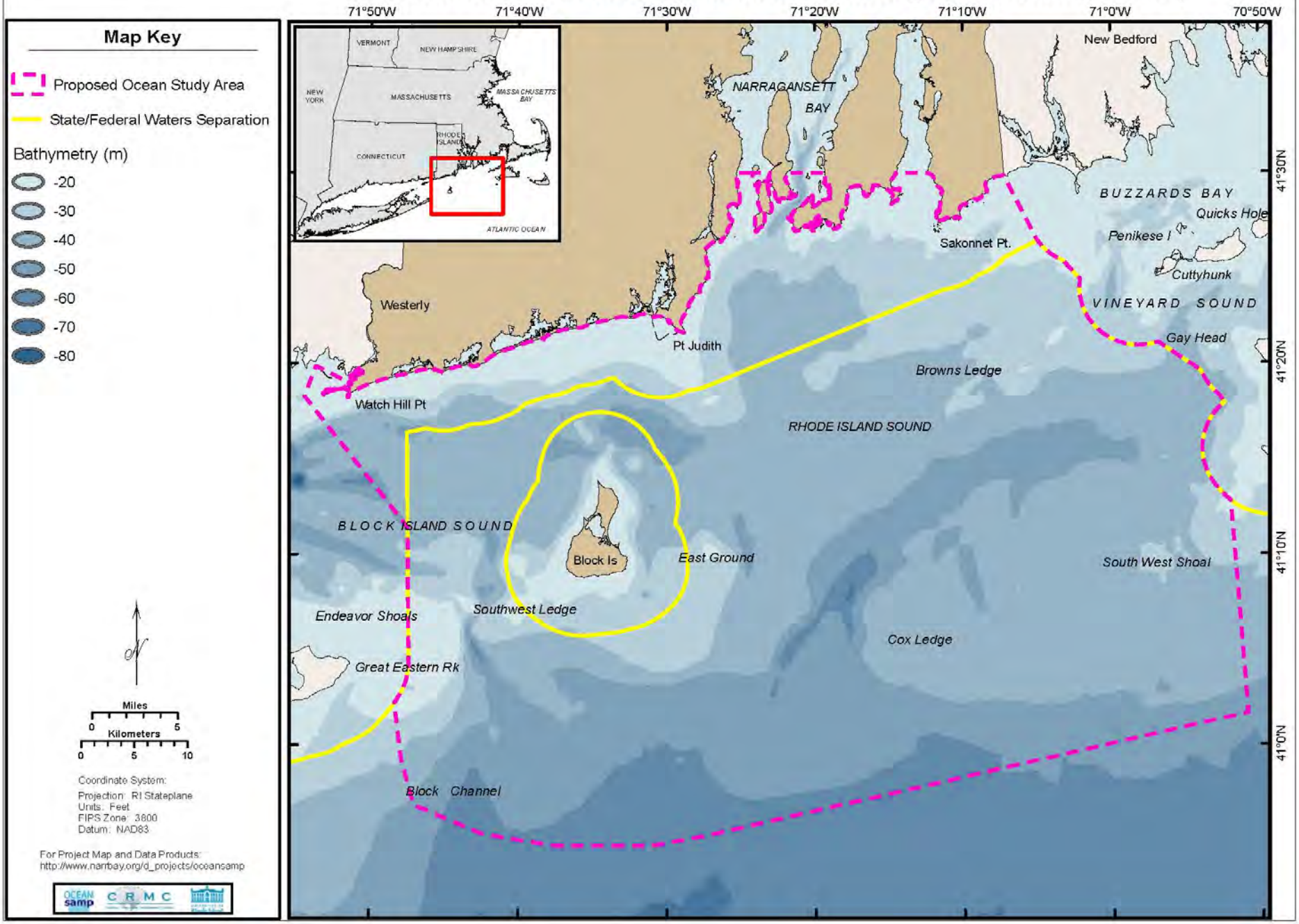
DeepWater Wind Technology, OWEC (Norwegian)



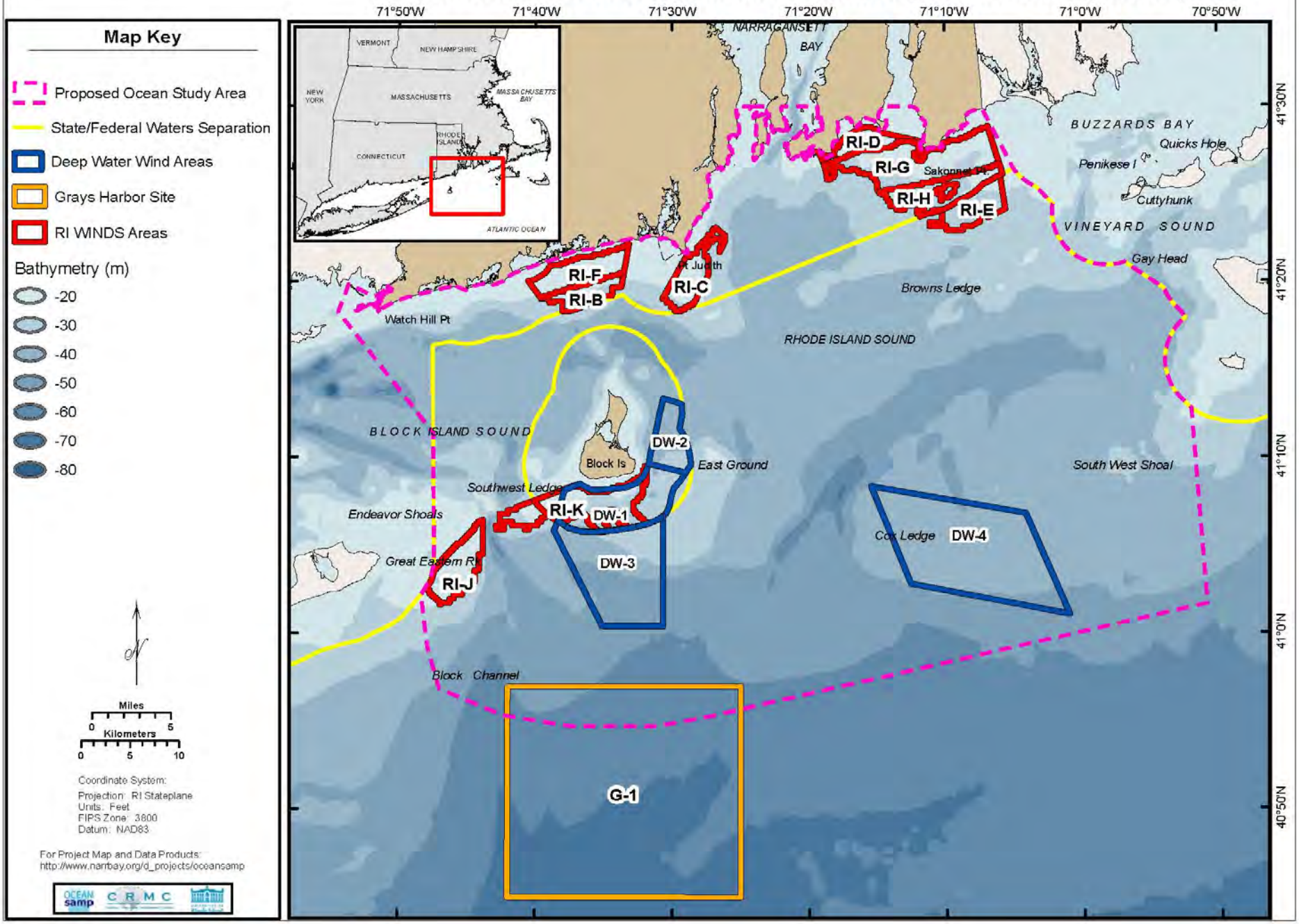
NASA Quik Scat Winds



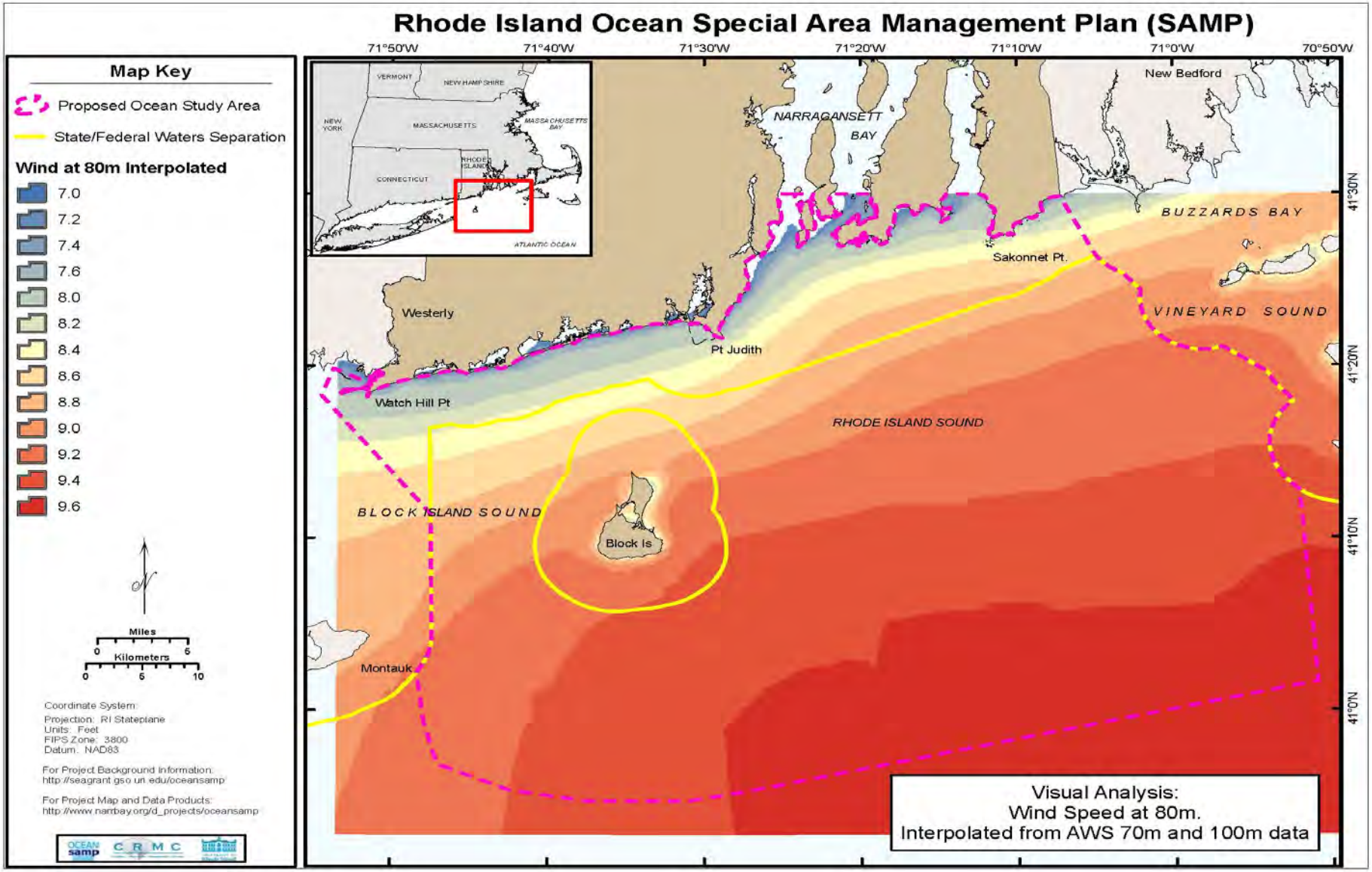
Rhode Island Ocean Special Area Management Plan (SAMP)



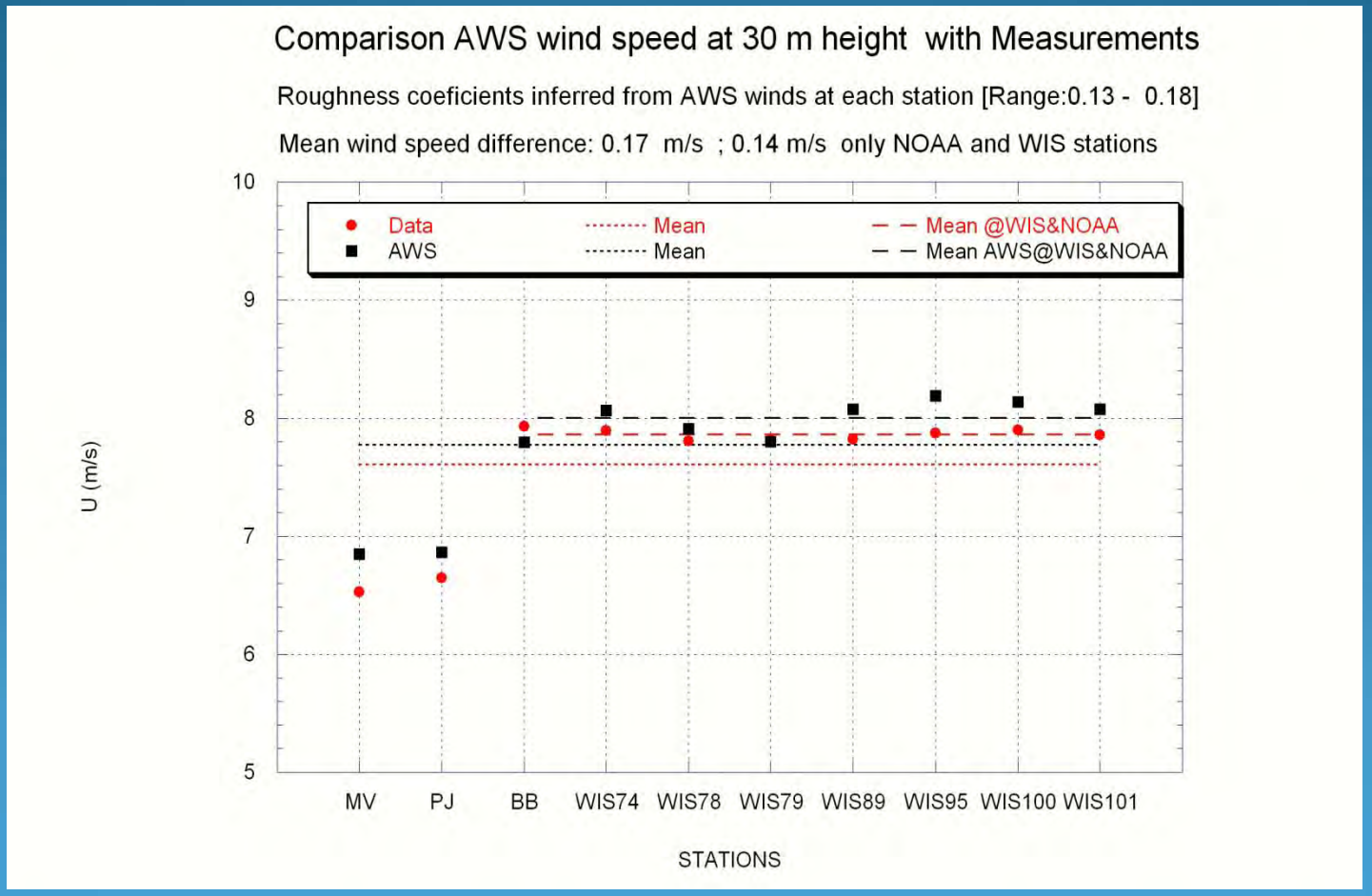
Rhode Island Ocean Special Area Management Plan (SAMP)



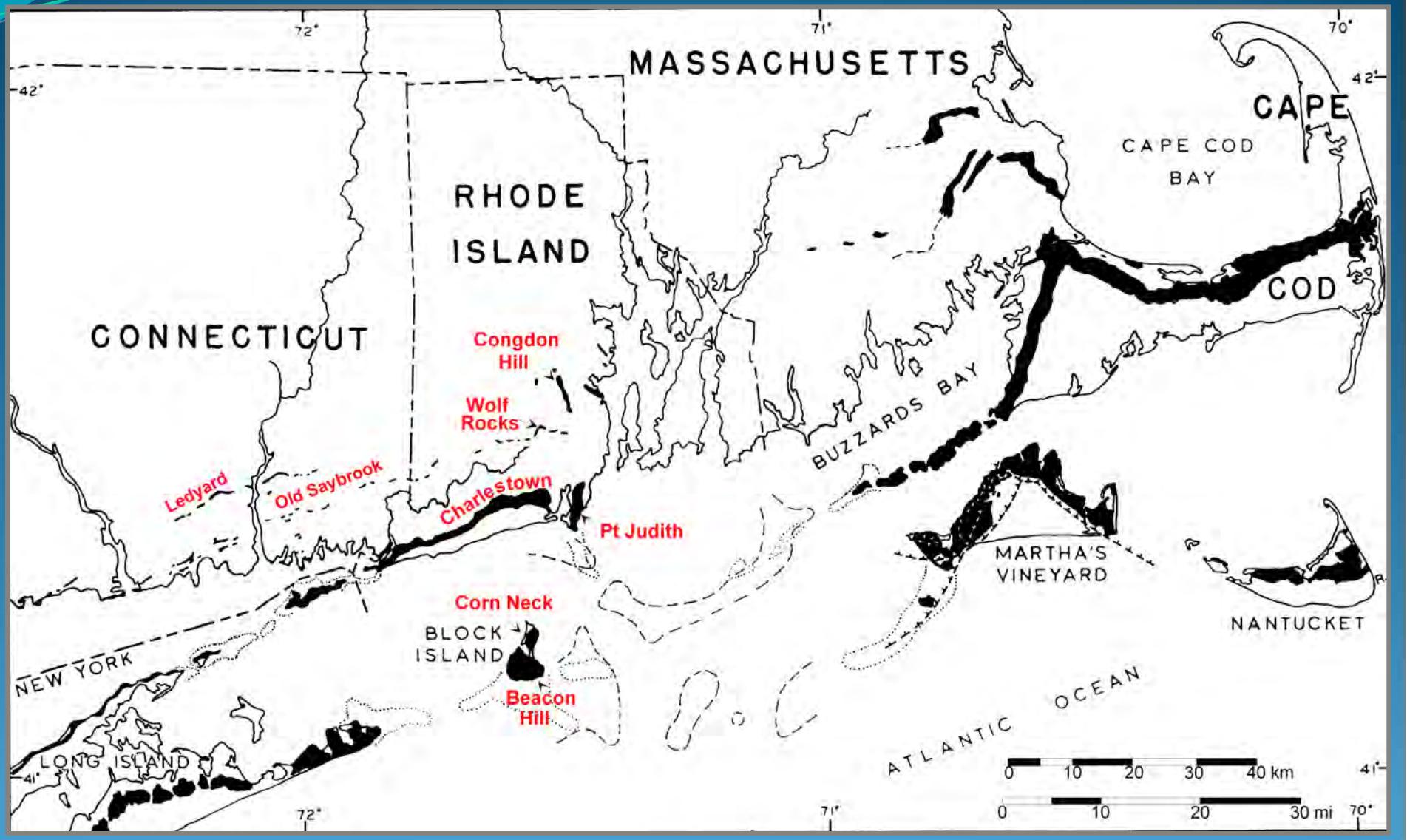
Estimates of 80 m wind speeds
AWS TrueWinds data



Comparison of AWS Winds and Observations

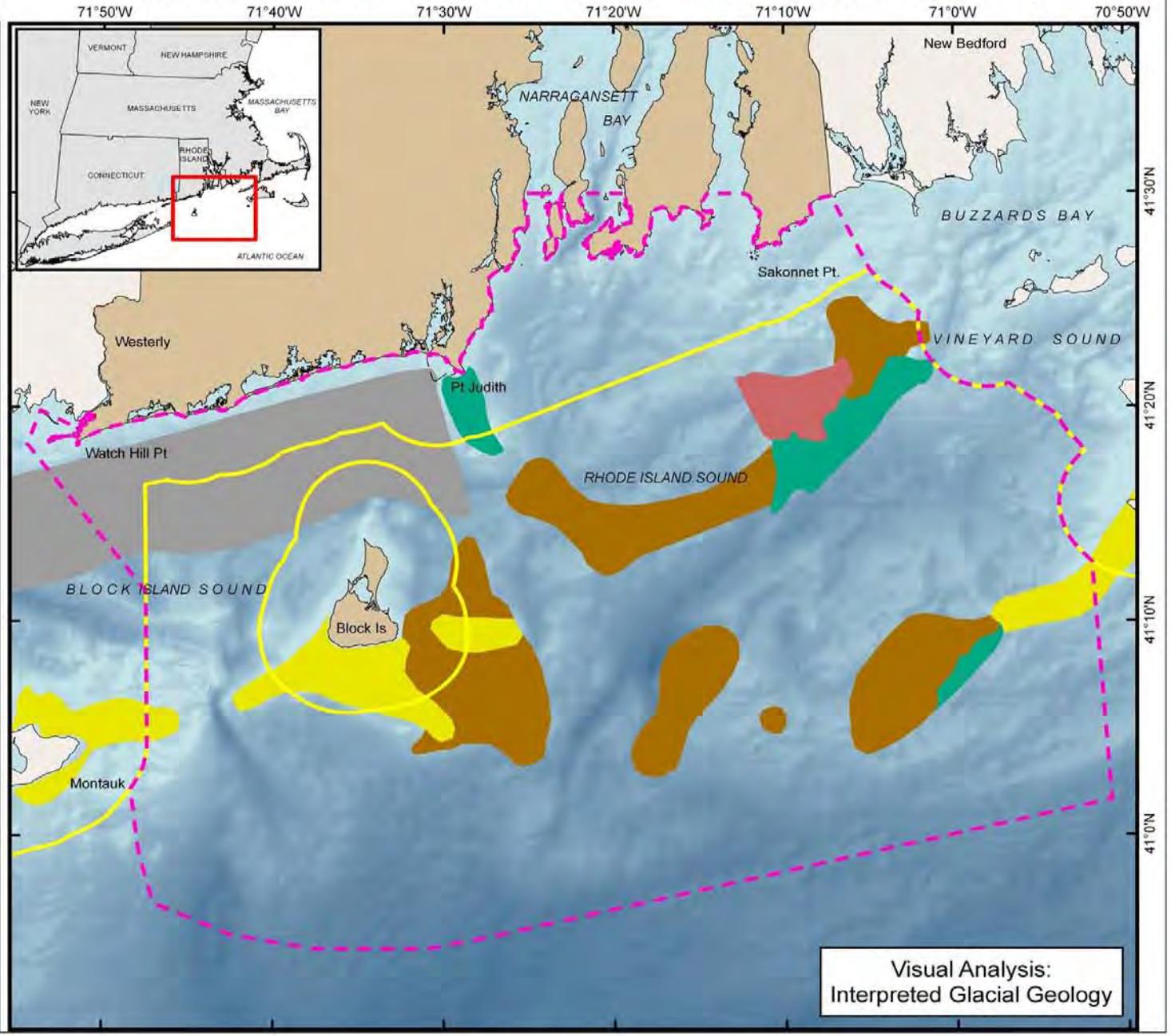


End Moraines of Southeastern New England



Schafer and Hartshorn, 1965; Sirkin, 1982

Rhode Island Ocean Special Area Management Plan (SAMP)



Map Key

- Proposed Ocean Study Area
- State/Federal Waters Separation

Glacial Geology

Stone-Borns 1986

- Glacial Lakefloor
- End Moraine - Blocky
- End moraine - Boulder
- End moraine - Bold., Cob., Sand
- Tertiary Manetto Gravel

Miles: 0 – 5

Kilometers: 0 – 5 – 10

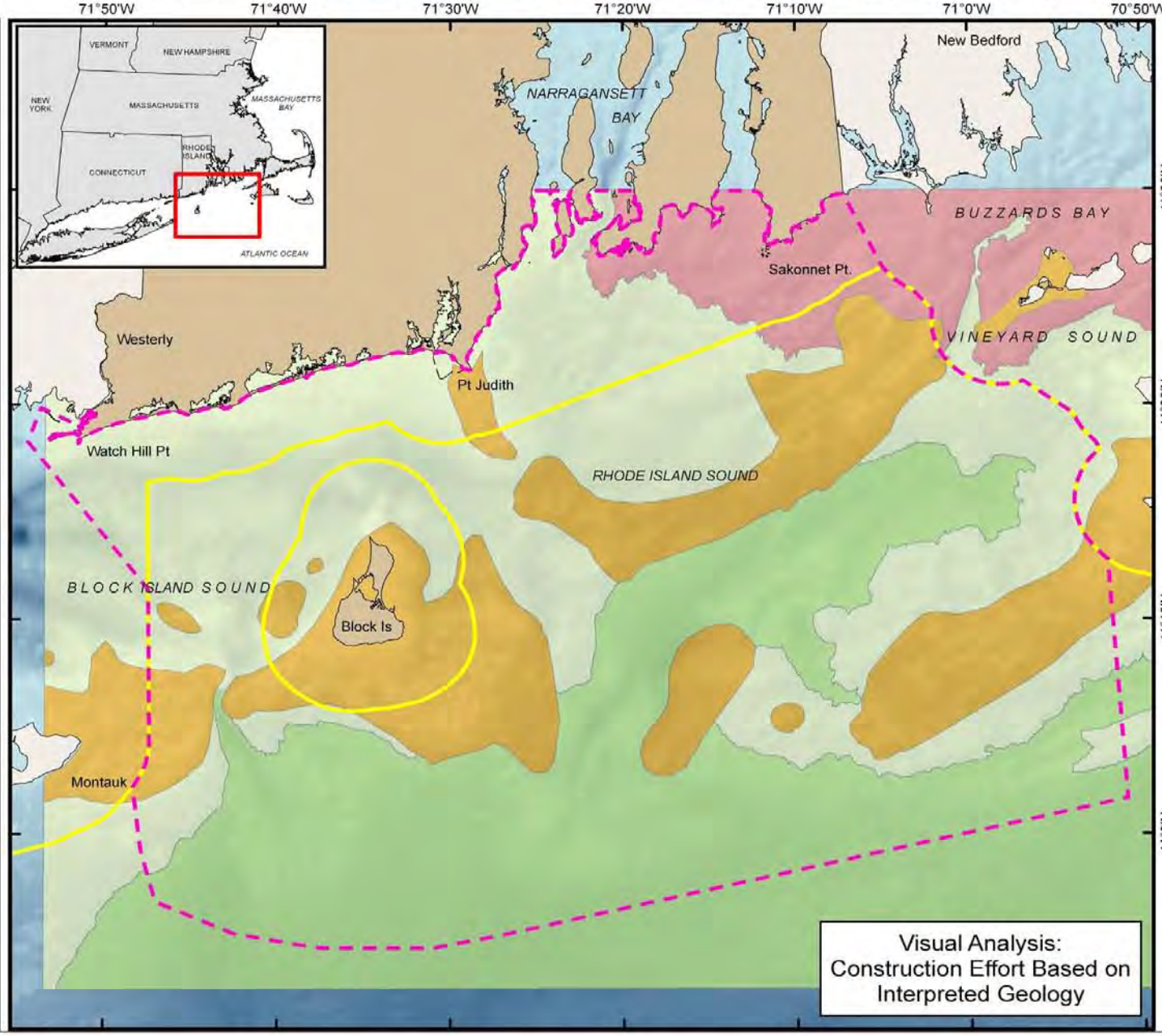
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83

For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp

For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp

OCEAN samp · CRMC · Rhode Island

Rhode Island Ocean Special Area Management Plan (SAMP)



Map Key

- Proposed Ocean Study Area
- State/Federal Waters Separation

Construction Effort

- 1 - 2
- 3
- 4 - 5
- 5

Miles: 0 – 5

Kilometers: 0 – 5 – 10

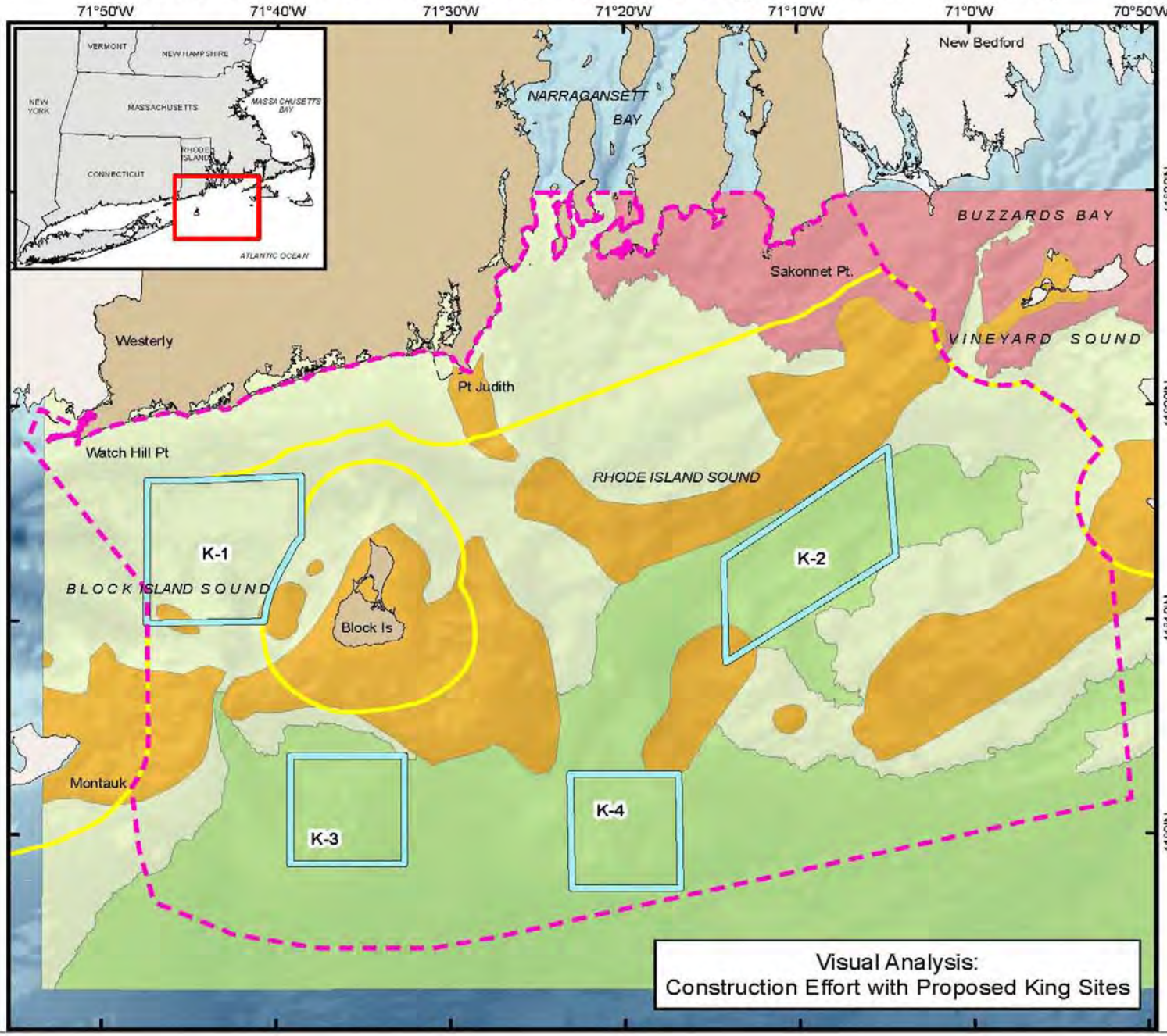
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83

For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp

For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp

OCEAN samp CRMC

Rhode Island Ocean Special Area Management Plan (SAMP)



Map Key

- Proposed Ocean Study Area
- State/Federal Waters Separation
- King Proposed Study Areas

Construction Effort

- 1 - 2
- 3
- 4 - 5
- 5

Miles 0 5

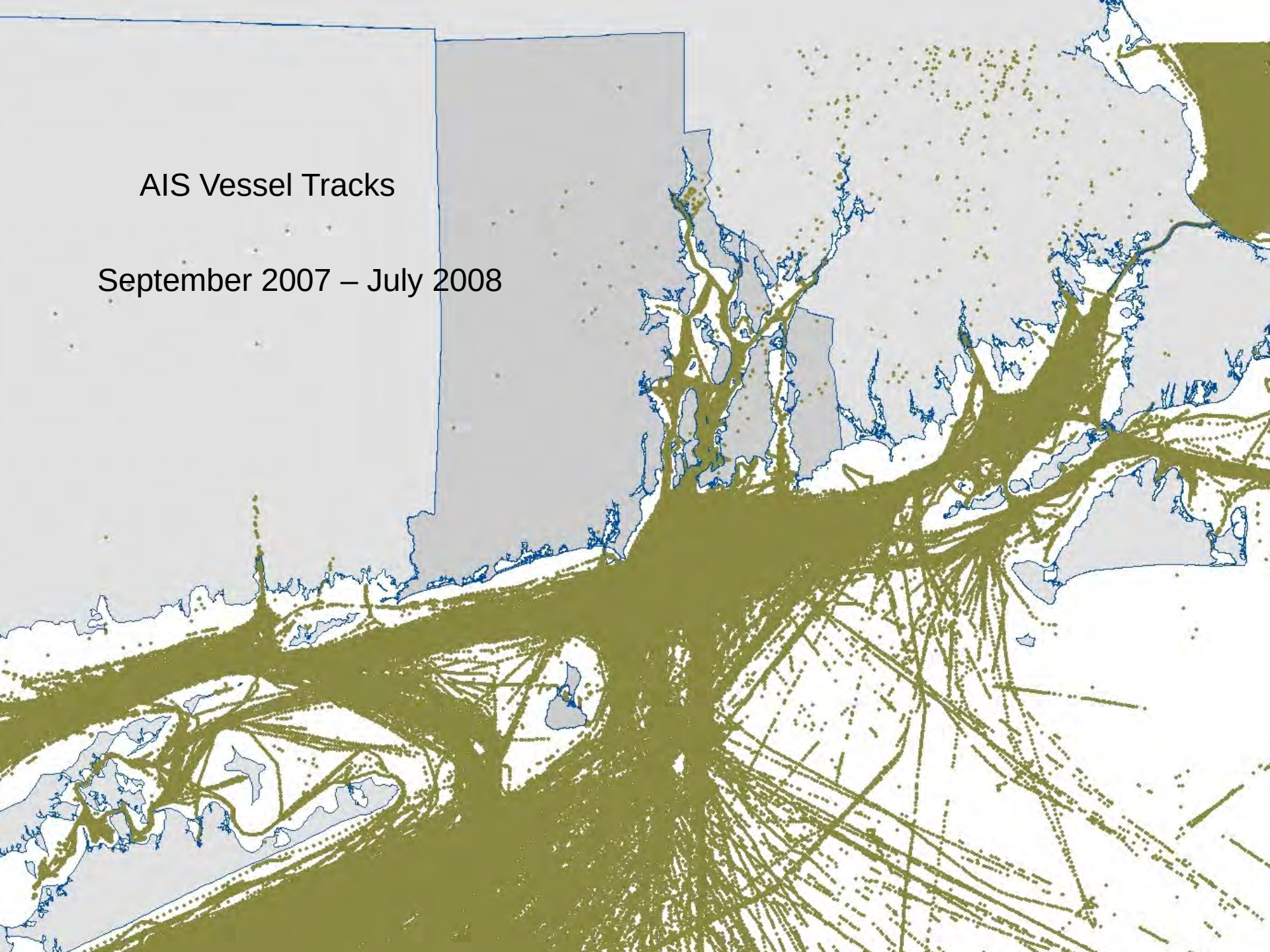
Kilometers 0 5 10

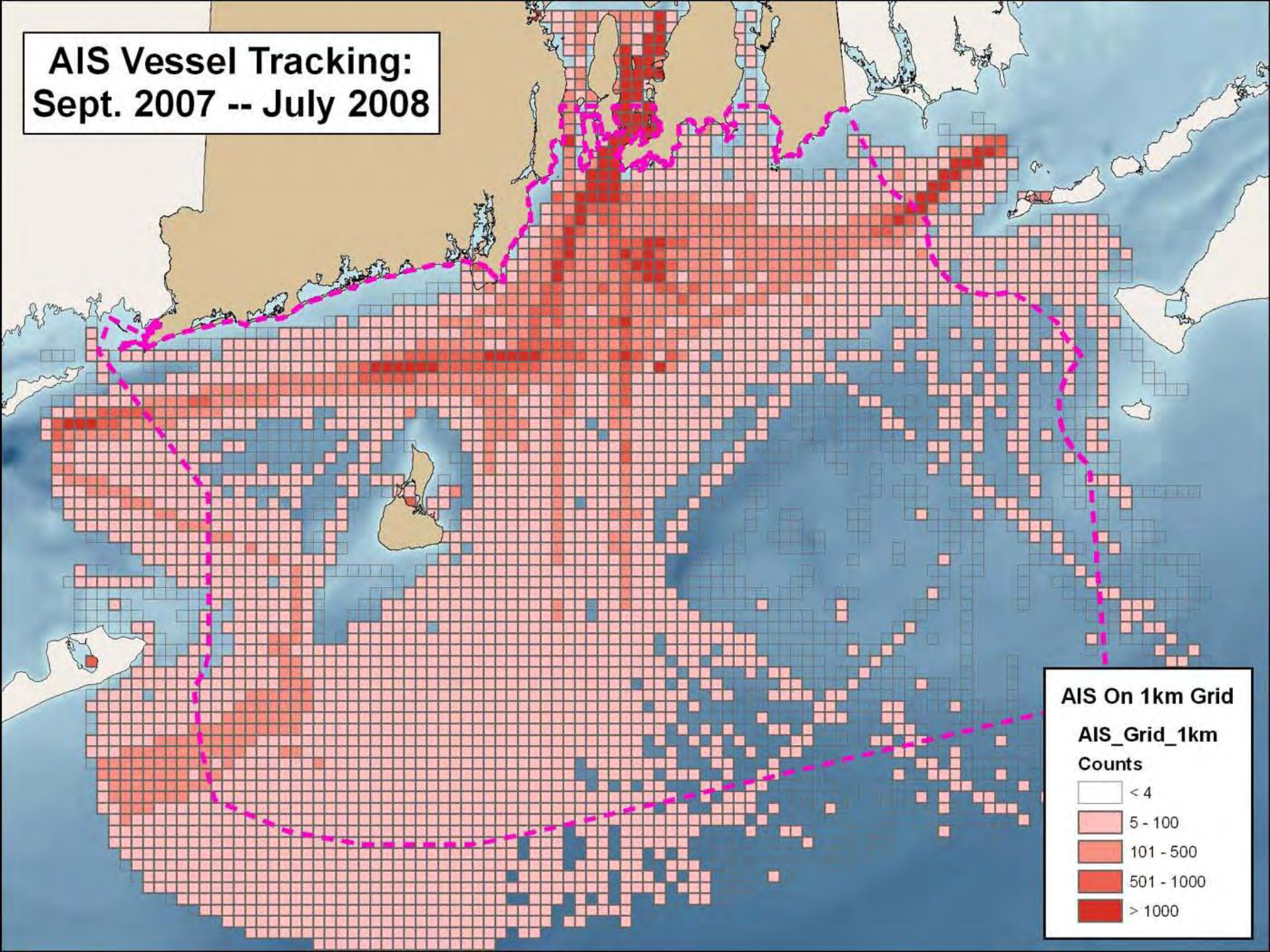
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83

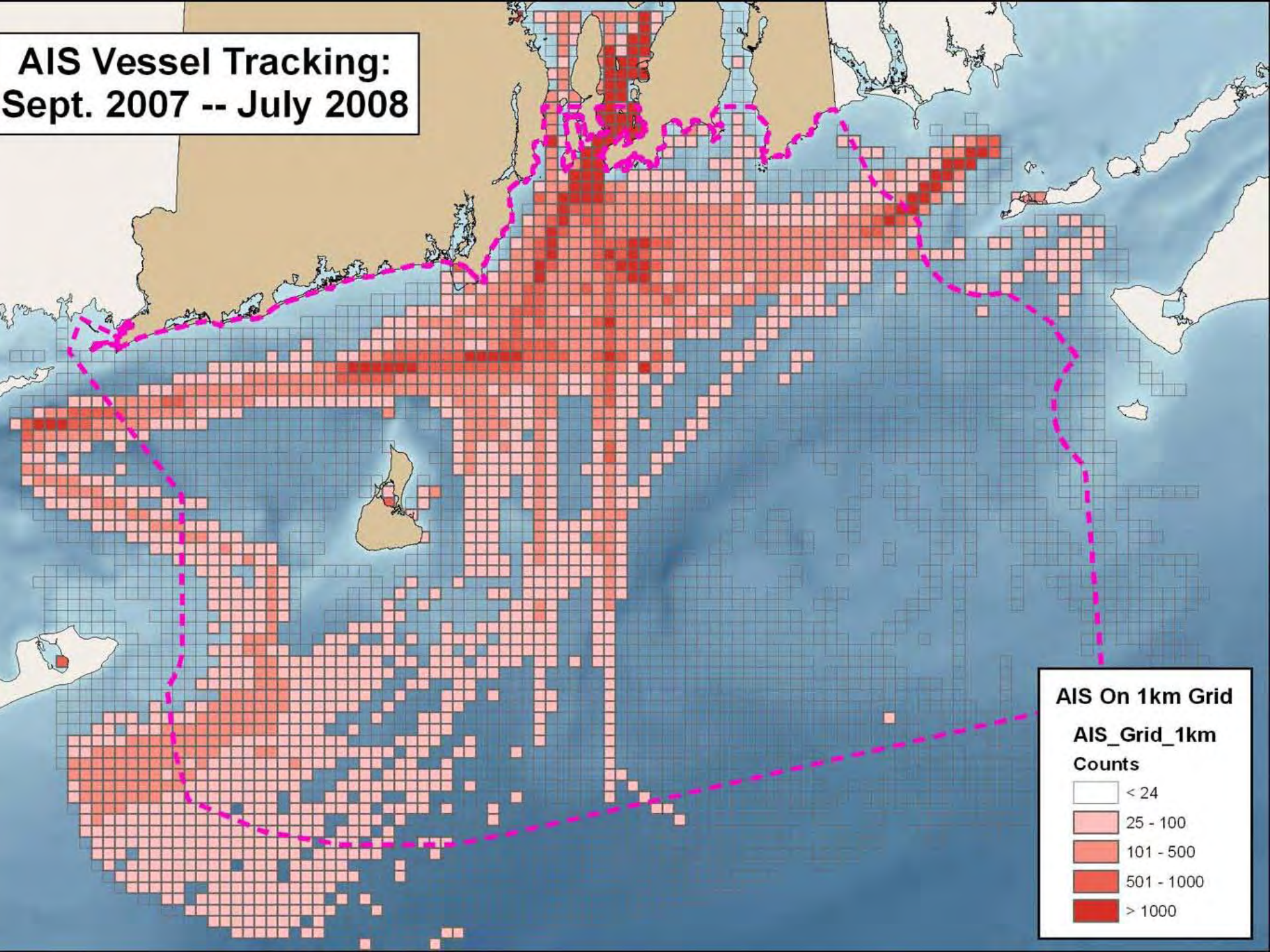
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp

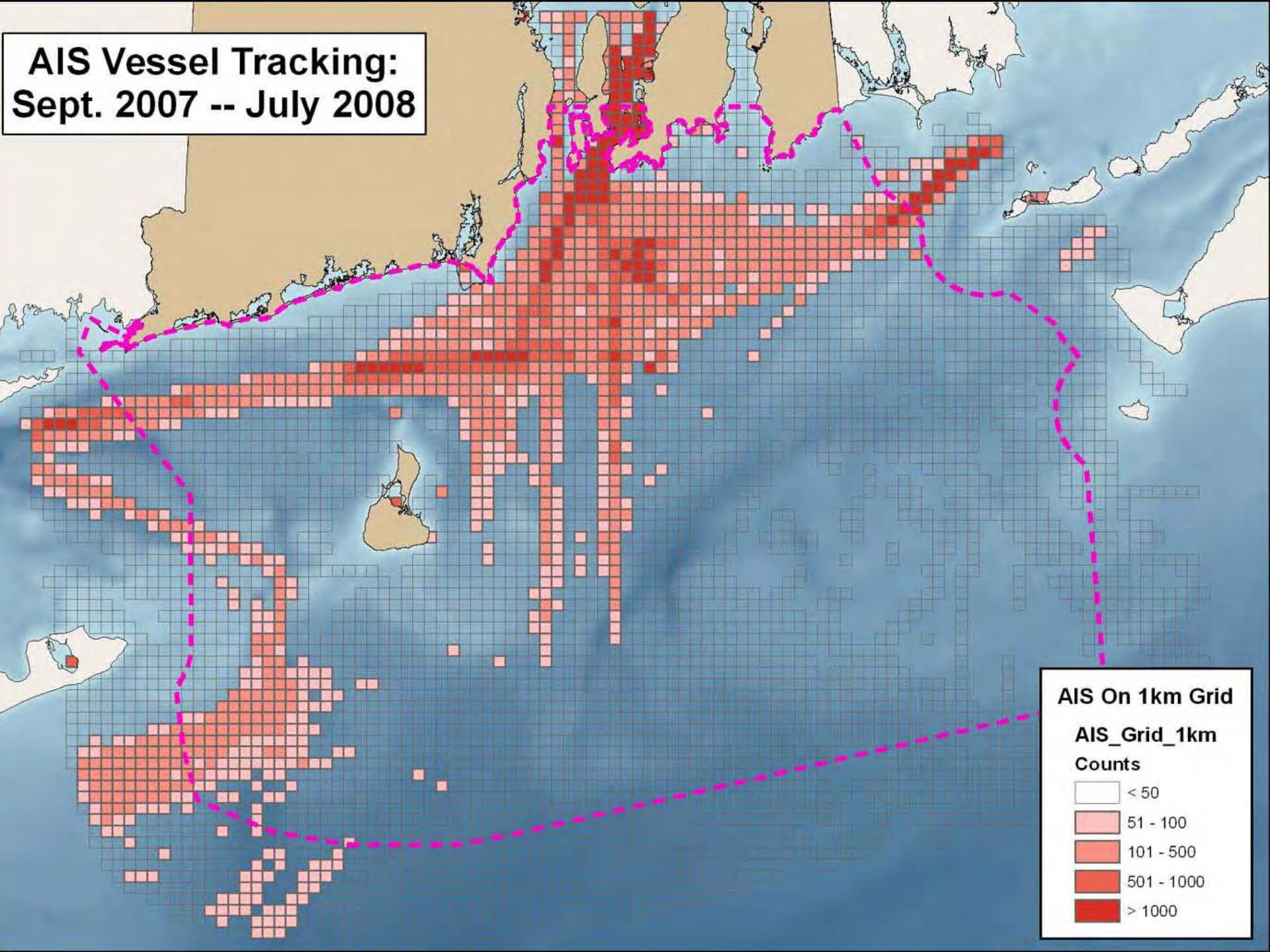
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp

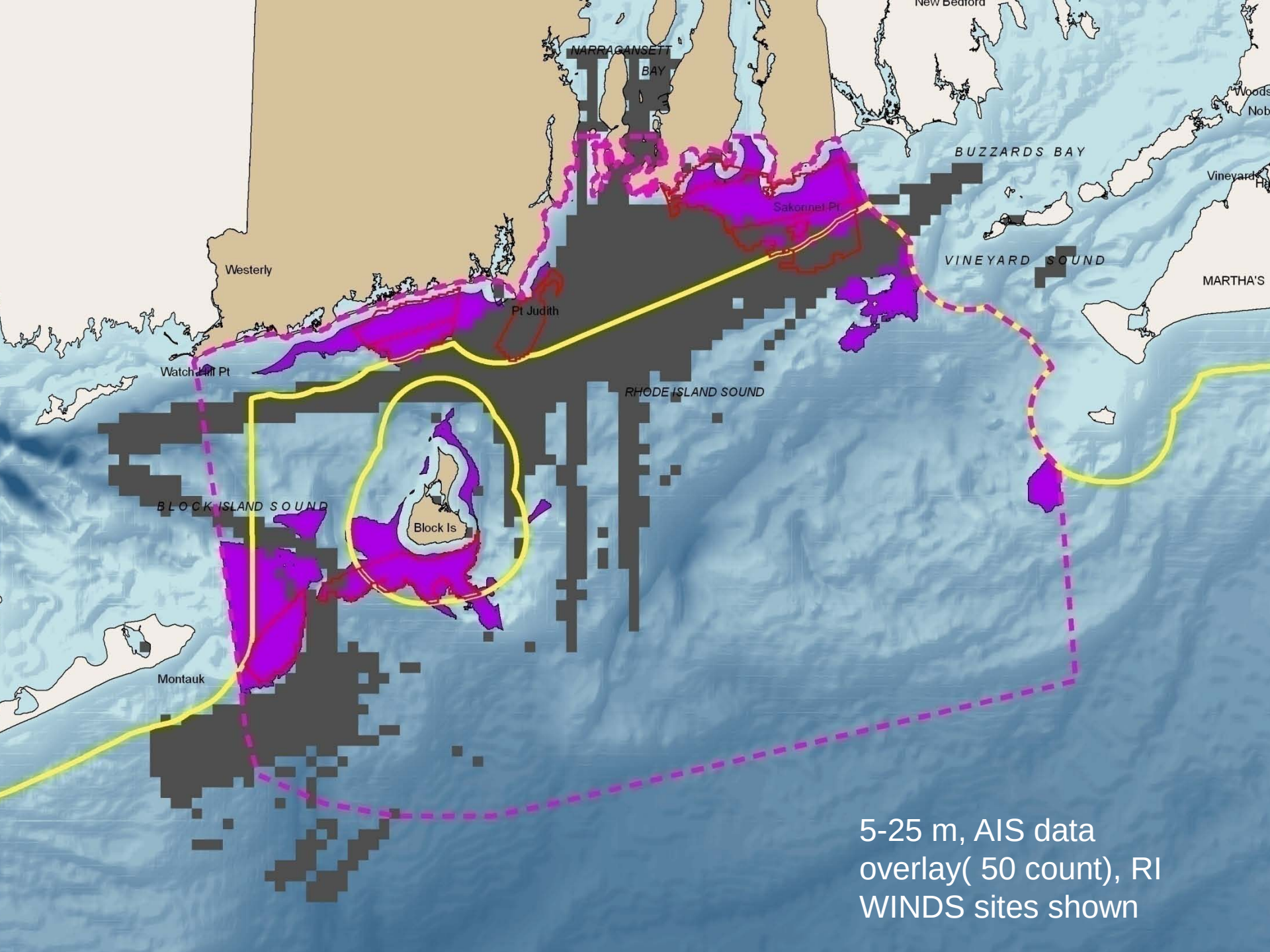
OCEAN samp CRMC


AIS Vessel Tracks
September 2007 – July 2008

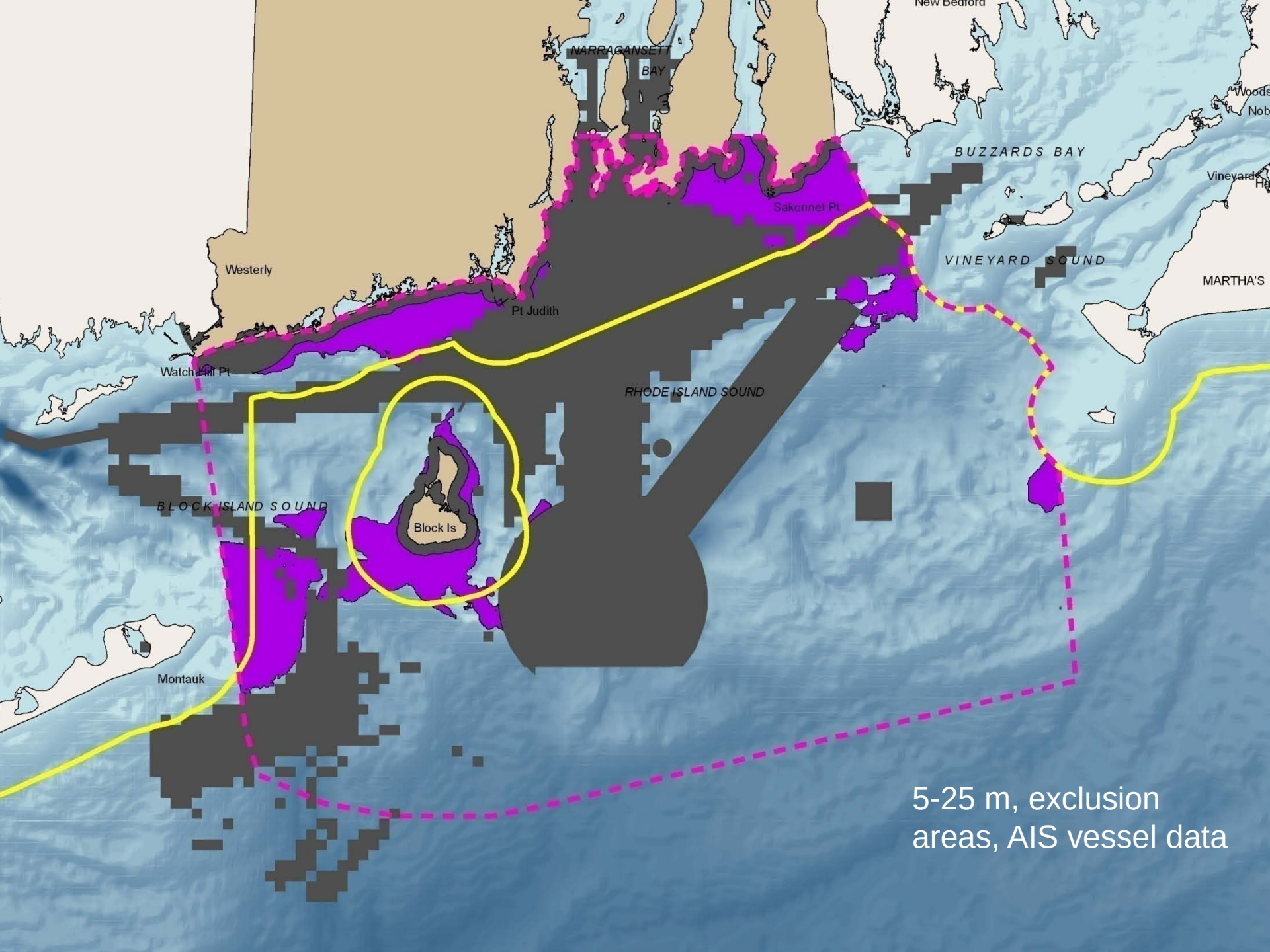

AIS Vessel Tracking:
Sept. 2007 -- July 2008
AIS On 1km Grid
AIS_Grid_1km
Counts
< 4
5 - 100
101 - 500
501 - 1000
> 1000


AIS Vessel Tracking:
Sept. 2007 -- July 2008
AIS On 1km Grid
AIS_Grid_1km
Counts
< 24
25 - 100
101 - 500
501 - 1000
> 1000


AIS Vessel Tracking:
Sept. 2007 -- July 2008
AIS On 1km Grid
AIS_Grid_1km
Counts
< 50
51 - 100
101 - 500
501 - 1000
> 1000

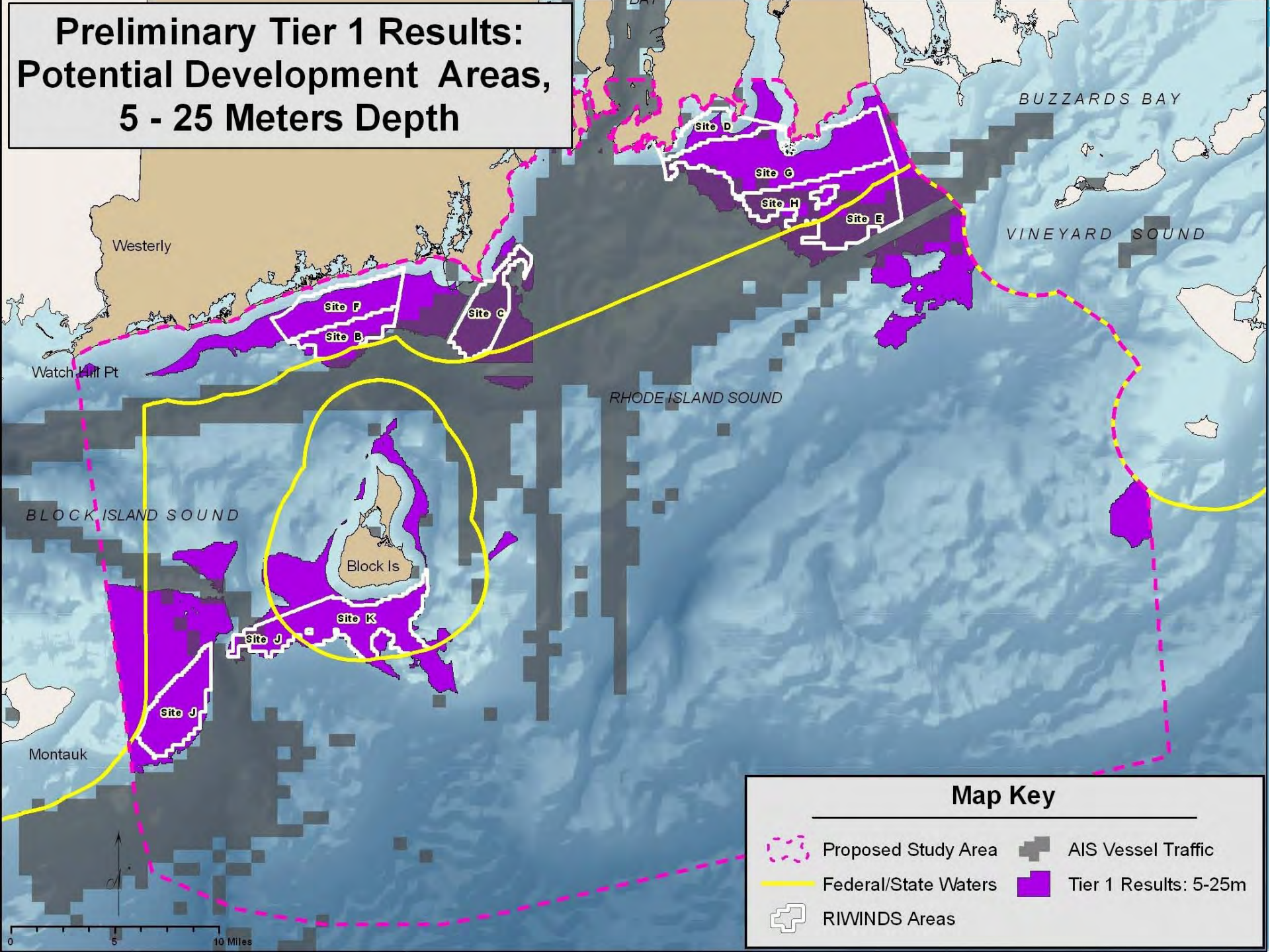


5-25 m, AIS data overlay(50 count), RI WINDS sites shown



5-25 m, exclusion areas, AIS vessel data

Preliminary Tier 1 Results: Potential Development Areas, 5 - 25 Meters Depth



Technology Based Assessment

Objective: Develop a metric based on technical challenge to power production potential to screen for sites.

$$TDI = TCI/PPP$$

where TDI –Technical Development Index

TCI- Technical Challenge Index

PPP- Power Production Potential

Presented in form of dimensionless values (Predicted TDI divided by lowest TDI possible in area of interest)

Components of TDI

- PPP- Power Production Potential

$$PPP = W*CF$$

Where W- annual mean wind power at hub height of wind turbine (-80 m) (kW/m^2) (Data from AWS TrueWinds)

CF- capacity factor (35 %)

Components of TDI

- TCI – Technical Challenge Index

TCI = TT + CD

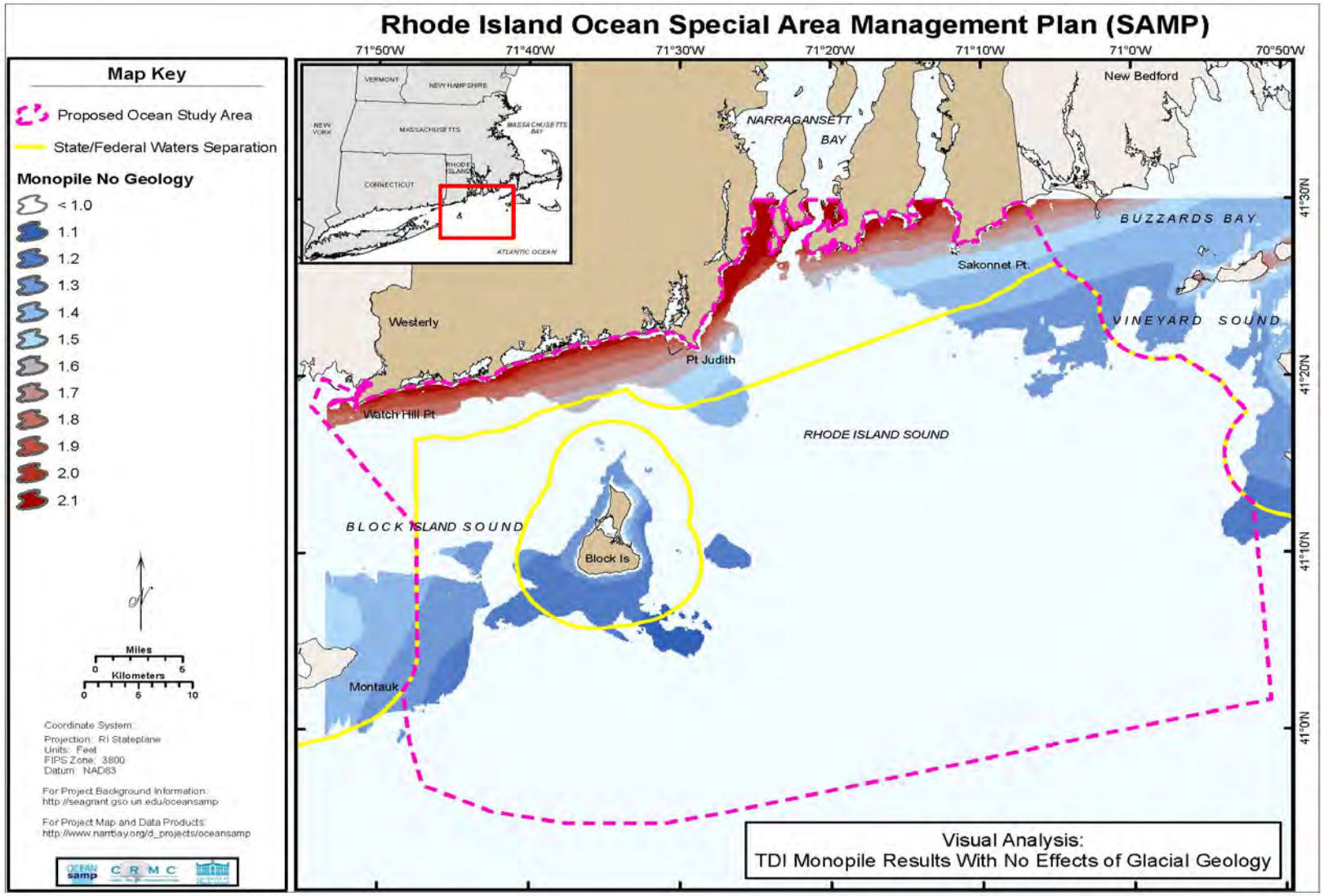
Where TT- Technology Type

CD- pro-rated distance to nearest electrical grid

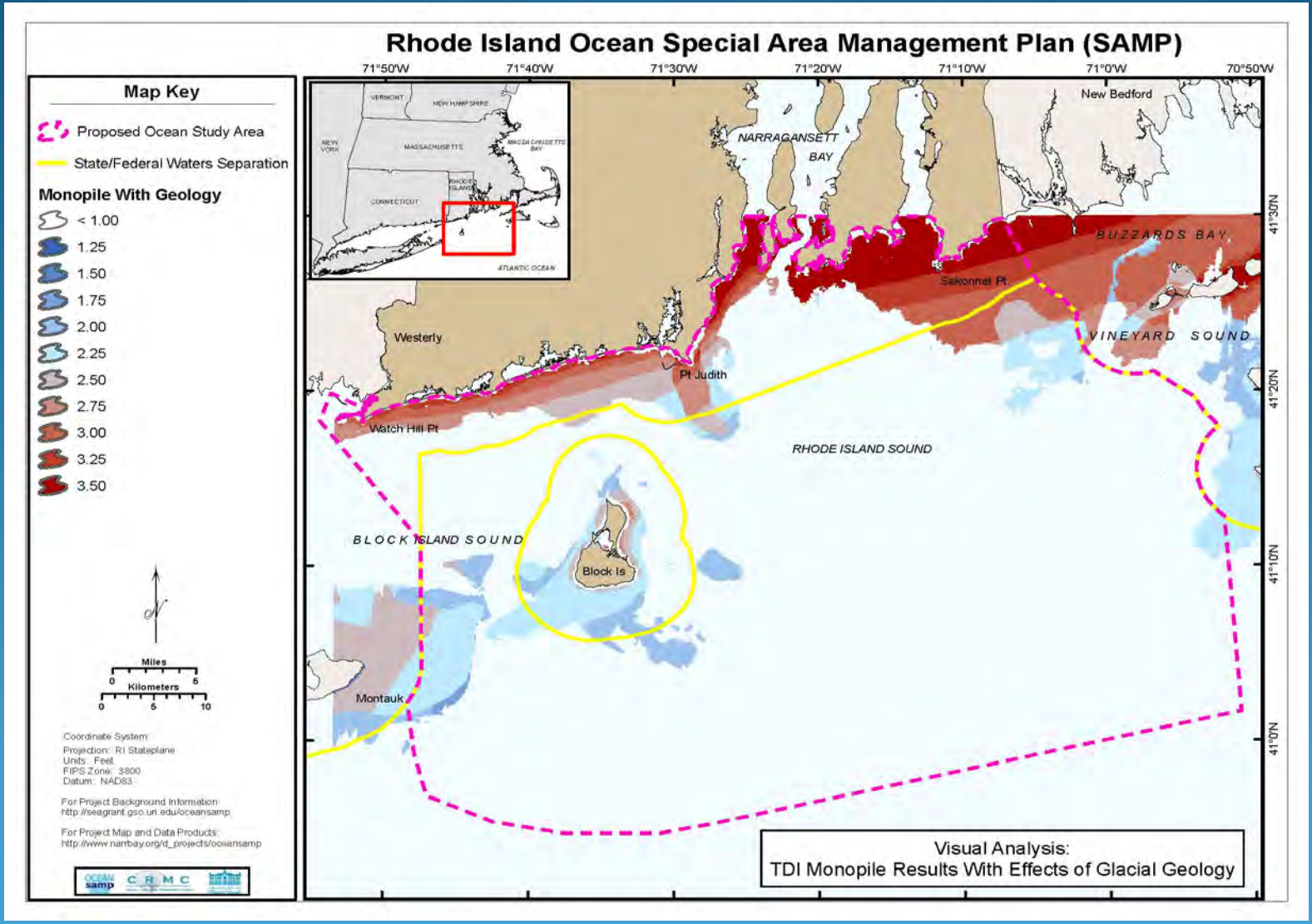
(distance to grid * SF/ number of turbines in wind farm)

SF- scale factor that assesses technology challenge for cable (nominal – 0.8)

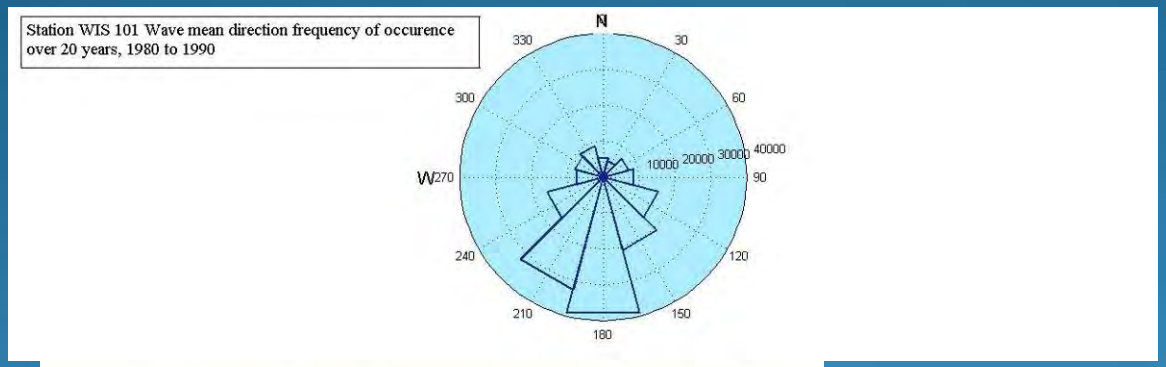
TDI Monopile (0 -25m), no geology



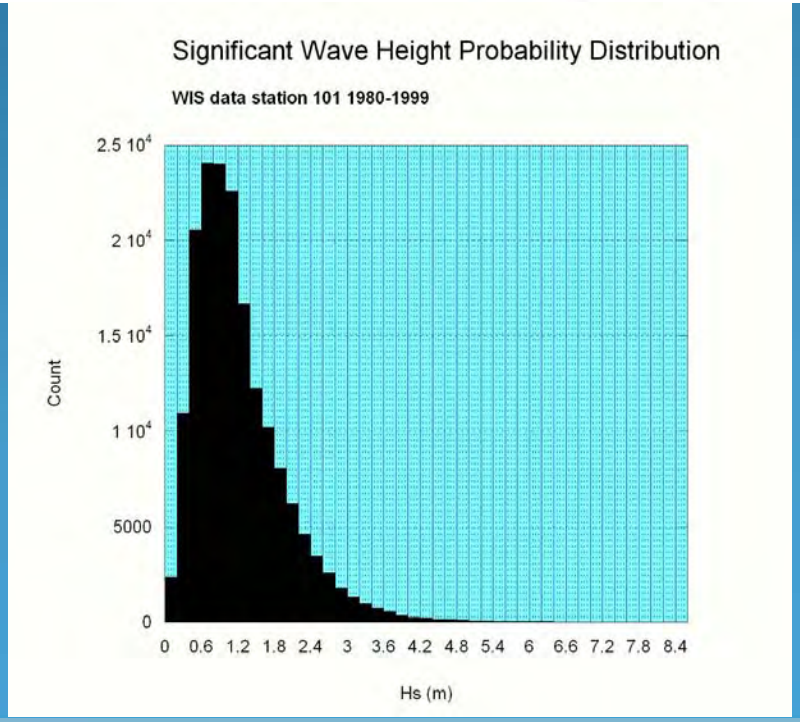
TDI Monopile (0-25m) with geology

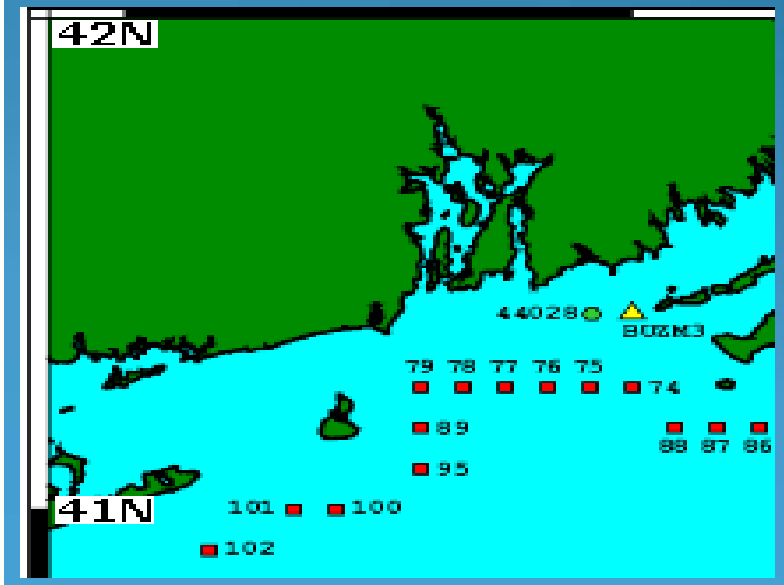


Wave Rose and Wave Height Histogram, WIS 101

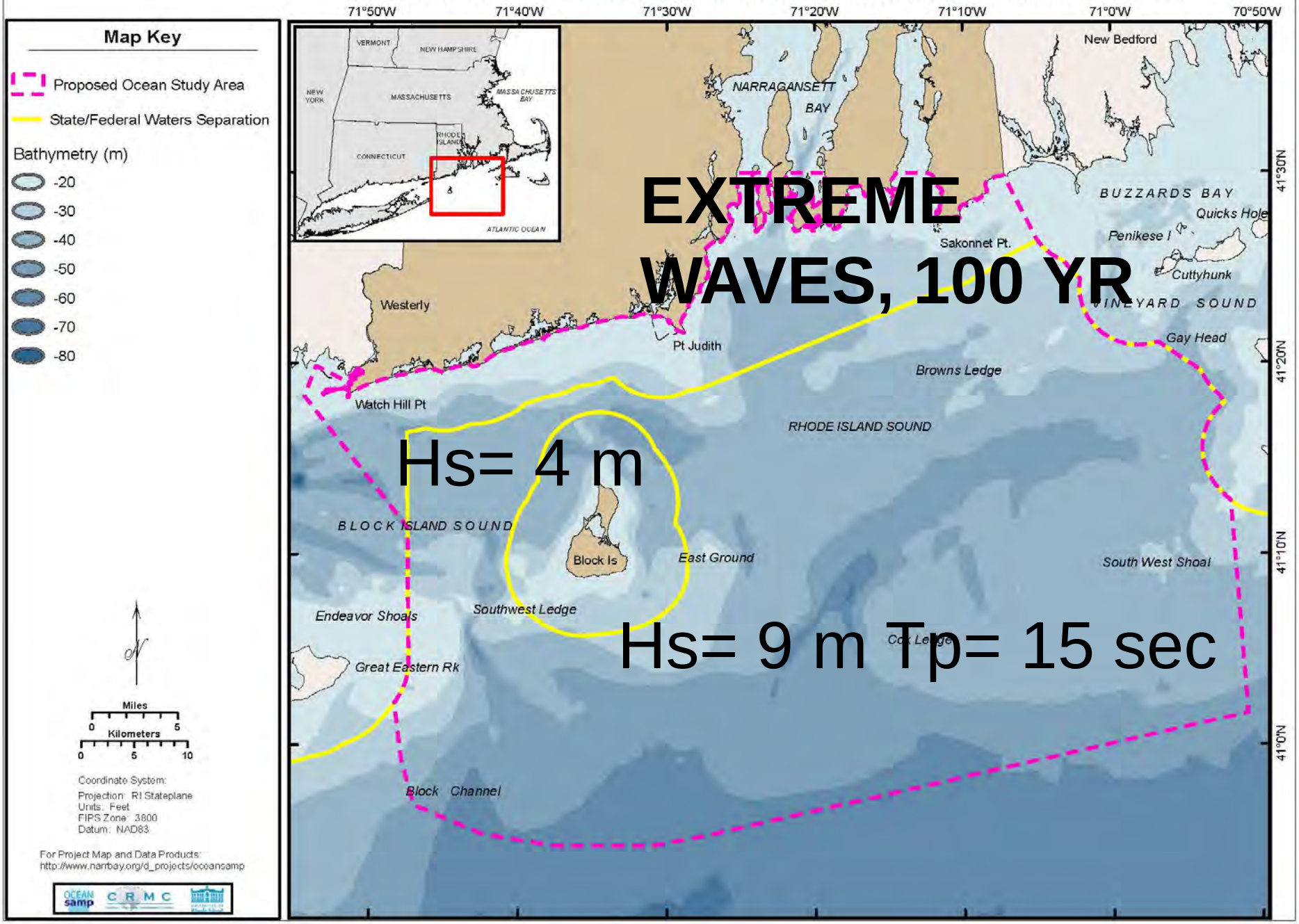


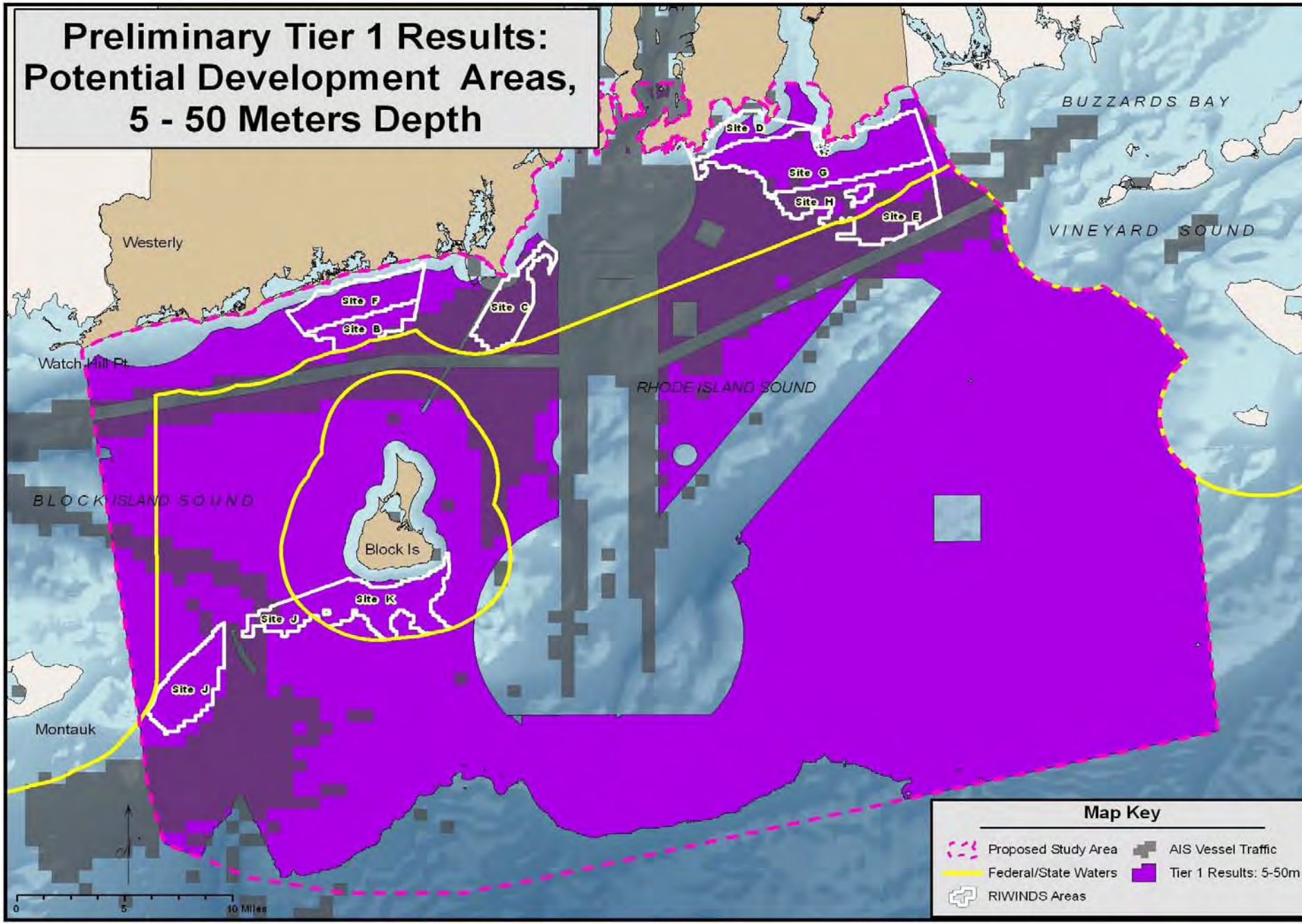
Waves Primarily from South and Southwest





Rhode Island Ocean Special Area Management Plan (SAMP)




Preliminary Tier 1 Results:
Potential Development Areas,
5 - 50 Meters Depth
BUZZARDS BAY
VINEYARD SOUND
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Westerly
Watch Hill Pt
Montauk
Block Is
Site D
Site G
Site H
Site E
Site F
Site B
Site C
Site K
Site J
Site J
0
5
10 Miles
Map Key
Proposed Study Area
Federal/State Waters
RIWINDS Areas
AIS Vessel Traffic
Tier 1 Results: 5-50m

Approach
to Identify Sites in Deep Water
(25 to 60 m)

Visual Impacts
Technical Development Index
(Principal Component Analysis)
Marine Transportation

Visualization Assessment

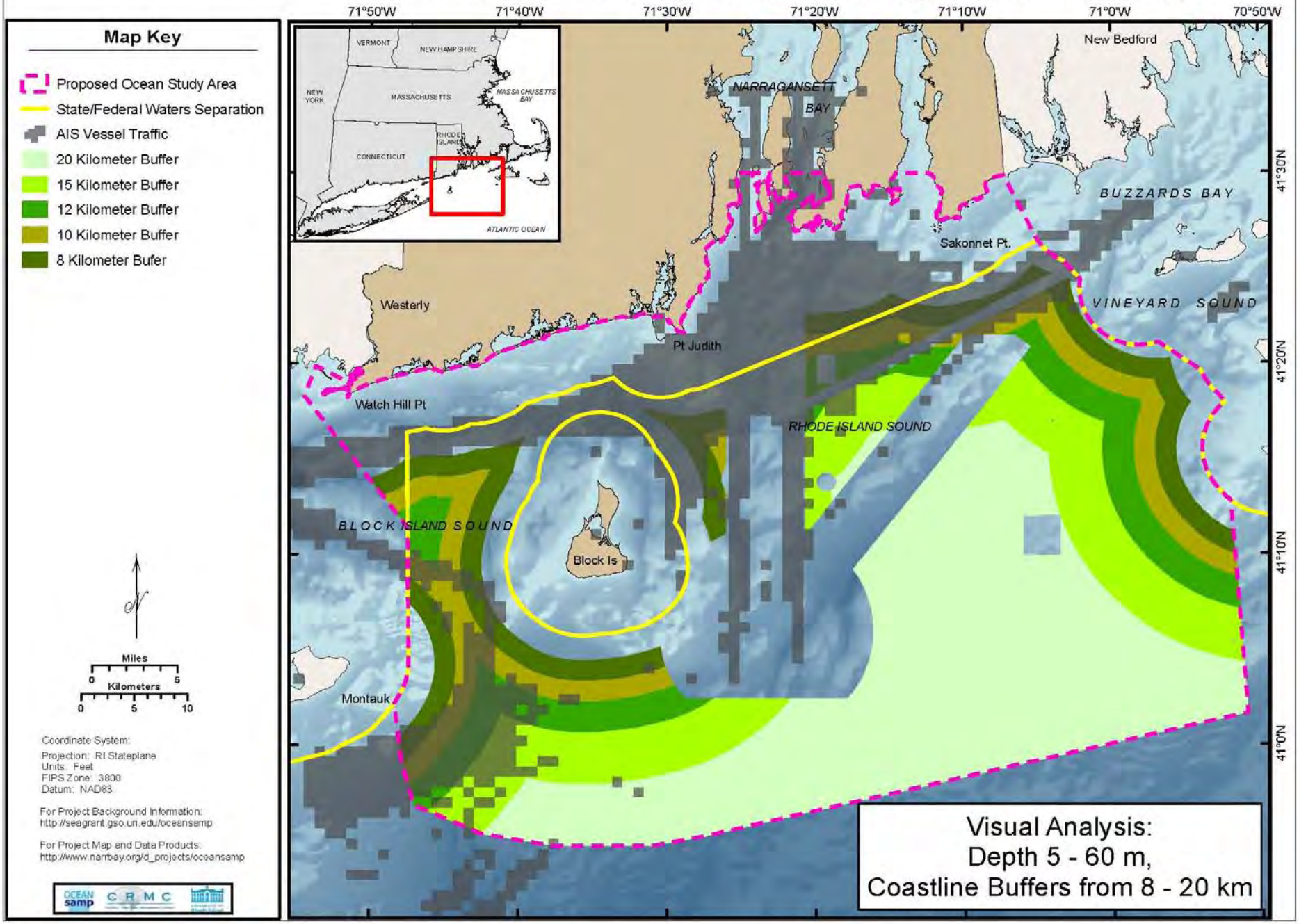
- One of principal reasons to move sites offshore is to minimize visual impacts
- Set back analysis (from any land body) performed

  Set backs of 8, 10, 12, 15, and 20 km

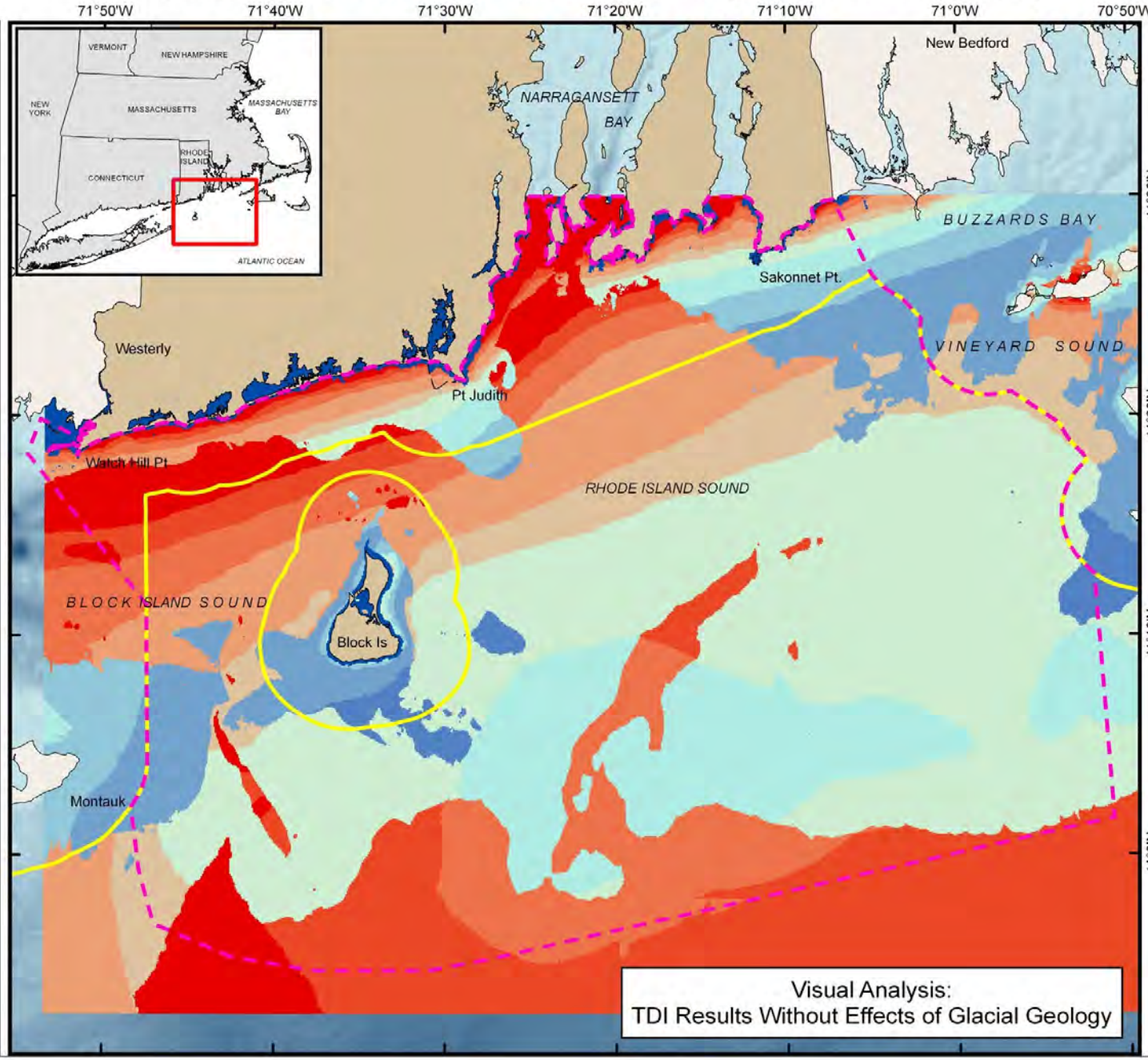
  20 km (12 miles) limit of visualization

  10 -12 km(5-6 miles) set back for Cape Wind

Rhode Island Ocean Special Area Management Plan (SAMP)



Rhode Island Ocean Special Area Management Plan (SAMP)



Map Key

Proposed Ocean Study Area

State/Federal Waters Separation

TDI - No Geology

- 1.0
- 1.1
- 1.2
- 1.3
- 1.4
- 1.5
- 1.6
- 1.7
- 1.8
- 1.9
- 2.0
- 2.1

Miles: 0 – 5

Kilometers: 0 – 5 – 10

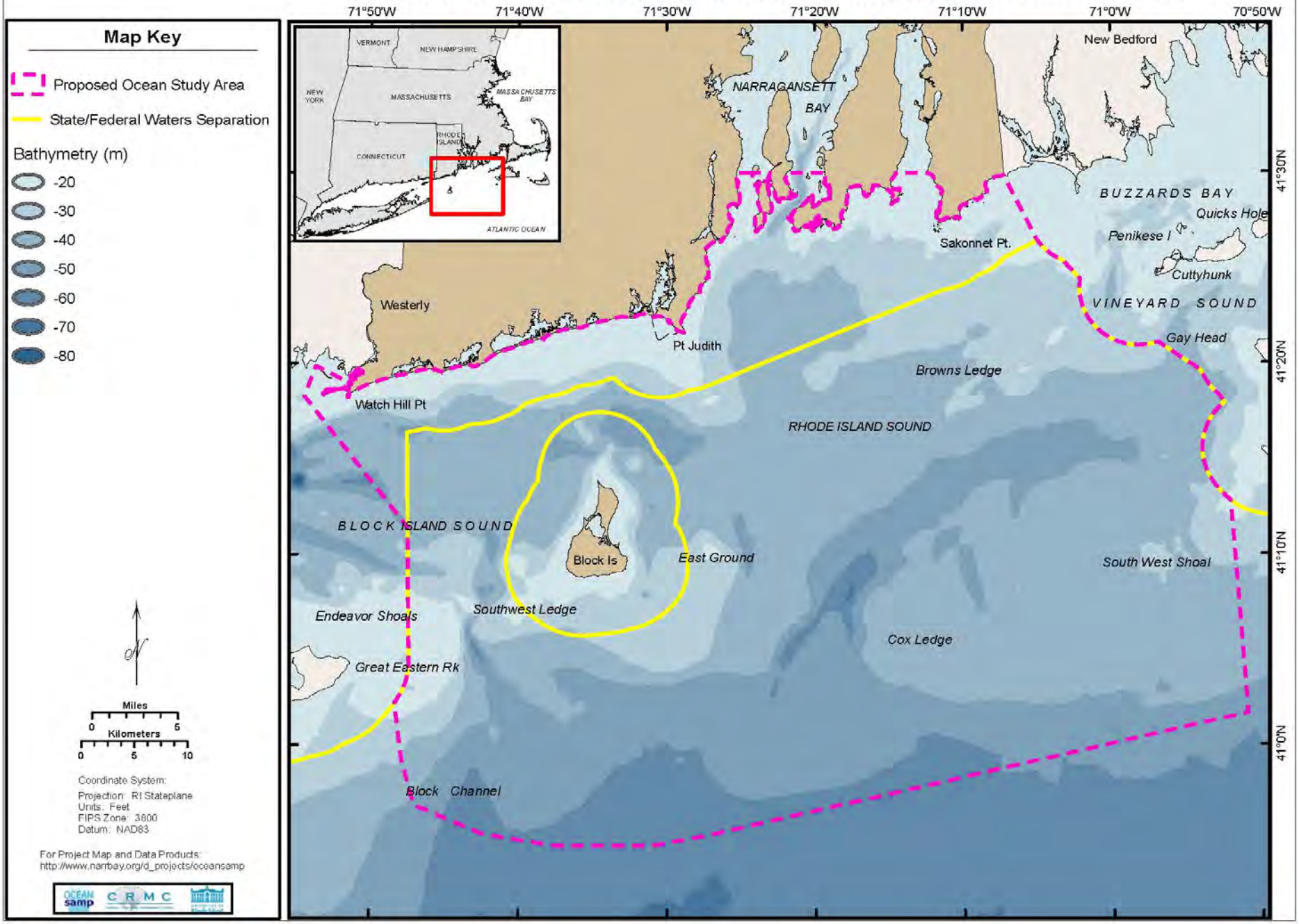
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83

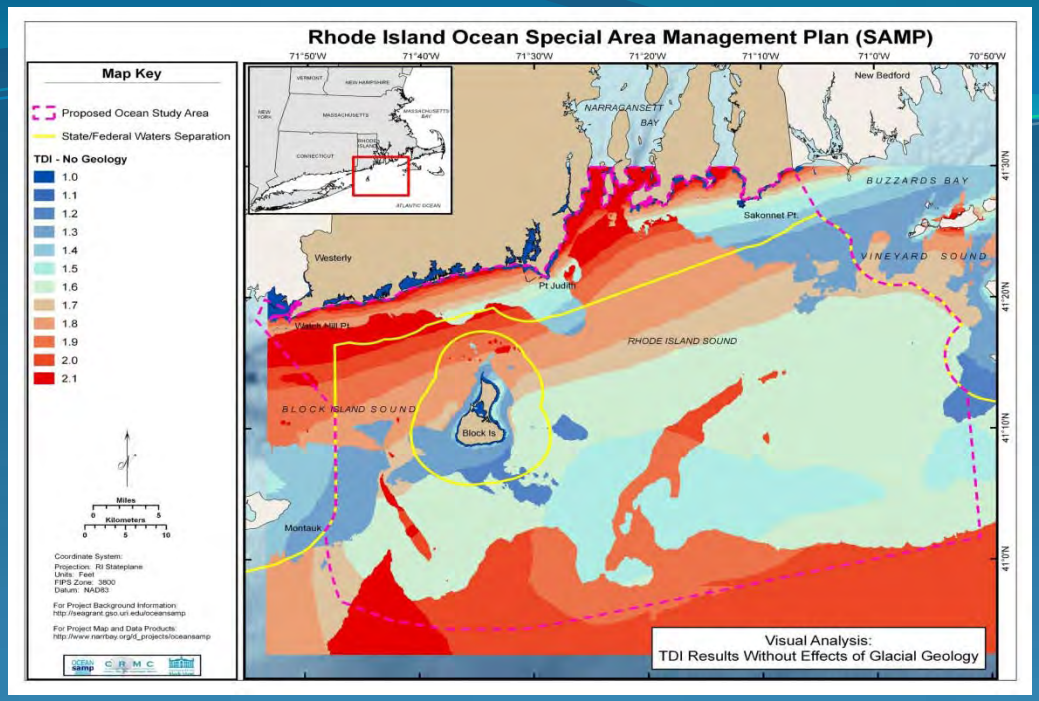
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp

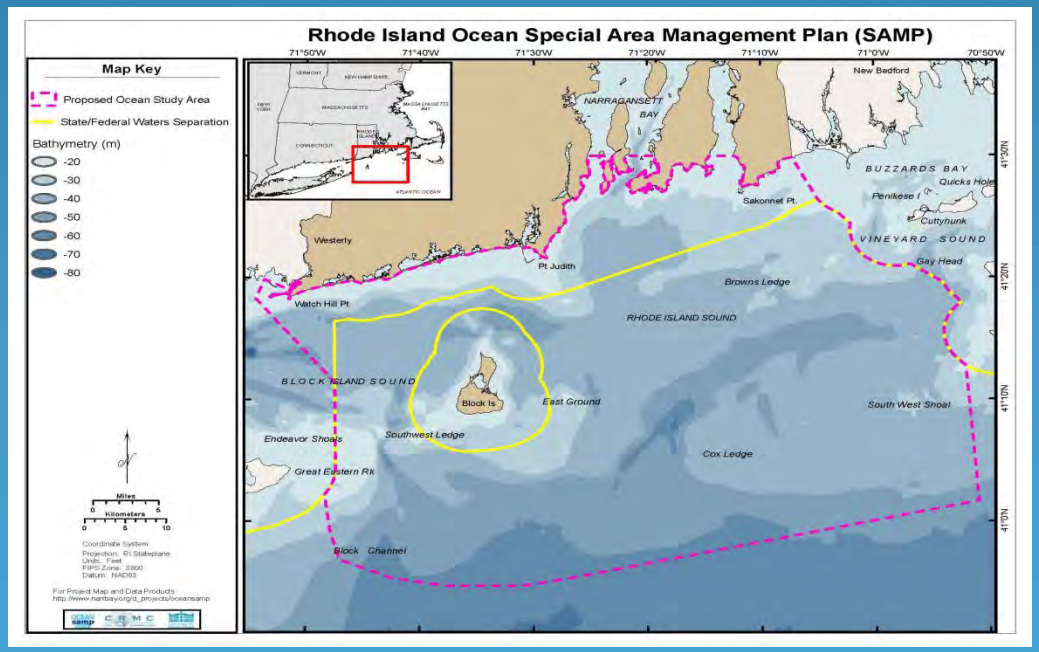
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp

OCEAN samp · CRMC · Rhode Island

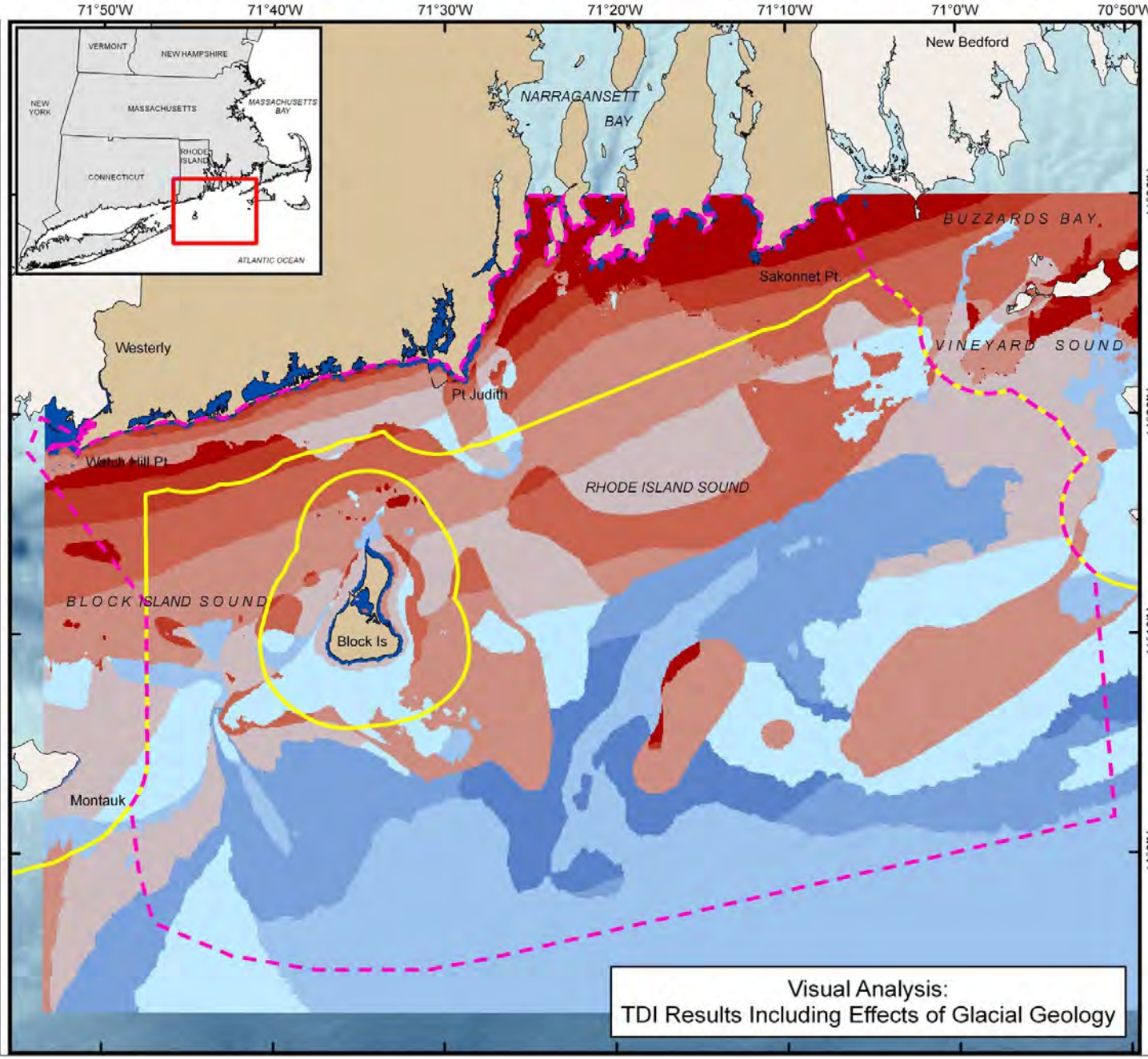
Rhode Island Ocean Special Area Management Plan (SAMP)




Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - No Geology
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis:
TDI Results Without Effects of Glacial Geology


Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
Bathymetry (m)
-20
-30
-40
-50
-60
-70
-80
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Quicks Hole
Penikese I
Cuttyhunk
Sakonnet Pt
VINEYARD SOUND
Gay Head
Westerly
Pt Judith
Browns Ledge
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
East Ground
South West Shoal
Endeavor Shoals
Southwest Ledge
Cox Ledge
Great Eastern Rk
Block Channel

Rhode Island Ocean Special Area Management Plan (SAMP)



Map Key

Proposed Ocean Study Area

State/Federal Waters Separation

TDI - With Geology

- 1.00
- 1.25
- 1.50
- 1.75
- 2.00
- 2.25
- 2.50
- 2.75
- 3.00
- 3.25
- 3.50

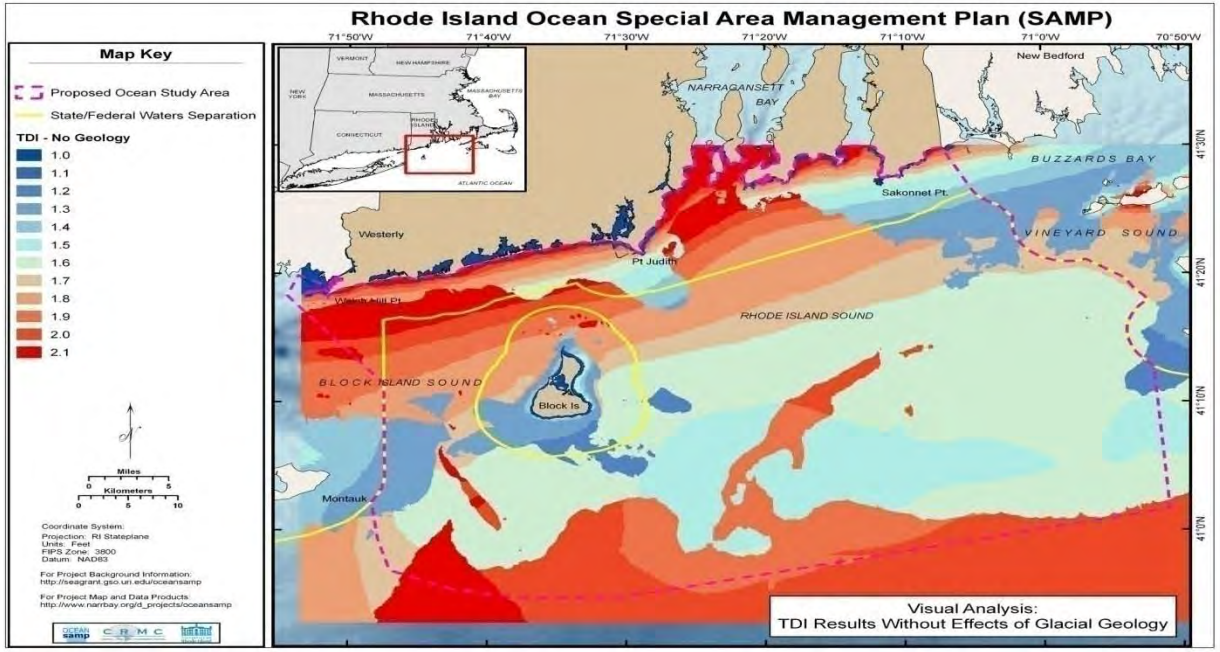
Miles: 0 – 5

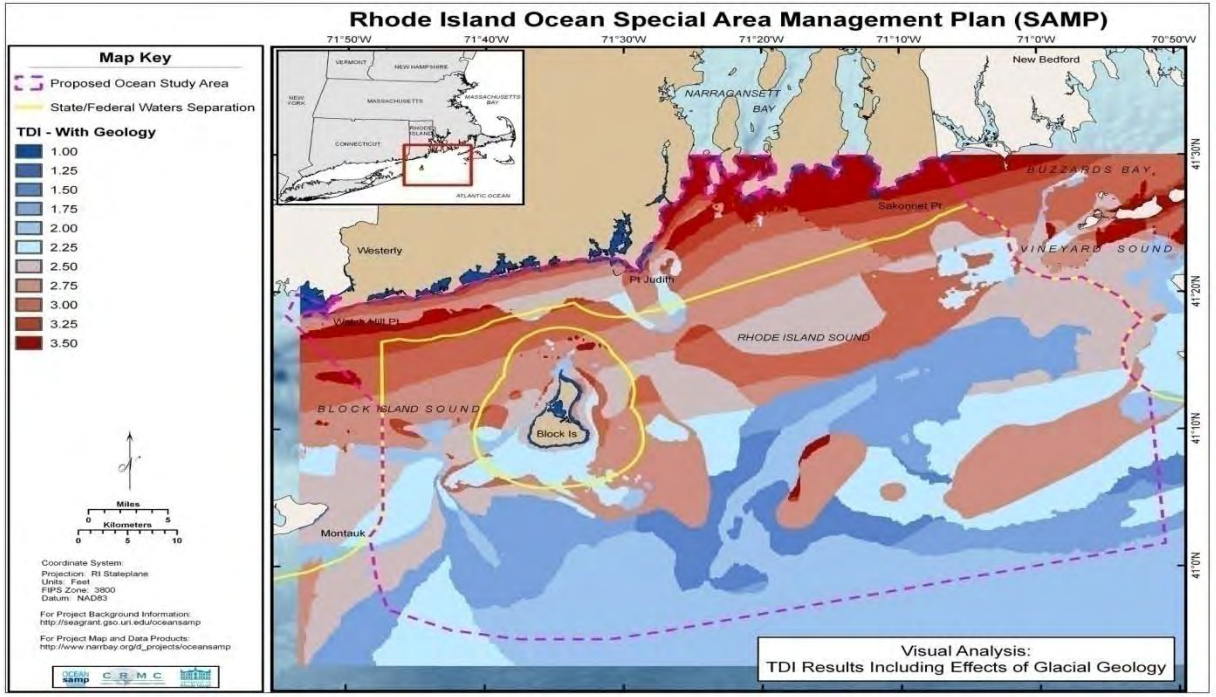
Kilometers: 0 – 5 – 10

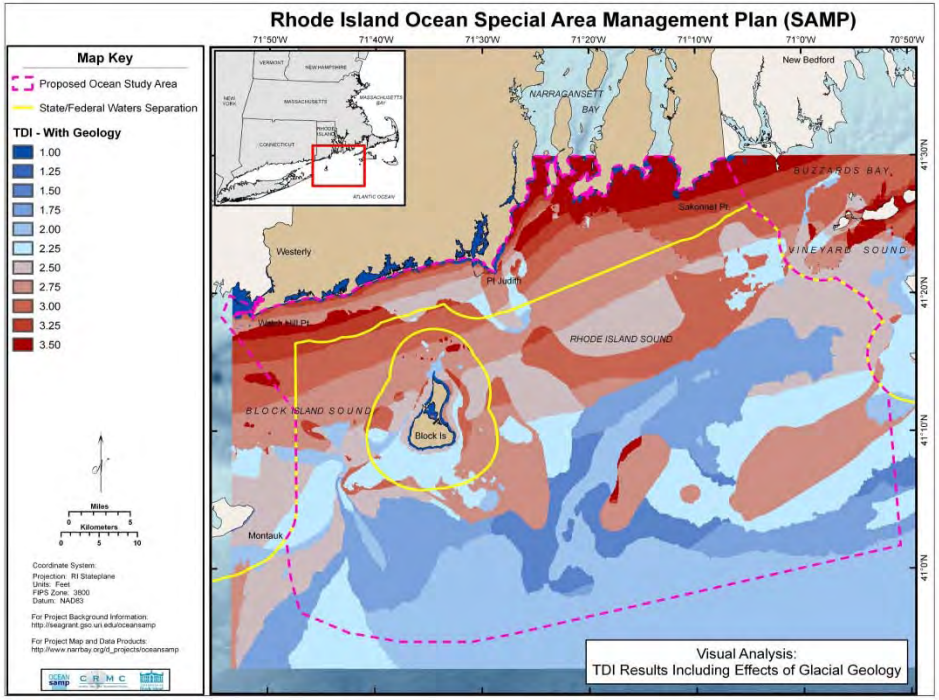
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83

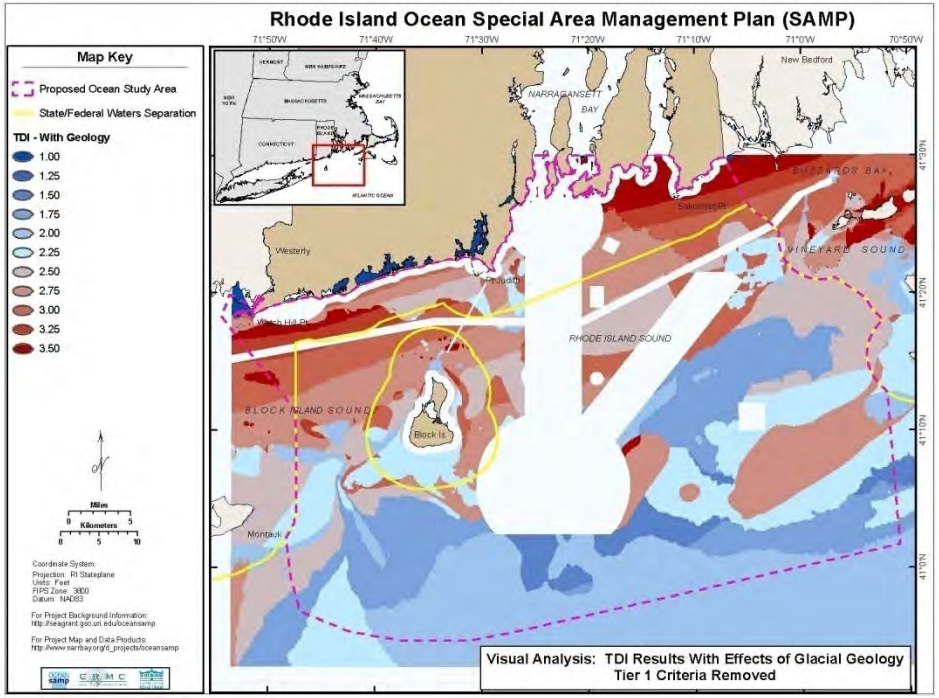
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp

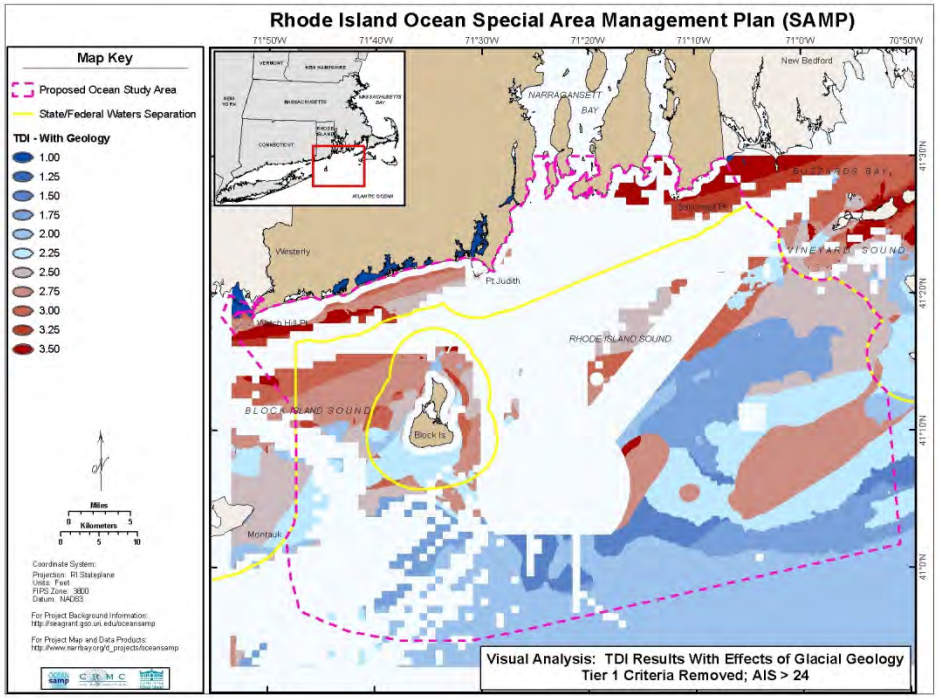
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp


Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - No Geology
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2.0
2.1
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt.
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis:
TDI Results Without Effects of Glacial Geology

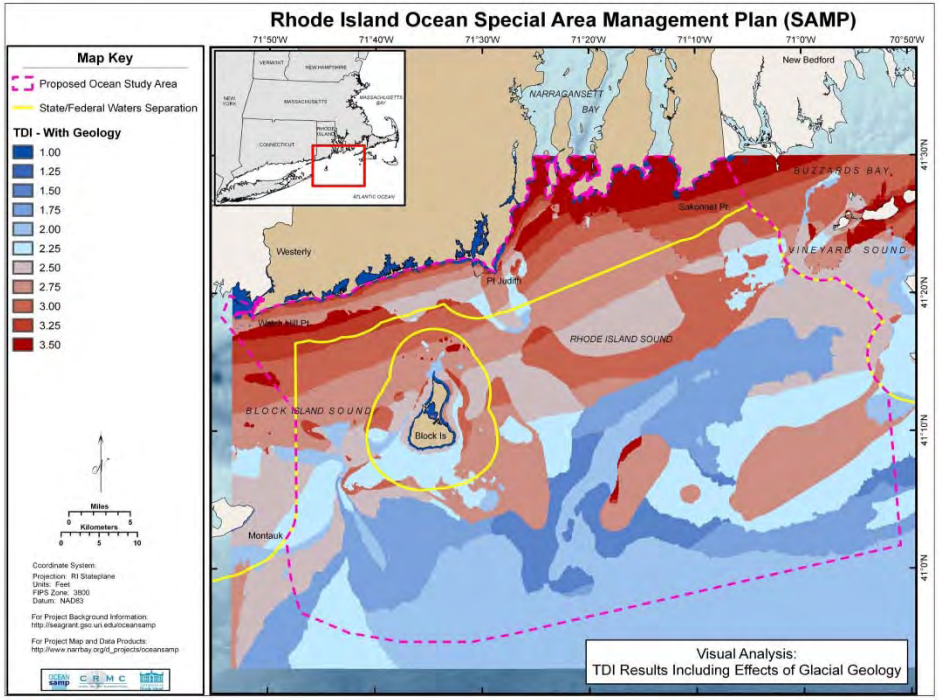

Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
41°30'N
41°20'N
41°10'N
41°0'N
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt.
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis:
TDI Results Including Effects of Glacial Geology

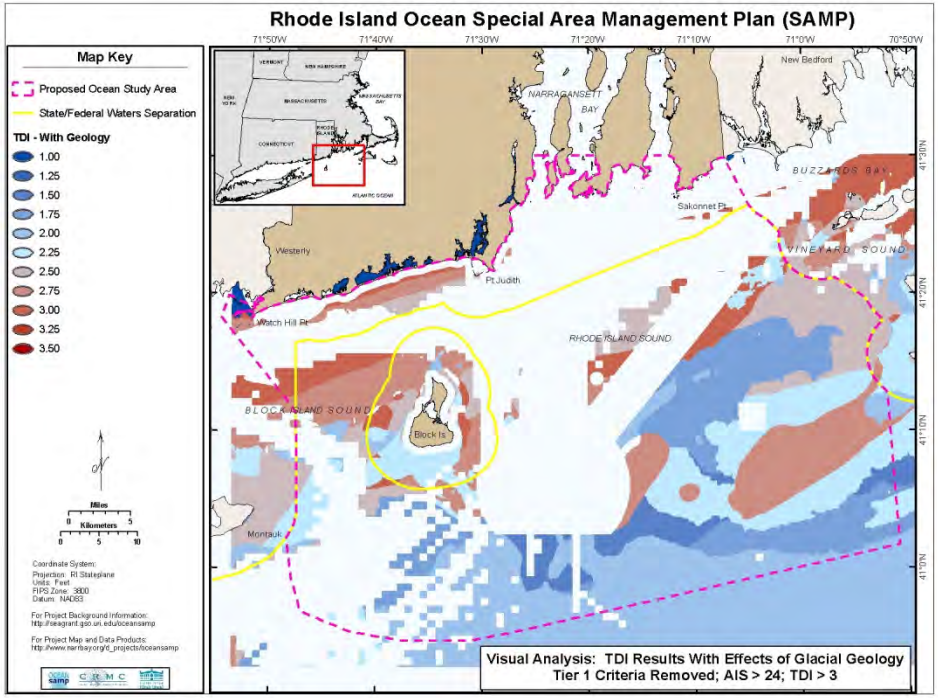

Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
41°30'N
41°20'N
41°10'N
41°0'N
Visual Analysis:
TDI Results Including Effects of Glacial Geology

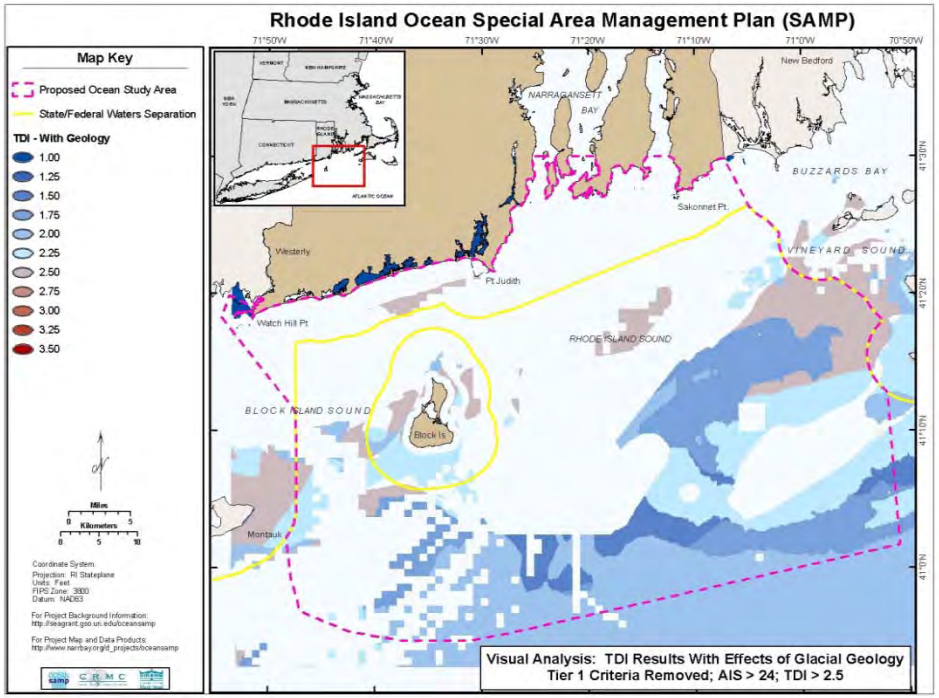

Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
41°30'N
41°20'N
41°10'N
41°0'N
Visual Analysis: TDI Results With Effects of Glacial Geology
Tier 1 Criteria Removed


Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
Miles
Kilometers
Coordinate System:
Projection: RI Stateplane
Units: Feet
FIPS Zone: 3800
Datum: NAD83
For Project Background Information:
http://seagrant.gso.uri.edu/oceansamp
For Project Map and Data Products:
http://www.narrbay.org/d_projects/oceansamp
71°50'W
71°40'W
71°30'W
71°20'W
71°10'W
71°0'W
70°50'W
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
41°30'N
41°20'N
41°10'N
41°0'N
Visual Analysis: TDI Results With Effects of Glacial Geology
Tier 1 Criteria Removed; AIS > 24

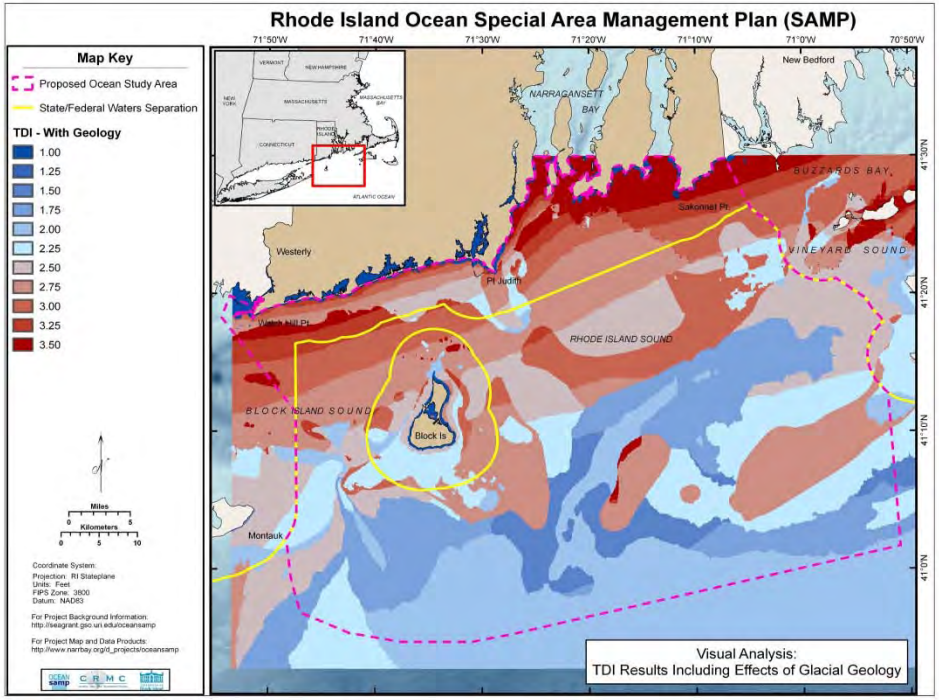
AIS SERIES

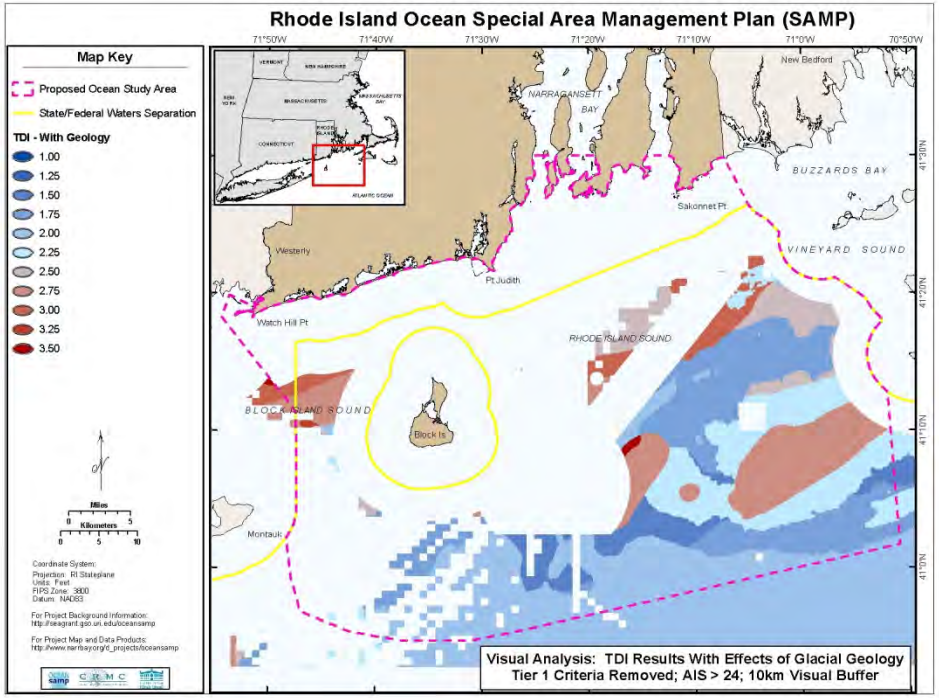

Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis:
TDI Results Including Effects of Glacial Geology

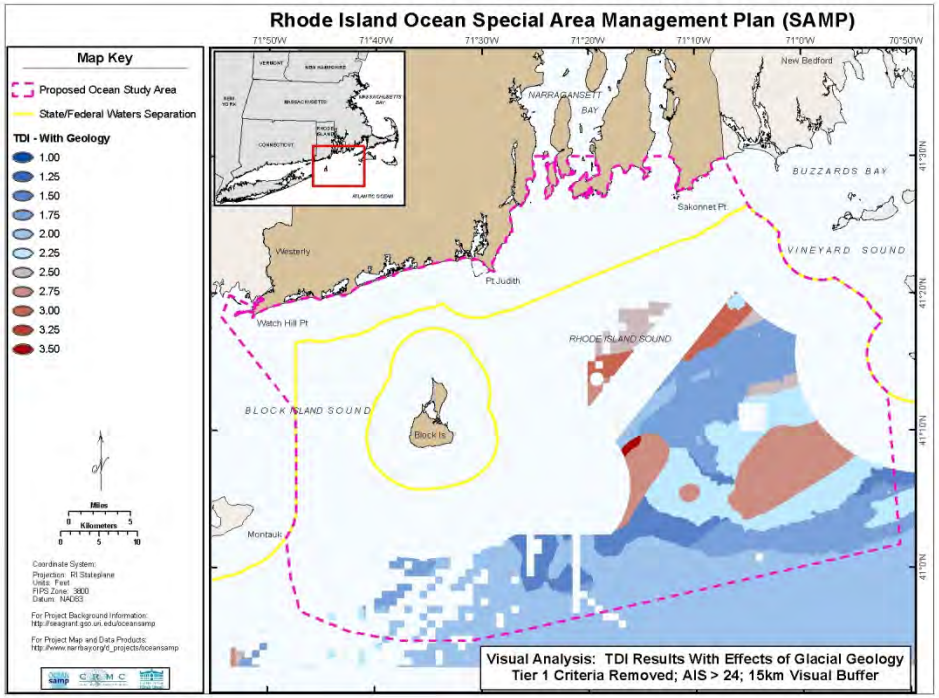

Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis: TDI Results With Effects of Glacial Geology
Tier 1 Criteria Removed; AIS > 24; TDI > 3


Rhode Island Ocean Special Area Management Plan (SAMP)
Map Key
Proposed Ocean Study Area
State/Federal Waters Separation
TDI - With Geology
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
New Bedford
NARRAGANSETT BAY
BUZZARDS BAY
Sakonnet Pt
VINEYARD SOUND
Westerly
Pt Judith
Watch Hill Pt
RHODE ISLAND SOUND
BLOCK ISLAND SOUND
Block Is
Montauk
Visual Analysis: TDI Results With Effects of Glacial Geology
Tier 1 Criteria Removed; AIS > 24; TDI > 2.5

TDI Series

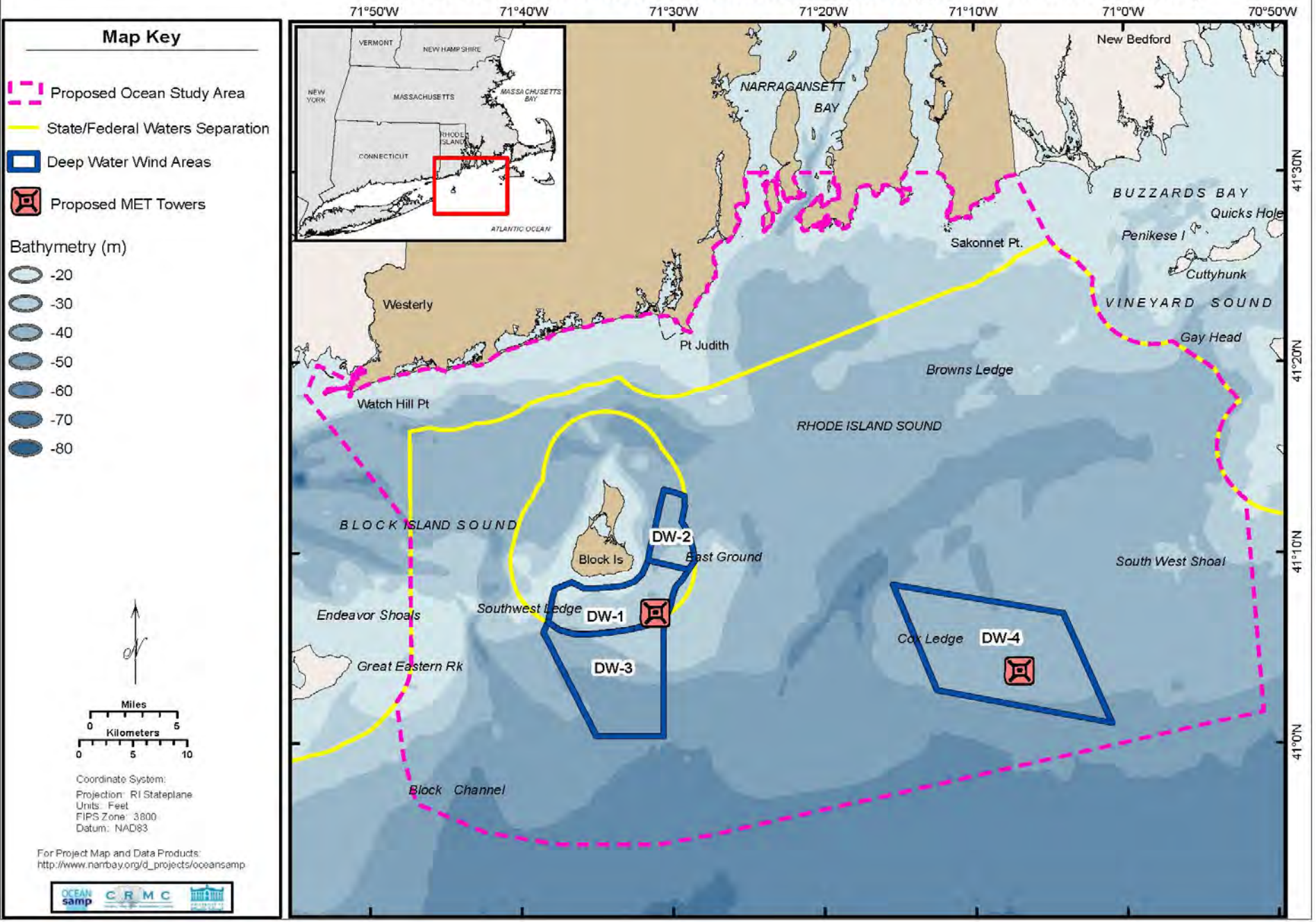




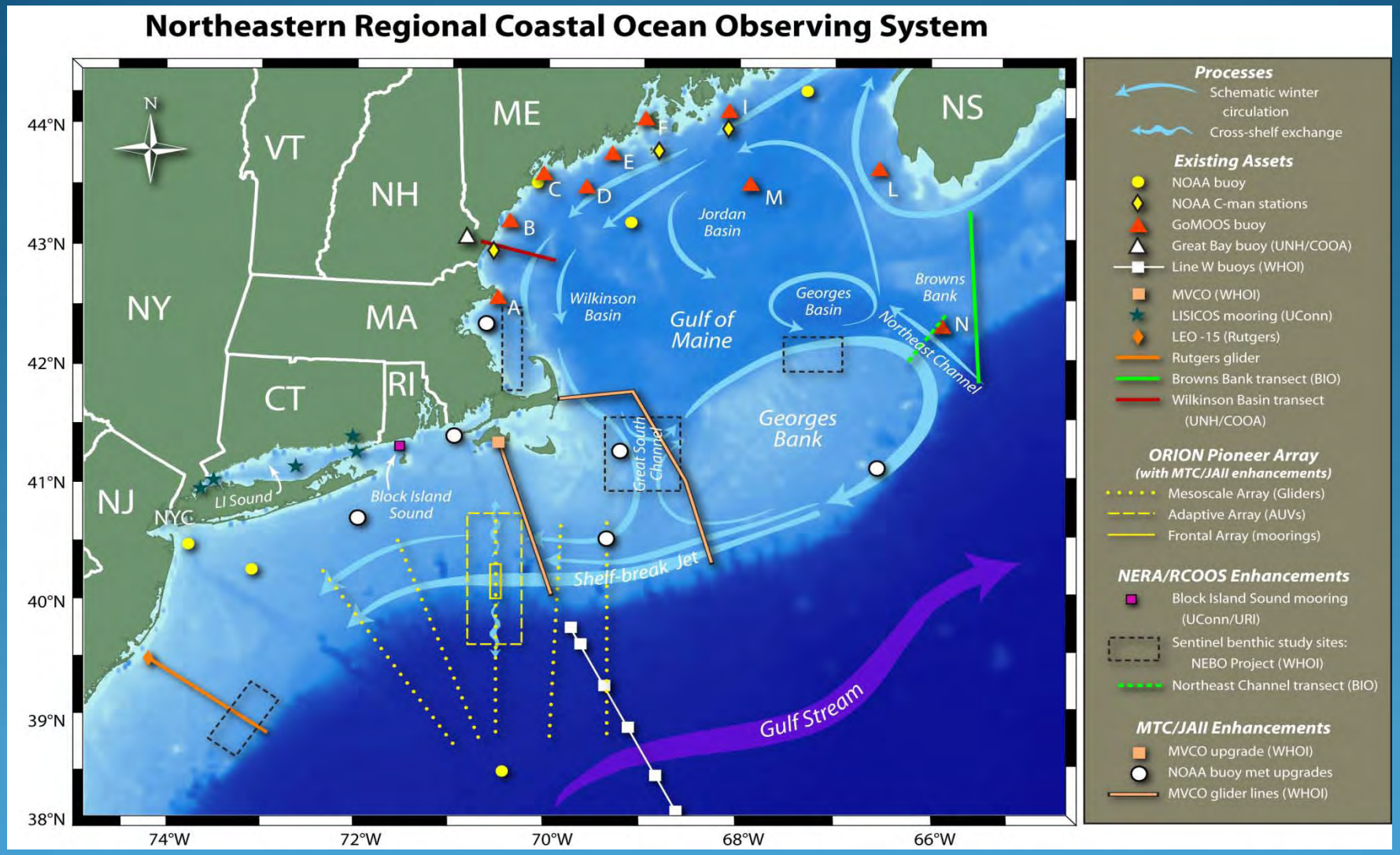


Visualization Series

Rhode Island Ocean Special Area Management Plan (SAMP)



NERACOOS Observation Network



Alternate Strategy Principal Component(PC)-Cluster Analysis(CA)

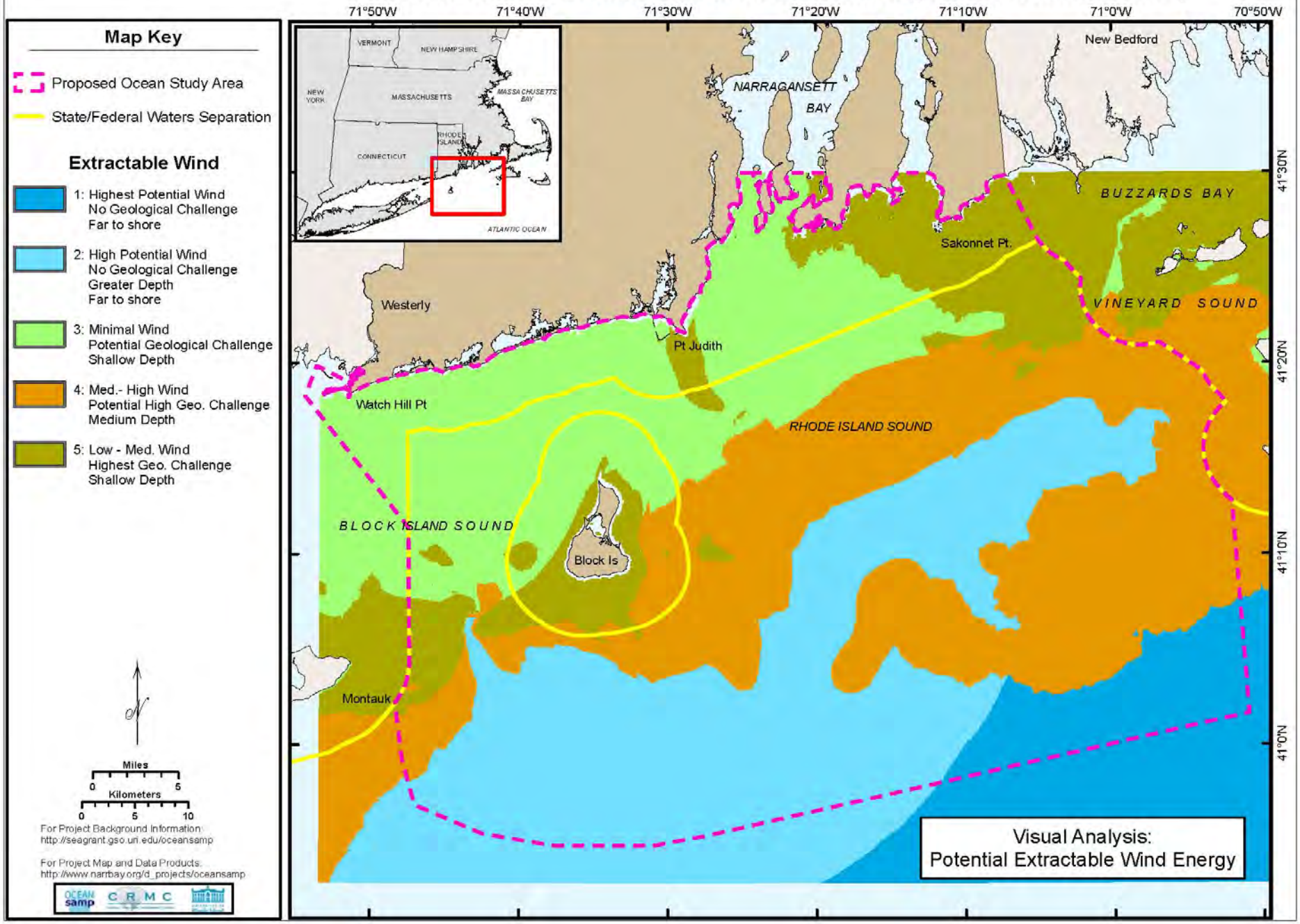
- Input Variables
  - Wind Power
  - Water Depth
  - Distance to Coast
  - Geology Type (construction effort)

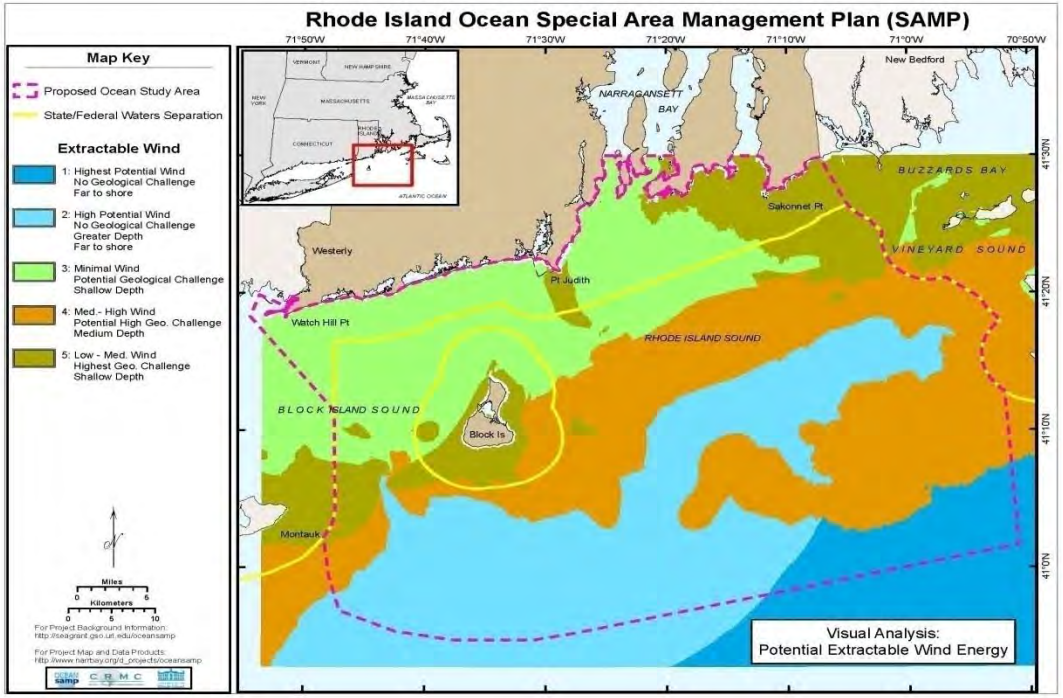
Linear combination of above variables for each 200 m square grid

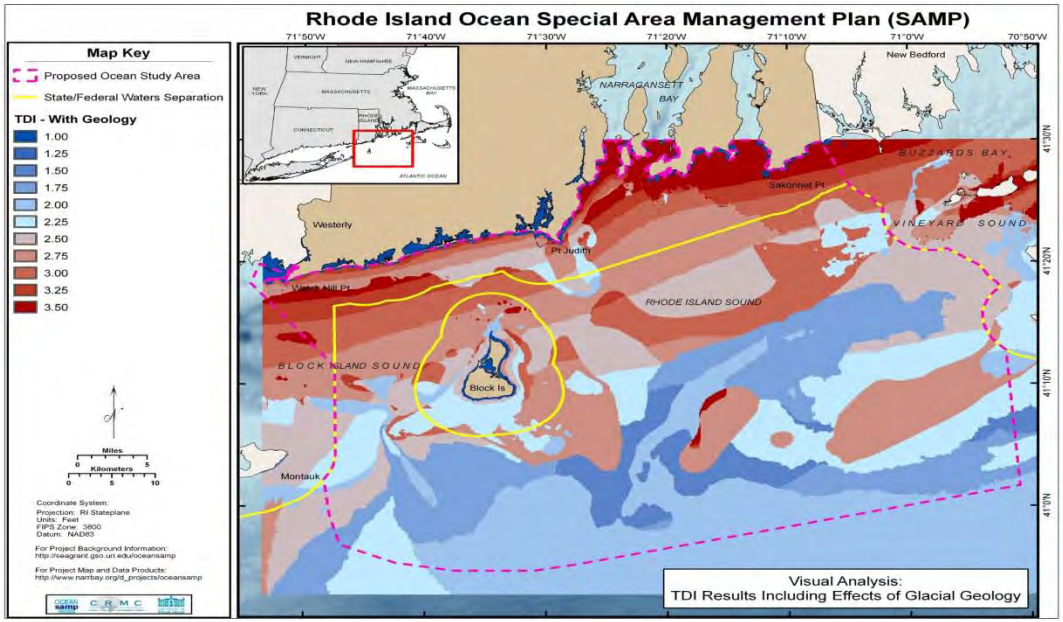
Clusters

	Wind Power	*Depth*	*Distance*	*Geology Challenge*
Cluster 1	Highest	Deep	Far	Low
Cluster 2	High	Mid	Mid	Low
Cluster 3	Lowest	Shallow	Close	Mid
Cluster 4	Mid-High	Mid	Mid	Mid-High
Cluster 5	Mid-Low	Shallow	Close	High

Rhode Island Ocean Special Area Management Plan (SAMP)







Comparison

Principal Component & Cluster Analysis
(upper)

TDI Analysis
(with geology)
(lower)

Conclusions

- TDI and PC analysis useful in identifying possible sites for offshore wind energy development. Both methods give consistent results; site locations are balance between wind energy resource and technical development challenge.
- Useful to identify sites for more in-depth analysis
- Principal data needed at this step in analysis, sub-bottom geology

Next Steps

- Perform Tier #2 analysis
  - Use conflicts
    - Commercial and recreational fishing
    - Recreational boating
    - Existing licenses (leases)
    - Aggregate extraction
    - Conservation
    - Aquaculture

Next Steps (Cont'd)

Tier # 2 Screening

- Environmental Impact
  - Birds
  - Fish and fish habitat
  - Marine mammals and turtles
  - Water and air quality
- Historical and cultural resources