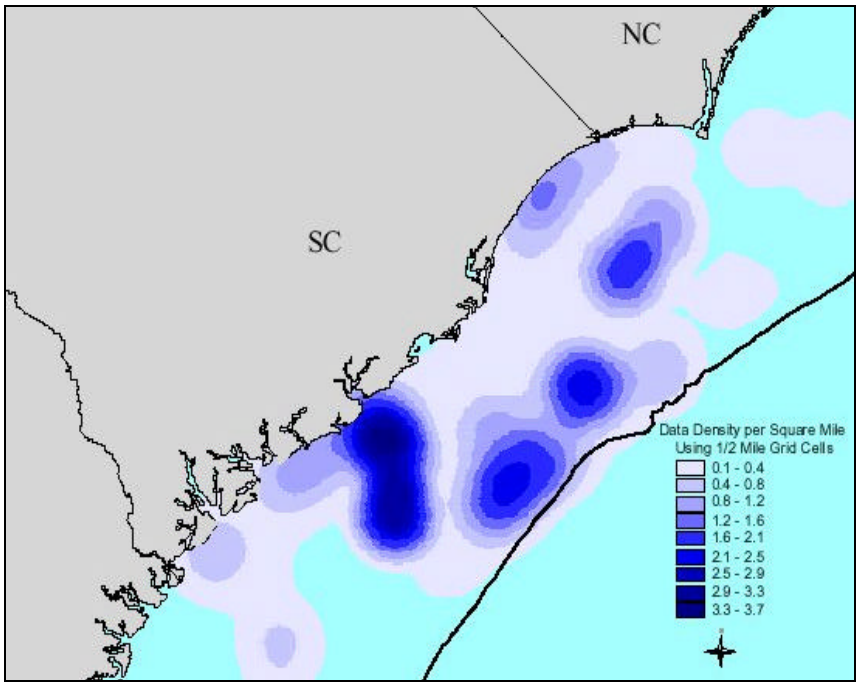
Spatial Analysis of Bottom Habitats and Sand Deposits on the Continental Shelf off South Carolina

prepared by

P.R. Weinbach and R.F. Van Dolah



Final Report

South Carolina Task Force on Offshore Resources
and the
Minerals Management Service
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Spatial Analysis of Bottom Habitats and Sand Deposits on the Continental Shelf off South Carolina

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Submitted To

South Carolina Task Force on Offshore Resources
and the
Minerals Management Service
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Executive Summary

The South Carolina Task Force on Offshore Resources has compiled an extensive database on bottom habitat characteristics for the coastal waters off South Carolina, extending from the beach out to depths of approximately 200 m. The database represents a compilation of both historical data obtained from previous scientific studies conducted in the region and more recent studies that have been completed as part of a cooperative program with the Minerals Management Service (MMS) Office of International Activities and Marine Minerals (INTERMAR). The data are compiled in both Access® and ArcView® shape files.

The database analyzed for this report consists of 14,512 records that provide information on one or more of the following bottom characteristics: presence or absence of hard-bottom reef habitat, percent sand composition, mean grain size, and thickness of the sand layer over harder substrate or subsurface reflectors. Each of these characteristics were examined to identify the location and density of records, with emphasis placed on relating the distribution of these records to the state's beaches which are periodically nourished, or may need nourishment in the future.

Most of the hard-bottom reef habitat is located further offshore than 5-10 miles from the beach and would not be areas of concern to beach nourishment projects. However, extensive hard bottom areas are documented in the Grand Strand area. Mean grain size and sediment thickness data are not well represented in the database. Those data that are available were largely collected through studies completed for recent beach nourishment projects or the INTERMAR program. These data are critical to evaluating the suitability and location of sand deposits that could be used for nourishment operations. Information on percent sand content in the bottom sediments is more extensive and most records indicate >90% sand content.

Based on the information available in the database, there appears to be suitable concentrations of nourishment quality sand deposits in reasonable proximity to most of the state's beaches. While the database will help identify areas of potential interest, more intensive surveys will be required in some areas to identify suitable sand deposits that meet grain size and depth of sediment lens criteria. Areas where records are especially lacking in the database in within 5-10 miles of the beach include Pawleys Island, Fripp

Island and Daufuskie Island. Studies have recently been completed off Pawleys Island through the South Carolina Cooperative with INTERMAR. Data from those studies have identified potential borrow sites and areas that should be avoided. Those data will be incorporated into the INTERMAR database in 2001. Additional studies are still needed to address data gaps off the other beaches of concern.

Introduction

Beginning in 1992, the *South Carolina Task Force on Offshore Resources* began a multi-year cooperative program with the Minerals Management Service, Office of International Activities and Mineral Resources (INTERMAR). One major goal of the program was to compile a comprehensive database on bottom habitat characteristics in the coastal waters of South Carolina from the beach out to depths of approximately 200 meters. The primary purpose of this database was to identify sand resources that may be useful in beach nourishment projects in the state. Therefore, emphasis was placed on characterizing bottom habitats located within 10 miles of the beach. Data on other bottom characteristics, such as the presence of critical biological resources and the location of economically valuable minerals, and data located in waters further offshore were also included in the assessment effort where information was available.

The initial efforts of the Task Force involved compiling existing geological and bottom habitat data that had been collected by other programs into a database, which was then graphically analyzed and summarized using a Geographic Information System (GIS). The results of those efforts are summarized in reports by Van Dolah et al. (1994a) and Bury and Van Dolah (1995). Subsequently, the Task Force has conducted a series of small reconnaissance geological and geophysical surveys along sections of the South Carolina coast in areas where (1) limited data had been collected and (2) there was an existing or anticipated demand for sand resources to support beach nourishment projects. Such studies have been completed at Folly Beach (Gayes and Donovan-Ealy, 1995), Edisto Island (Gayes, et al., 1998), Hilton Head Island (Wright, et al., 1998) and Pawleys Island (Wright et al. 1999). Other Task Force activities have included completing an evaluation of the physical recovery rates for existing sand borrow sites on the inner shelf (Van Dolah *et al*., 1998), and completing studies of shoreline migration, shoreline erosion, and sediment budgets for selected barrier islands in South Carolina (Katuna, 1995, King and Katuna, 1999).

As a result of the nearshore reconnaissance efforts, approximately 4,000 new data records have been added to the database. The purpose of this report is to summarize the updated database in a GIS framework using protocols similar to those described by Bury

and Van Dolah (1995). The only data not included in this report are those obtained from the Pawleys Island study, since those data are still being modified for input into the Access database.

Methods

Data Integration

The data analyzed for this report include all 14,512 records presently contained in the MMS/INTERMAR Access® database. All data were converted to ASCII text files and latitude and longitude coordinates were converted to decimal degrees. Point and line records were separated into two files to enable conversion to ARC/INFO coverages. Point data had only a single latitude/longitude pair and line data had beginning and ending latitude/longitude coordinates. ARC/INFO coverages were converted to the geographic projection to facilitate compatibility with other background or overlay coverages. The geographic projection can easily be converted to other projections if future data integration is desired.

Data Analysis

The records in the MMS/INTERMAR database have various positional accuracies based on the methods used. The majority of records were collected using LORAN-C positioning systems (Table 1), and largely represent data collected prior to the initiation of the INTERMAR program. Most of the records collected for INTERMAR Task Force studies utilized GPS positioning.

Table 1. Positioning methods used in the MMS-INTERMAR database

Position Method	Number of Records	Percentage of Total Records
LORAN-C	12219	84.20
LORAN-A	587	4.04
GPS	1495	10.30
Mini Ranger Positioning System	55	0.38
Dead Reckoning	30	0.21
Range and Bearing	5	0.03
None Identified	121	0.83

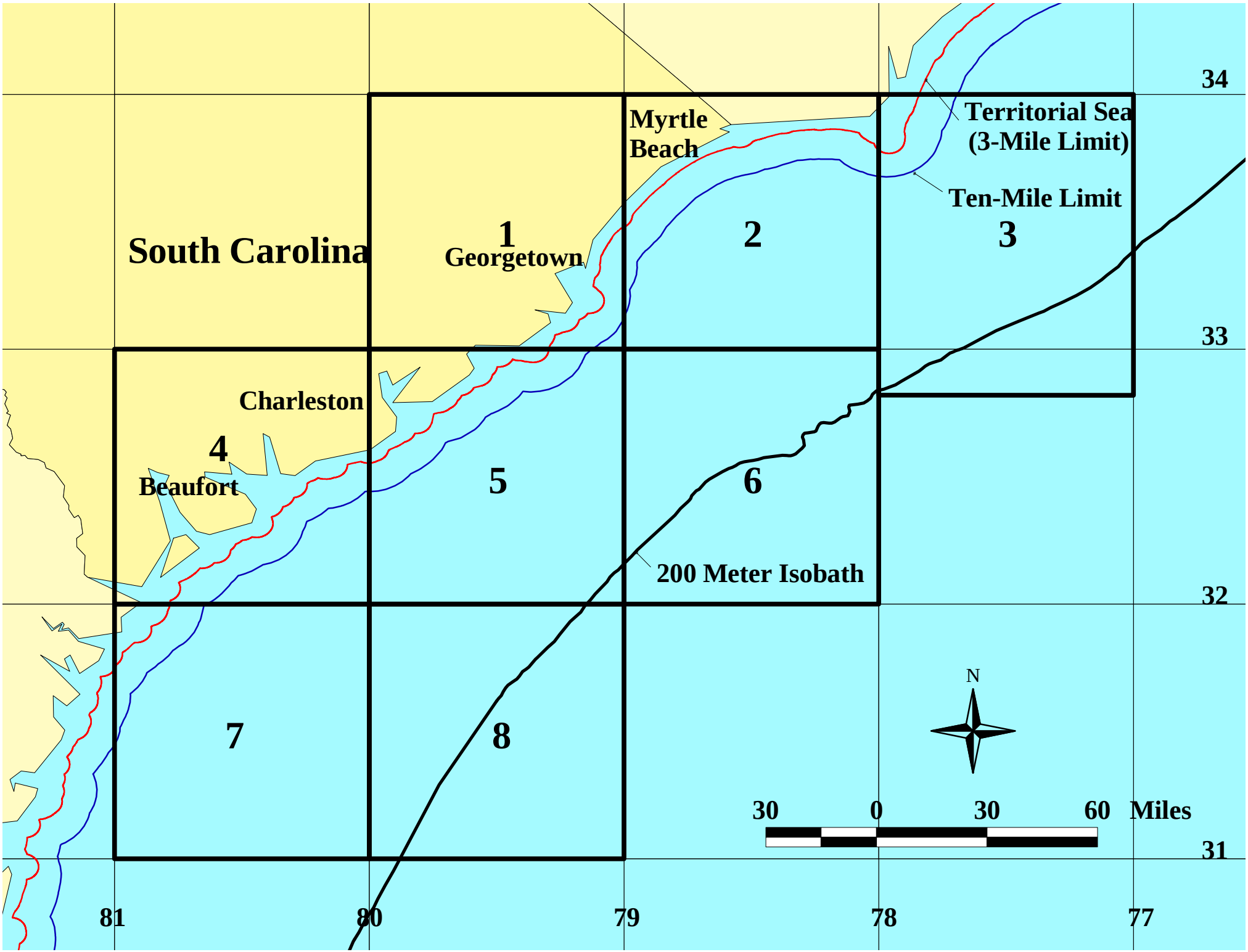

Figure 1: Survey area showing the eight subzones that were analyzed

Distribution of Bottom-Type Data

Mining operations necessary for beach nourishment processes disturb bottom habitats. Because of this, it is important that vulnerable locations of hard-bottom reef habitat are identified and avoided during mining operations. A summary of all data that provide information on bottom type is provided in Figure 2 and the type of bottom represented by each record is summarized in Appendix A. The overall proportion of hard-bottom or possible hard-bottom habitats compared to non-hard bottom habitats that has been documented in each subzone is probably greater than the actual proportion of these habitat types because many sampling efforts were concentrated on areas of known reef habitats (Van Dolah et al., 1994a,b). Possible hard-bottom indicates that evidence of hard-bottom may be present, but the data were inconclusive. Van Dolah, et al. (1994b), provides full explanations of protocols used for defining bottom type.

The majority of records indicating the presence of hard-bottom habitat are found in deeper waters of the shelf, greater than 10 miles from shore. There are dense patches of hard-bottom habitat within 3 miles of shore near Myrtle Beach and within 5-10 miles of shore near the Isle of Palms, Sullivan's Island, Folly Beach, Seabrook Island, Edisto Beach, Hunting Island, Fripp Island, and Hilton Head Island. As data gaps are eliminated through future data sampling efforts, the locations of additional reef habitat will be documented in the database.

Distribution of Mean Grain Size Data

One sediment characteristic analyzed where data were available was mean grain size. For an area to be useful for beach nourishment processes, the mean grain size should be comparable to, or greater than, the sand on the beach to be nourished. The distributions of records with sand grain size information (1776 points) are shown in Figure 5 and in more detail in Appendix B. Overall, mean grain size records are sparse in the database. There are, however, high concentrations of records off the coast near the Grand Strand area, the Isle of Palms, Sullivan's Island, and Folly Beach as well as smaller concentrations along Edisto Beach and Hunting Island. These data are primarily the result of studies conducted for the INTERMAR program. When compared to our previous analysis of the INTERMAR database (Bury and Van Dolah, 1995), the number

of records having mean grain size data increased significantly. Only 7.33% of the 10,243 records analyzed in 1995 had information on mean grain size compared to 12.23% of the 14,512 records in the present database. However, more grain size data are still needed off many of the beaches requiring periodic renourishment in areas where significant sand deposits are located.

Distribution of Sediment Thickness Data

Another sediment characteristic analyzed was maximum sediment thickness. These data were derived from geophysical surveys of surficial sediment (to the first subsurface reflector) and coring data. Maximum sediment thickness records (894 points, 366 lines) are shown in Figure 6 and in more detail in Appendix C. Sediment thickness data records are sparse in the database. Coastal Carolina University has additional data on sediment thickness obtained through subbottom profiling and vibracores. However, funding limitations have precluded full incorporation of these data into the database. In many cases, sand depth estimates are limited to specific coordinates along the transects. Future data acquisition efforts should be expanded with respect to identifying areas where there are significant sand deposits (e.g. sediment thickness > 2-3 m).

Distribution of Percent Sand Data

The final sediment characteristic analyzed for this report was percent sand. For an area to be useful for beach nourishment, the sediments should have >90% sand content. Records (1925 points) with information on the percent sand content are shown in Figure 7 and in more detail in Appendix D. There are high concentrations of suitable sediments along most of the beaches needing periodic nourishment. Other erosional beaches have limited percent sand data and are in need of increased sampling effort. Once again, the number of records with percent sand data increased considerably since the last analysis of the database. In 1995, 8.48% of the 10,243 records had information on percent sand while the present database has 13.26% of the 14,512 records with information on percent sand.

Data Gap Analyses

A major goal of this analysis was to determine the locations of data gaps. Although the database consists of over 14,000 records, there are several geographic regions that are lacking in data. The most important of these data gaps are those that occur near erosional beaches in need of nourishment.

Figure 7 shows the overall density of data records near each of the state's erosional beaches that need periodic nourishment and Figure 8 shows the relative density of data records over the entire continental shelf off South Carolina. It clearly shows high density of data records near the Grand Strand area as well as near Folly Beach. It was necessary to employ a much smaller scale to investigate the data density for individual beaches (Figures 9-11).

North Myrtle Beach, Myrtle Beach and Surfside Beach all have high concentrations of data records. Pawley's Island had a much lower sampling effort, but new studies here have subsequently addressed this data gap (Figure 9). In the middle region of South Carolina (Figure 10), the highest density of data records is located off Folly Beach and Edisto Beach. Most of these data were obtained through studies supported by the INTERMAR Program. There is less data available for the Isle of Palms, Sullivan's Island and Seabrook Island. These islands do not have well-documented sand sources in near proximity, but it is likely that suitable sand sources exist in those areas, especially off the Isle of Palms and Sullivan's Island. In the southern region of the state (Figure 11), the highest density of data records is off Hilton Head Island and Hunting Island. This is largely due to recent sand resource surveys for beach nourishment projects that were completed for all of these islands.

Summary

Based on the information available in the database, there appears to be suitable concentrations of nourishment quality sand deposits in reasonable proximity to most of the state's beaches. While the database will help identify areas of potential interest, more intensive surveys will be required in some areas to identify suitable sand deposits that meet grain size and depth of sediment lens criteria. Areas where records are especially lacking in the database in within 5-10 miles of the beach include Pawley's Island, Fripp

Island and Daufuskie Island. Studies have recently been completed off Pawley's Island through the South Carolina Cooperative with INTERMAR. Data from those studies have identified potential borrow sites and areas that should be avoided. Those data will be incorporated into the INTERMAR database in 2001. Additional studies are still needed to address data gaps off the other beaches of concern.

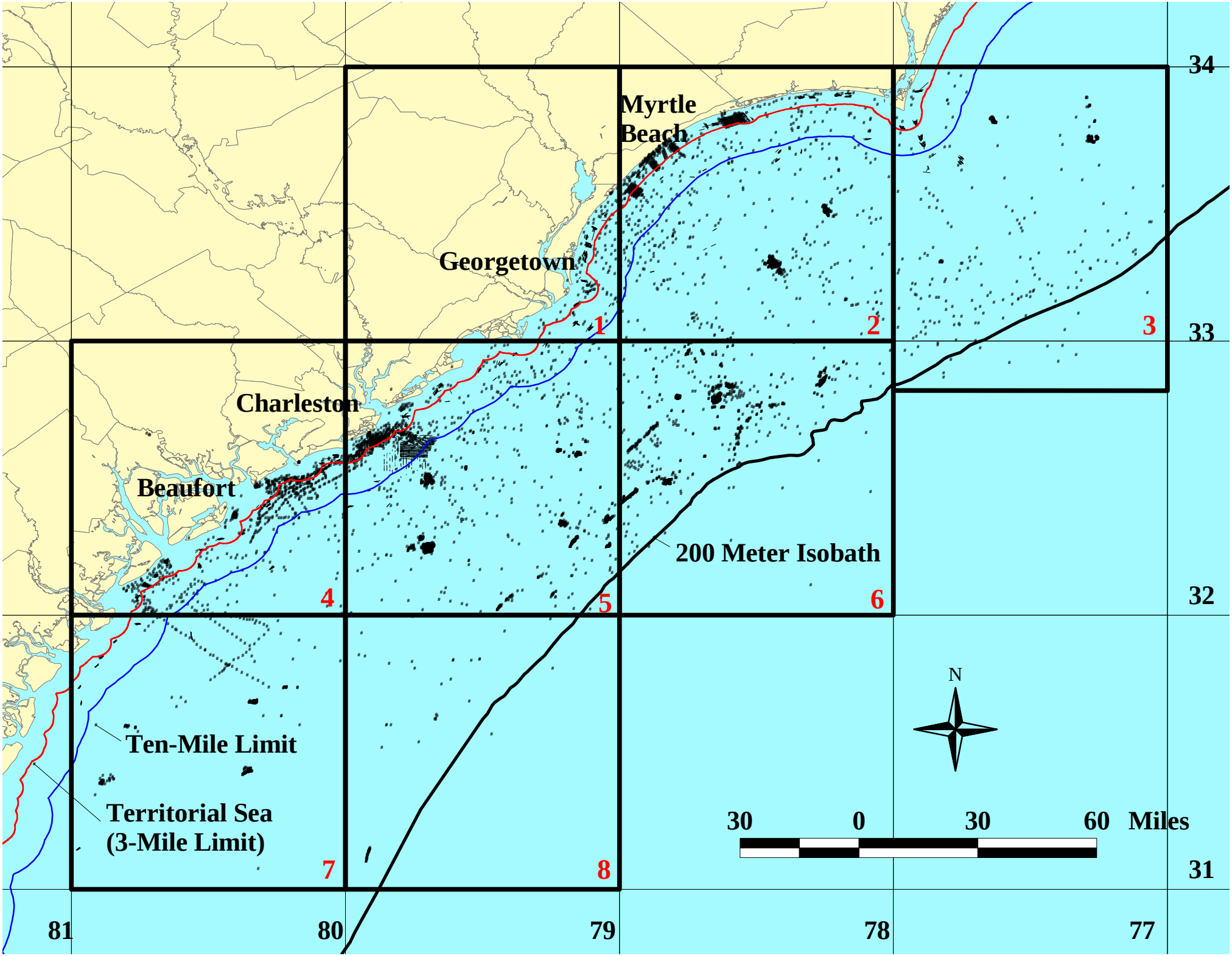

Figure 2: Distribution of records that have information on bottom-type. See Appendix A for additional information on subzones 1-8.

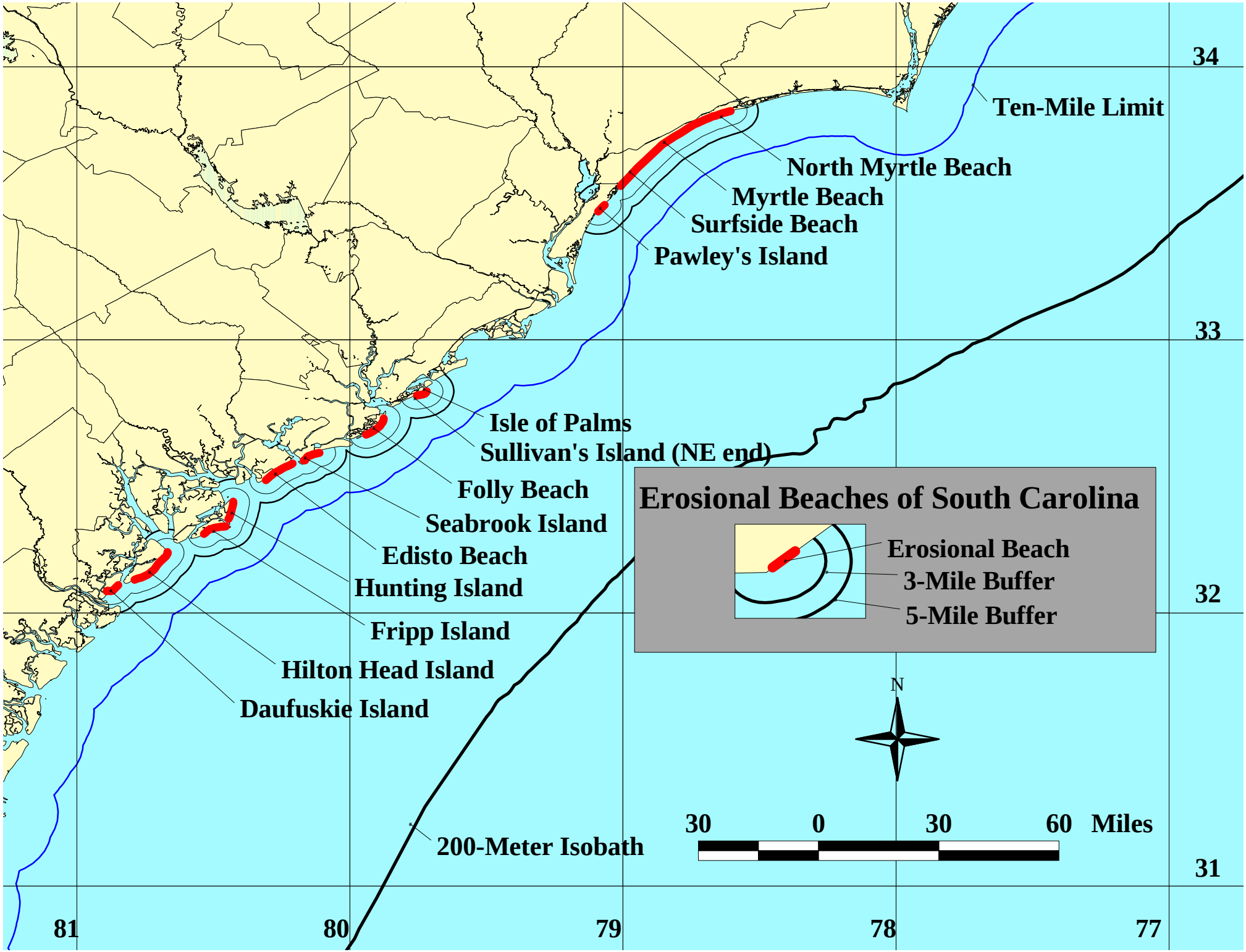

Figure 3: Erosional beaches along the coast of South Carolina

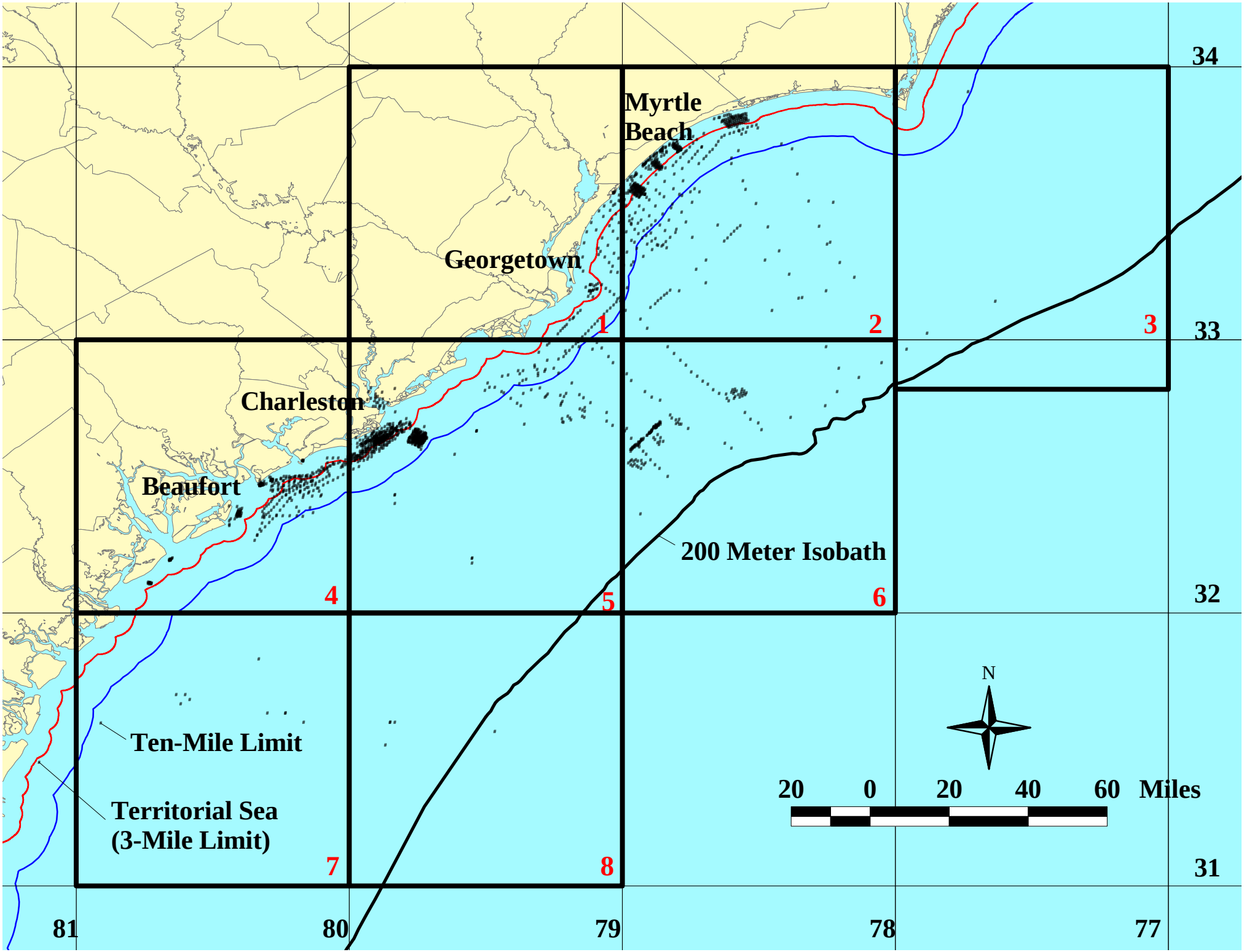

Figure 4: Distribution of records that have information on mean grain size. See Appendix B for additional information on subzones 1-8.

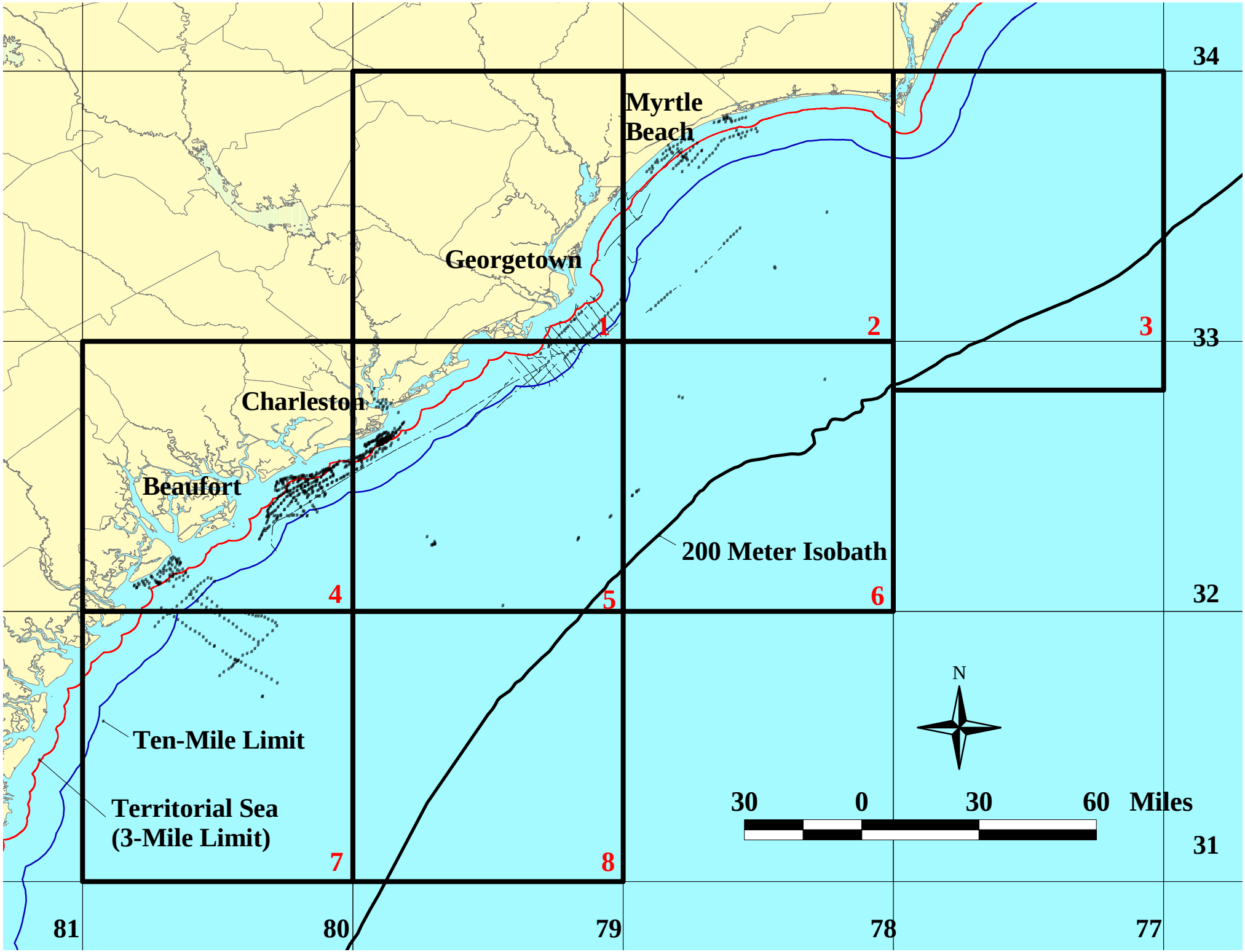

Figure 5: Distribution of records that have information on maximum sediment thickness. See Appendix C for additional information on subzones 1-8.

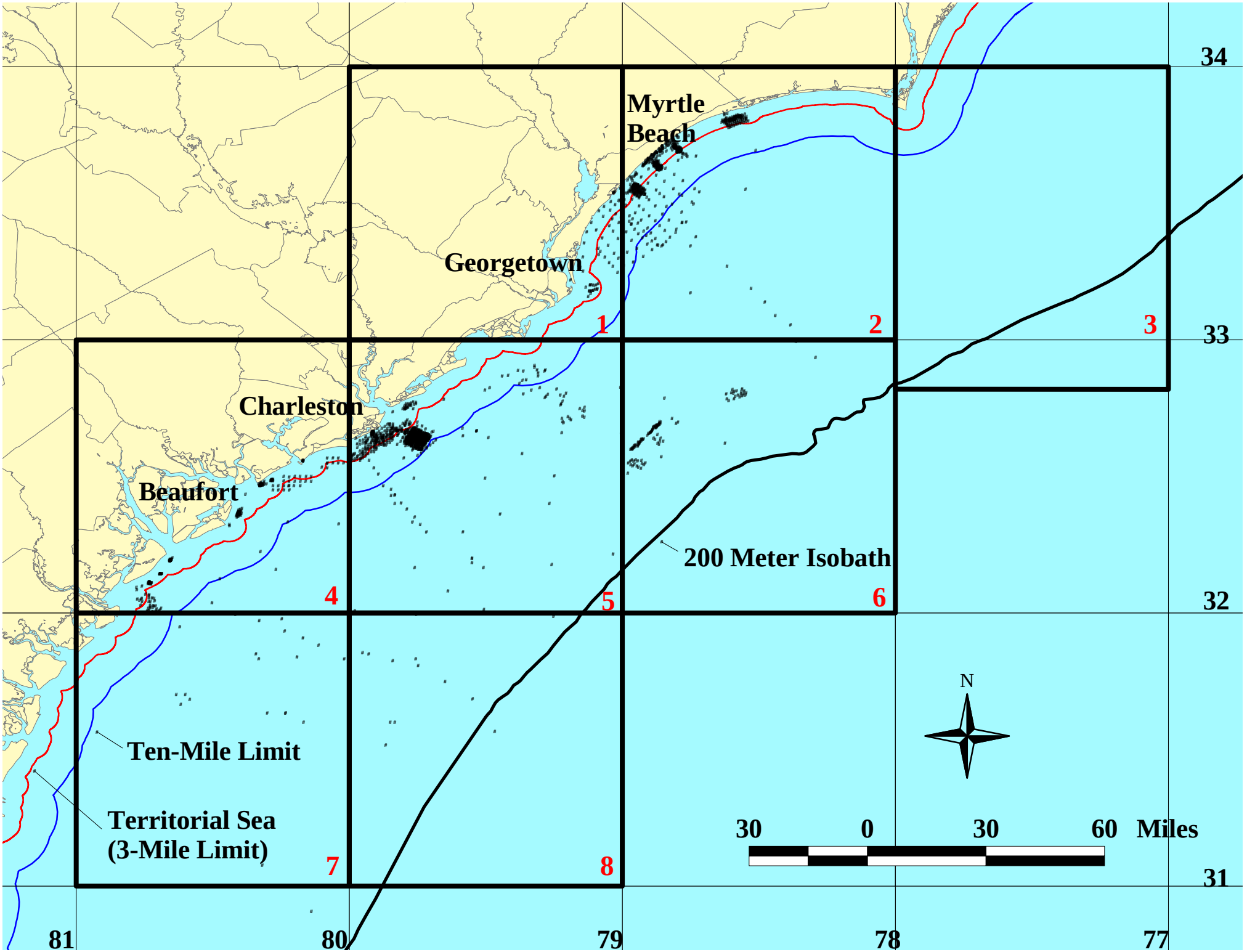

Figure 6: Distribution of records that have information on percent sand. See Appendix D for additional information on subzones 1-8.

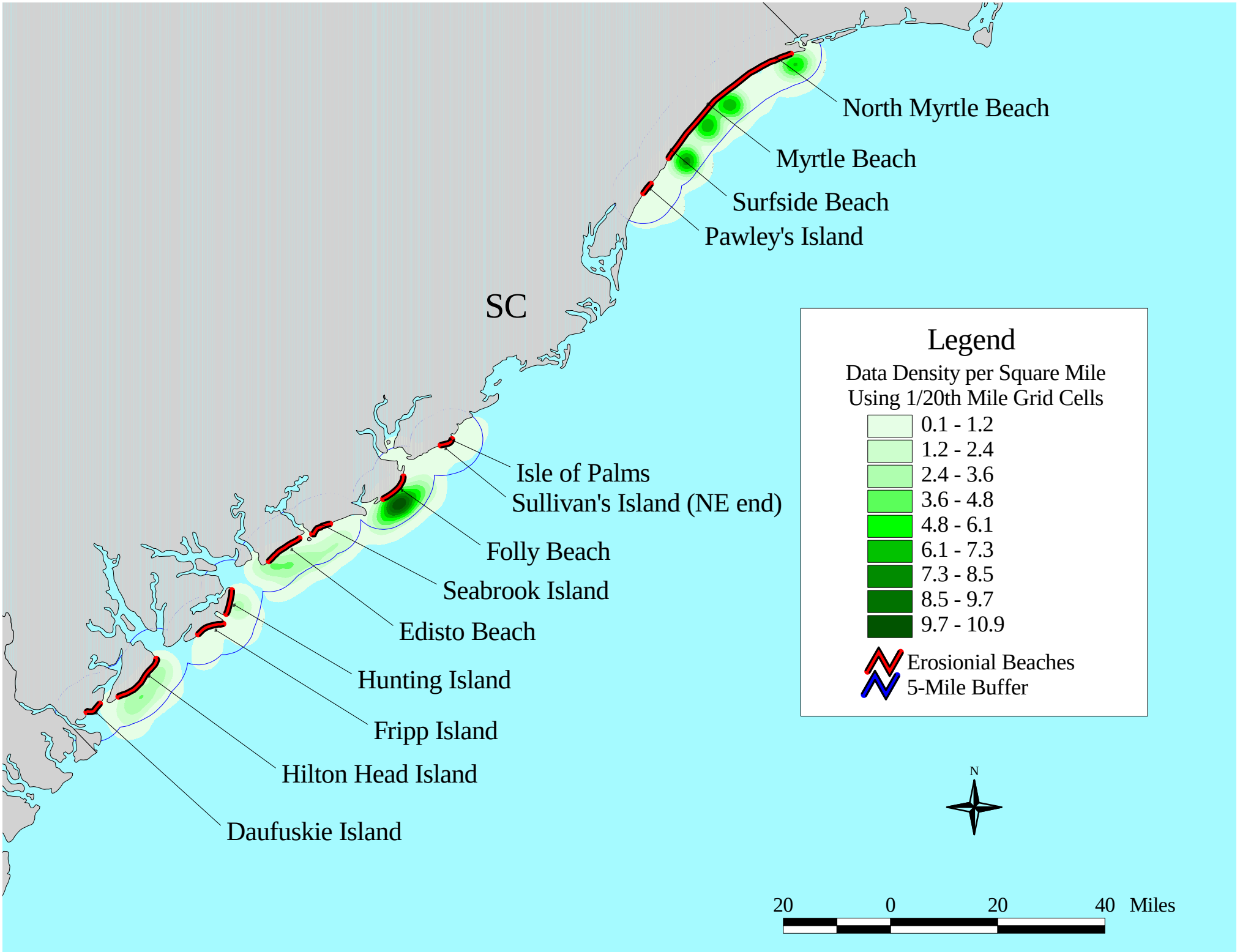

Figure 7: Overall density of data records near each of the state's erosional beaches

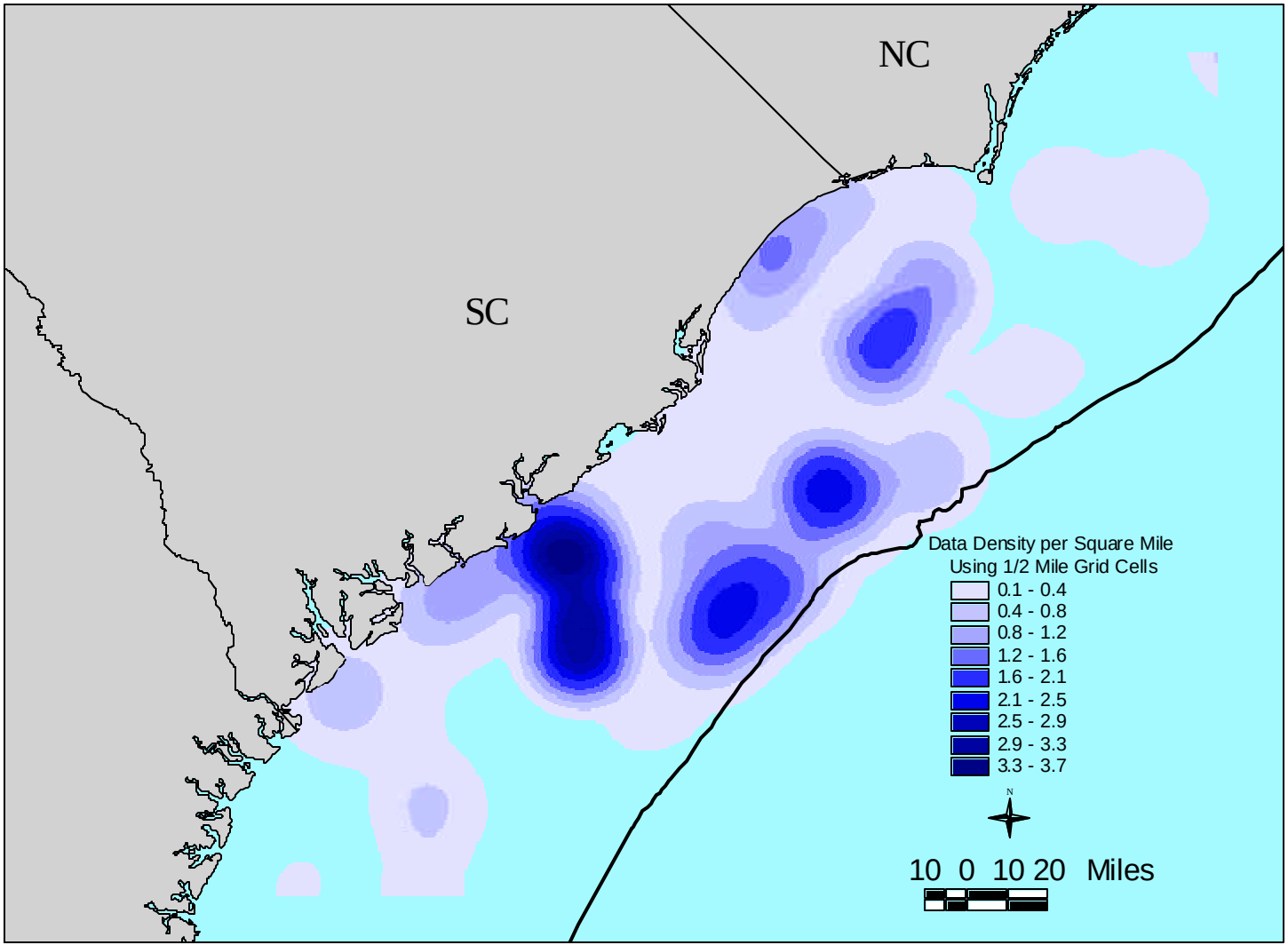

Figure 8: Relative density of data records over the entire continental shelf off South Carolina

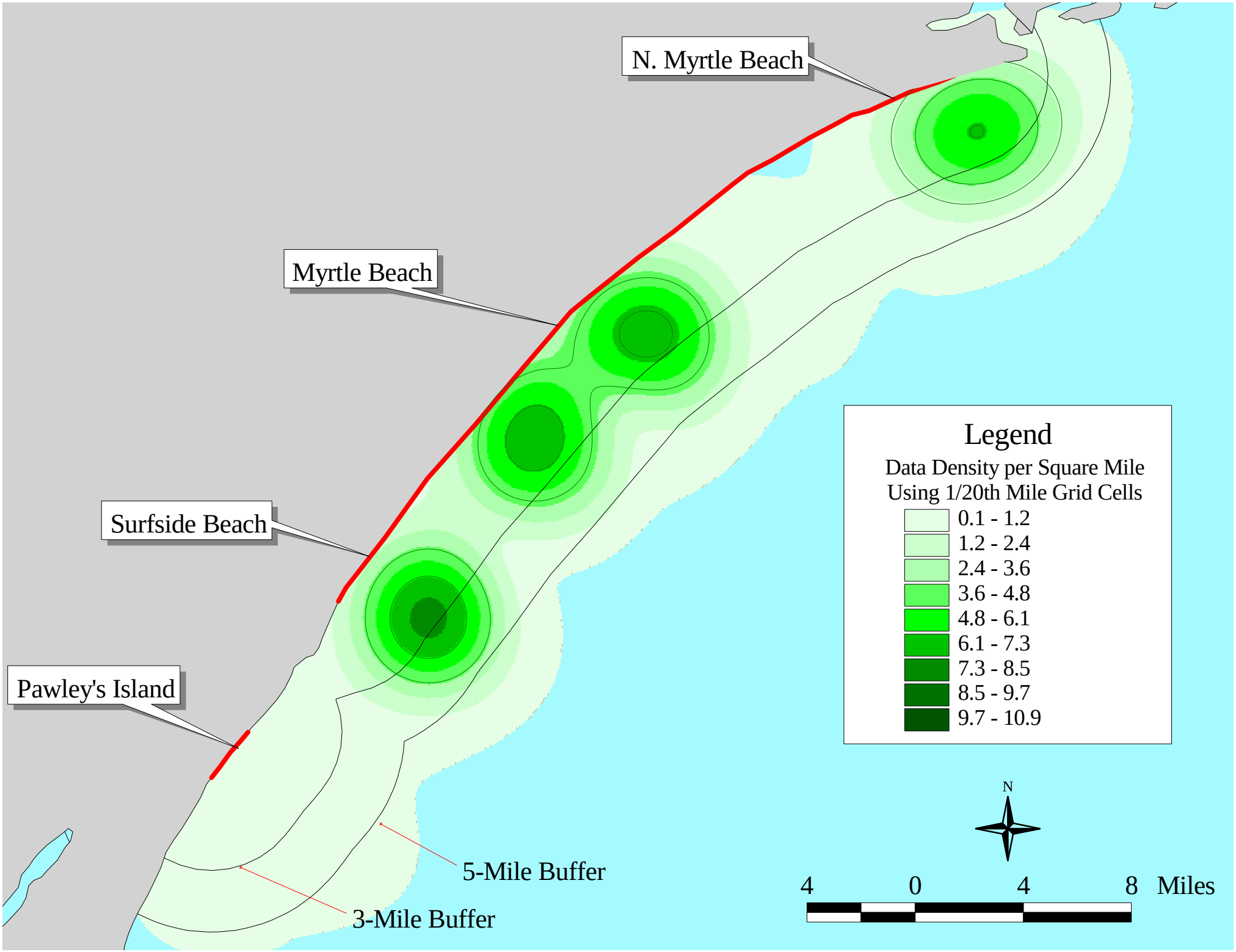

Figure 9: Density of data records along the northern region of the South Carolina coast

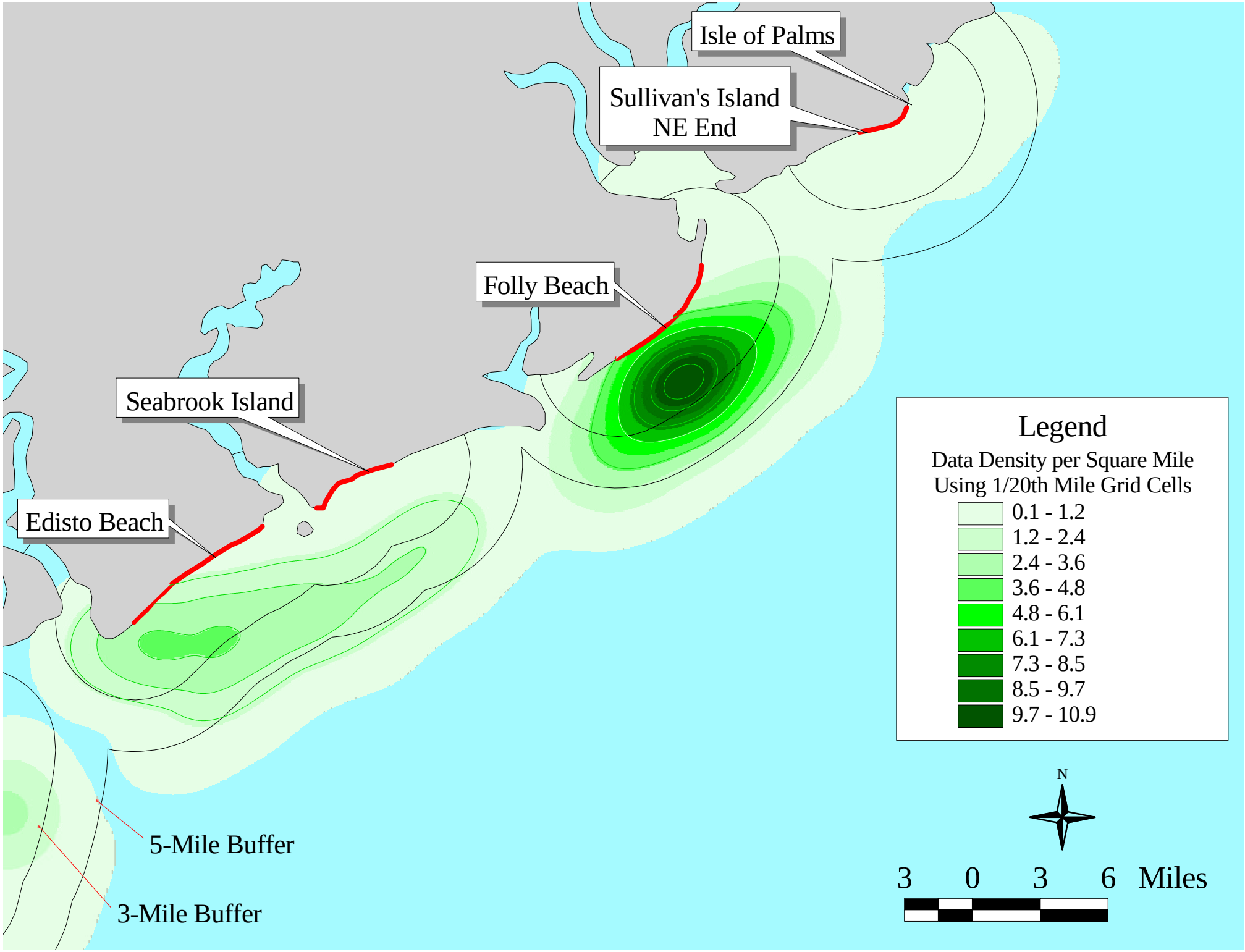

Figure 10: Density of data records along the central region of the South Carolina coast

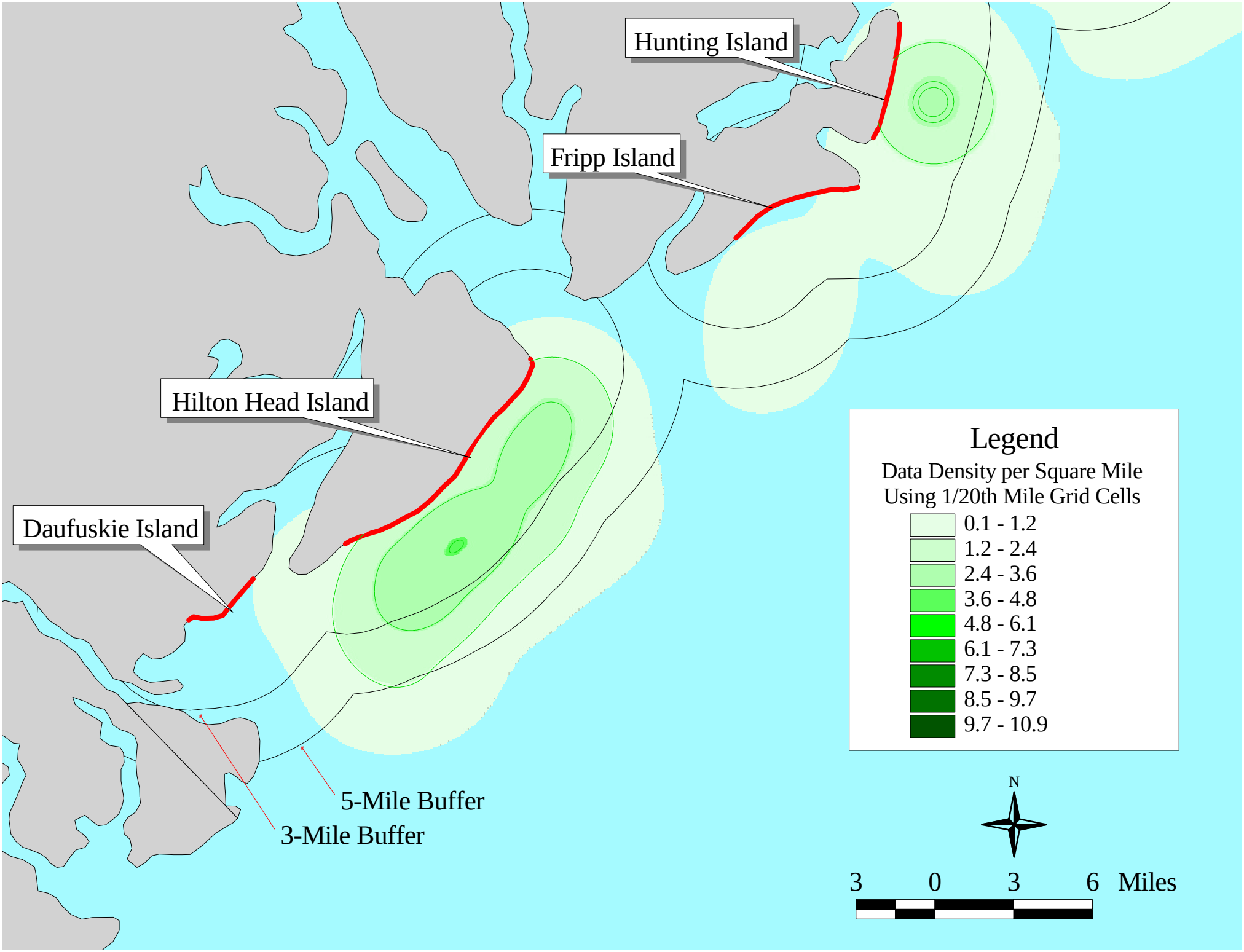

Figure 11: Density of data records along the southern region of the South Carolina coast

Acknowledgements

We wish to thank several individuals who contributed to the compilation of the database used for this report. Members of the South Carolina Task Force on Offshore Resources worked cooperatively to develop the initial concept for the database and display characteristics desired, and review a draft of this report. In addition to one of the authors (R. Van Dolah, SC Department of Natural Resources [SCDNR]-Marine Resources Division), these members include Mr. Rick DeVoe (SC Sea Grant Consortium), Mr. Millard Dowd (US Army Corps of Engineers, Charleston District), Mr. Rob Dunlap (SCDNR, Marine Resources Division), Mr. Bill Eiser (SC Department of Health and Environmental Control [SCDHEC]-Office of Ocean and Coastal Resources Management), Dr. Paul Gayes (Coastal Carolina University), Mr. Tony Giordano (Mineral Management Service- International Activities and Marine Minerals Divison [INTERMAR] Division), Ms. Brenda Hockensmith (SCDNR; SCDNR-Land,Water and Conservation Division), Dr. Mike Katuna (University of Charleston), Mr. Roger Pugliese (South Atlantic Fishery Management Council), Mr. Mark Williams (SCDNR- Land, Water and Conservation Division), and both Mr. Alan Zupan and Mr. Ralph Willoughby (South Carolina Geological Survey).

Data from many studies were compiled to display the data depicted in this report. Those data sources can be found in the INTERMAR database files. Much of the more recent data were obtained through various offshore surveys by Dr. Paul Gayes and his staff at the Center for Marine and Wetland Studies at Coastal Carolina University through funding largely provided by South Carolina-MMS Offshore Resource Cooperative funded through the MMS-INTERMAR Division. Ms. Pat Donovan-Ealy at the CMWS was especially helpful in compiling much of the geological records presented.

The INTERMAR database and this report could not have been completed without the generous support of the Minerals Management Service INTERMAR Divison through the SC-MMS Offshore Resource Cooperative Agreement (No. 14-35-0001-30679). We would particularly like to thank Mr. Tony Giordano, who serves as the Contracting Officer for the South Carolina – MMS Cooperative, and Ms. Carol Hartgen, who is Chief of the INTERMAR Division for their continued support of our program.

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Appendices

Appendix A: Bottom-type plots in subzones 1-8 showing hard-bottom, possible hard-bottom, and no hard-bottom reef habitat where data exist.

Appendix B: Plots showing mean grain size in subzones 1-8 where data exist.

Appendix C: Plots showing maximum sediment thickness in subzones 1-8 where data exist.

Appendix D: Plots showing percent sand in subzones 1-8 where data exist.

Appendix E: Plots showing gear type in areas 1-8 where data exist.

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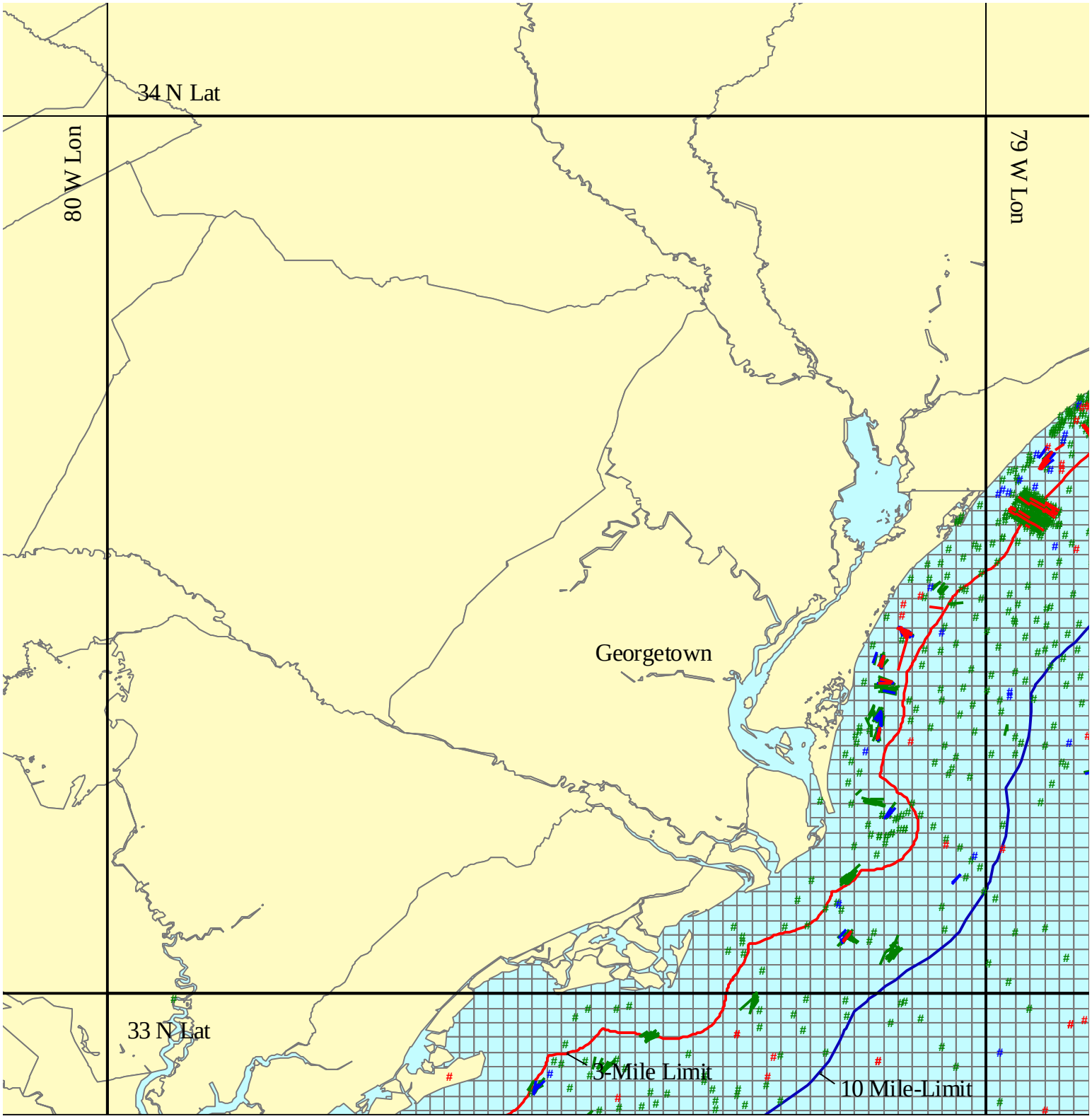

LEGEND

- Hard-Bottom
- Possible Hard-Bottom
- No Evidence of Hard-Bottom

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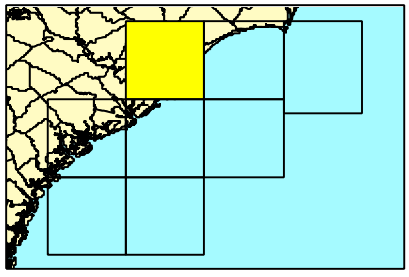
MMS-INTERMAR
Bottom Type Mapping



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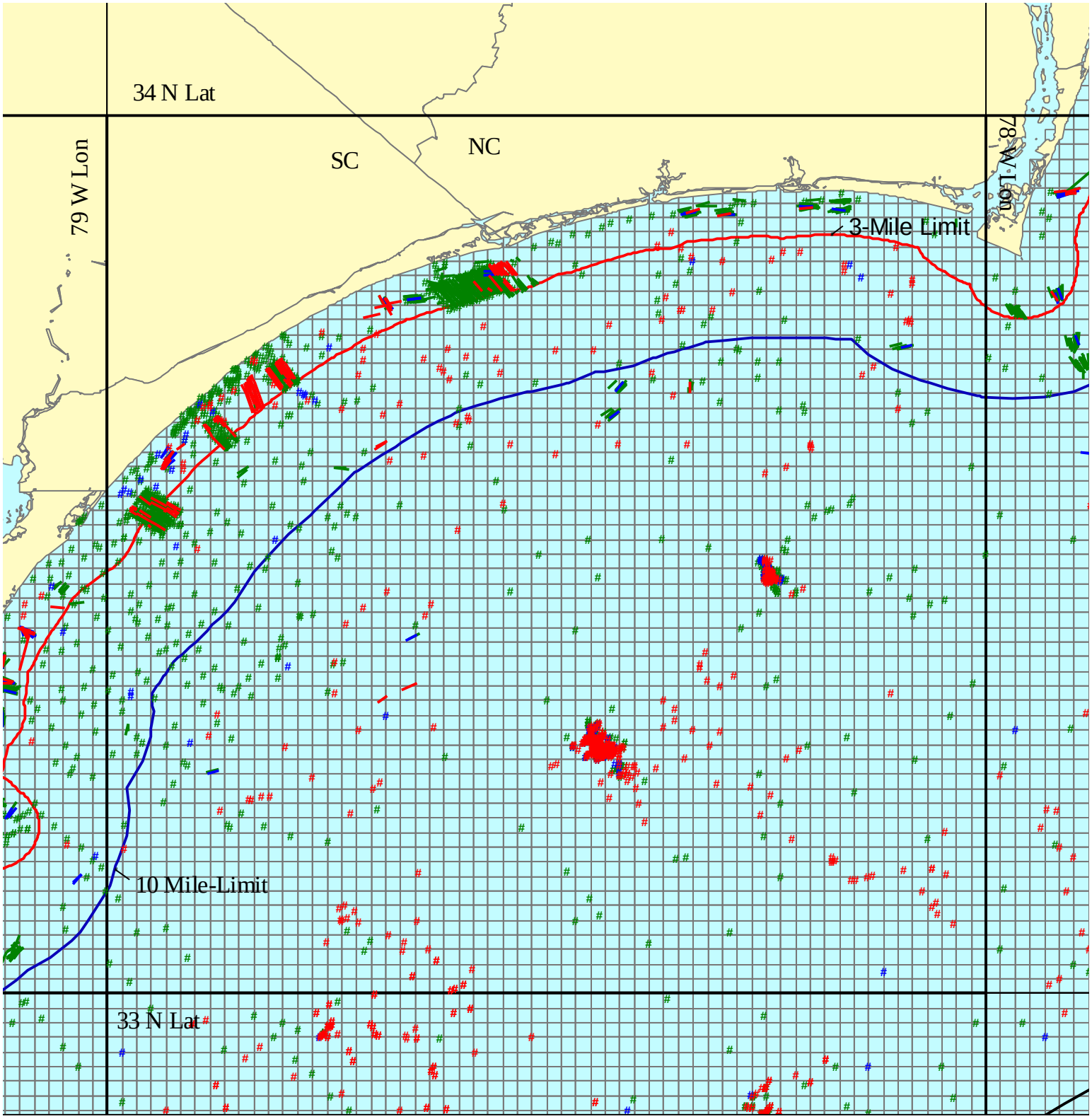

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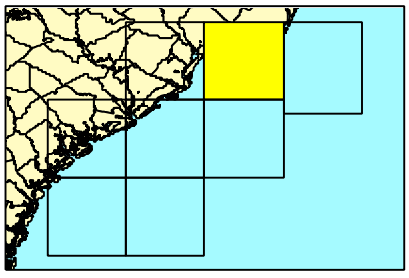

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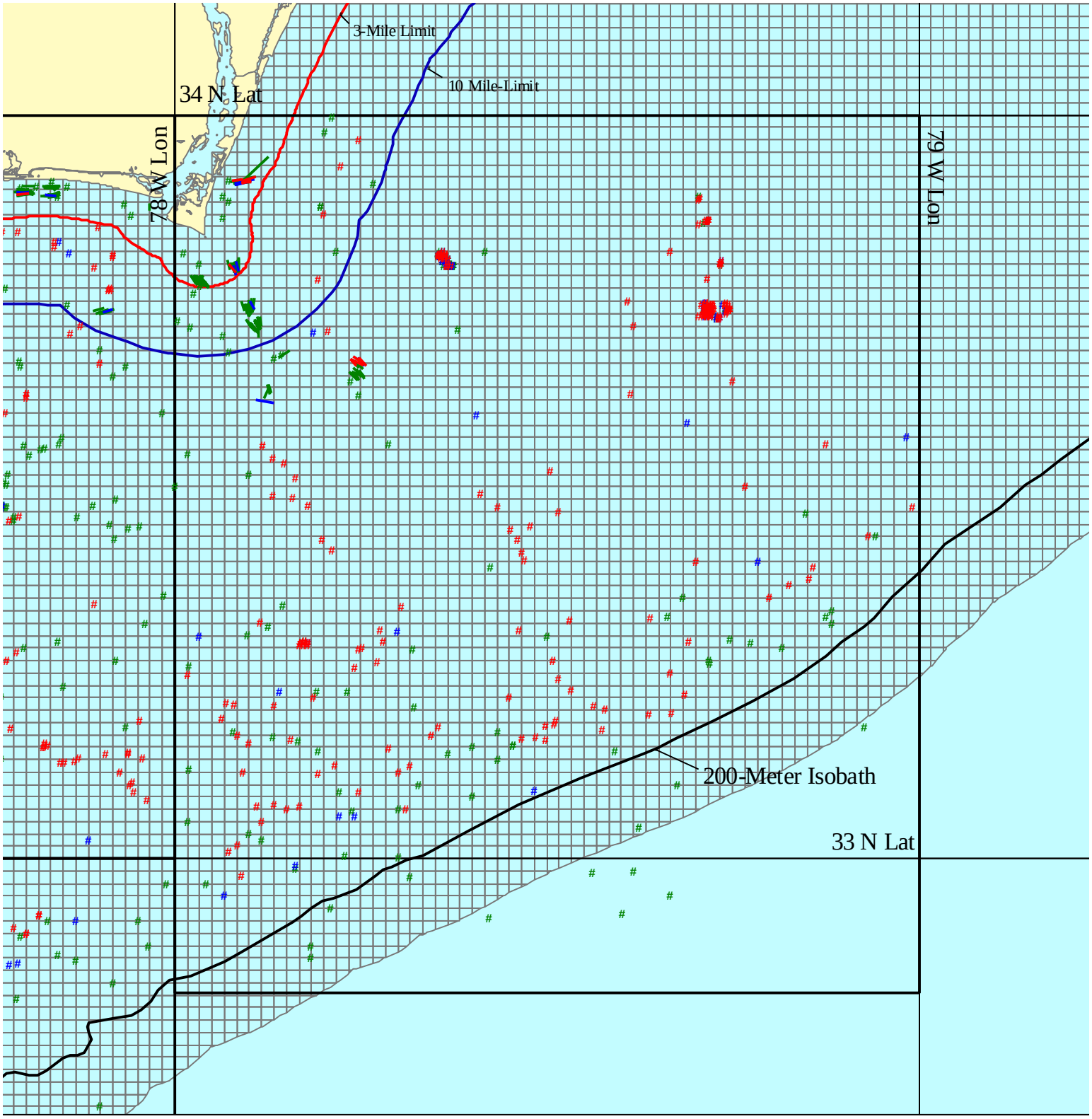

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MMS-INTERMAR
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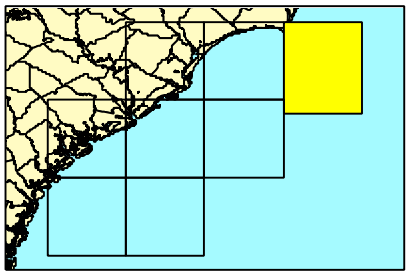

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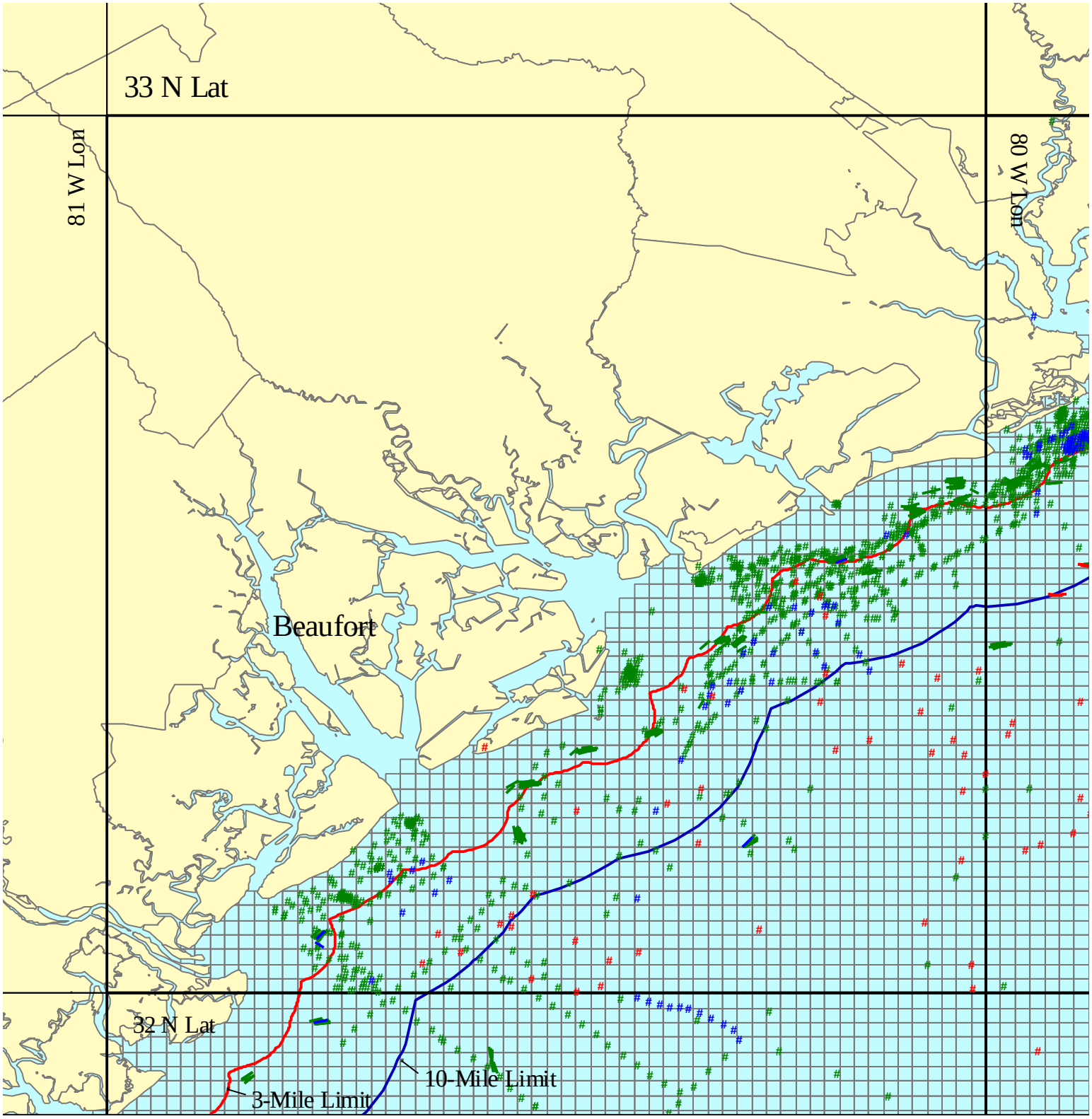

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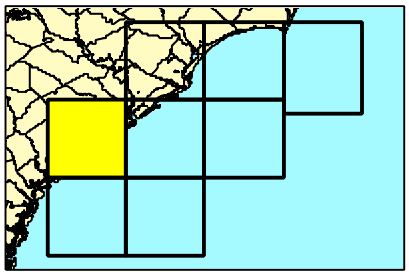

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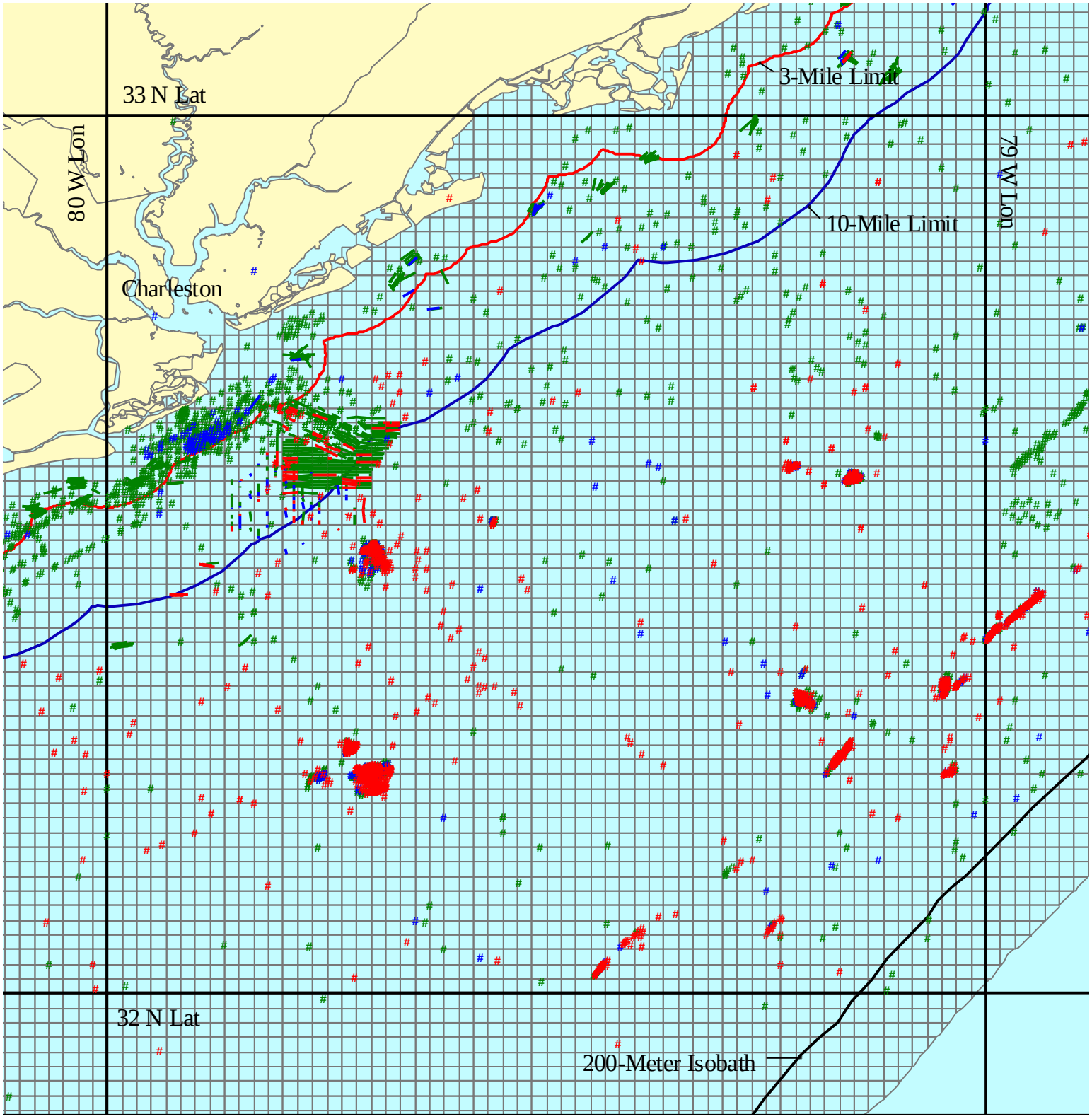

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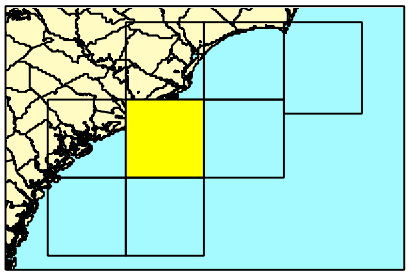

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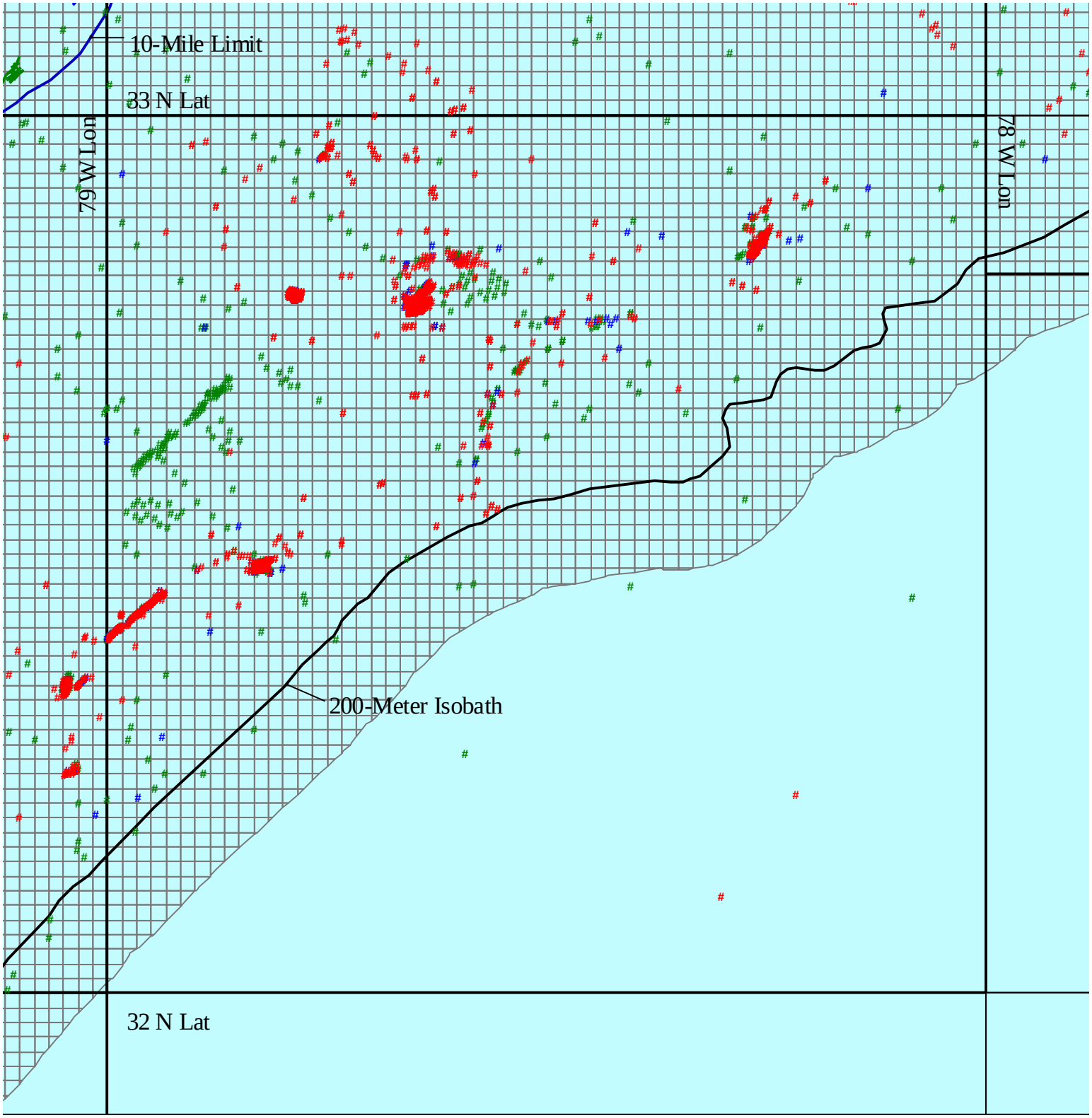

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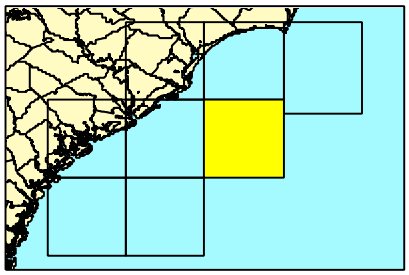
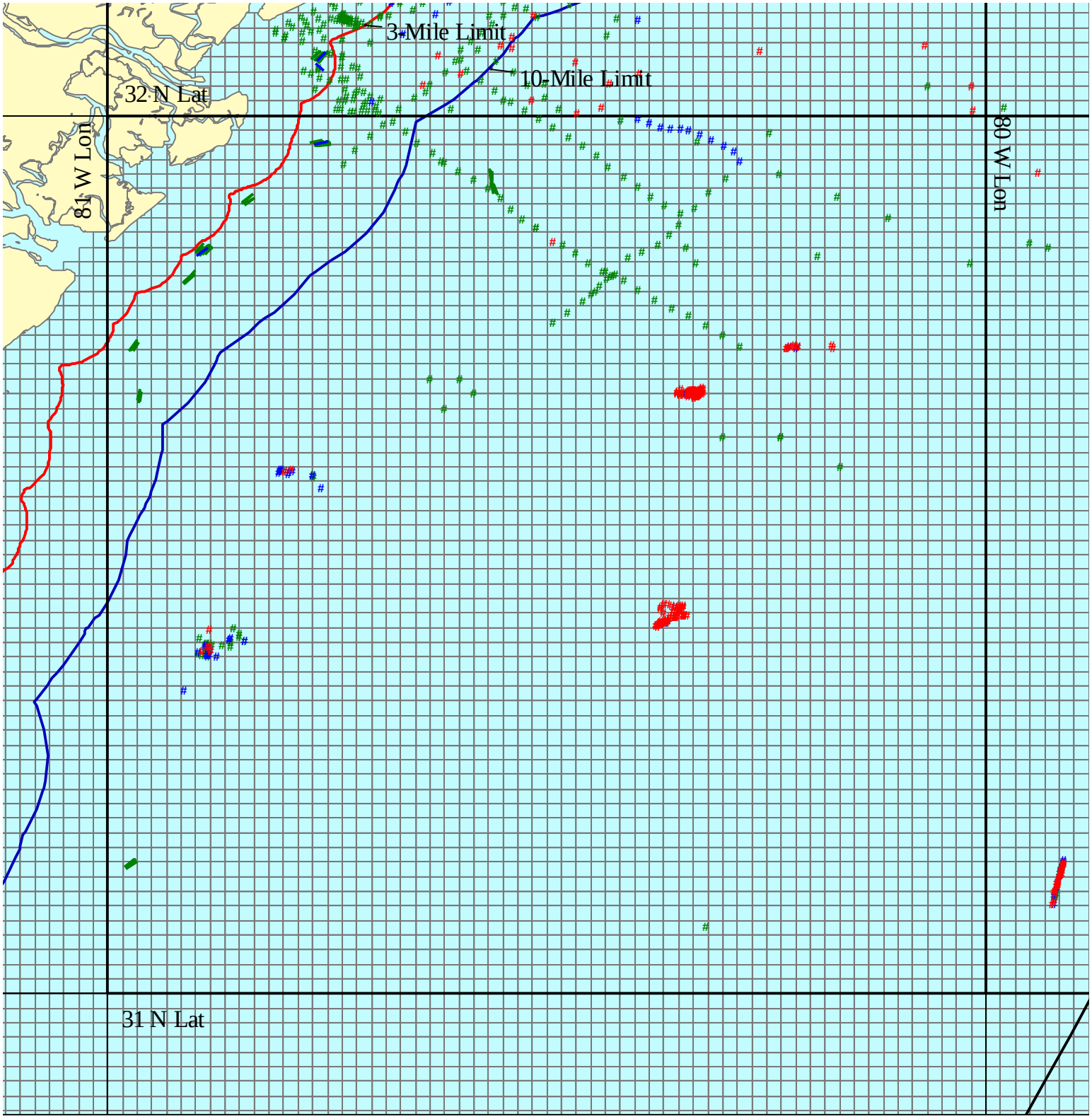


6 0 6 12 18 Miles

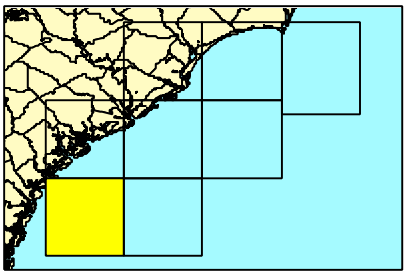


LEGEND

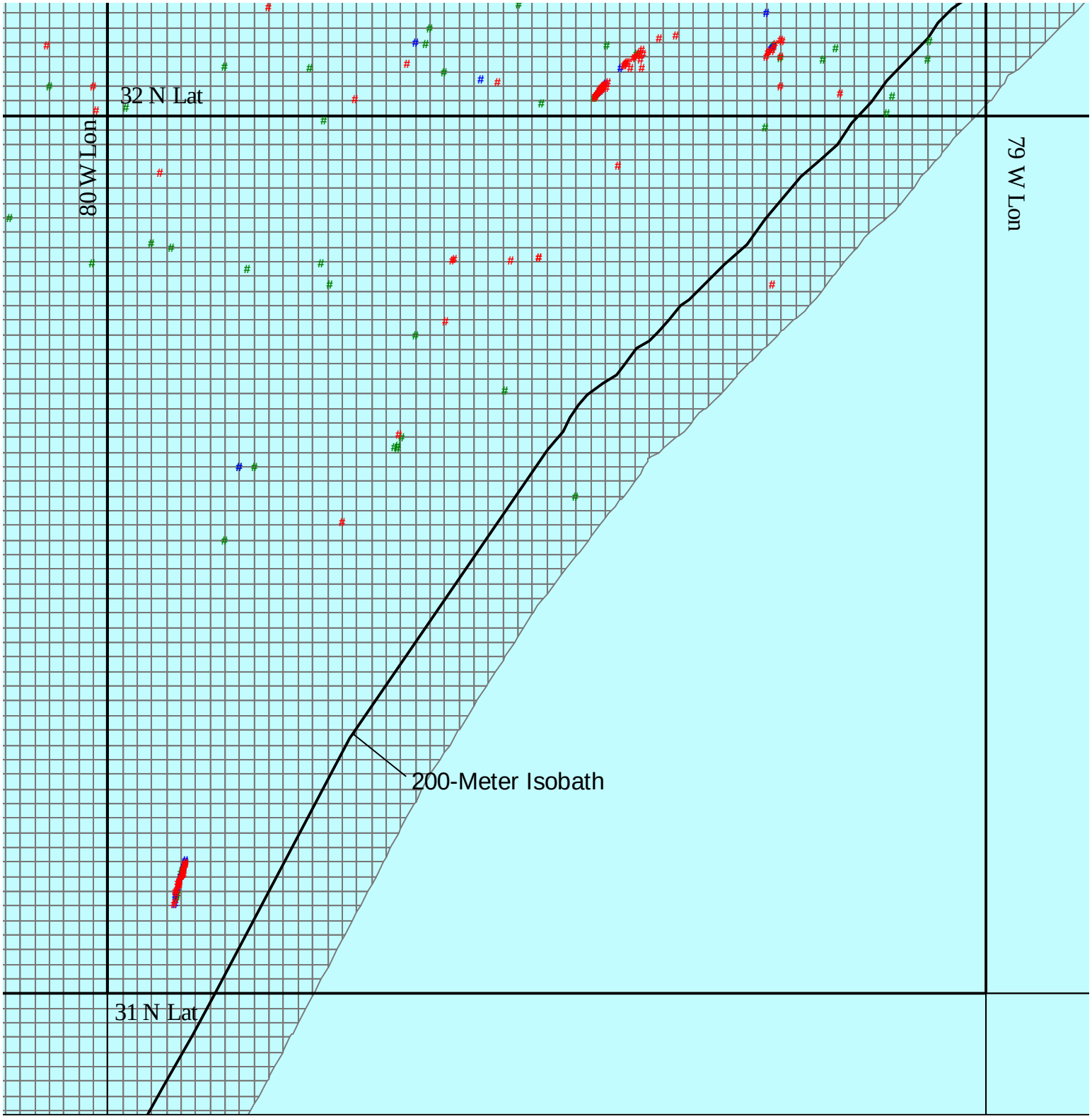
- Hard-Bottom
- Possible Hard-Bottom
- No Evidence of Hard-Bottom

N

MMS-INTERMAR
Bottom Type Mapping



6 0 6 12 18 Miles

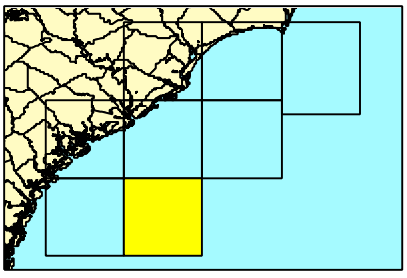


LEGEND

- Hard-Bottom
- Possible Hard-Bottom
- No Evidence of Hard-Bottom

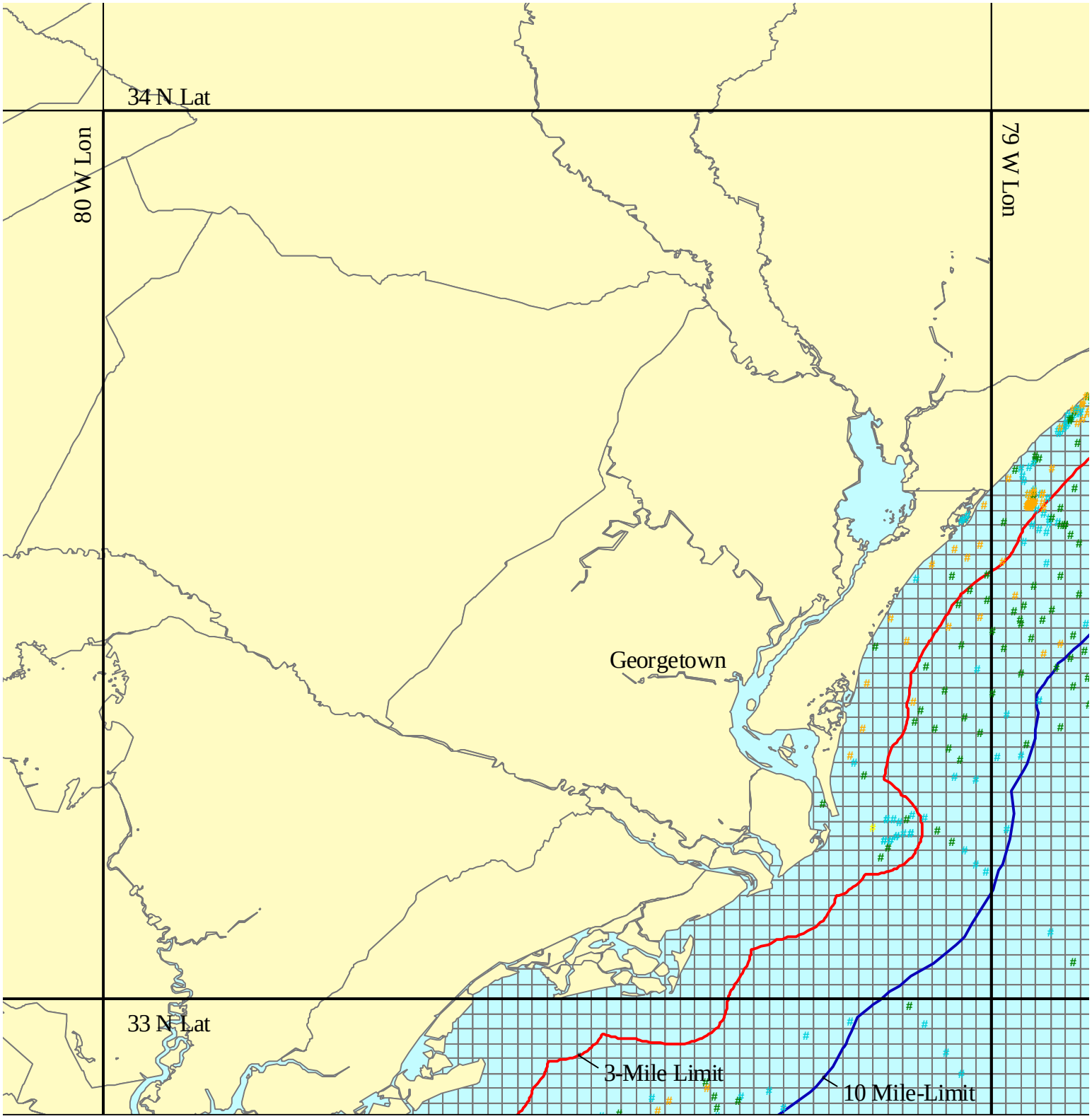
N

MMS-INTERMAR
Bottom Type Mapping



6 0 6 12 18 Miles

Appendix B: Plots showing mean grain size in subzones 1-8 where data exist.

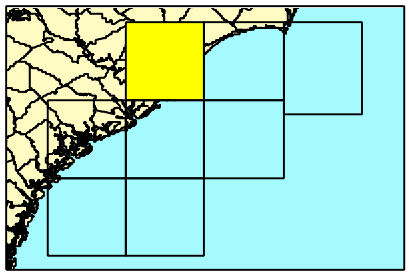


LEGEND

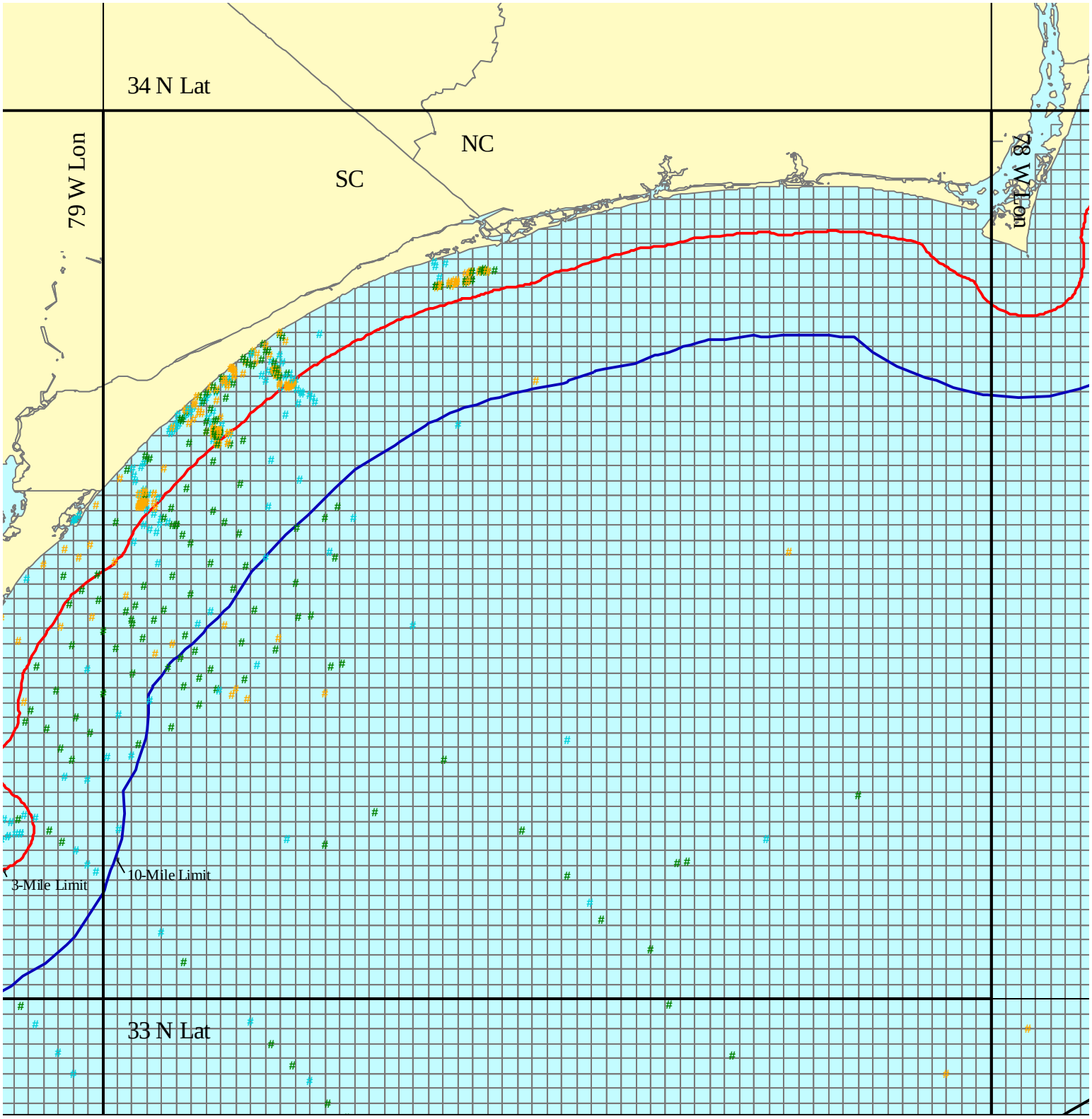
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- >1 phi to 2 phi (medium)
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

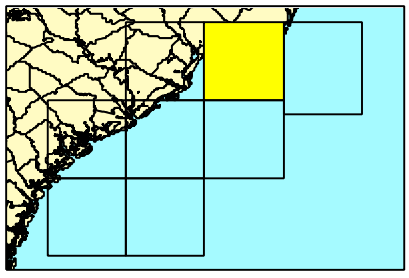


LEGEND

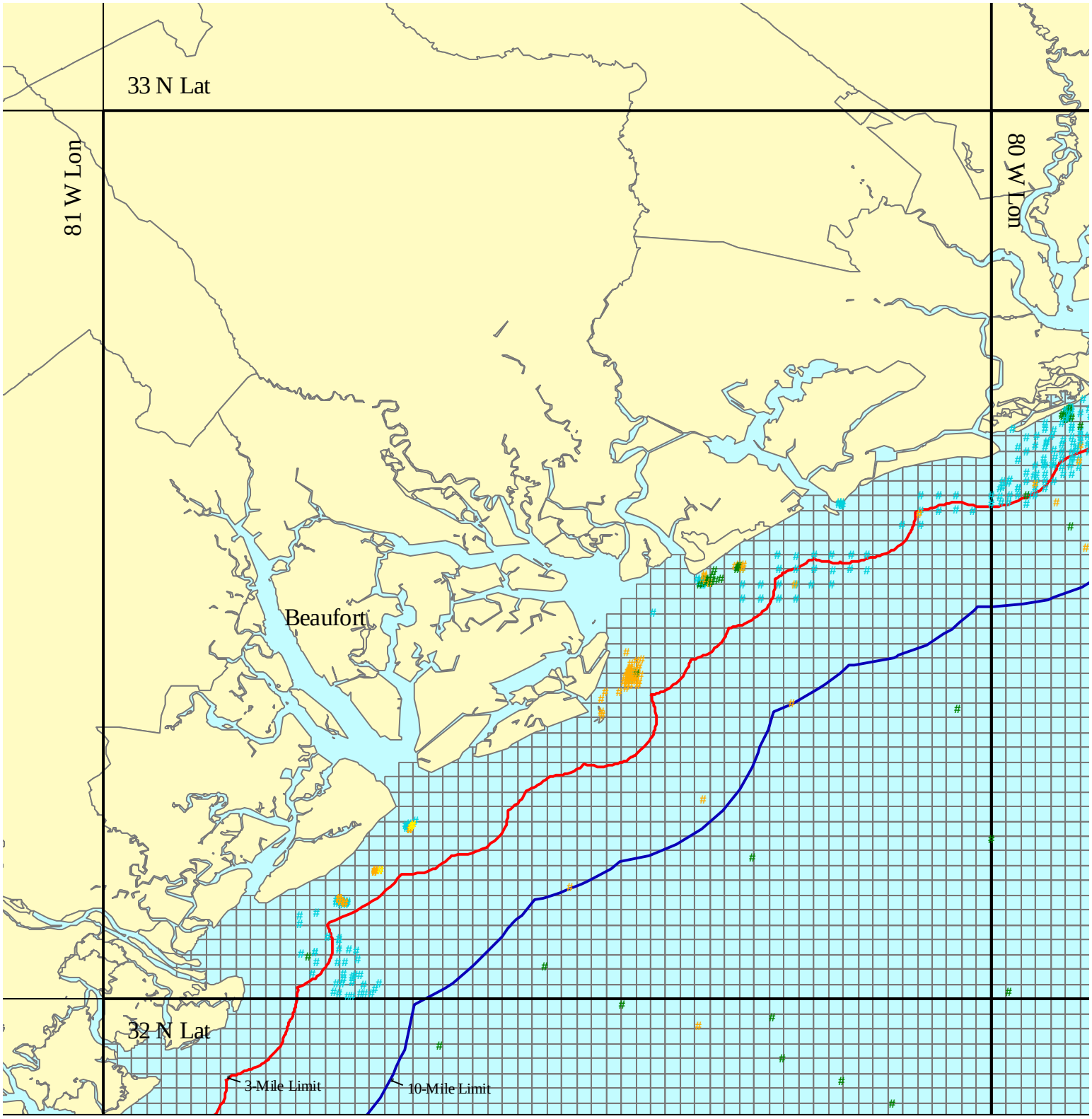
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- >1 phi to 2 phi (medium)
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

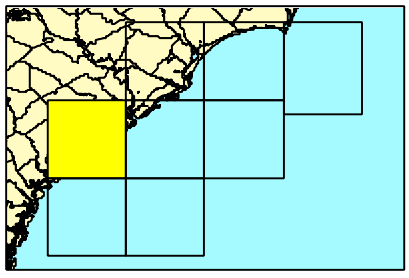


LEGEND

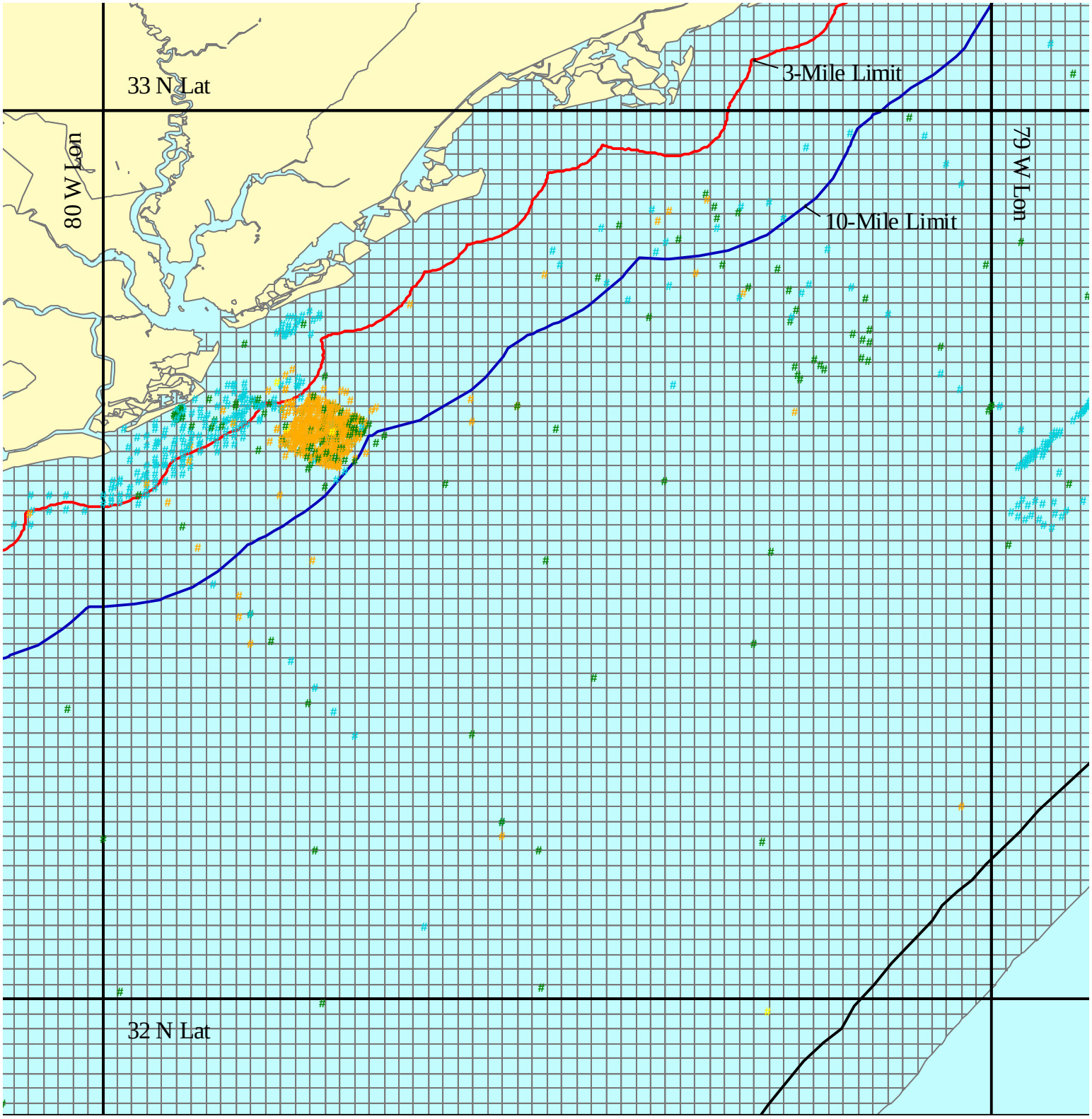
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- >1 phi to 2 phi (medium)
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

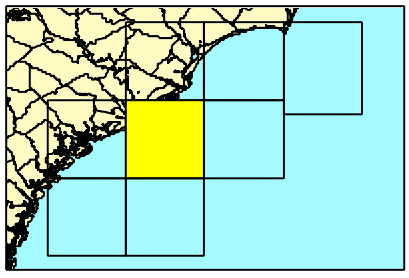


LEGEND

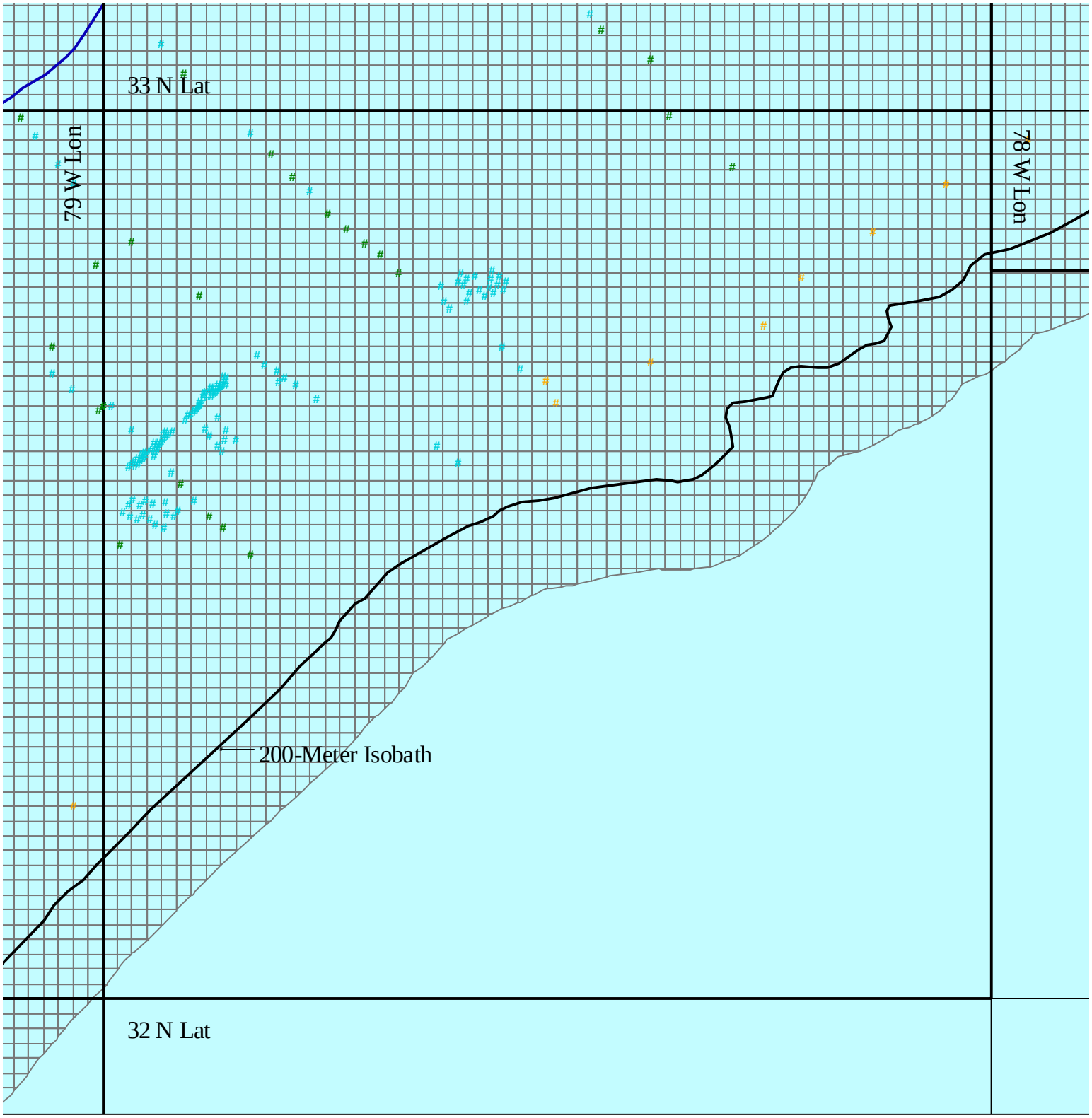
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- >1 phi to 2 phi (medium)
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

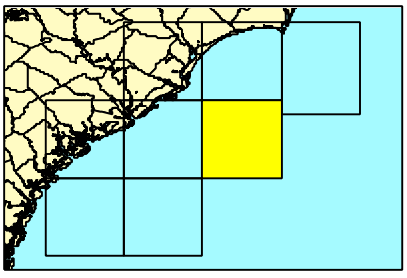


LEGEND

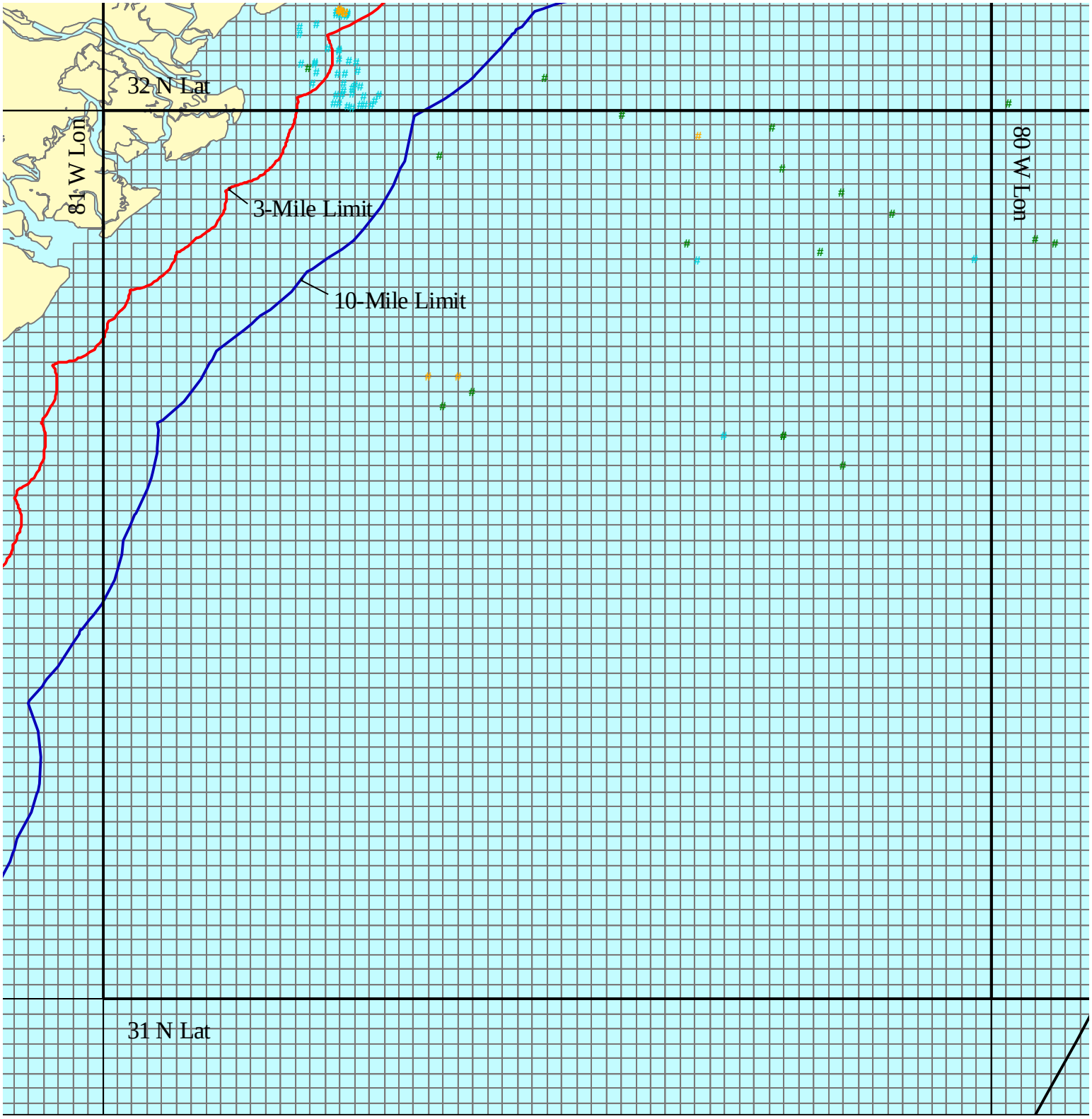
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- all pnt and line data by zones
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

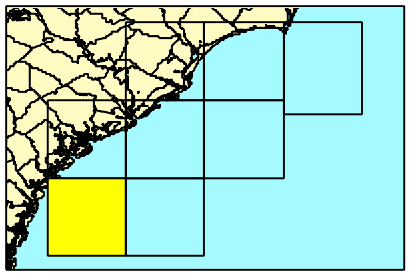


LEGEND

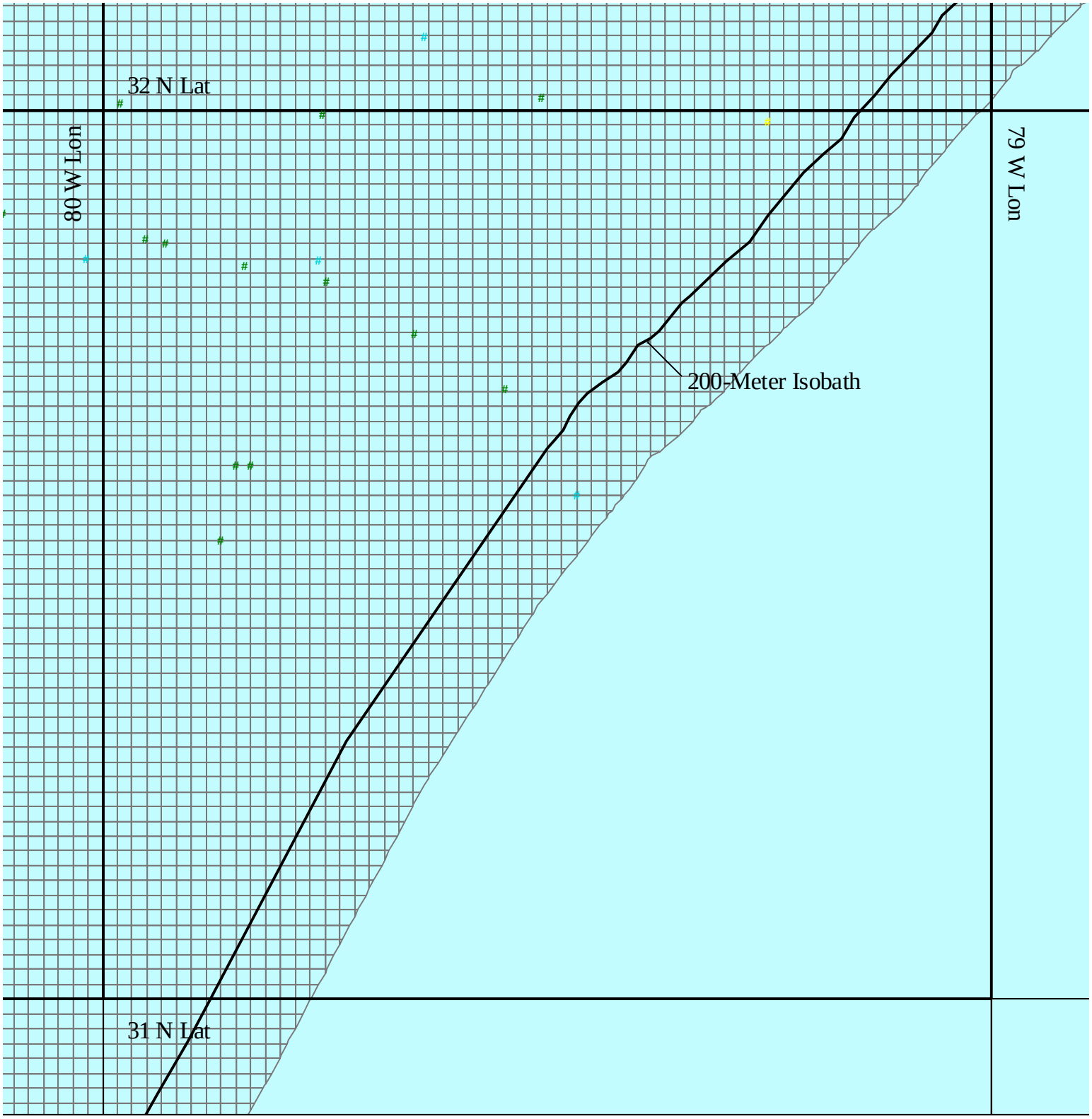
- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- all pnt and line data by zones
- >0 phi to 1 phi (coarse)

N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

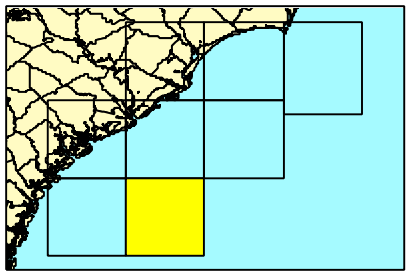


LEGEND

- >3 phi to 4 phi (very fine)
- >2 phi to 3 phi (fine)
- all pnt and line data by zones
- >0 phi to 1 phi (coarse)

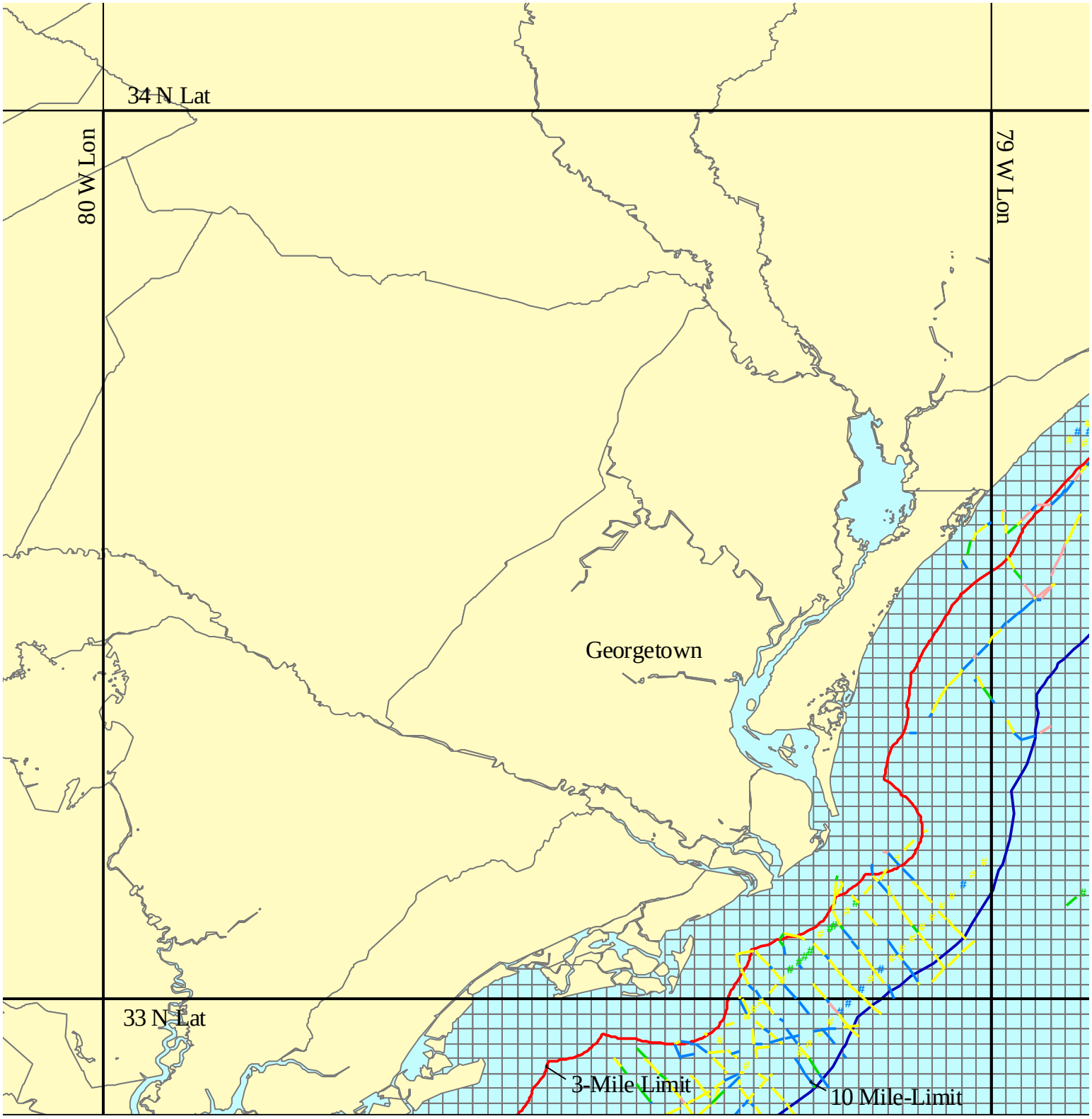
N

MMS-INTERMAR
Mean Grain Size



6 0 6 12 18 Miles

Appendix C: Plots showing maximum sediment thickness in subzones 1-8 where data exist.

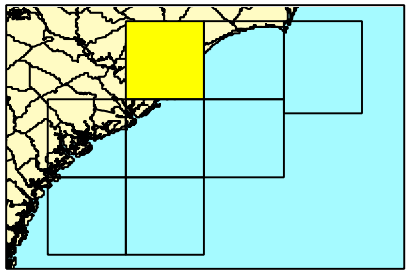


LEGEND

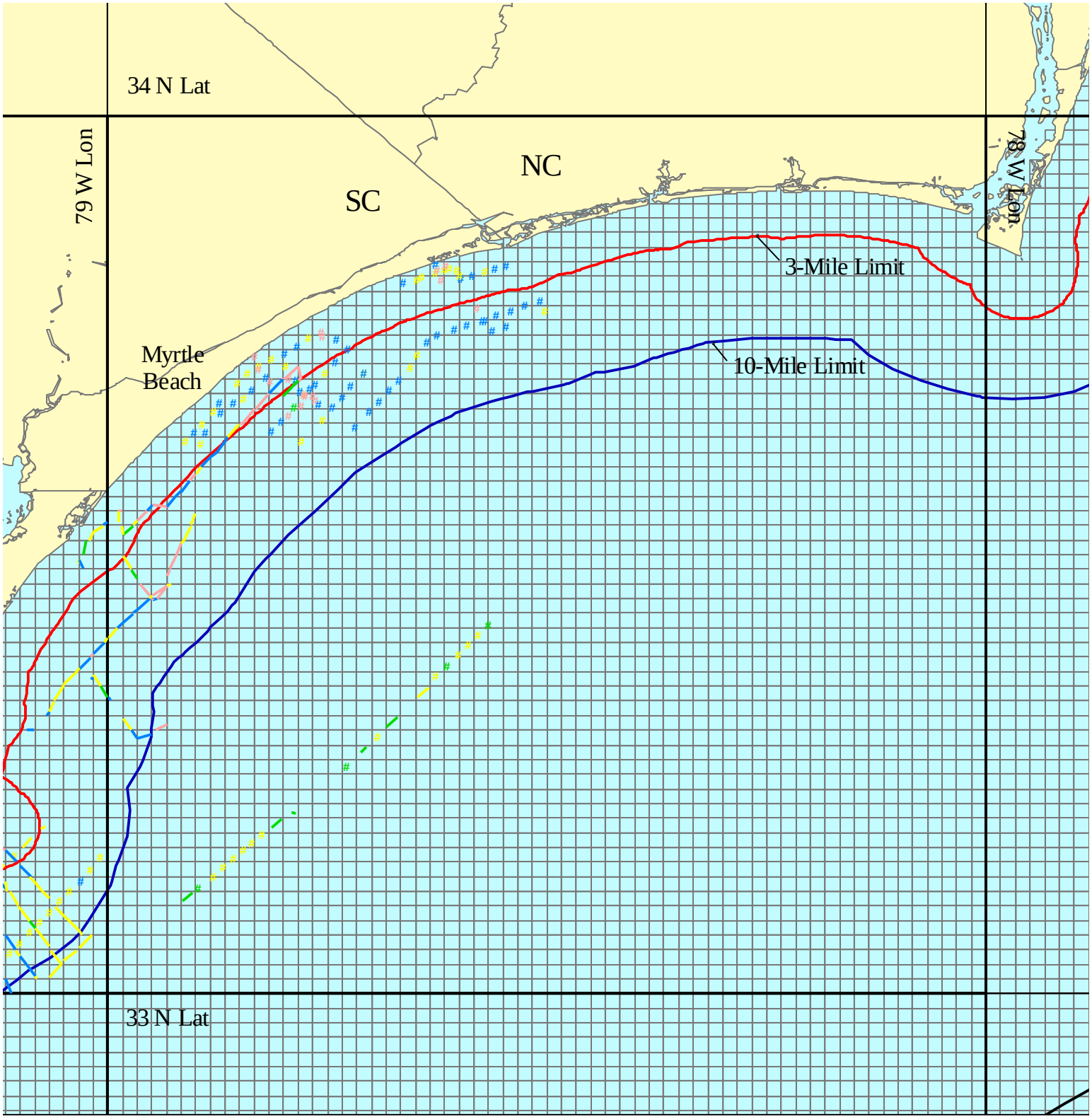
- > 6 Meters
- > 3 and < = 6 Meters
- > 1 and < = 3 Meters
- < = 1 Meter

N

MMS-INTERMAR
Maximium Sediment Thickness



6 0 6 12 18 Miles

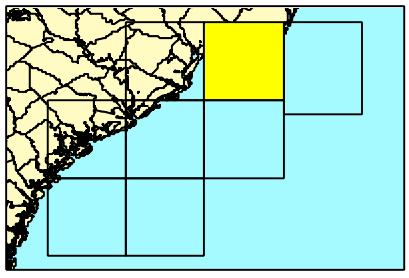


LEGEND

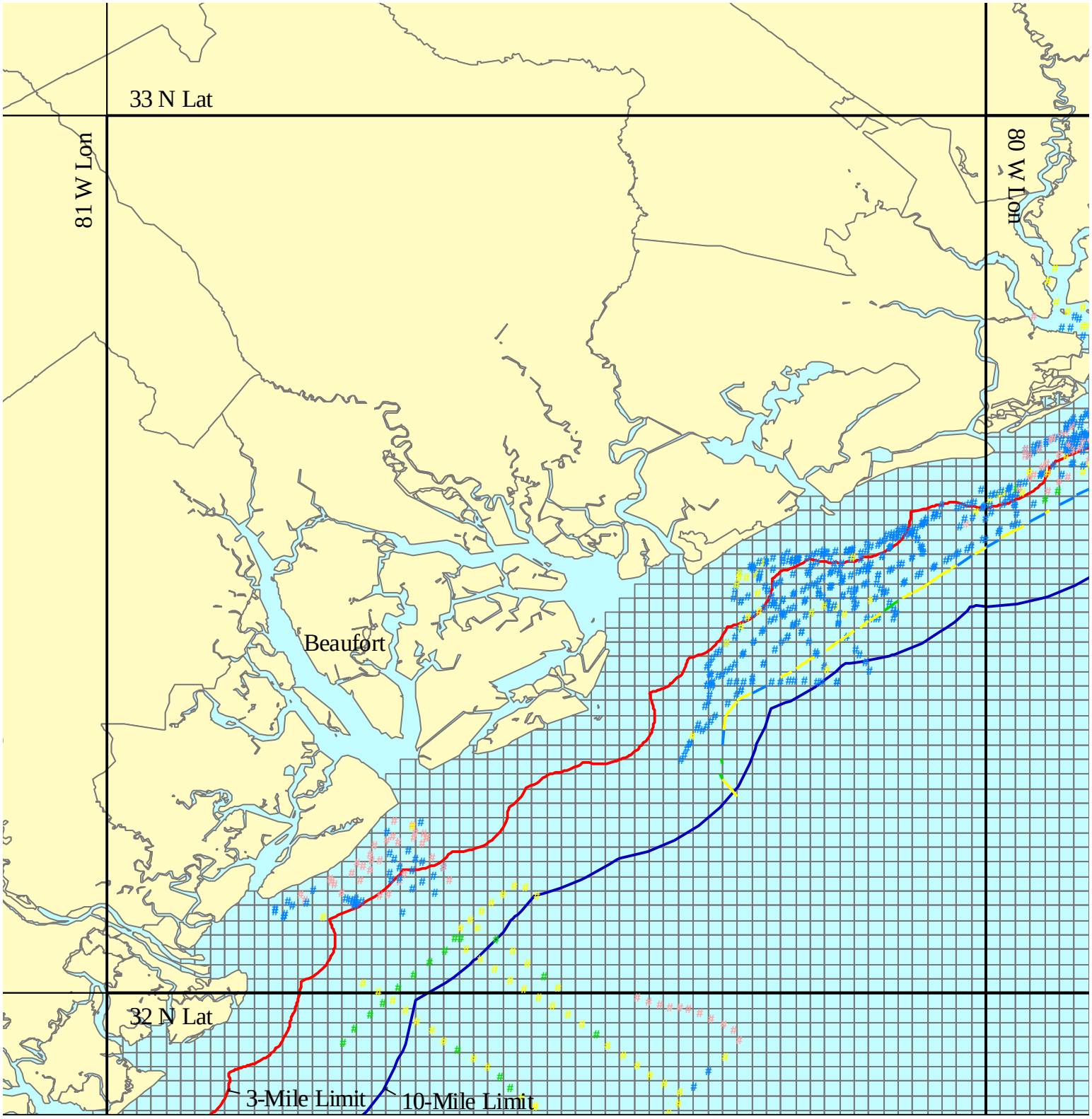
- > 6 Meters
- > 3 and < = 6 Meters
- > 1 and < = 3 Meters
- < = 1 Meter

N

MMS-INTERMAR
Maximium Sediment Thickness



6 0 6 12 18 Miles

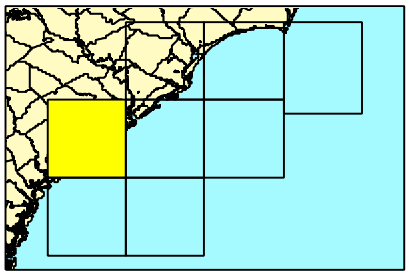


LEGEND

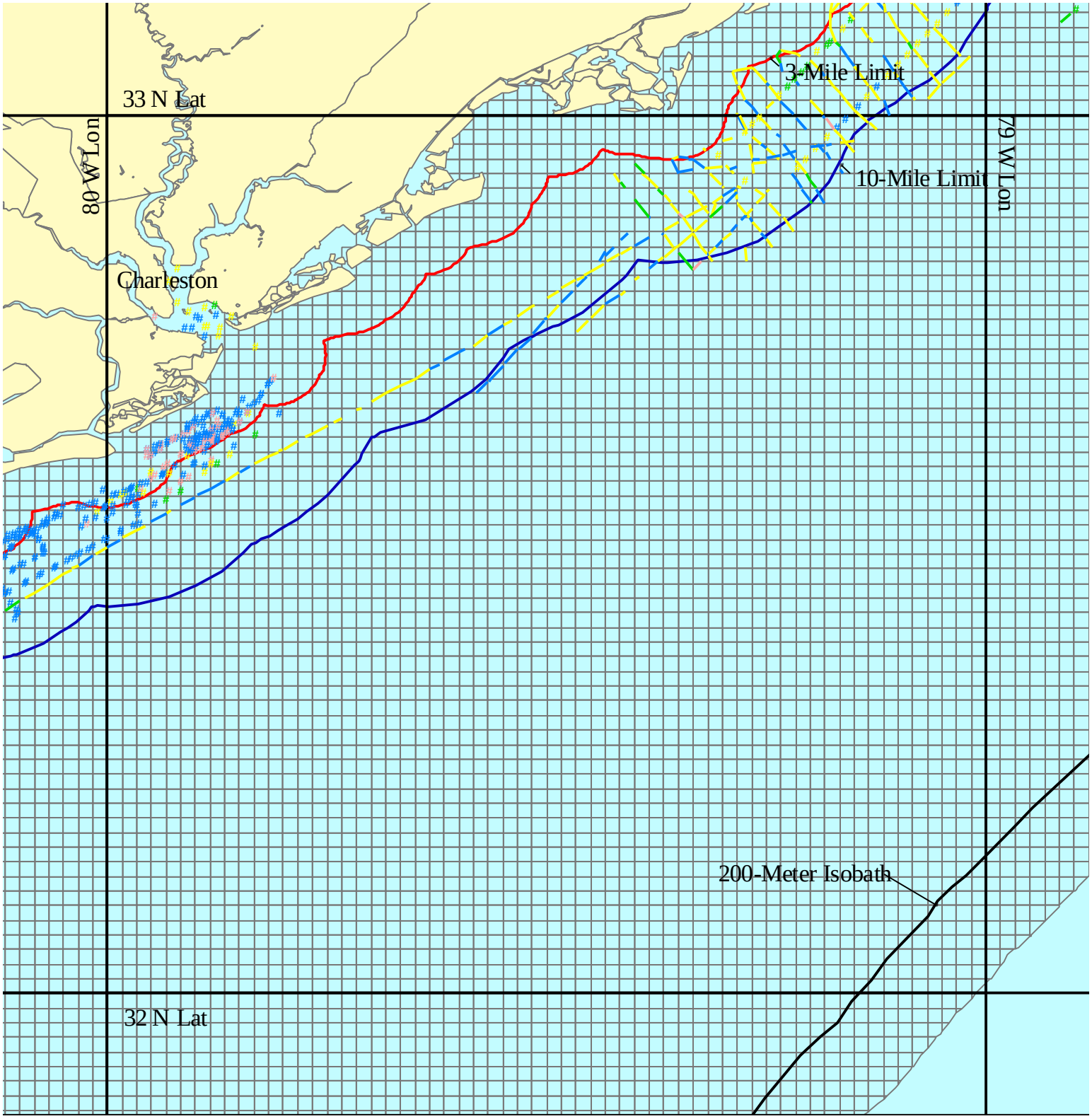
- > 6 Meters
- > 3 and < = 6 Meters
- > 1 and < = 3 Meters
- < = 1 Meter

N

MMS-INTERMAR
Maximium Sediment Thickness



6 0 6 12 18 Miles

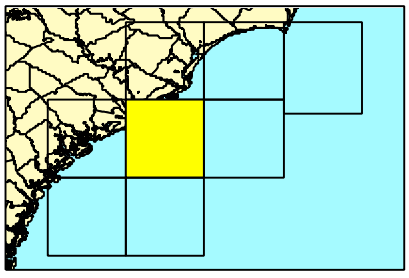


LEGEND

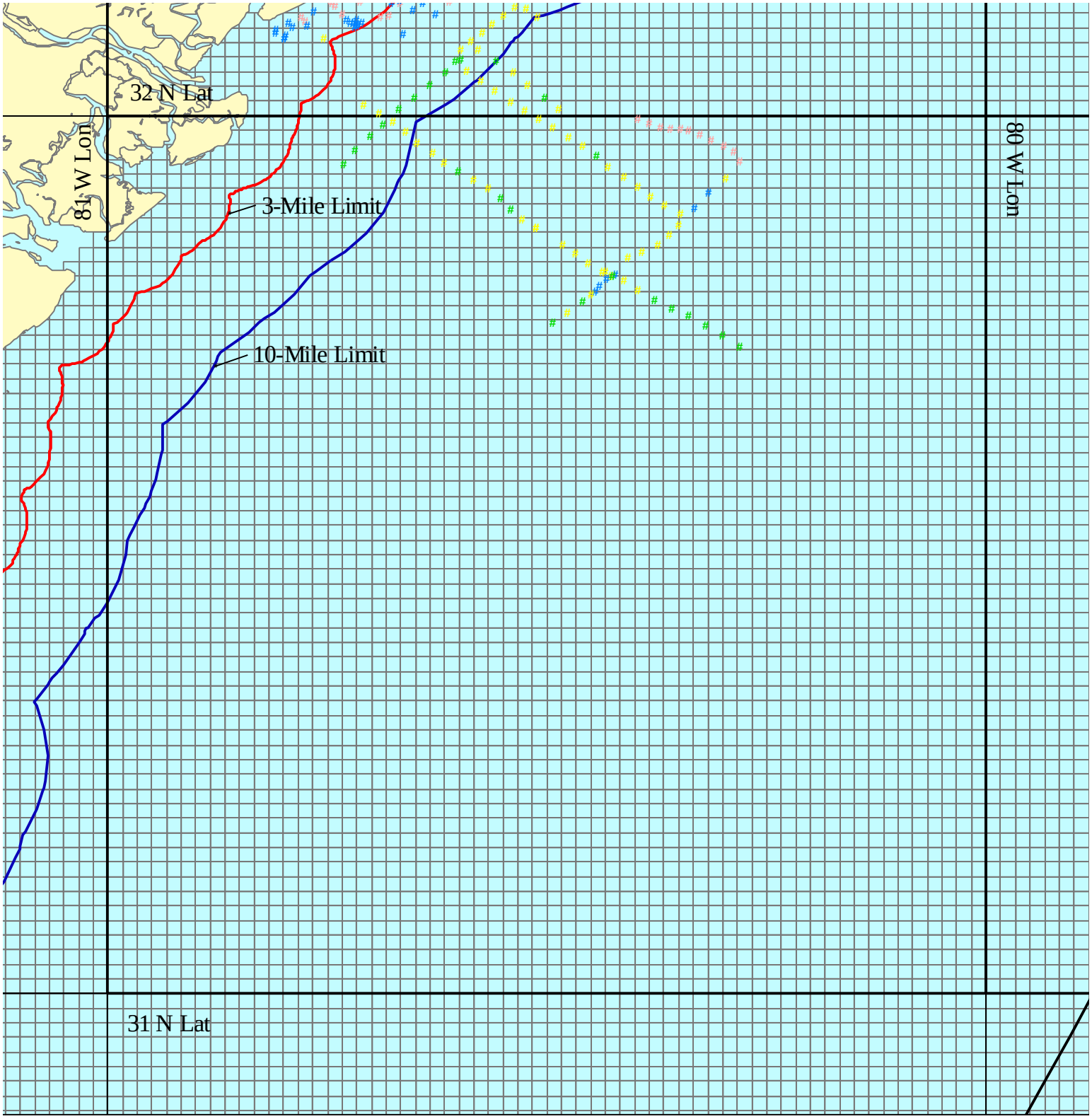
- > 6 Meters
- > 3 and < = 6 Meters
- > 1 and < = 3 Meters
- < = 1 Meter

N

MMS-INTERMAR
Maximium Sediment Thickness



6 0 6 12 18 Miles

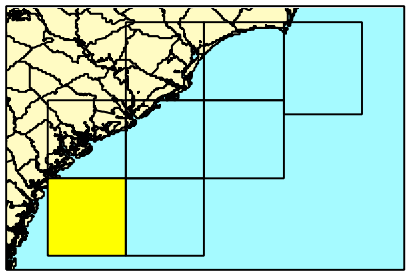


LEGEND

- > 6 Meters
- > 3 and < = 6 Meters
- > 1 and < = 3 Meters
- < = 1 Meter

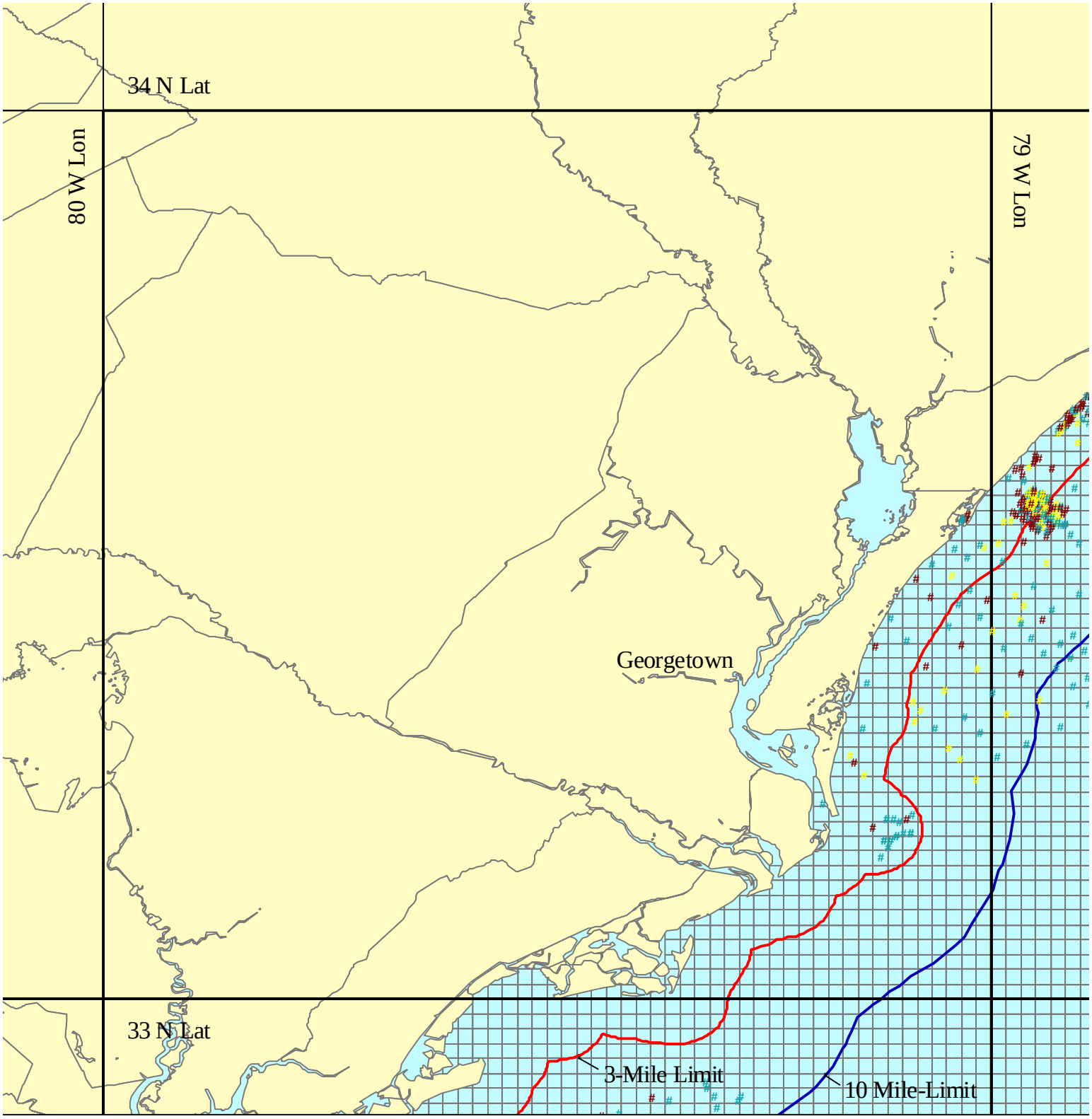
N

MMS-INTERMAR
Maximium Sediment Thickness



6 0 6 12 18 Miles

Appendix D: Plots showing percent sand in subzones 1-8 where data exist.

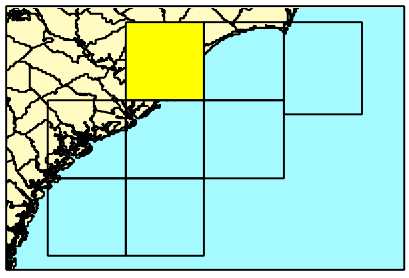


LEGEND

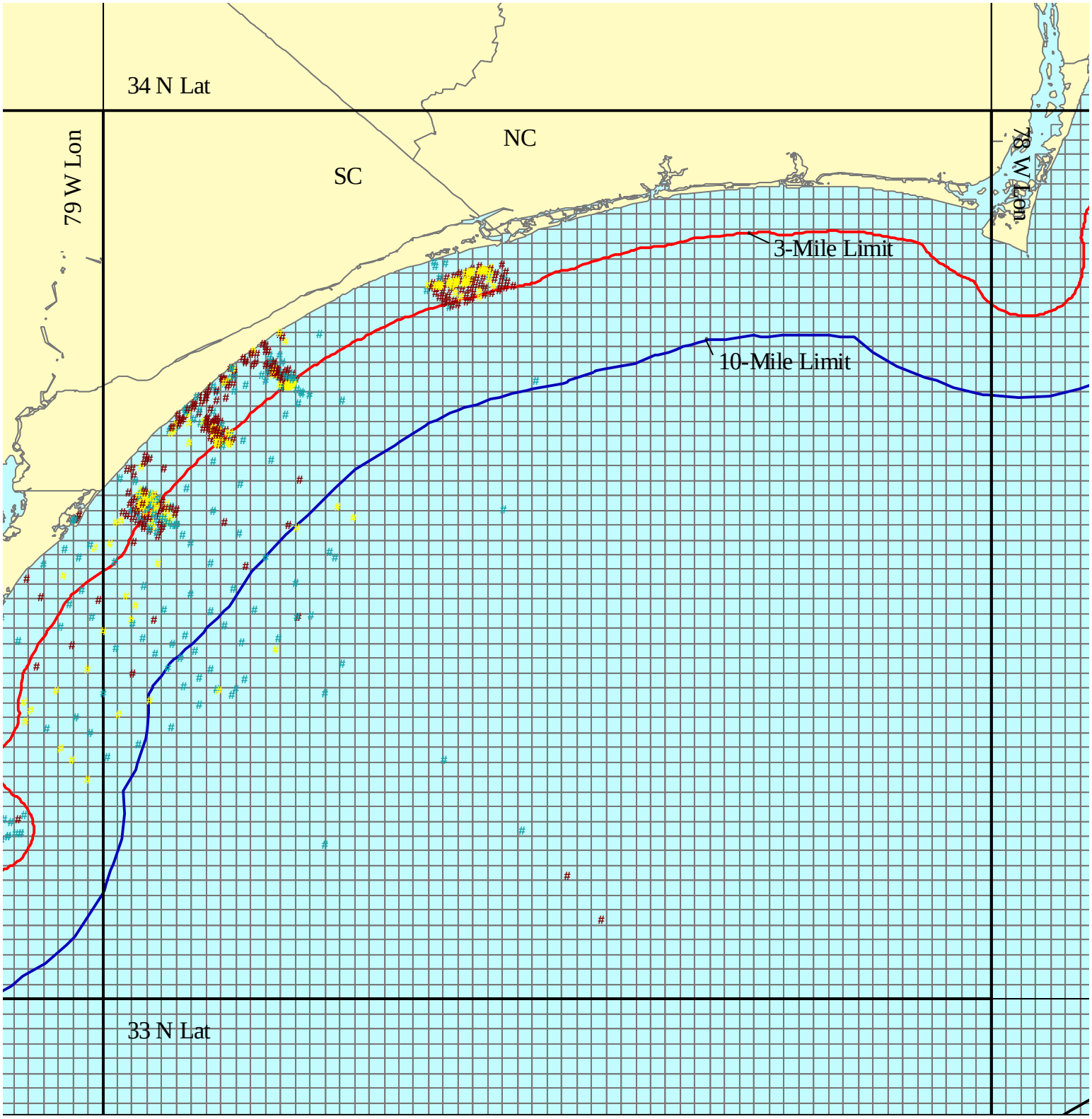
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

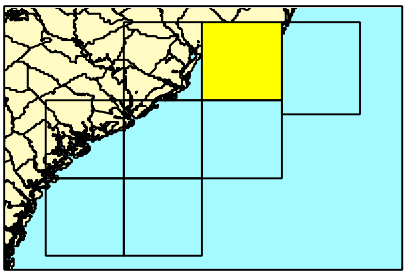


LEGEND

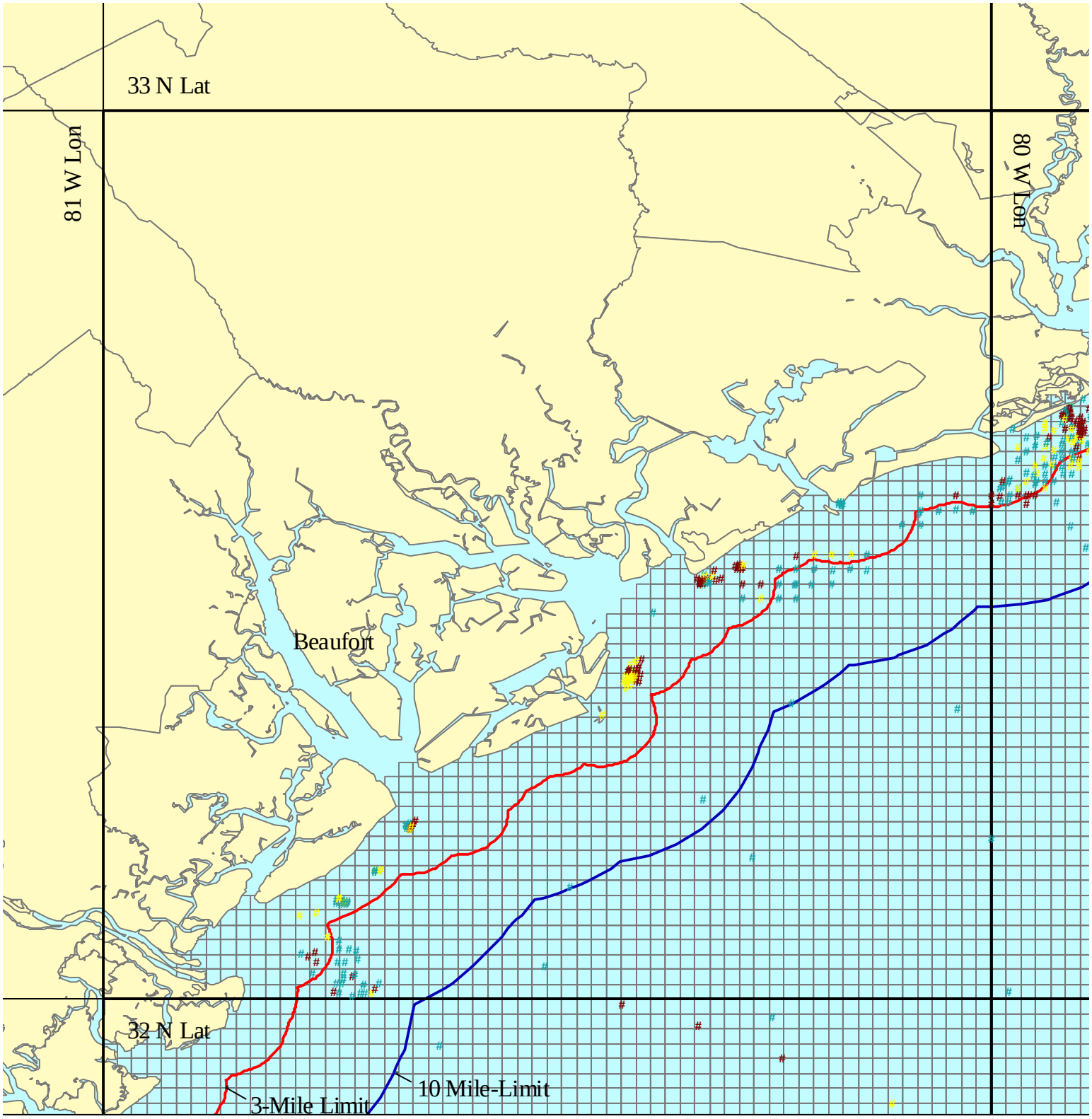
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

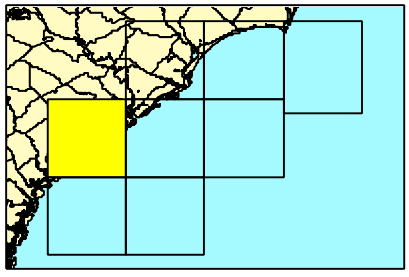


LEGEND

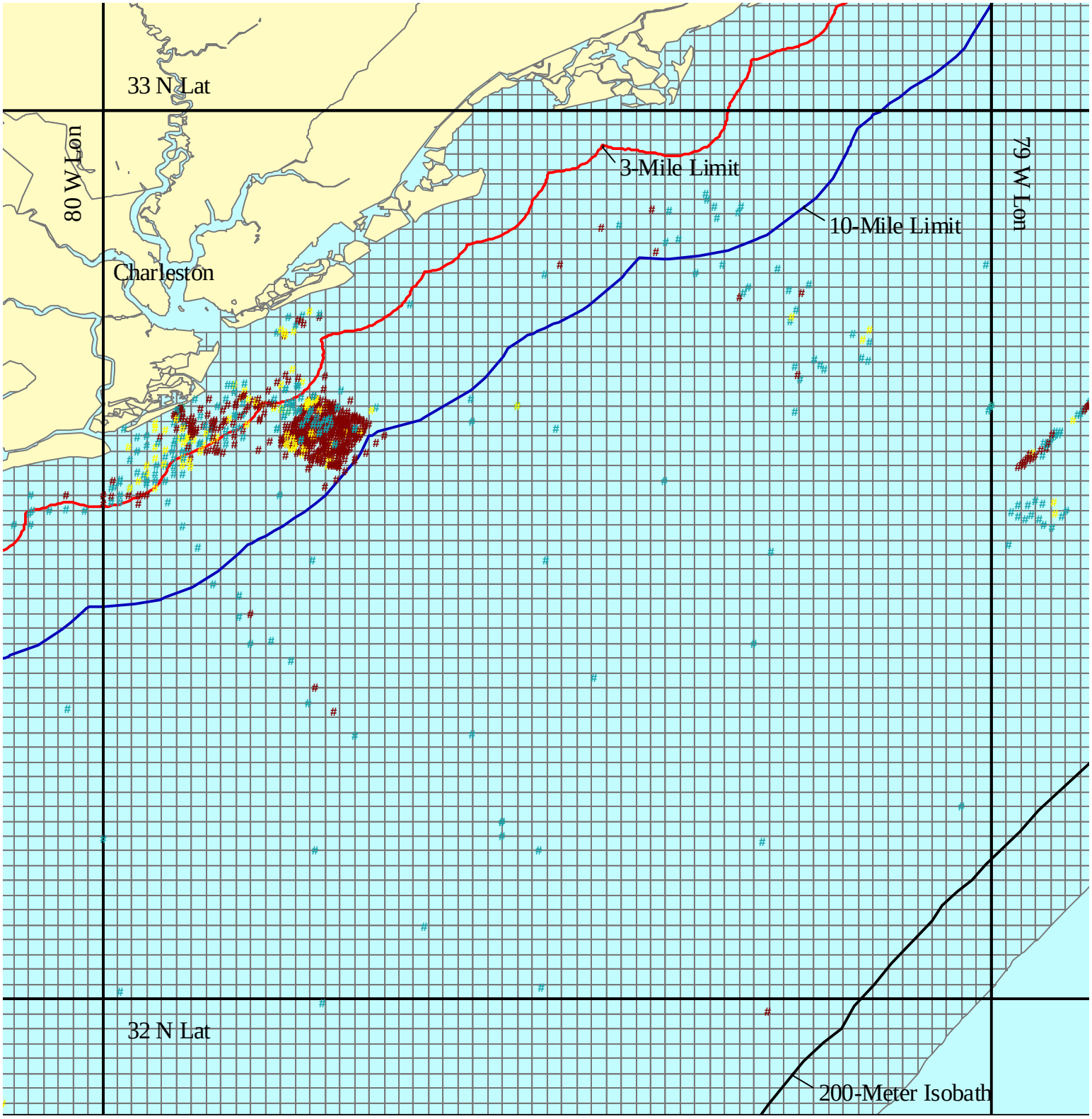
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

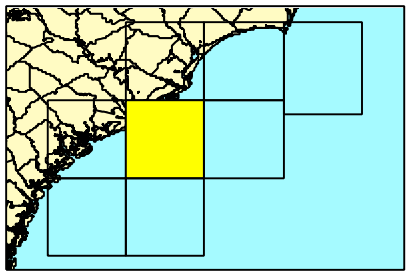


LEGEND

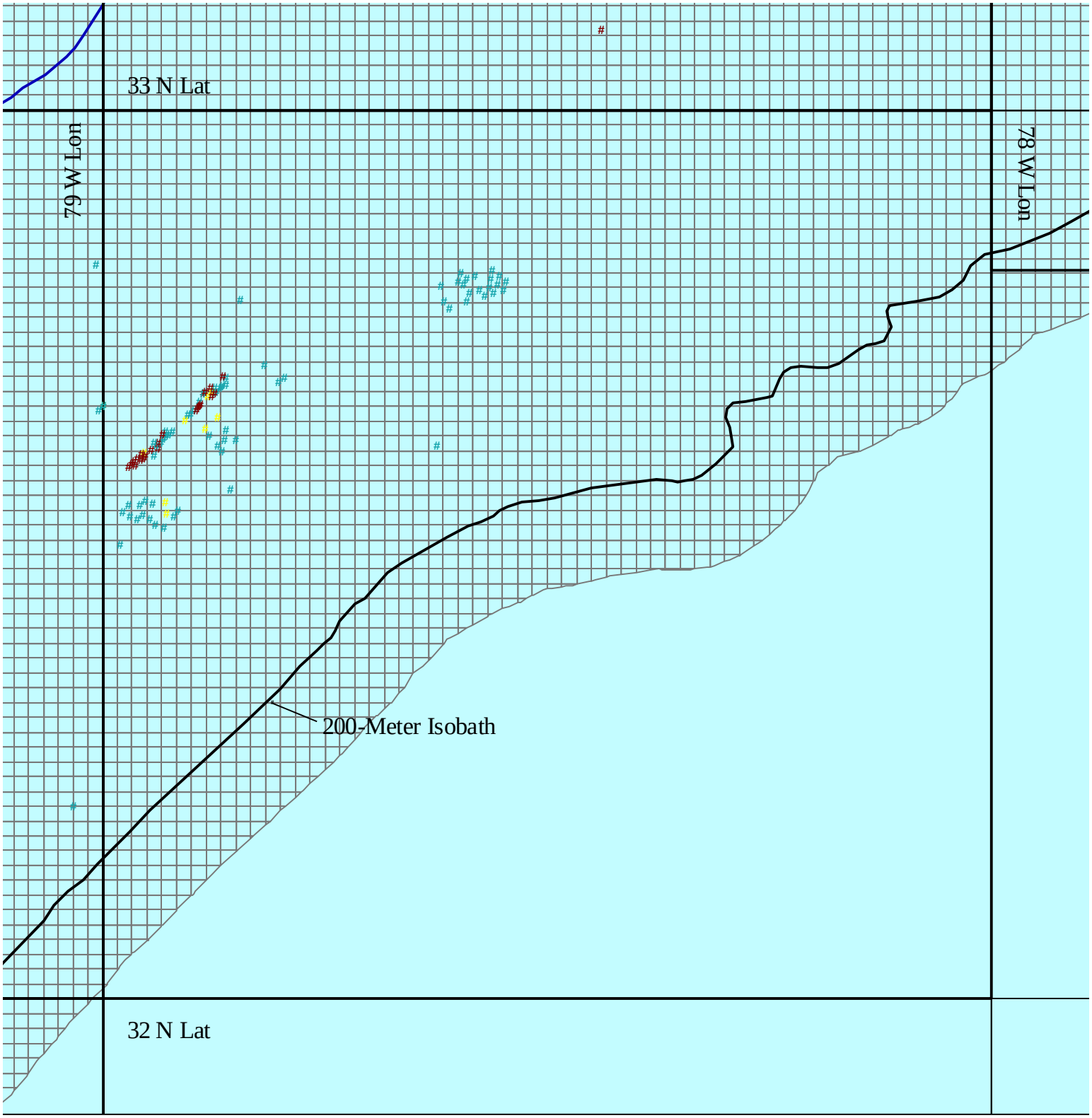
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

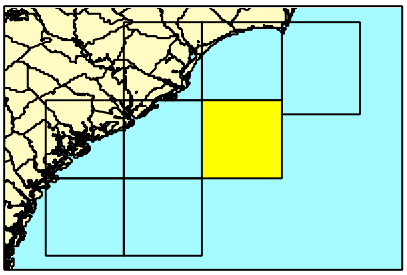


LEGEND

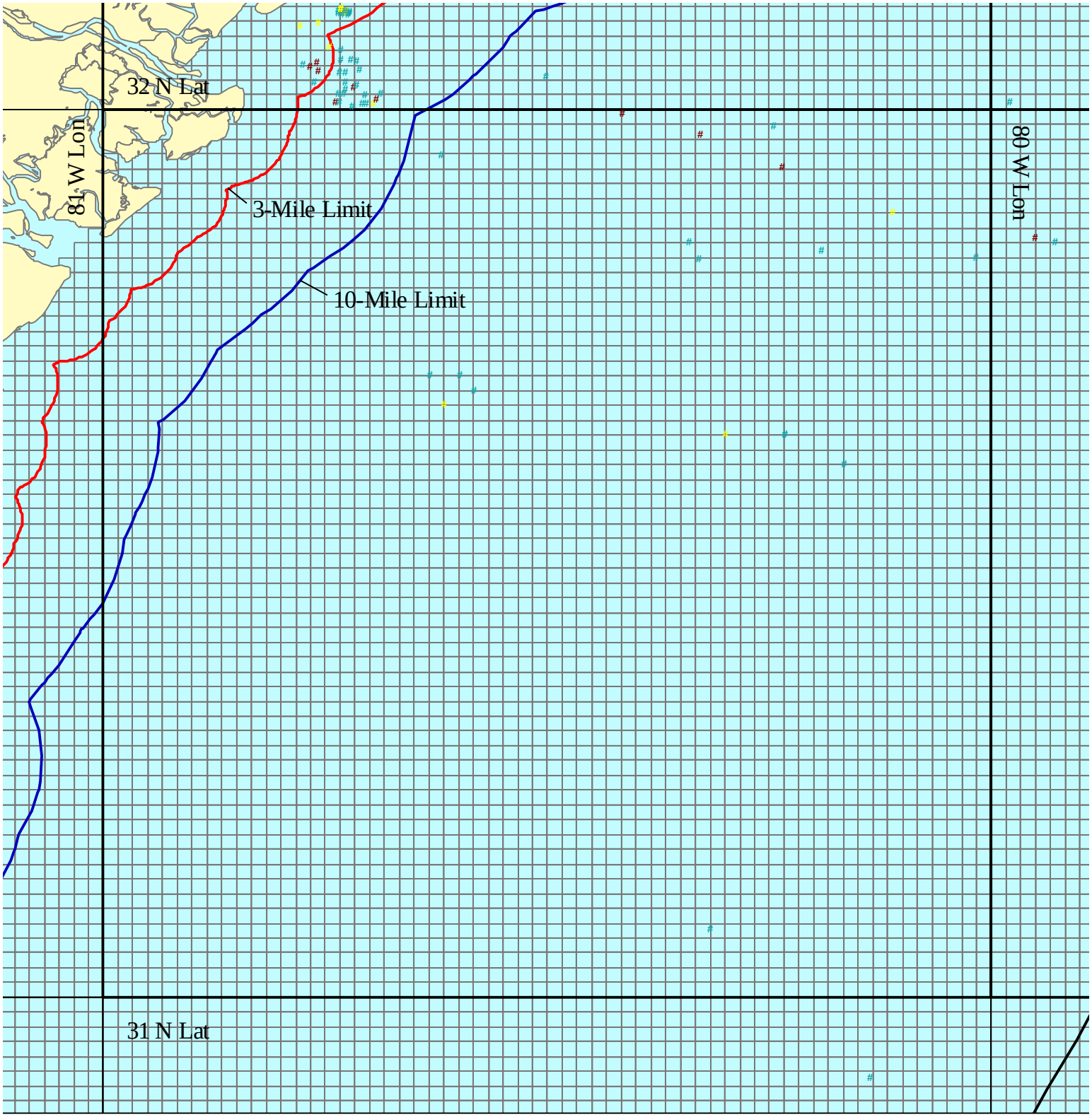
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

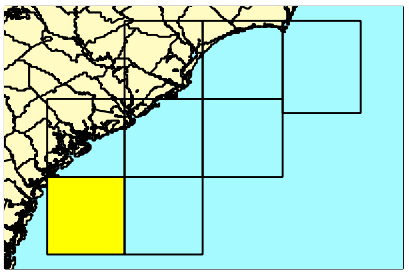


LEGEND

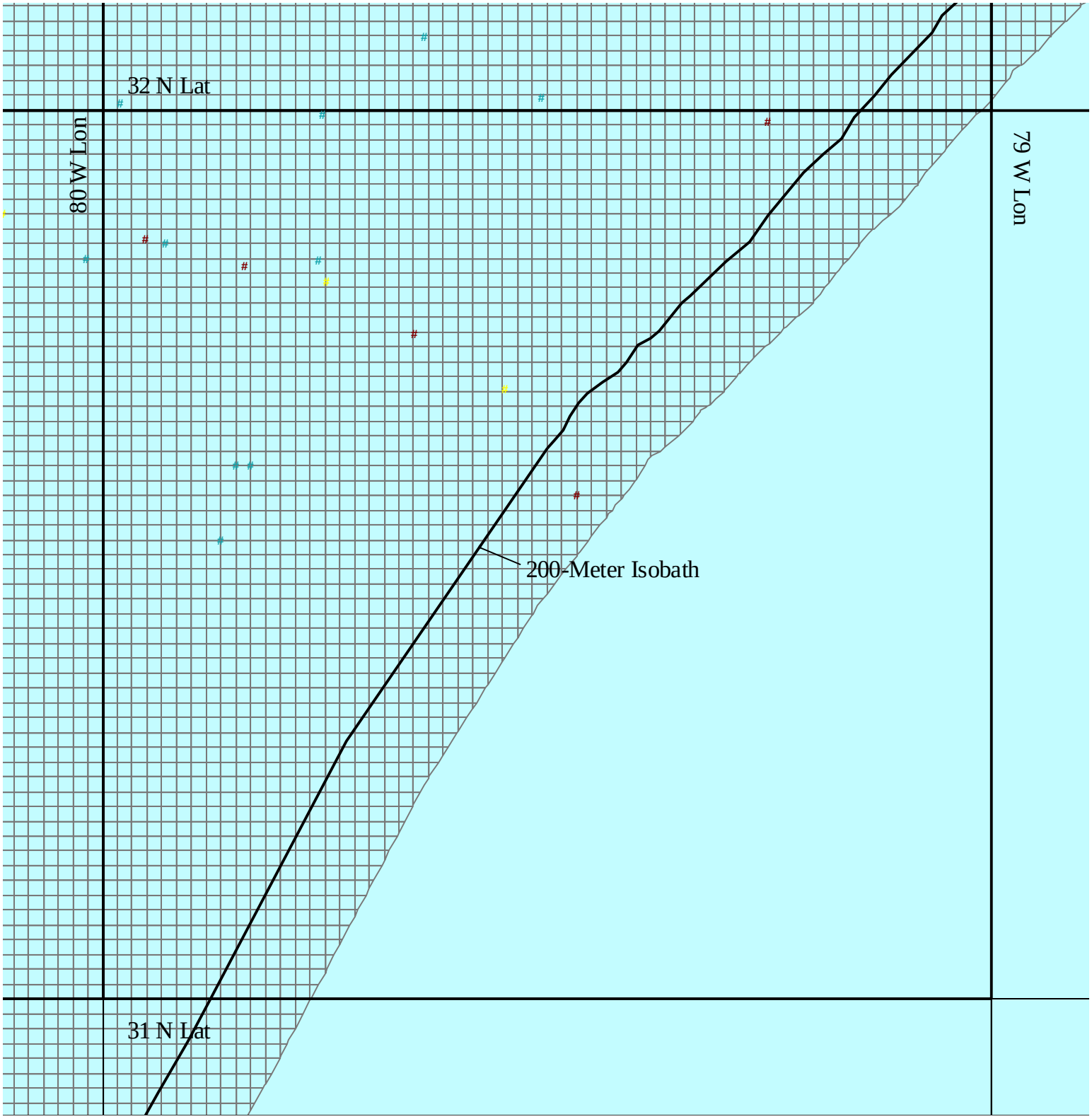
- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

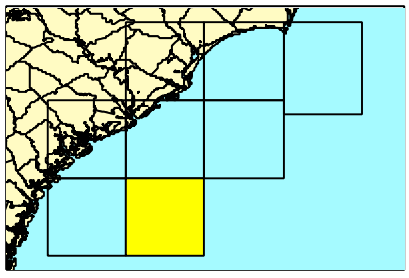


LEGEND

- > 95% Sand
- > 90% to 95% Sand
- <= 90% Sand

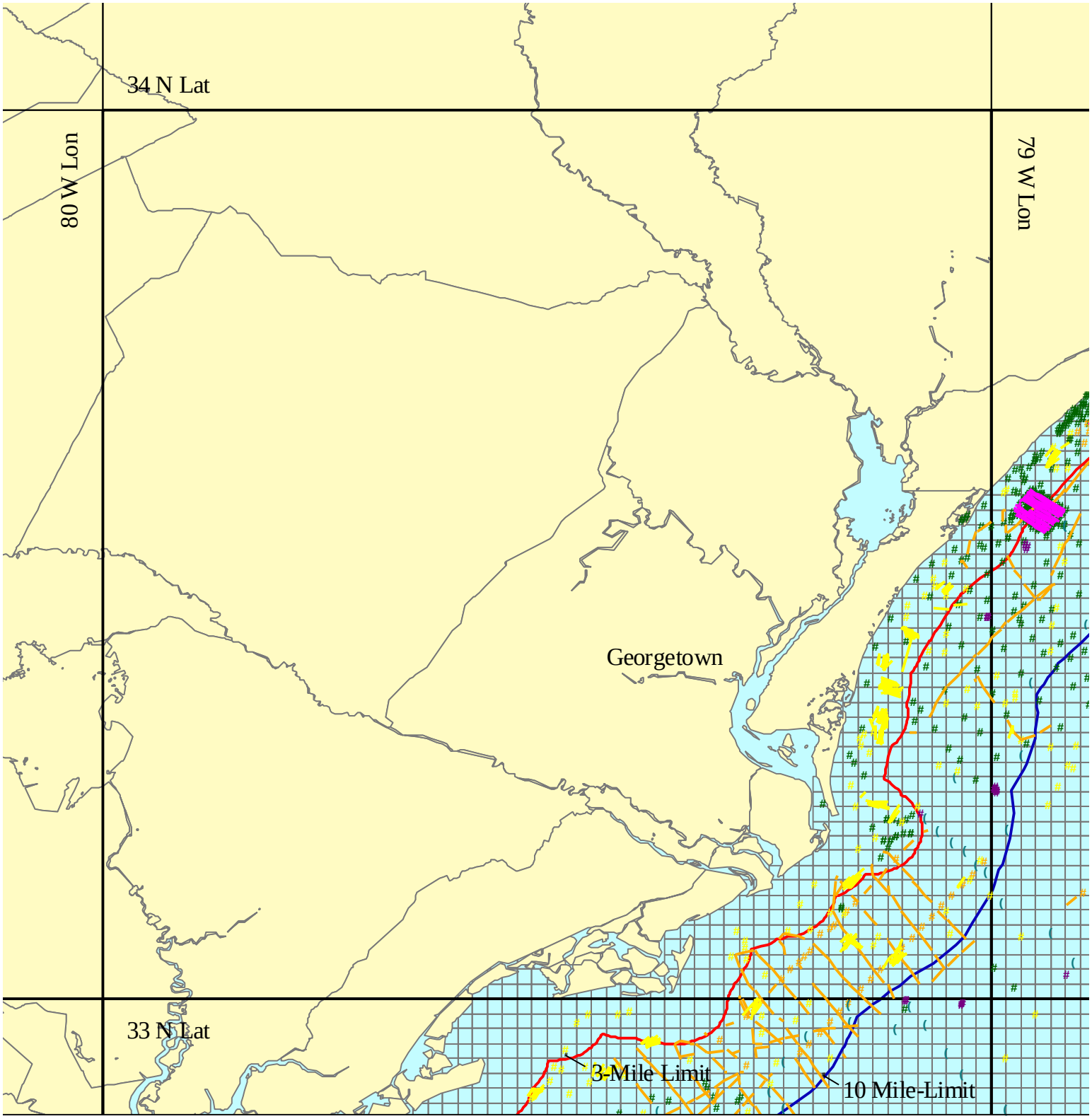
N

MMS-INTERMAR
Percent Sand



6 0 6 12 18 Miles

Appendix E: Plots showing gear type in areas 1-8 where data exist.

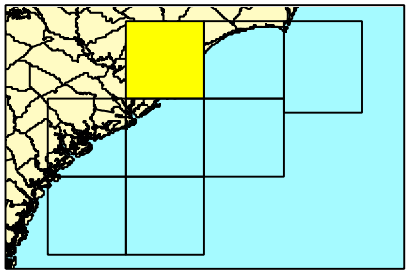


LEGEND

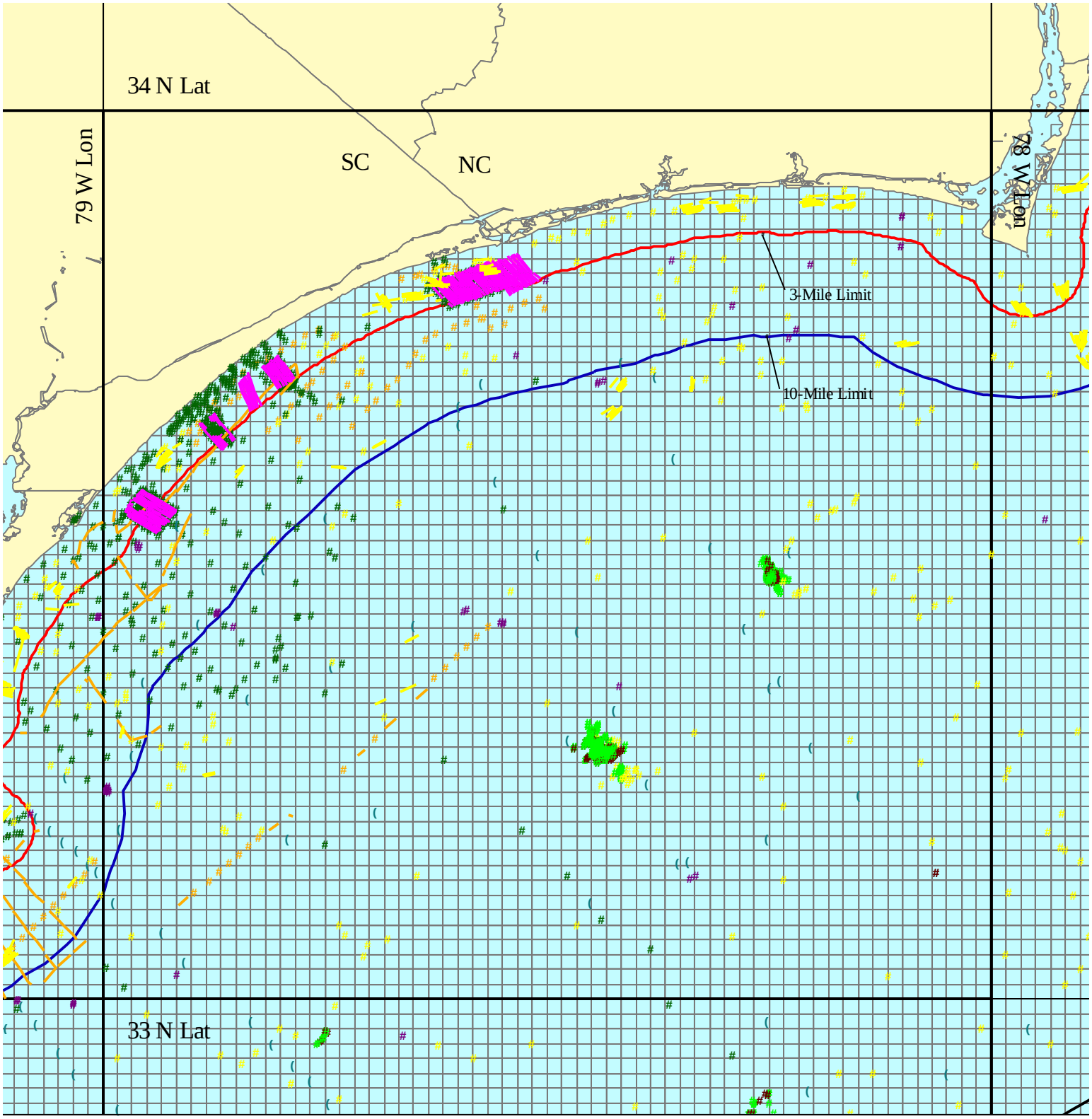
- Trawl
- Grabs/Cores and Vibracore
- Sub-Bottom Profiler
- SCUBA Diver
- Traps
- Side-Scan Sonar and Closed-Circuit TV
- Side-Scan Sonar
- Closed-Circuit TV
- Dredge

N

MMS-INTERMAR
Gear Type



6 0 6 12 18 Miles

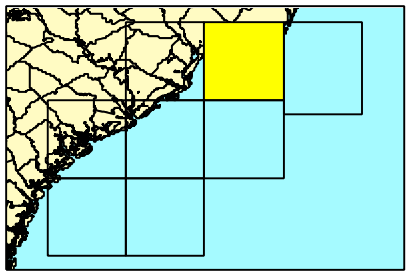


LEGEND

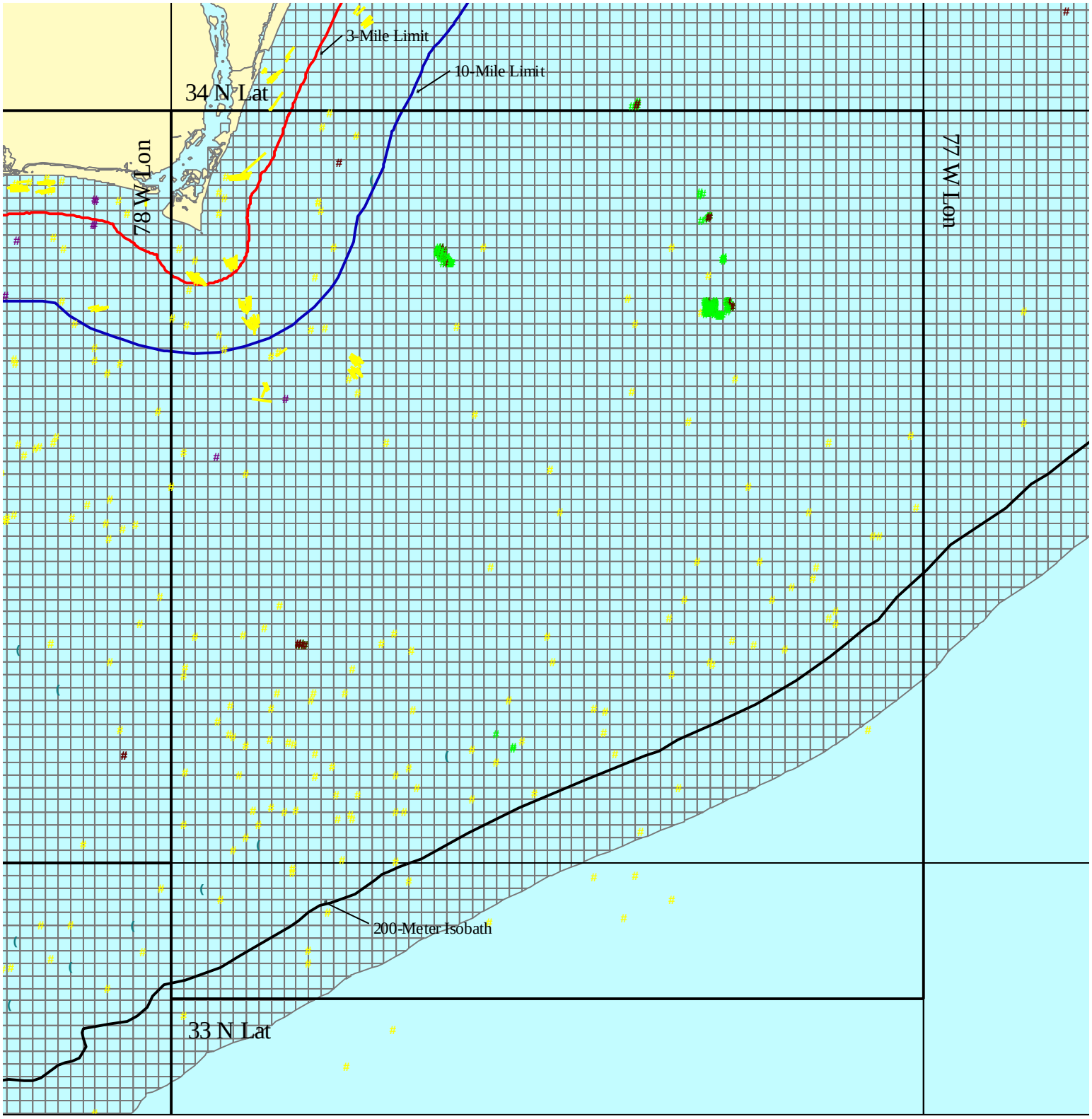
- Trawl
- Grabs/Cores and Vibracore
- Sub-Bottom Profiler
- SCUBA Diver
- Traps
- Side-Scan Sonar and Closed-Circuit TV
- Side-Scan Sonar
- Closed-Circuit TV
- Dredge

N

MMS-INTERMAR
Gear Type



6 0 6 12 18 Miles

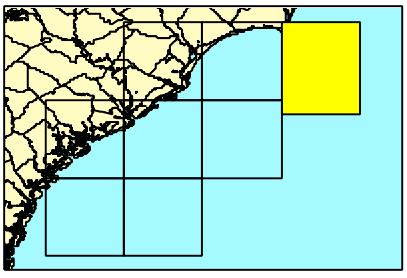


LEGEND

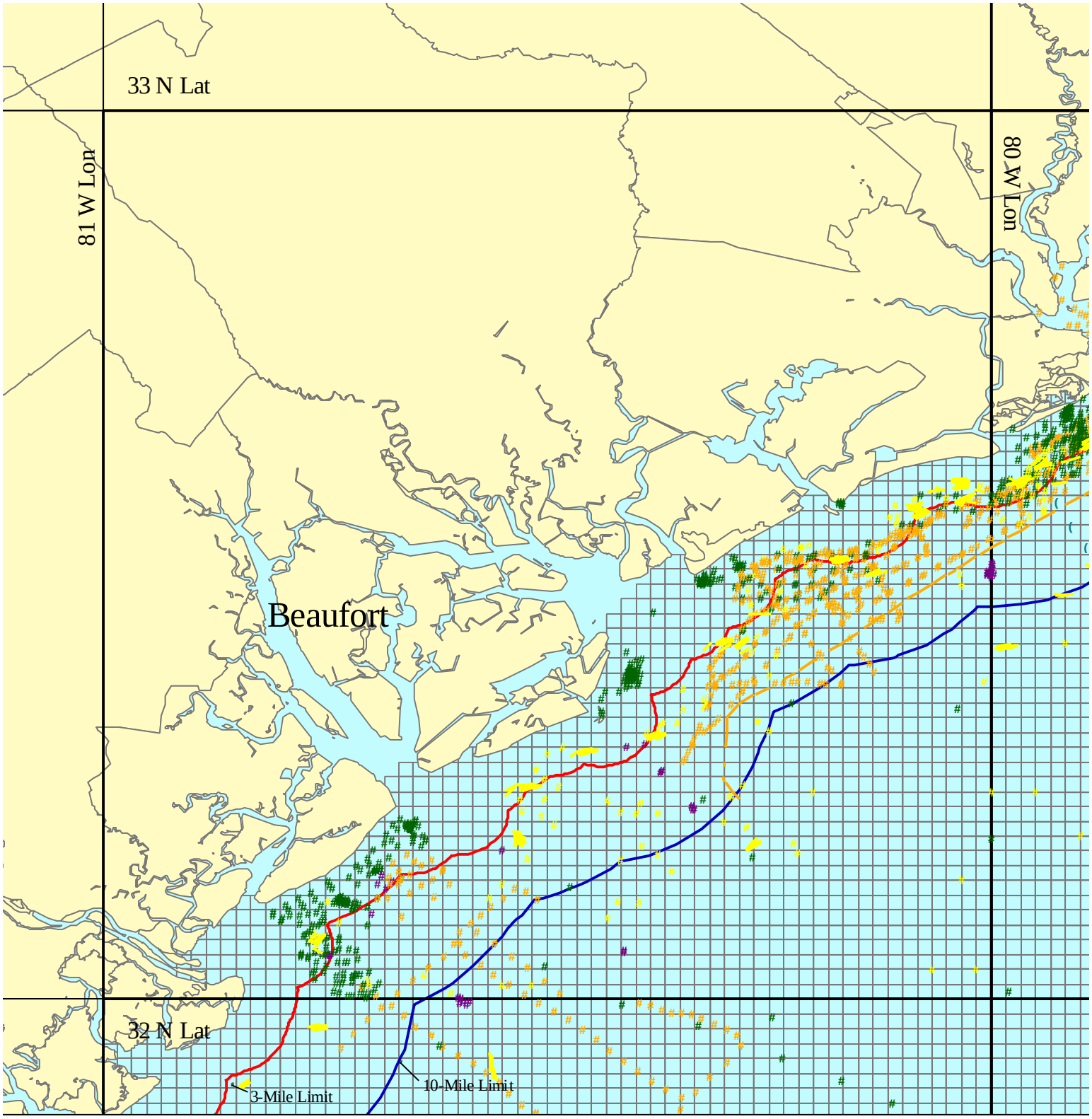
- Trawl
- Grabs/Cores and Vibracore
- Sub-Bottom Profiler
- SCUBA Diver
- Traps
- Side-Scan Sonar and Closed-Circuit TV
- Side-Scan Sonar
- Closed-Circuit TV
- Dredge

N

MMS-INTERMAR
Gear Type



7 0 7 14 21 Miles

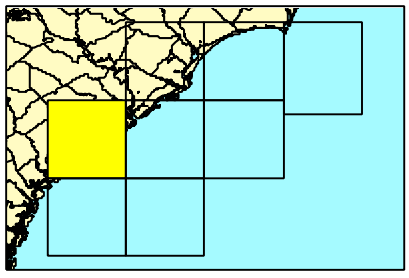


LEGEND

- Trawl
- Grabs/Cores and Vibracore
- Sub-Bottom Profiler
- SCUBA Diver
- Traps
- Side-Scan Sonar and Closed-Circuit TV
- Side-Scan Sonar
- Closed-Circuit TV
- Dredge

N

MMS-INTERMAR
Gear Type



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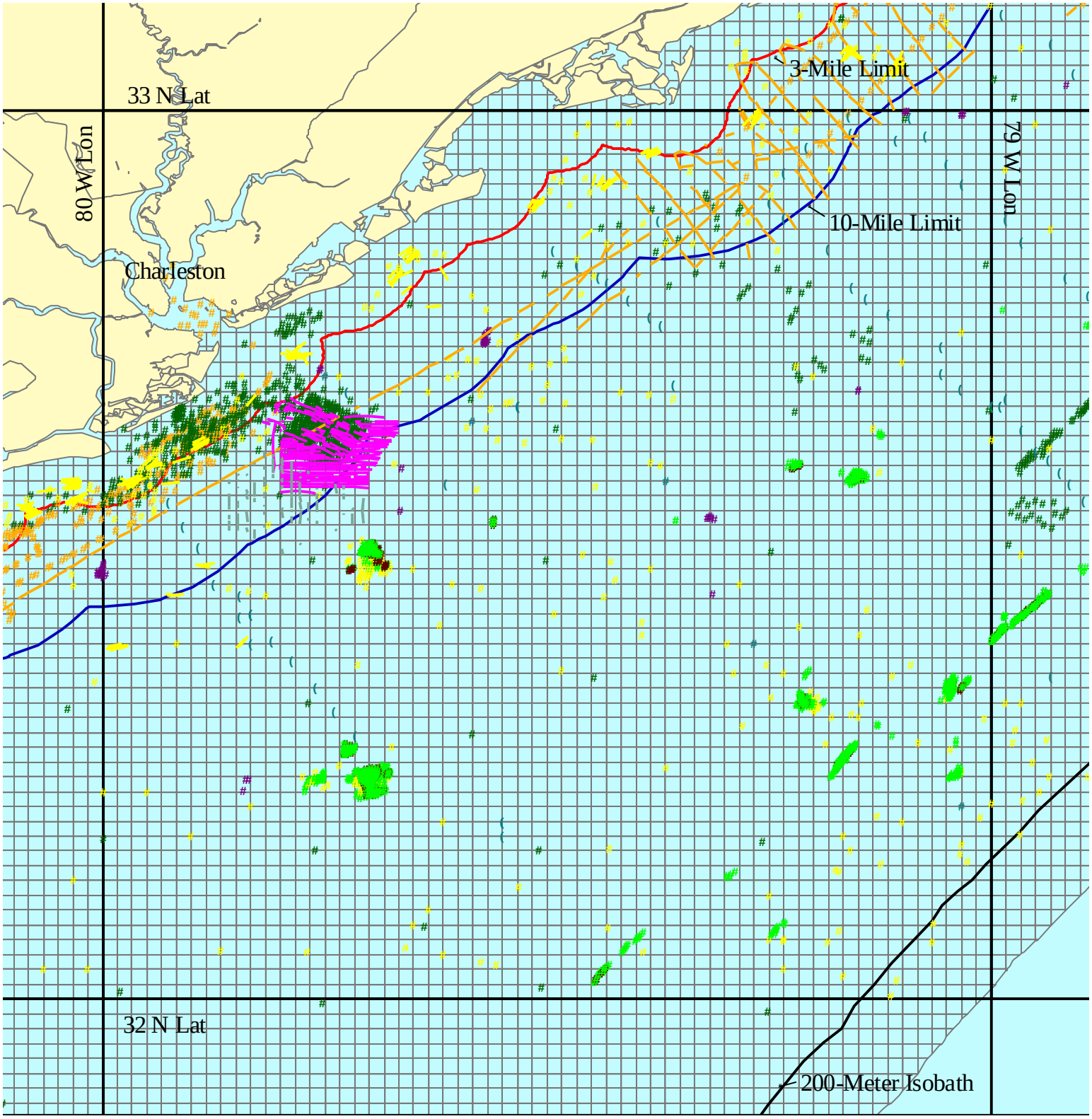

LEGEND

- Trawl
- Grabs/Cores and Vibracore
- Sub-Bottom Profiler
- SCUBA Diver
- Traps
- Side-Scan Sonar and Closed-Circuit TV
- Side-Scan Sonar
- Closed-Circuit TV
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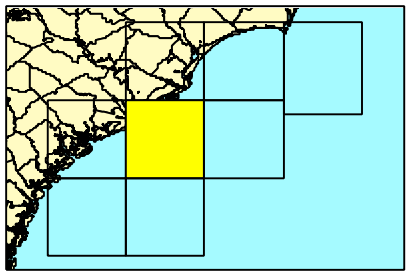
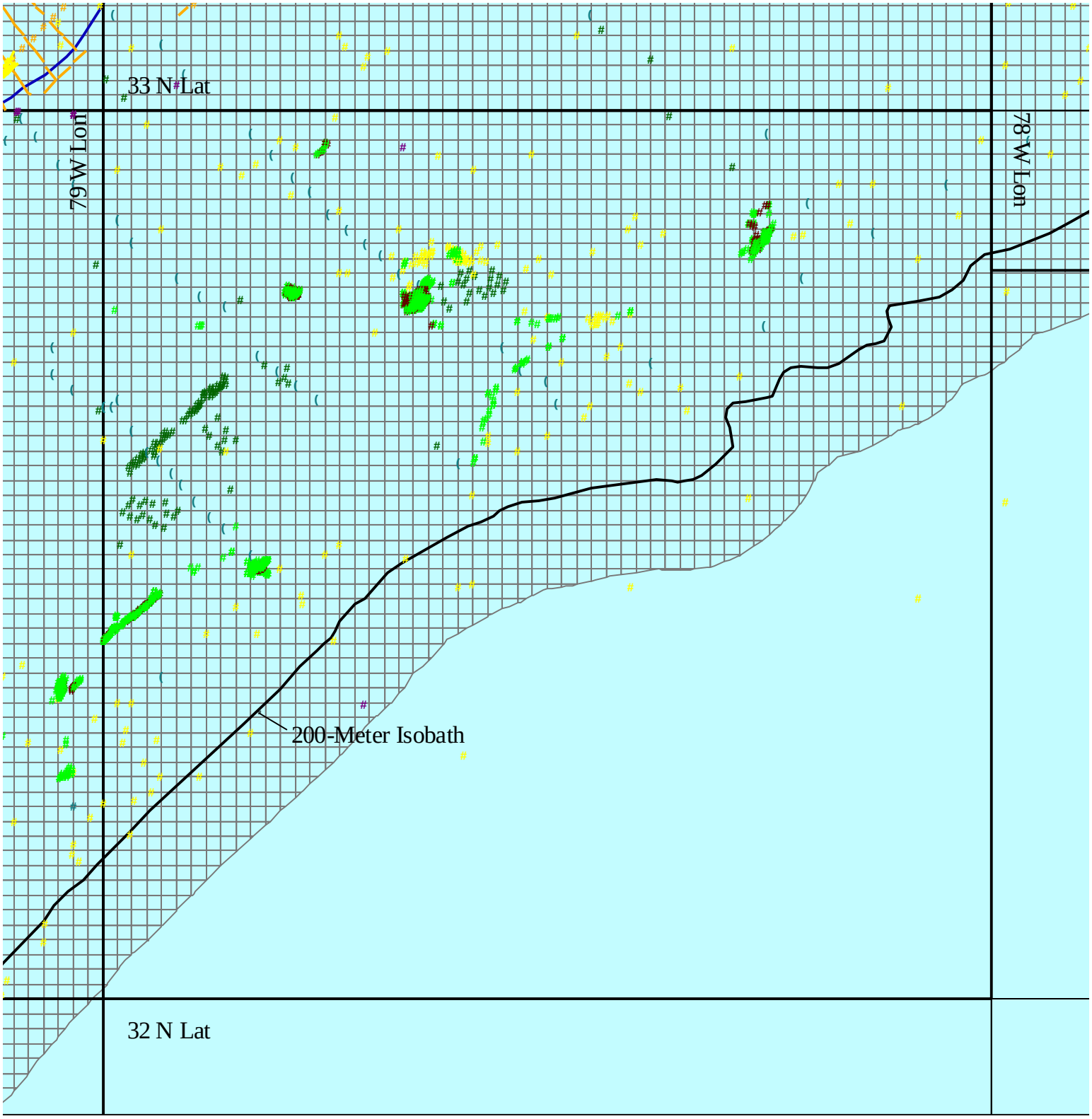
MMS-INTERMAR
Gear Type



6 0 6 12 18 Miles



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MMS-INTERMAR
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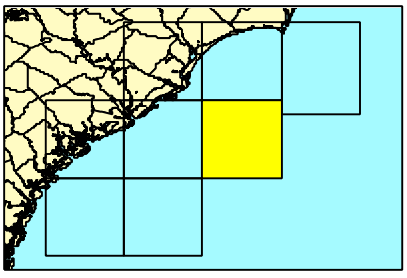

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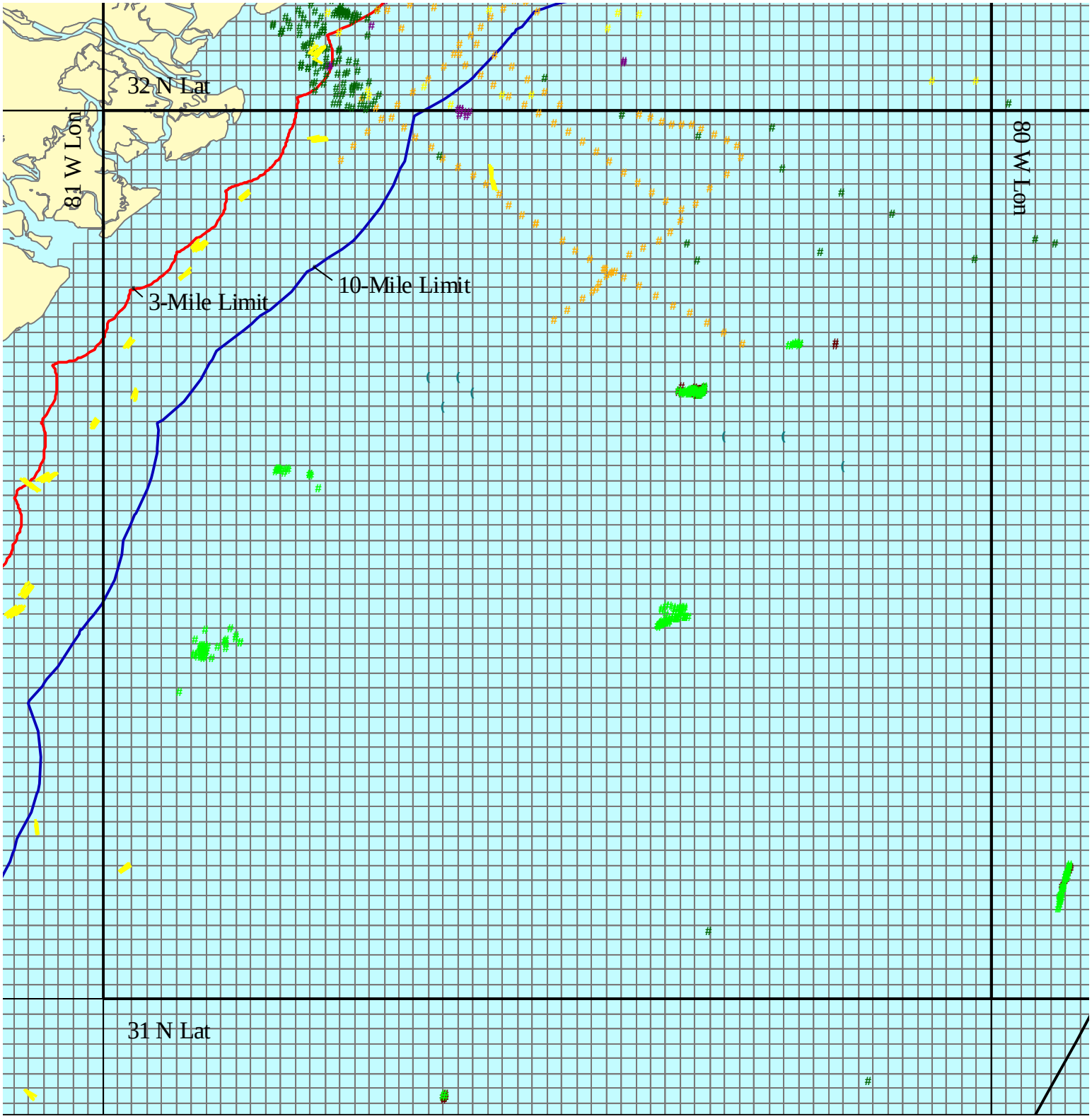

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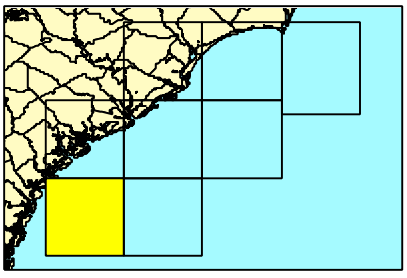

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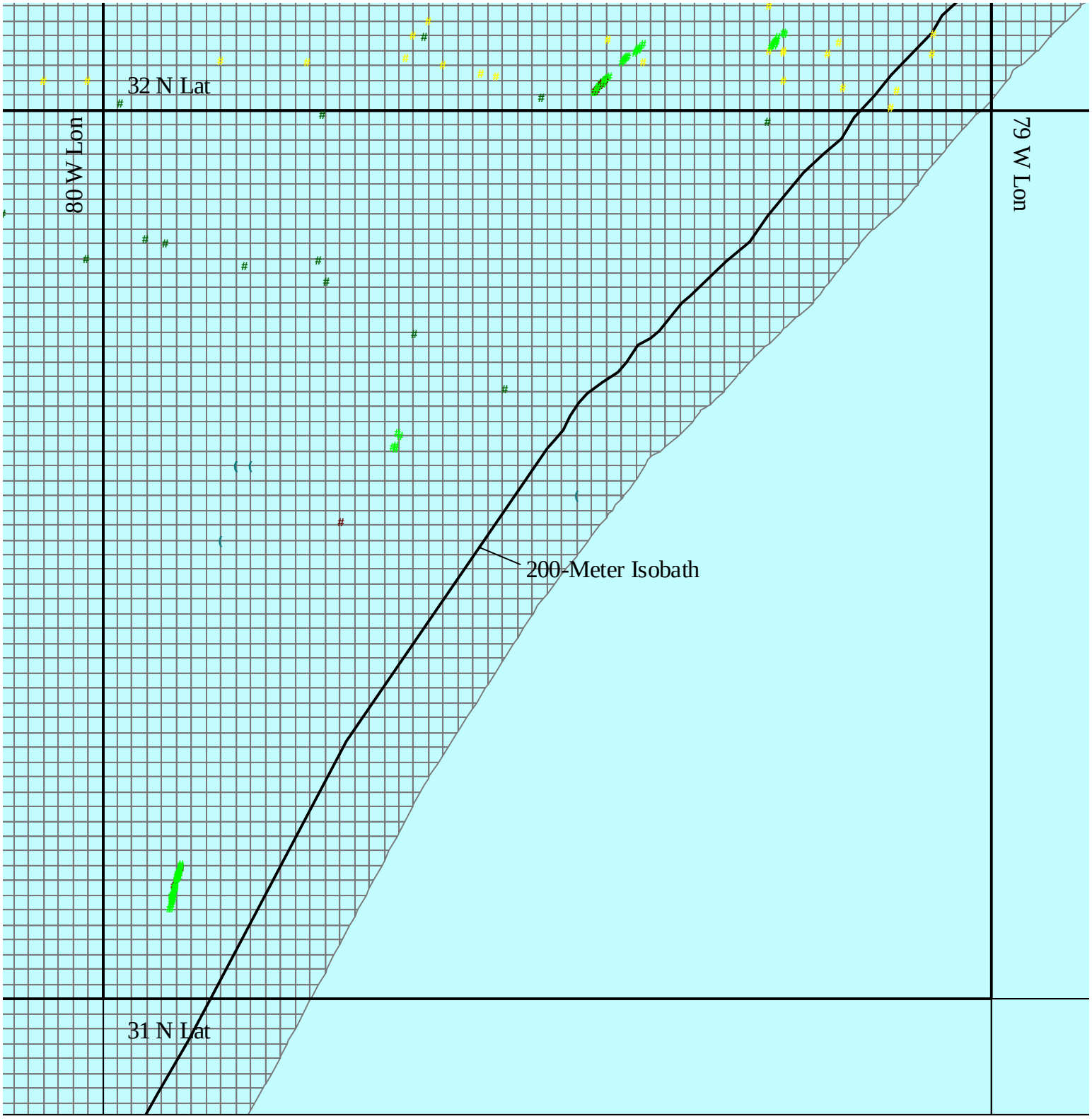

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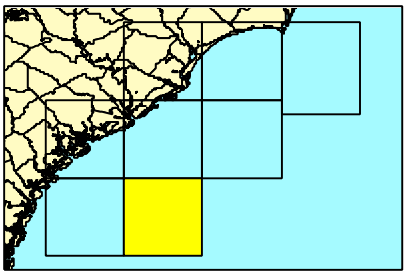

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