

Biogeographic Assessment of Florida Keys National Marine Sanctuary

- **NOAA – Florida Keys National Marine Sanctuary**
- **Florida Fish and Wildlife Commission**
- **NOAA – National Centers for Coastal Ocean Science**





Spatial data overview

FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

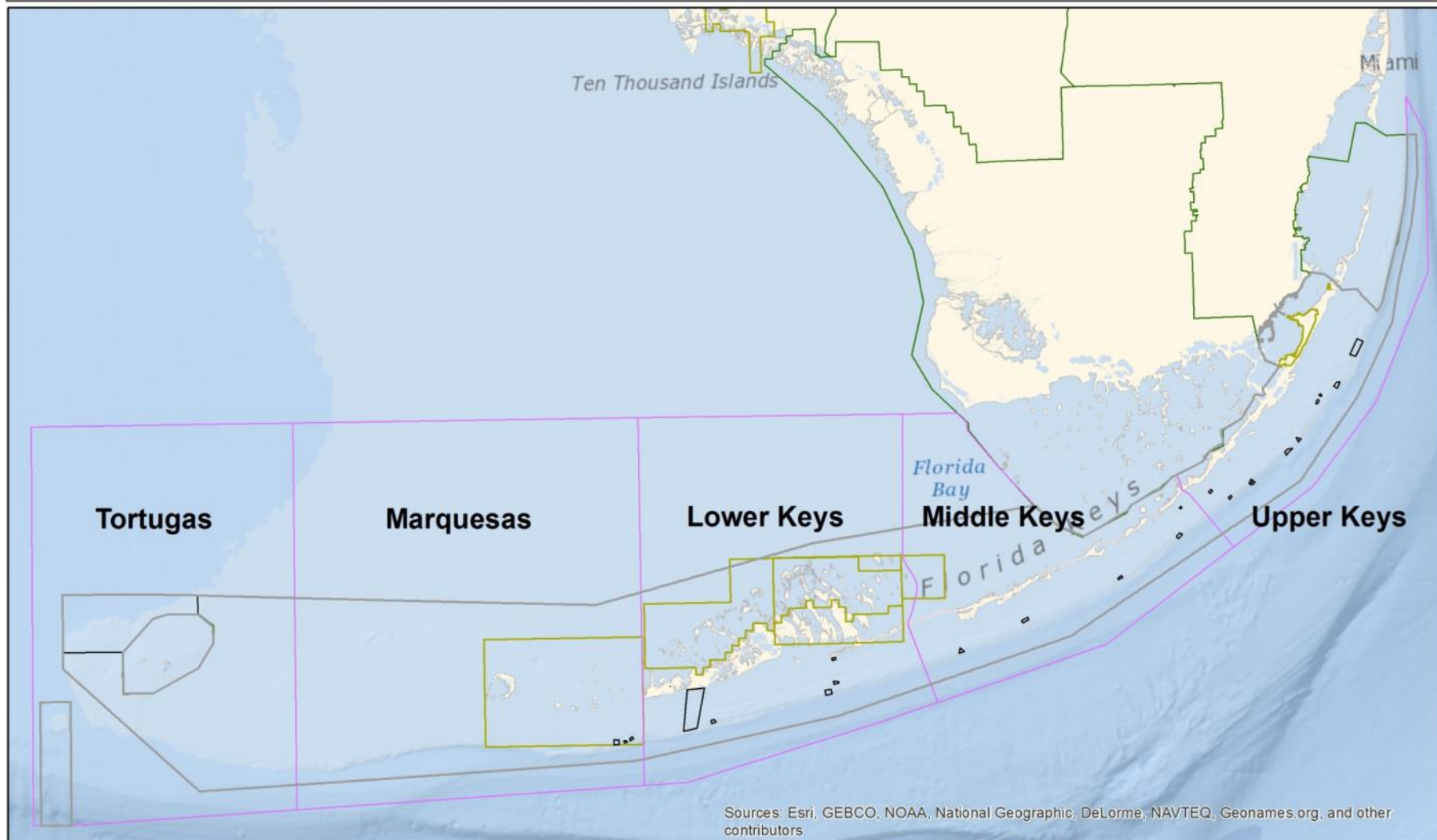
National Park

National Wildlife Refuges

N



0 12.5 25 50 Miles



FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

National Park

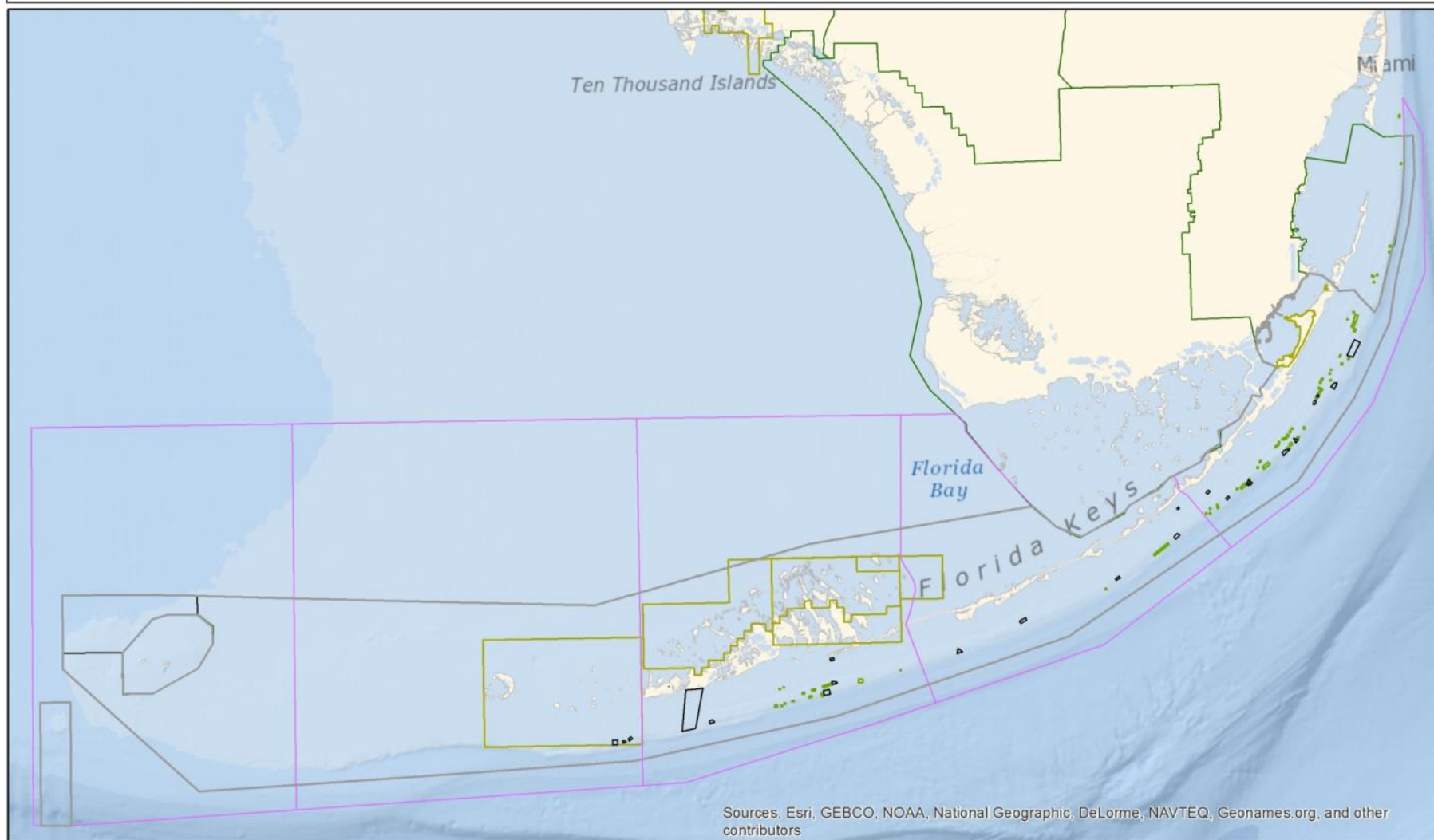
National Wildlife Refuges

Lobster Trap Exclusion Area

N



0 12.5 25 50 Miles



FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

State Park

National Park

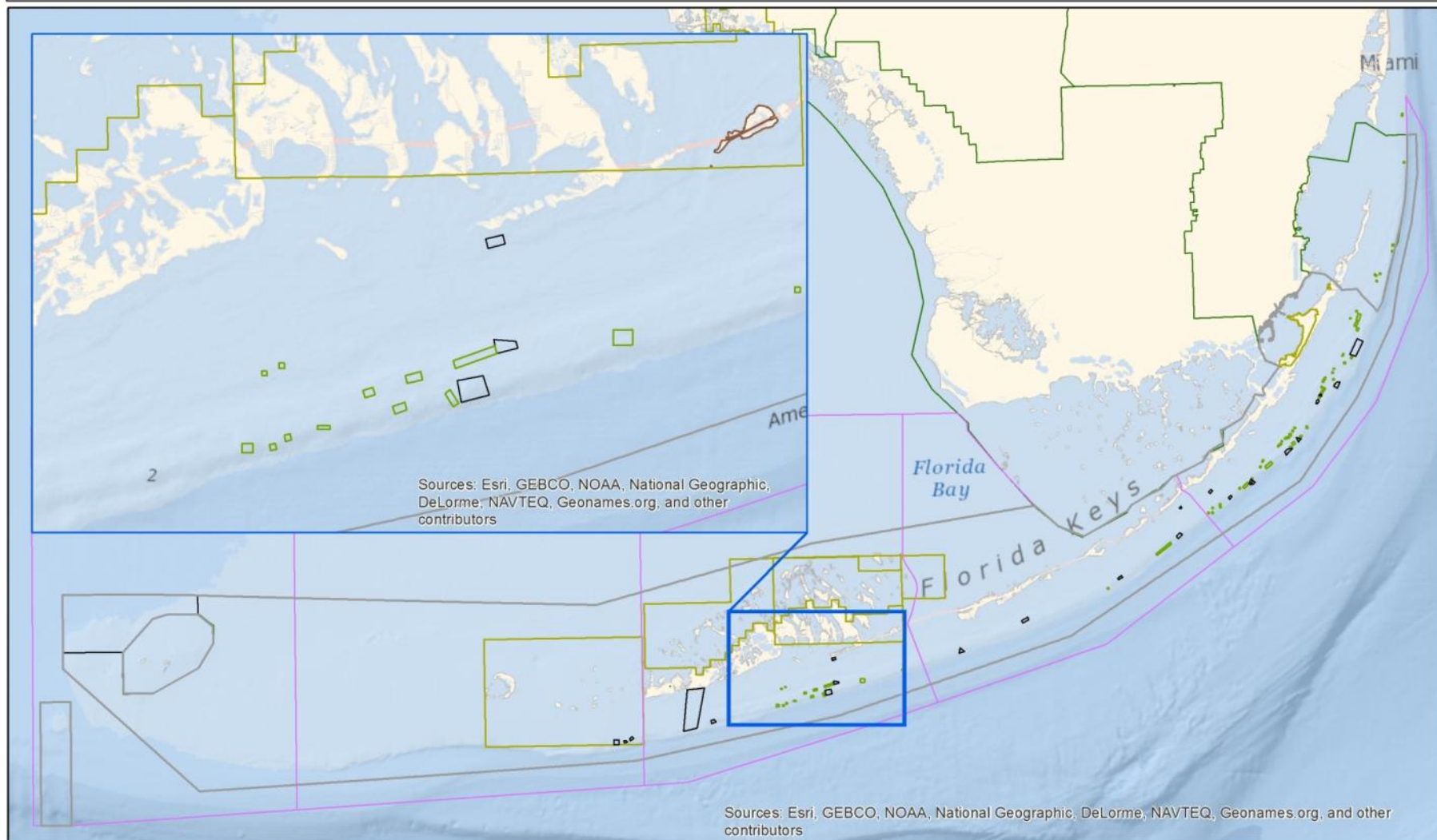
National Wildlife Refuges

Lobster Trap Exclusion Area

N



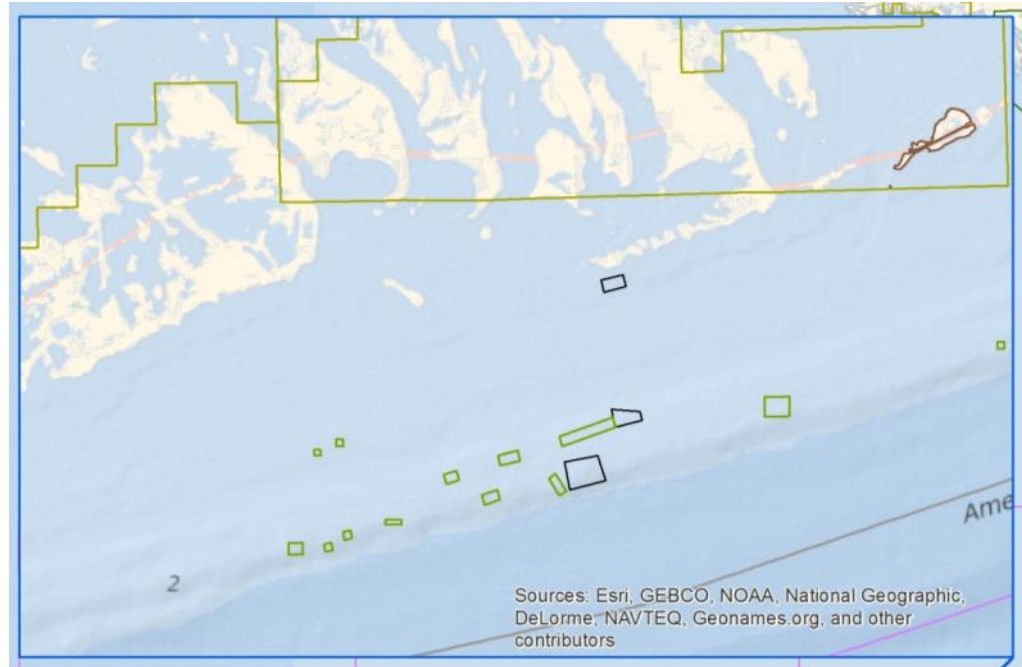
0 12.5 25 50 Miles



Spatial Data and GIS

Spatial Data

- Geographically referenced information
 - *Points*: ex. GPS coordinates
 - *Lines*: ex. Boat track
 - *Polygons*: ex. Sanctuary
 - *Rasters*: ex. Aerial Imagery



Geographic Information System (GIS)

- Computer system that *captures, stores, manipulates, queries, analyzes and displays* spatial data
- Uses: mapping and spatial analysis

Spatial Data and GIS

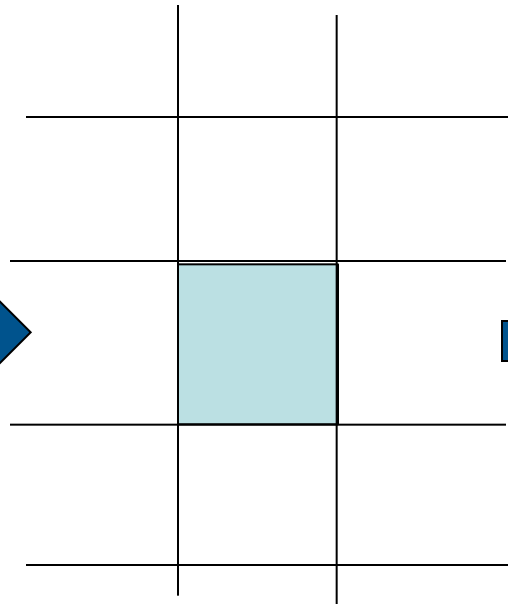
from GPS coordinates and counts...



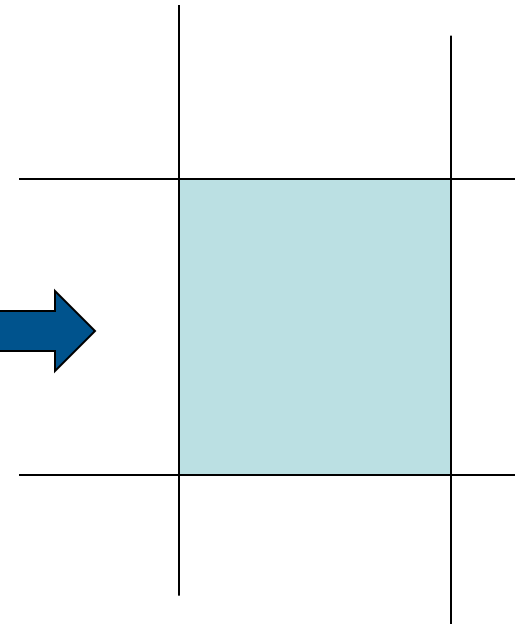
... to spatial data

Point
GPS coords
+ survey data

grid cell



Larger grid cell



Viewing data

Data

- Present/absent

- Categories

Very high 90 – 100 %

High 75 – 89 %

Medium 25 – 75 %

Low >0 – 24 %



Viewing data

Data

- Present/absent

- Categories

Very high	90 – 100 %
High	75 – 89 %
Medium	25 – 75 %
Low	>0 – 24 %



Very high
High
Medium
Low



Natural resources

Terminology

Data

Abundance = counts

Density = count per unit area (e.g. m^2 , nm^2)

Species richness = number of different species for a different area

Datasets: Natural Resources

Metrics

- Habitat
 - Patch & aggregated reef
 - High relief reefs
 - Turtle grass density
- Coral
 - Stony coral
 - Soft coral
 - Resilient reefs
- Fish
 - Reef fish
 - Fish aggregations
- Fauna
 - Queen conch aggregations





Habitat

High relief reefs

Data source

- NMFS diver surveys

Metric

- High relief reef



High Relief Reefs

Present

FKNMS

National Park

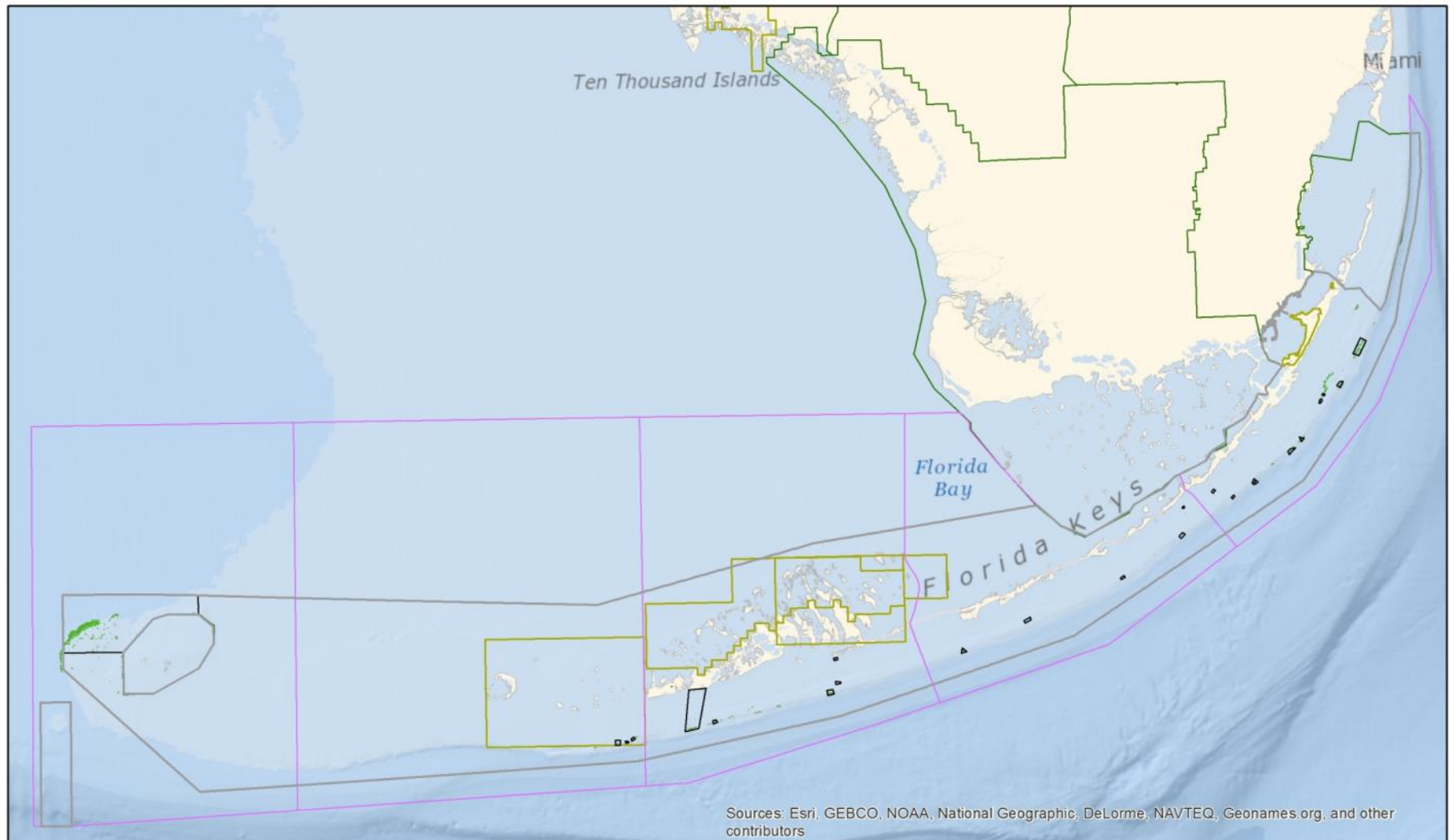
SPAs, ERs and SUAs

National Wildlife Refuges

Florida Keys Regions



0 12.5 25 50 Miles




Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

High Relief Reefs


 Present

 FKNMS

 SPAs, ERs and SUAs

 Florida Keys Regions

 National Park

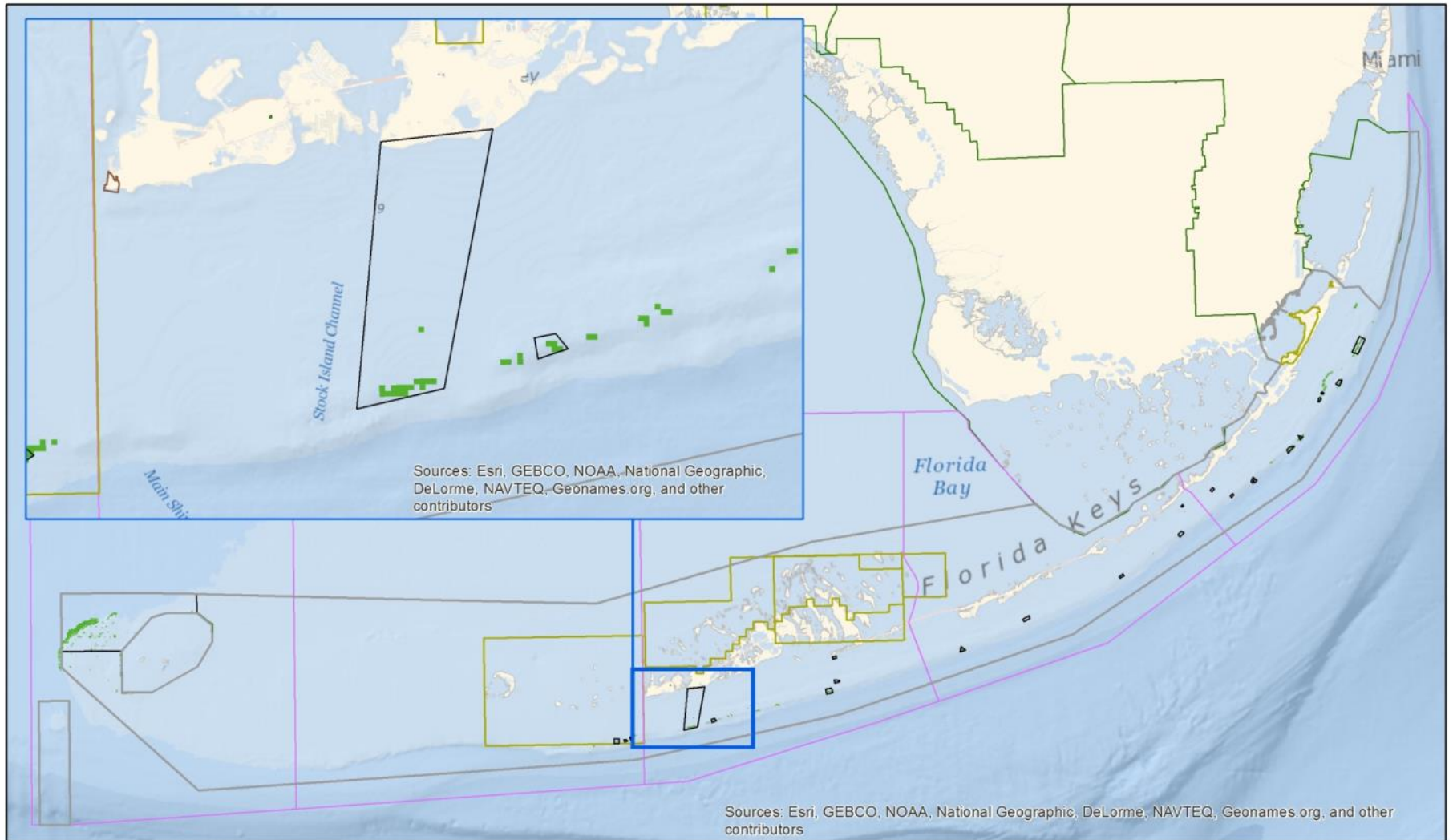
 National Wildlife Refuges

 State Park

N



0 12.5 25 50 Miles



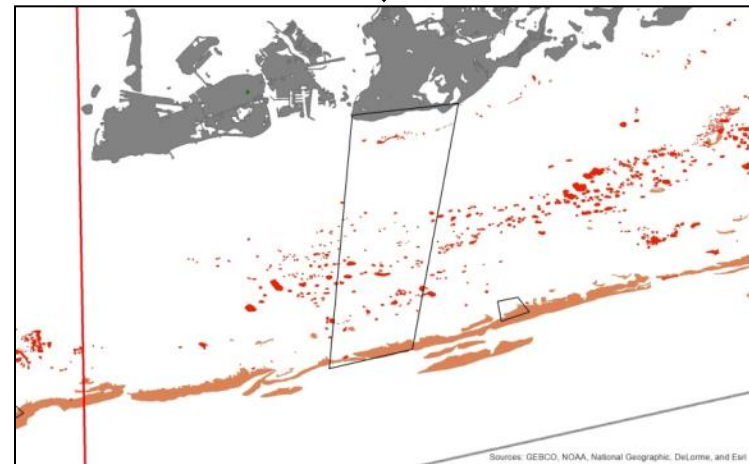
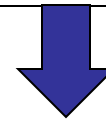
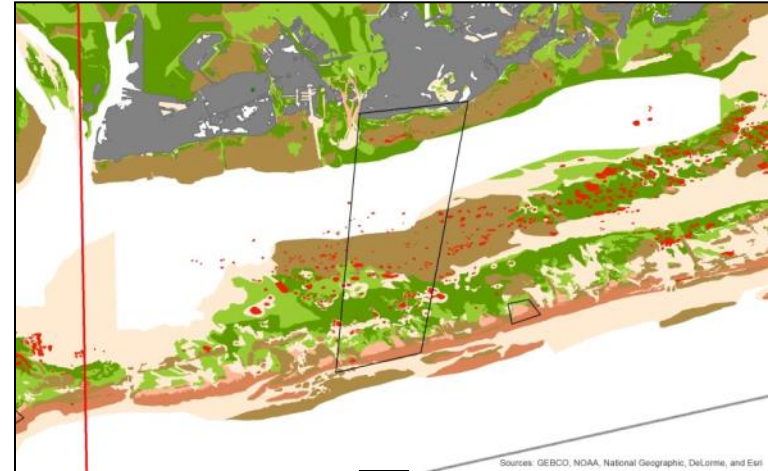
Patch & aggregate reefs

Data sources

- FL FWC Benthic habitat map

Metric

- Patch & Aggregate Reefs



Patch & Aggregate Reefs



Present



FKNMS



National Park



SPAs, ERs and SUAs



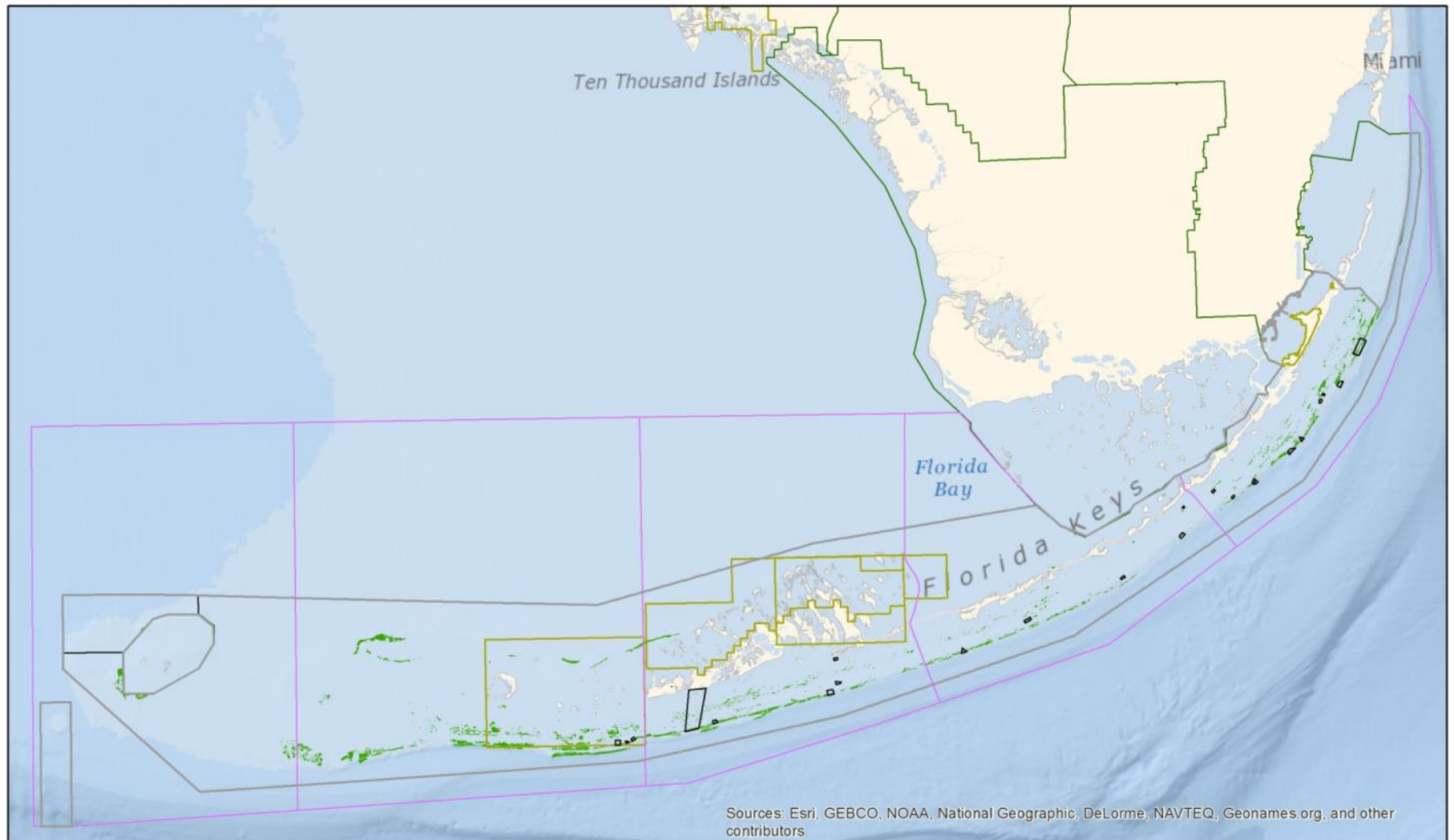
National Wildlife Refuges



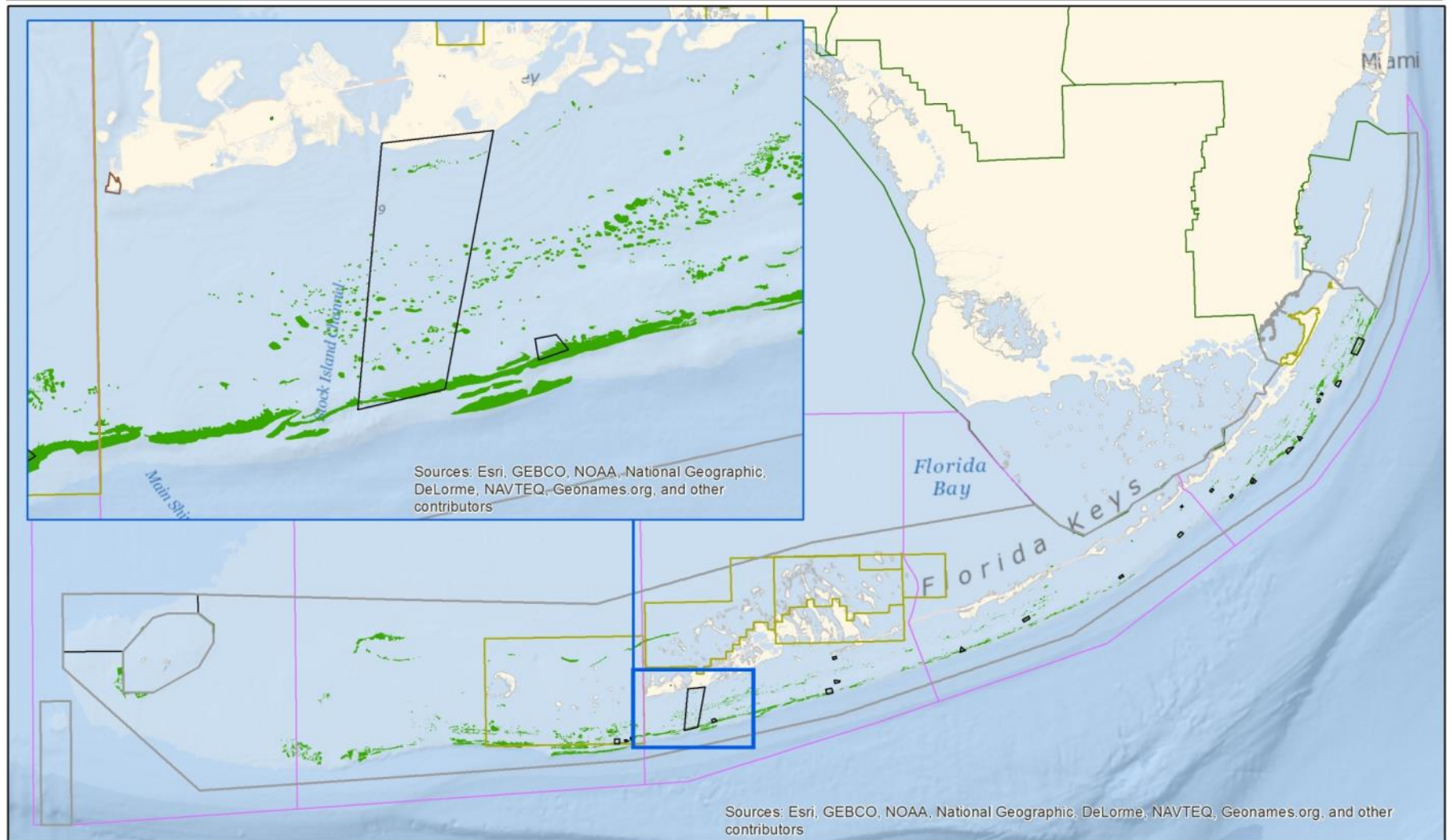
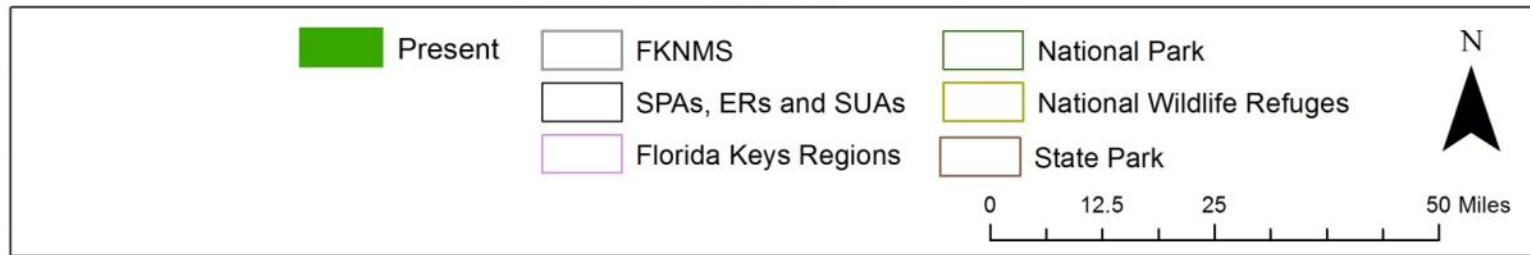
Florida Keys Regions



0 12.5 25 50 Miles



Patch & Aggregate Reefs



Seagrass

An underwater photograph showing a dense, healthy field of seagrass. The plants are green and have long, narrow leaves. The water is clear and blue, and the seagrass extends far into the background.

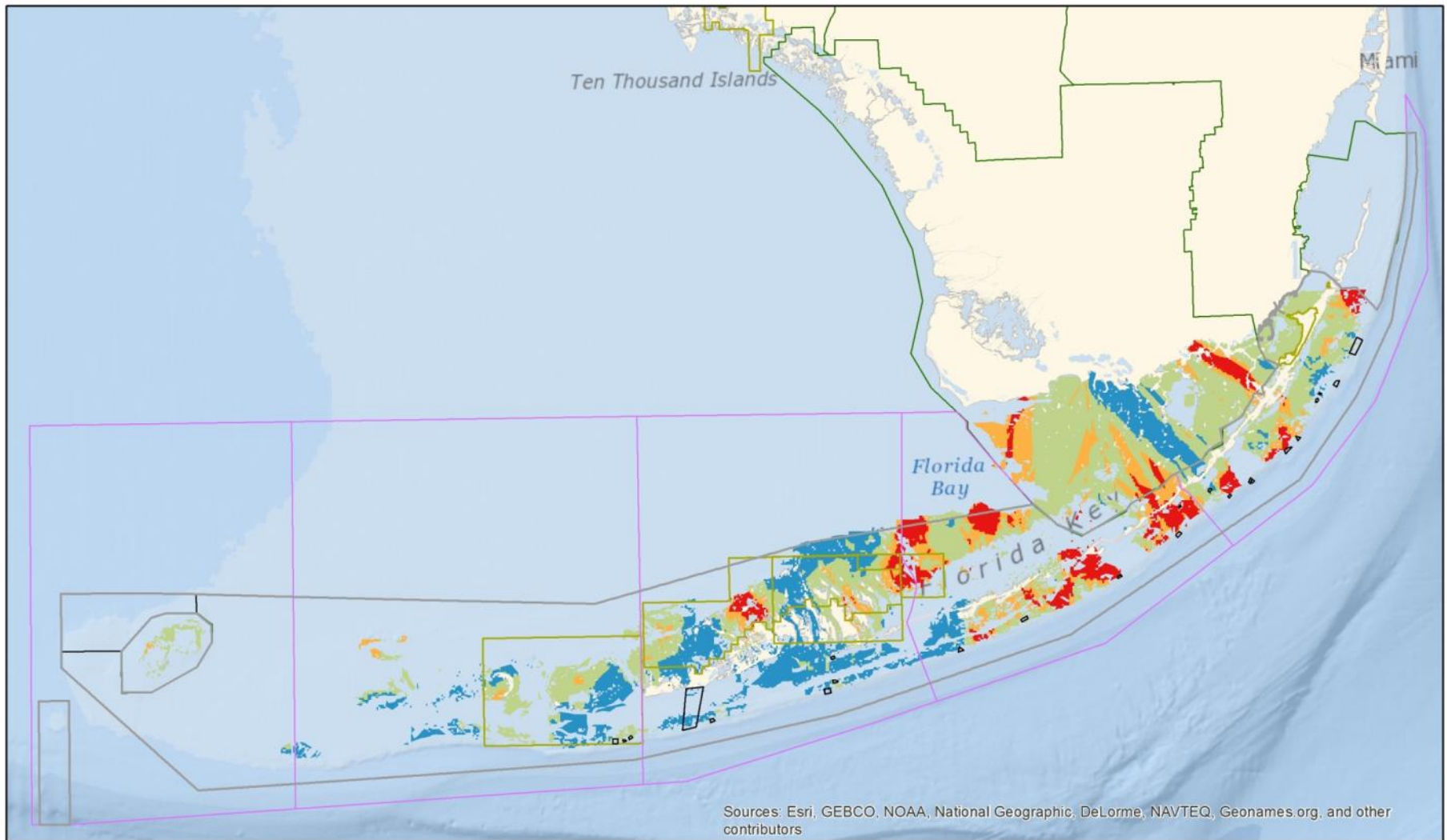
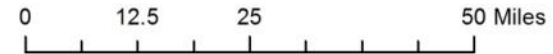
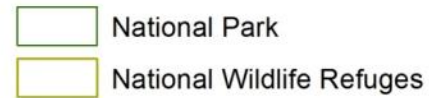
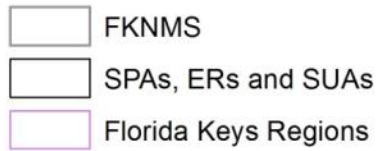
Data sources

- Seagrass monitoring, FIU
- FWC Benthic habitat map

Metric

- Turtle grass (*Thalassia testudinum*) density distribution

Turtle Grass Density



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors



Coral

Coral



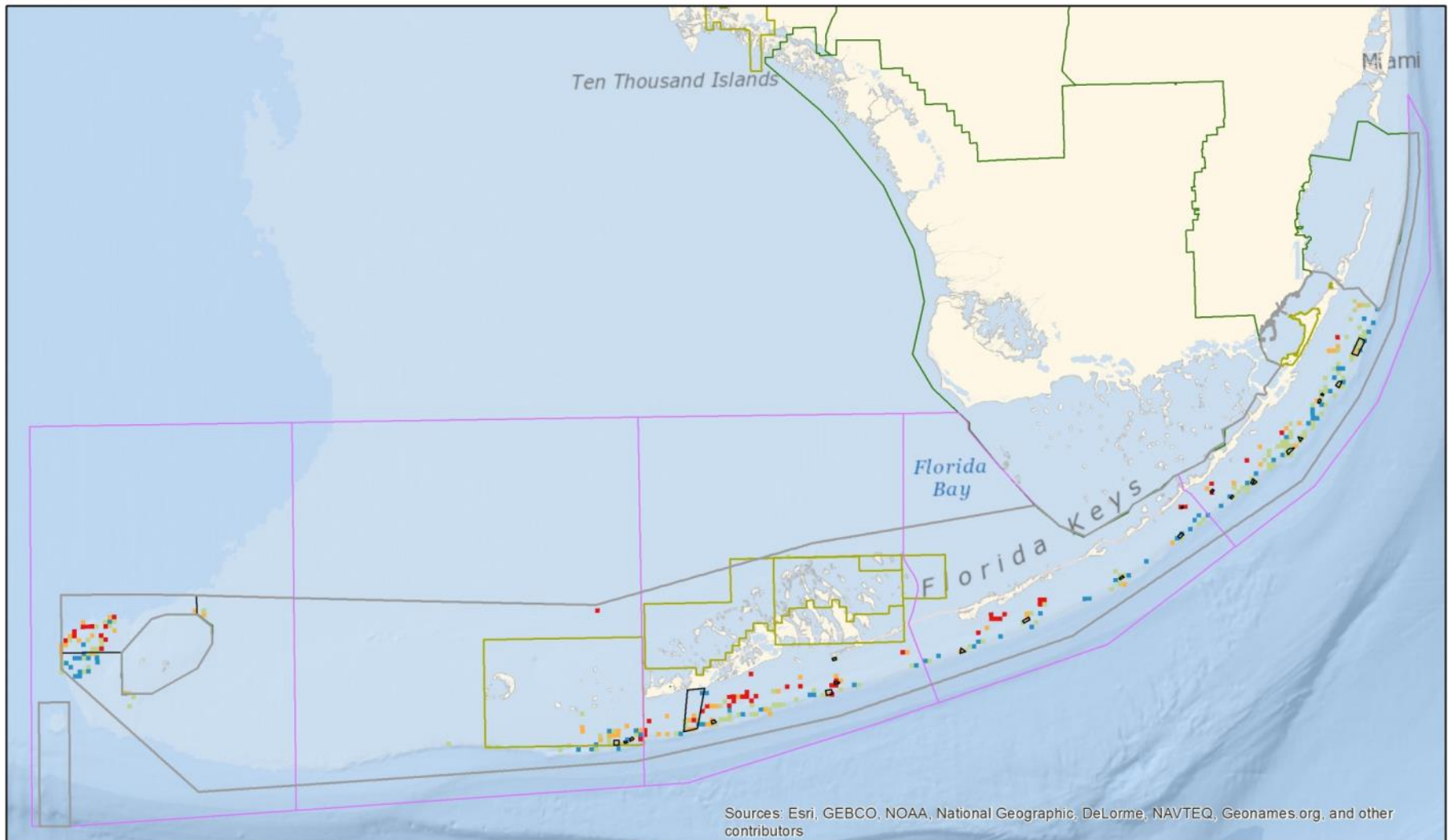
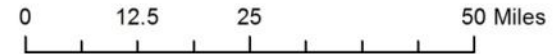
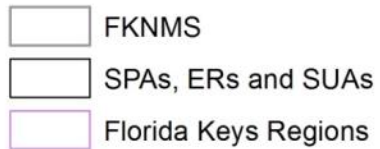
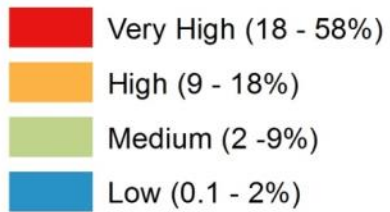
Data sources

- Sanctuary Coral Reef Ecosystem Assessment & Monitoring (SCREAM), Nova Southeastern University
- Florida Reef Resilience Program (FRRP)
- Coral Reef Ecosystem Monitoring Program (CREMP), FWC
- NOAA NCCOS

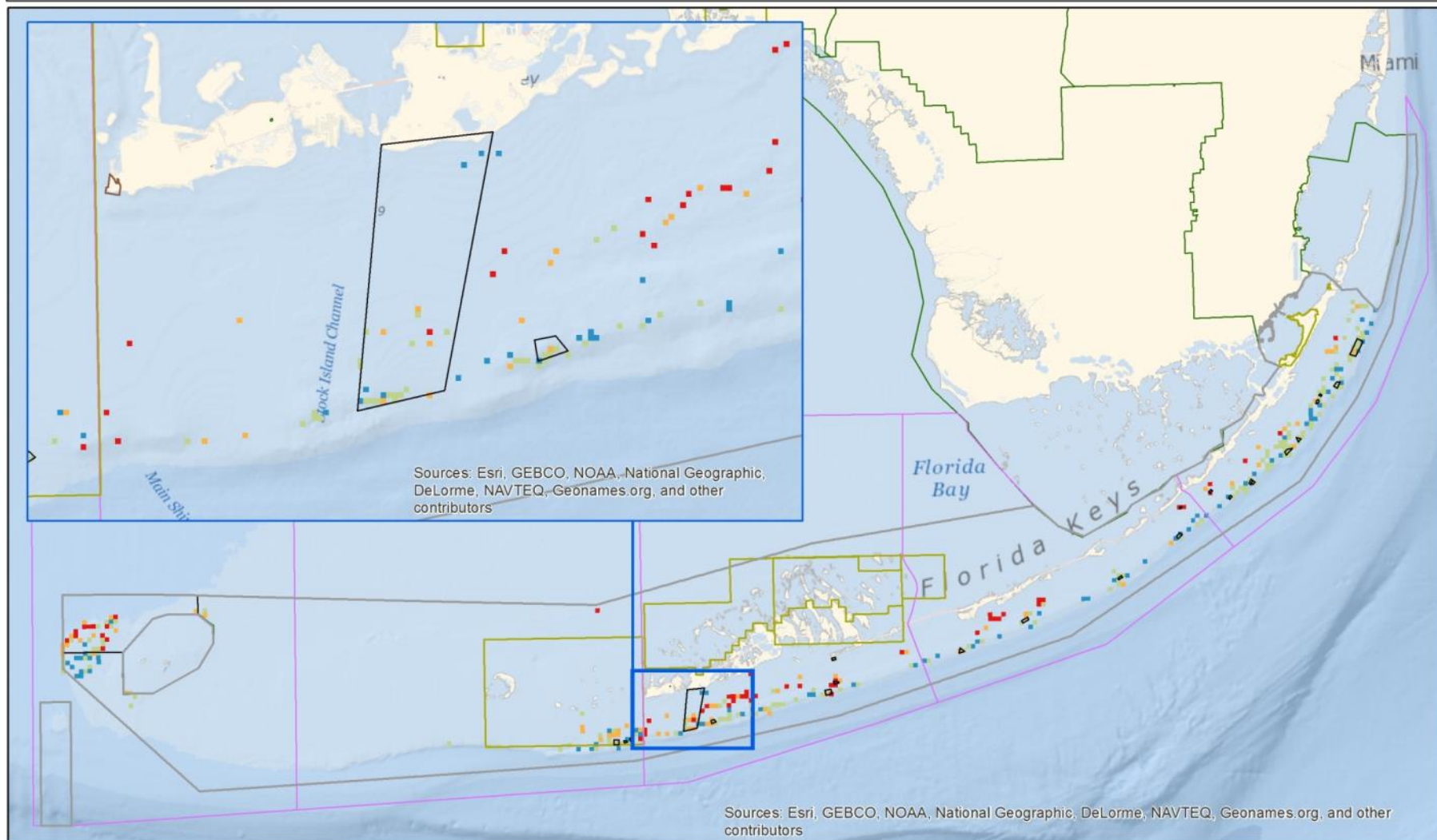
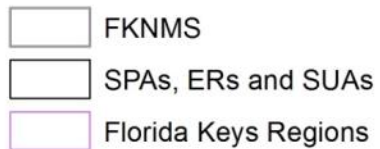
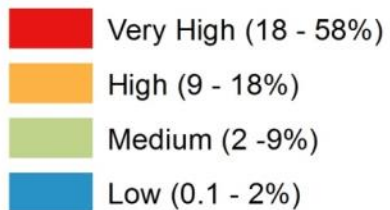
Metrics

- Stony coral
 - Benthic cover (%)
 - Density
 - Species richness
- Soft Coral (Octocoral)
 - Benthic cover (%)
 - Density
 - Species richness

Stony Coral Cover



Stony Coral Cover



Soft Coral (Octocoral)



Soft Coral Density



FKNMS

National Park

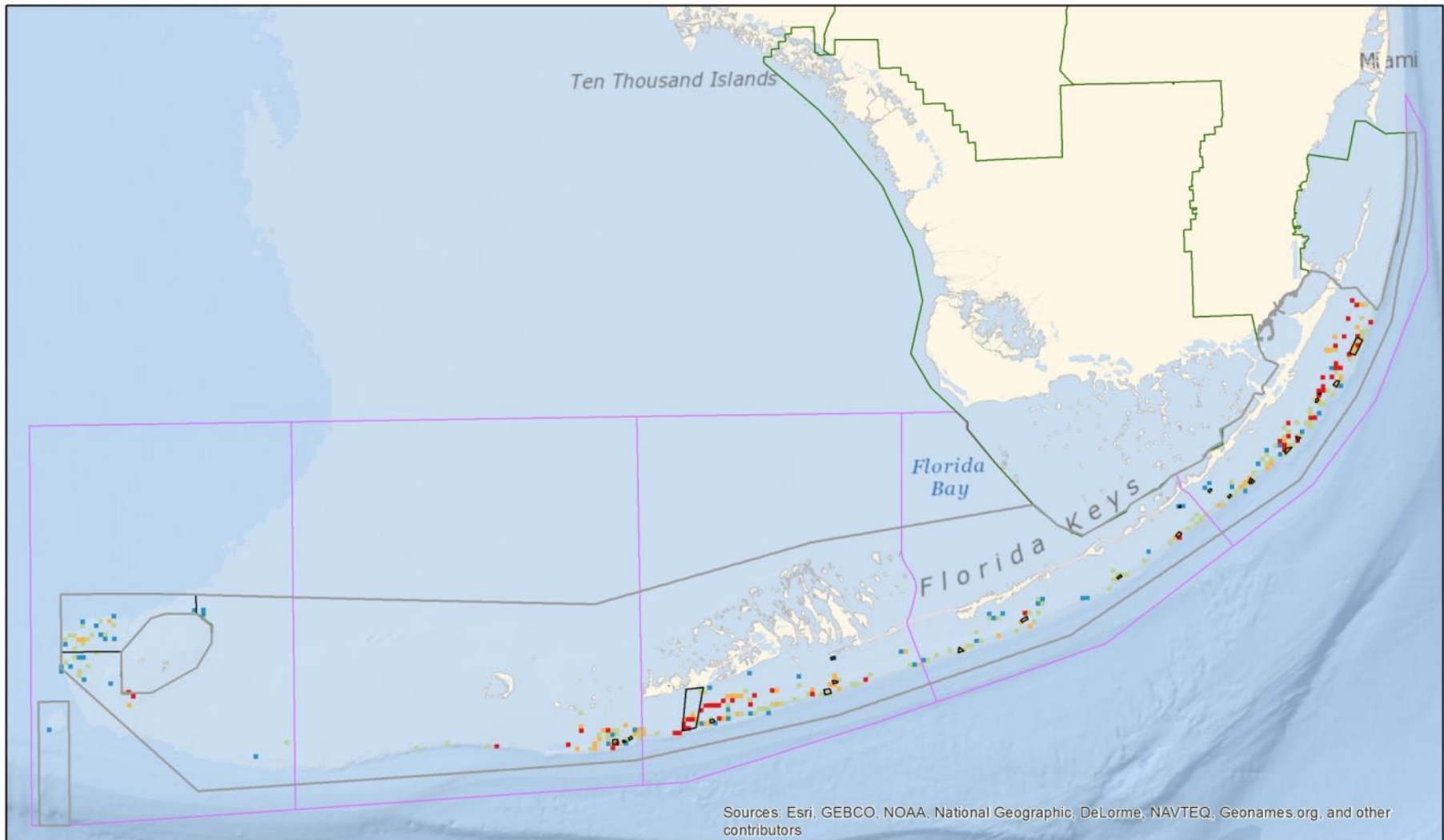
SPAs, ERs and SUAs

Florida Keys Regions

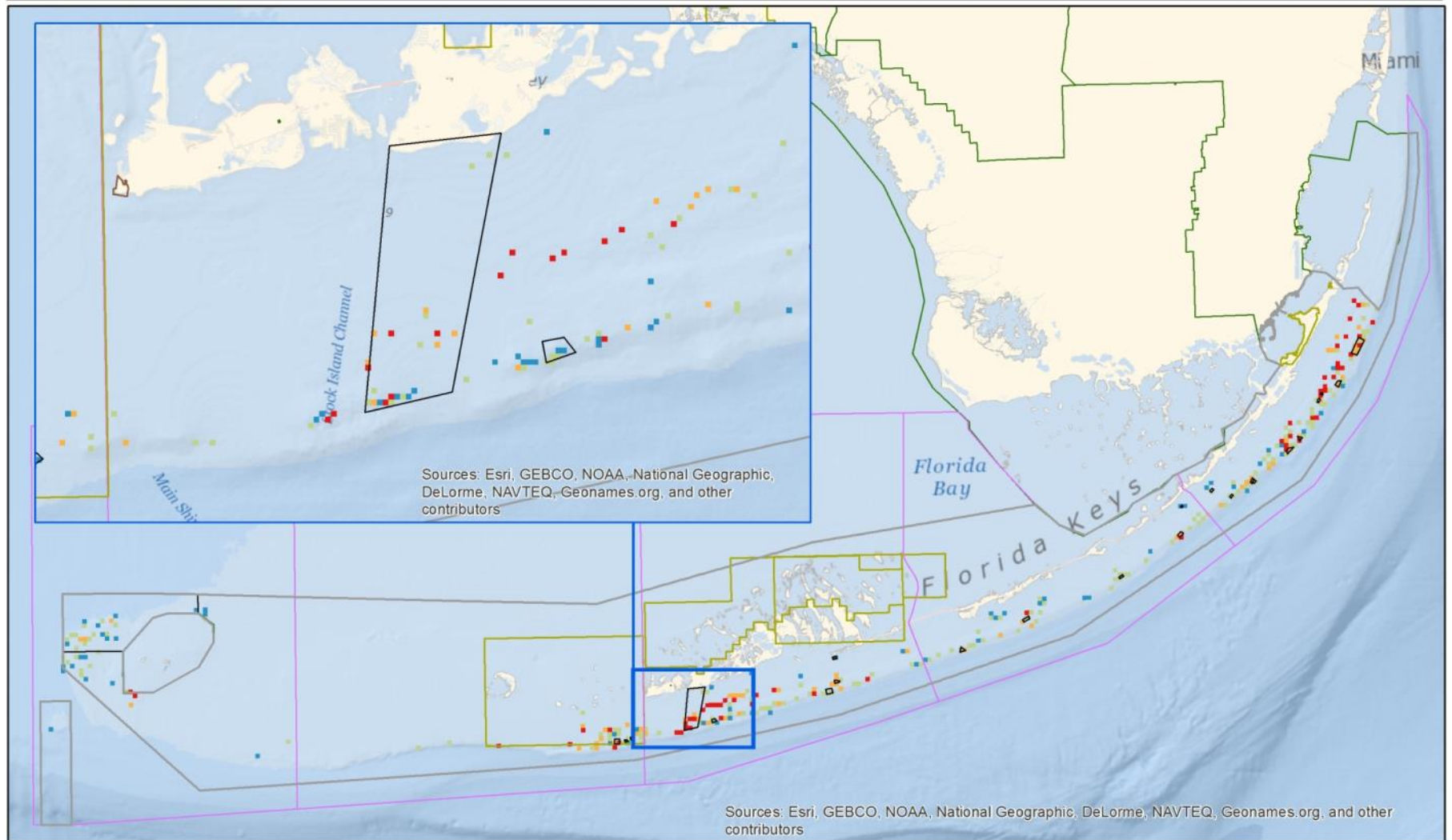
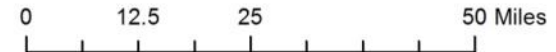
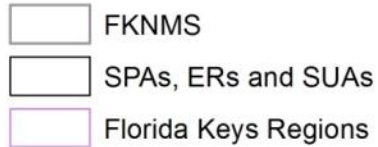
N



0 12.5 25 50 Miles



Soft Coral Density





Coral current and candidate ESA species

Data sources

- Sanctuary Coral Reef Ecosystem Assessment & Monitoring (SCREAM), Nova Southeastern University
- Florida Reef Resilience Program (FRRP)
- Coral Reef Ecosystem Monitoring Program (CREMP), FWC
- NOAA NMFS Protected Resources & FWC ESA monitoring

Species

- ESA Threatened: elkhorn (*Acropora palmata*), staghorn (*Acropora cervicornis*)
- State of FL Threatened: pillar (*Dendrogyra cylindrus*)
- Candidate ESA Endangered: elkhorn, staghorn, pillar, boulder star (*Montastraea annularis*), mountainous star (*M. faveolata*), star (*M. franksii*)
- Candidate ESA Threatened: sheet coral (*Agaricia lamarcki*), elliptical star coral (*Dichocoenia stokesii*)

Metrics

- presence/absence
- >3 species

Threatened Corals



Present



FKNMS



SPAs, ERs and SUAs



Florida Keys Regions



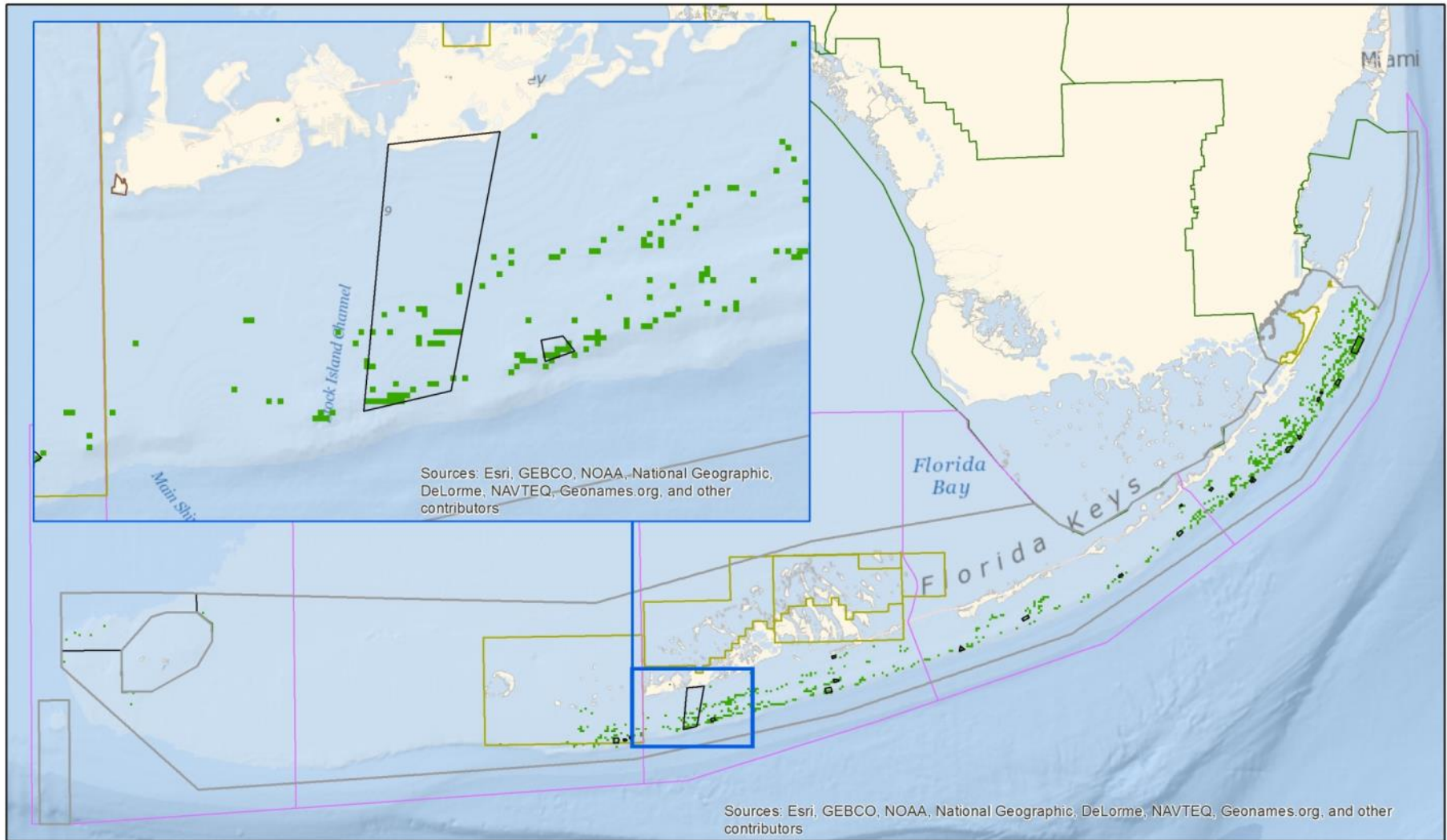
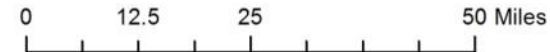
National Park



National Wildlife Refuges




State Park



ESA Candidate Corals


 Present

 FKNMS

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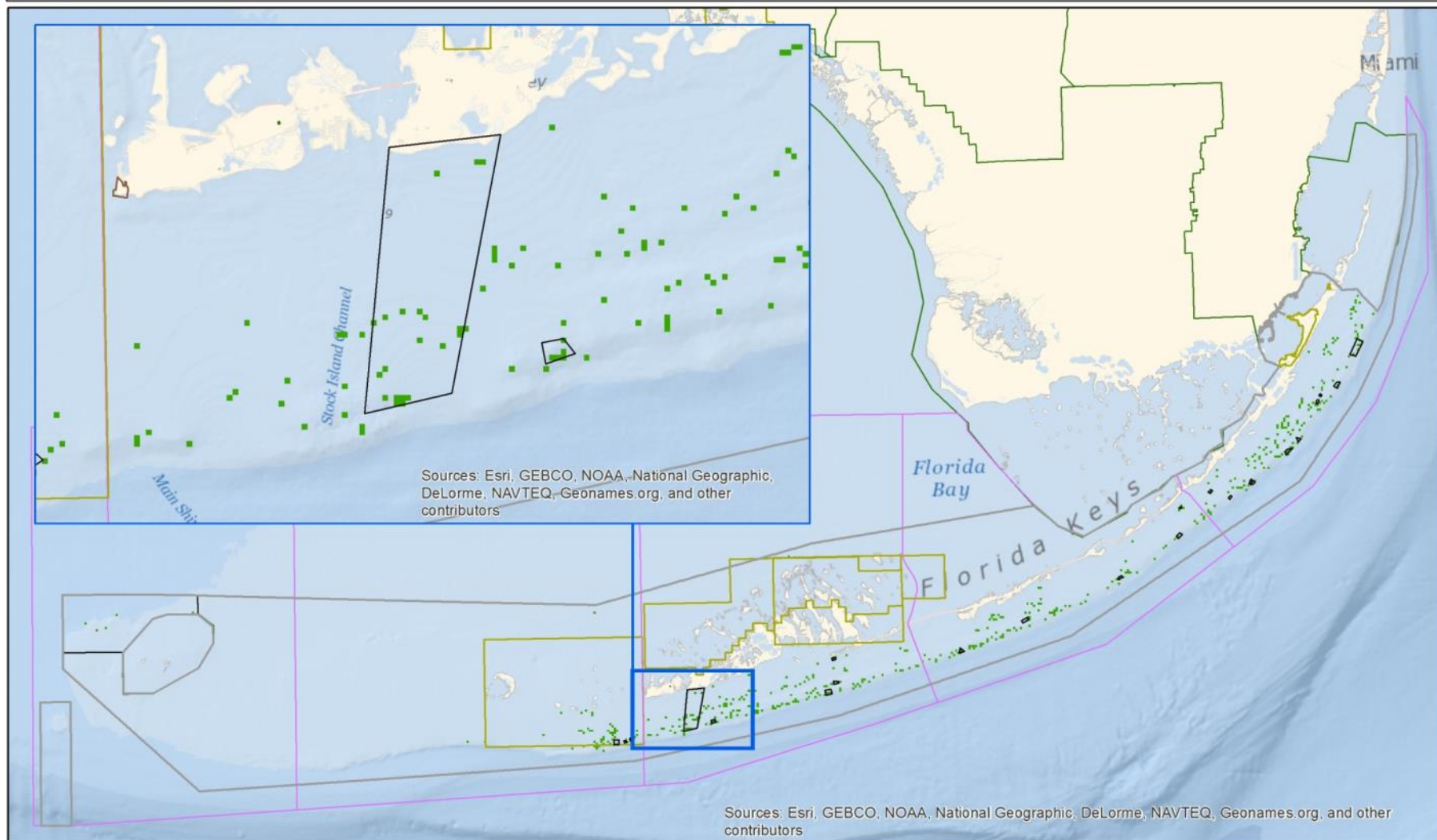
 National Wildlife Refuges

 State Park

N



0 12.5 25 50 Miles



Resilient Reefs

Data source

R. Van Woesik analysis of Florida Reef Resilience Program coral surveys, 2005-2010

Study methods

Coral survey data selected for high coral colony density, relatively low observations of disease and bleaching

Metric

- Resilient reefs

Resilient Reefs

Present

FKNMS

National Park

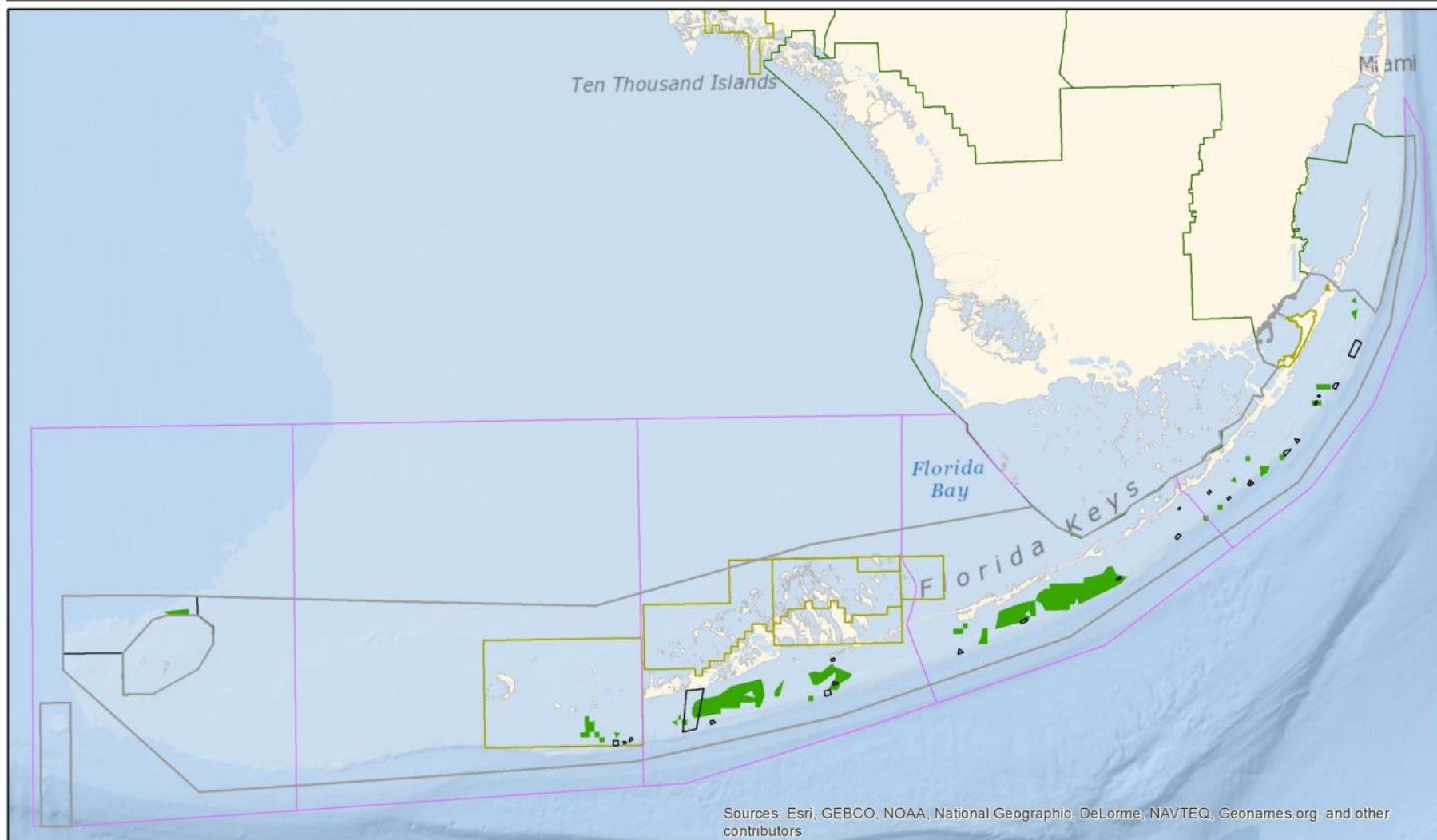
SPAs, ERs and SUAs

National Wildlife Refuges

Florida Keys Regions



0 12.5 25 50 Miles



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors



Fish

Fish

- Reef fish visual surveys
- Fish aggregations





Reef fish visual surveys

Data sources

NOAA NMFS and partners including University of Miami, FWC, etc

Study Methods

Diver-based stationary surveys on hardbottom reef

Metrics

- Fish abundance
- Fish species richness
- Grouper-snapper complex abundance
- Nassau-Goliath grouper abundance
- Marine life fishery fish species abundance
- Top 10 marine life fishery fish species abundance
- Parrotfish abundance
- Barracuda abundance
- Permit abundance

Total Fish Abundance



FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

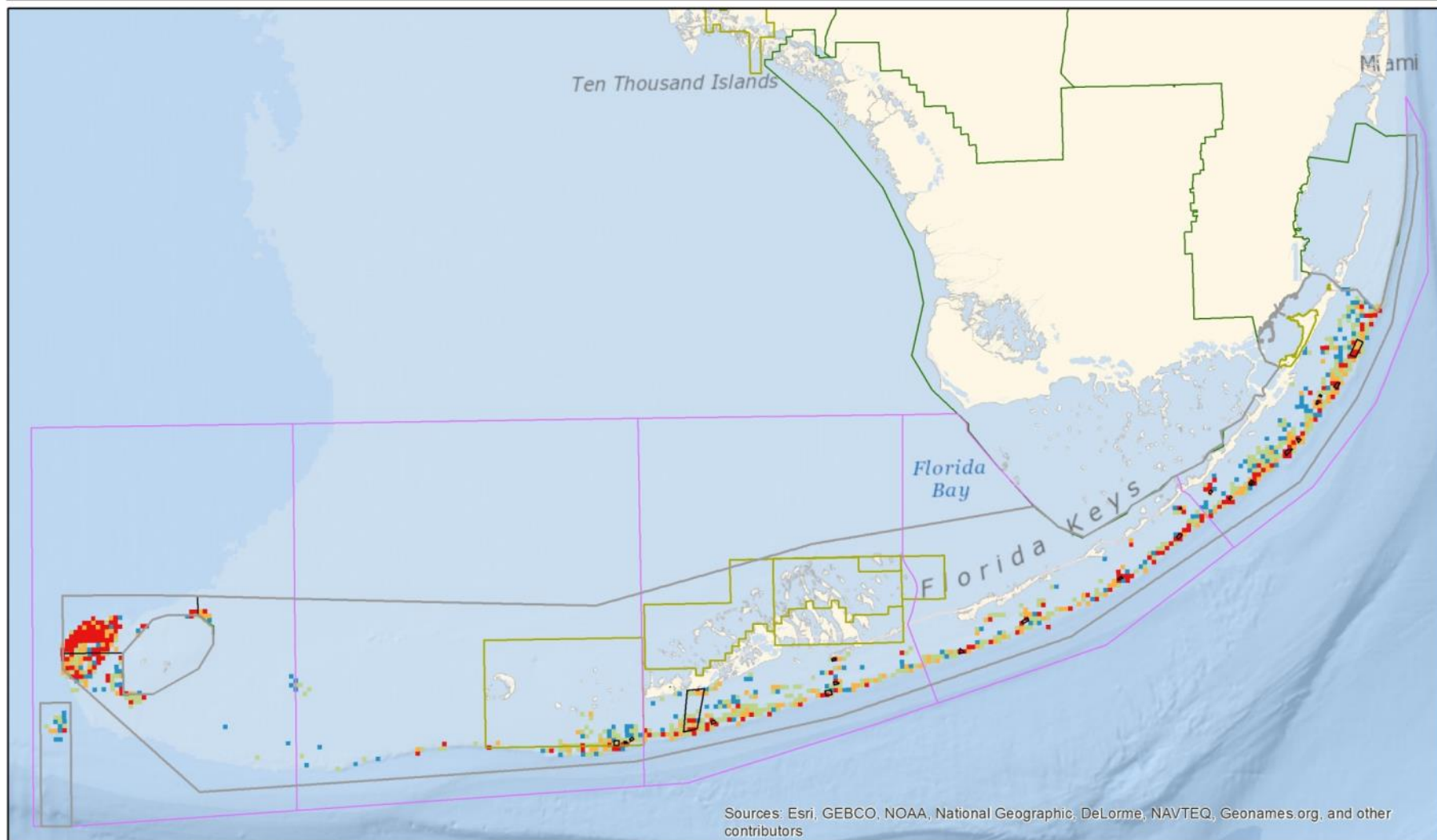
National Park

National Wildlife Refuges

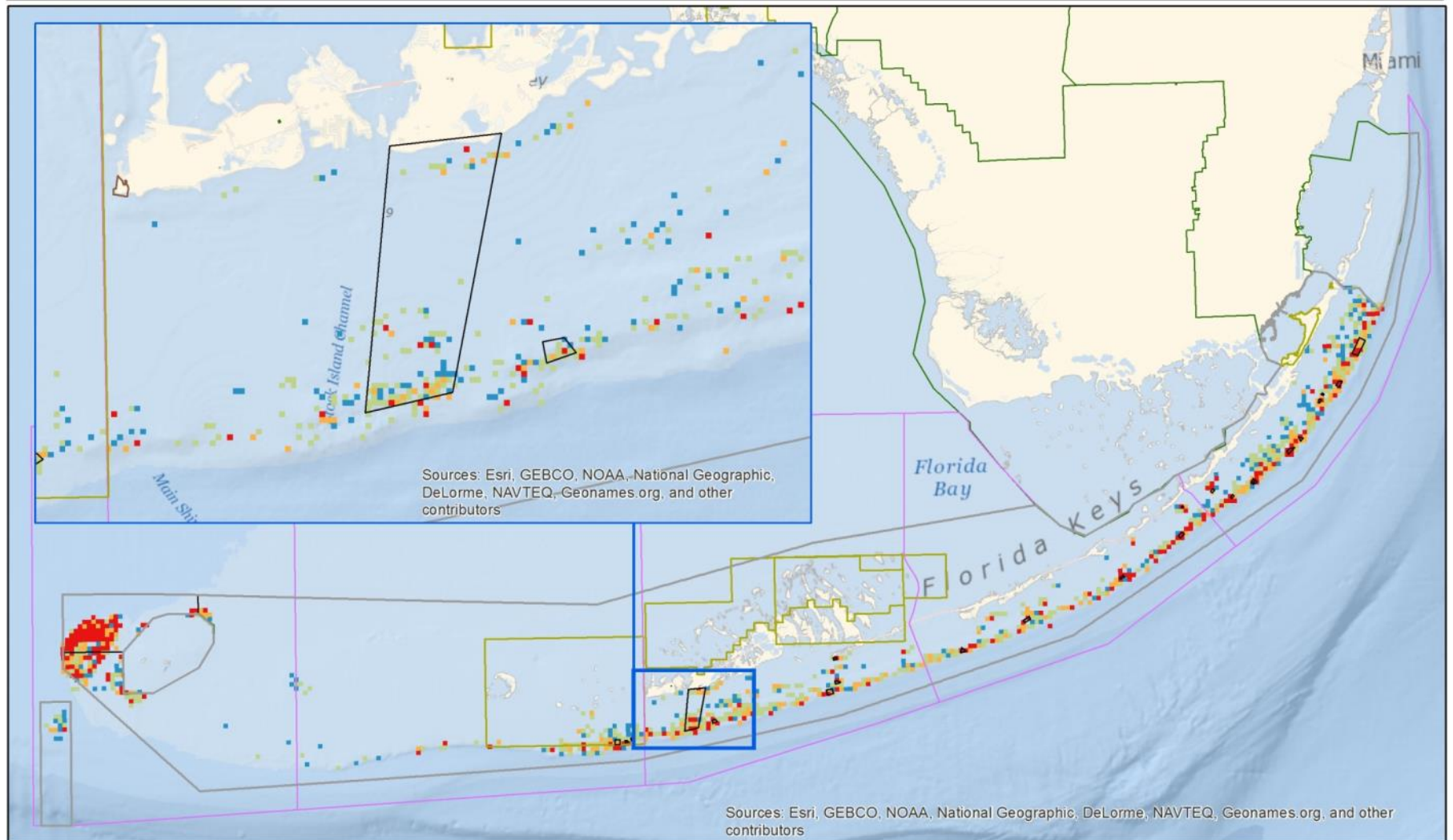
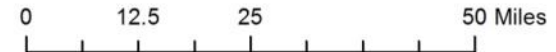
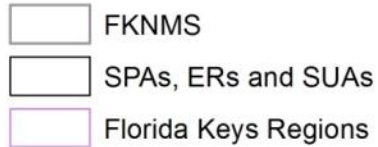
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0 12.5 25 50 Miles



Total Fish Abundance



Grouper & Snapper Fish Abundance

Very High (95 - 1,771)

High (49 - 95)

Medium (7 - 49)

Low (0.3 - 7)

FKNMS

SPAs, ERs and SUAs

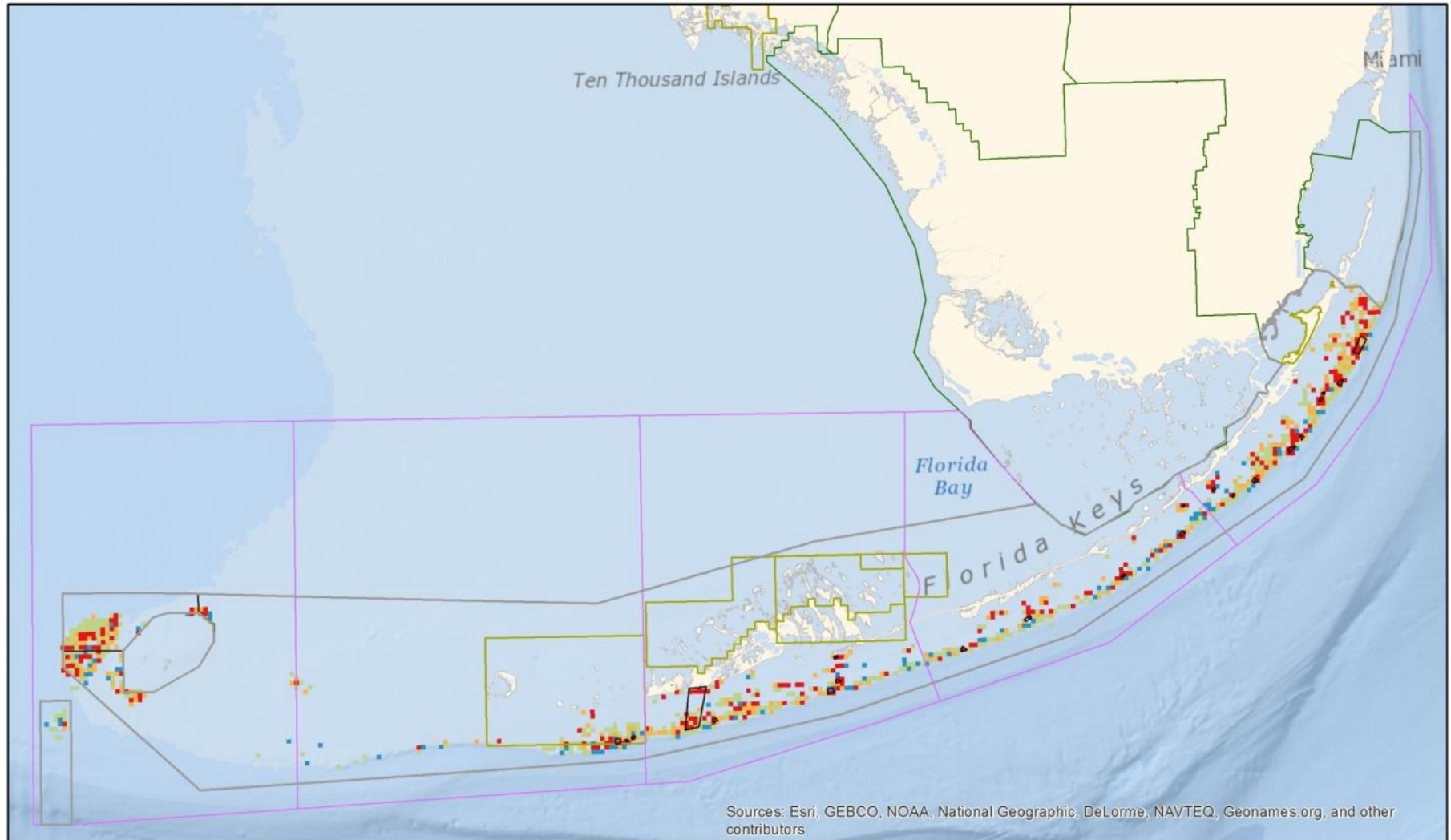
Florida Keys Regions

National Park

National Wildlife Refuges

N

0 12.5 25 50 Miles



Fish Aggregations

Data sources

NOAA & FWC

Study Methods

Fish spawning aggregation locations for snappers and groupers collected from interviews with fishers, reports and field surveys (acoustic and diver) from Key Largo to Marquesas and Dry Tortugas

Metrics

- Fish Aggregations
 - Single species, multi-species
 - FSA present, probable, potential, reported



Fish Aggregations



Photo credit: C. Parsons

Data sources

NOAA & FWC

Study Method

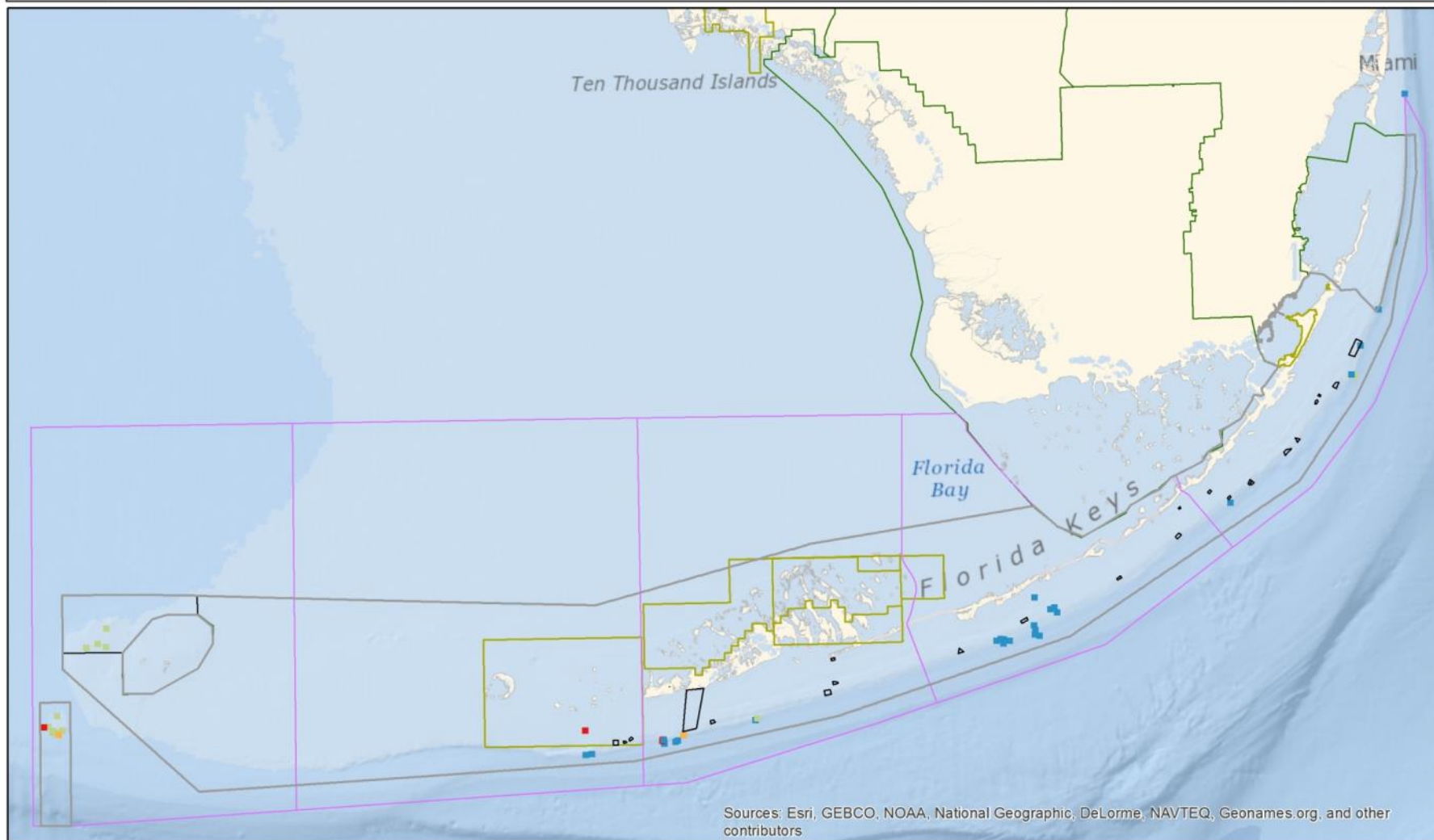
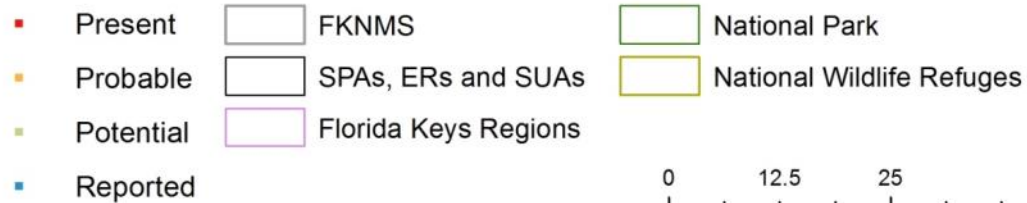
Fish spawning aggregation
fishers, reports and
Tortugas

Metrics

- Fish Aggregation
 - Single species
 - FSA present

FSA present	high scientific confidence that this is a spawning site
FSA probable	probably a spawning site, but could use more documentation
FSA potential	some field evidence that this is a spawning site
FSA reported	information that this could be an area of interest but not field-confirmed

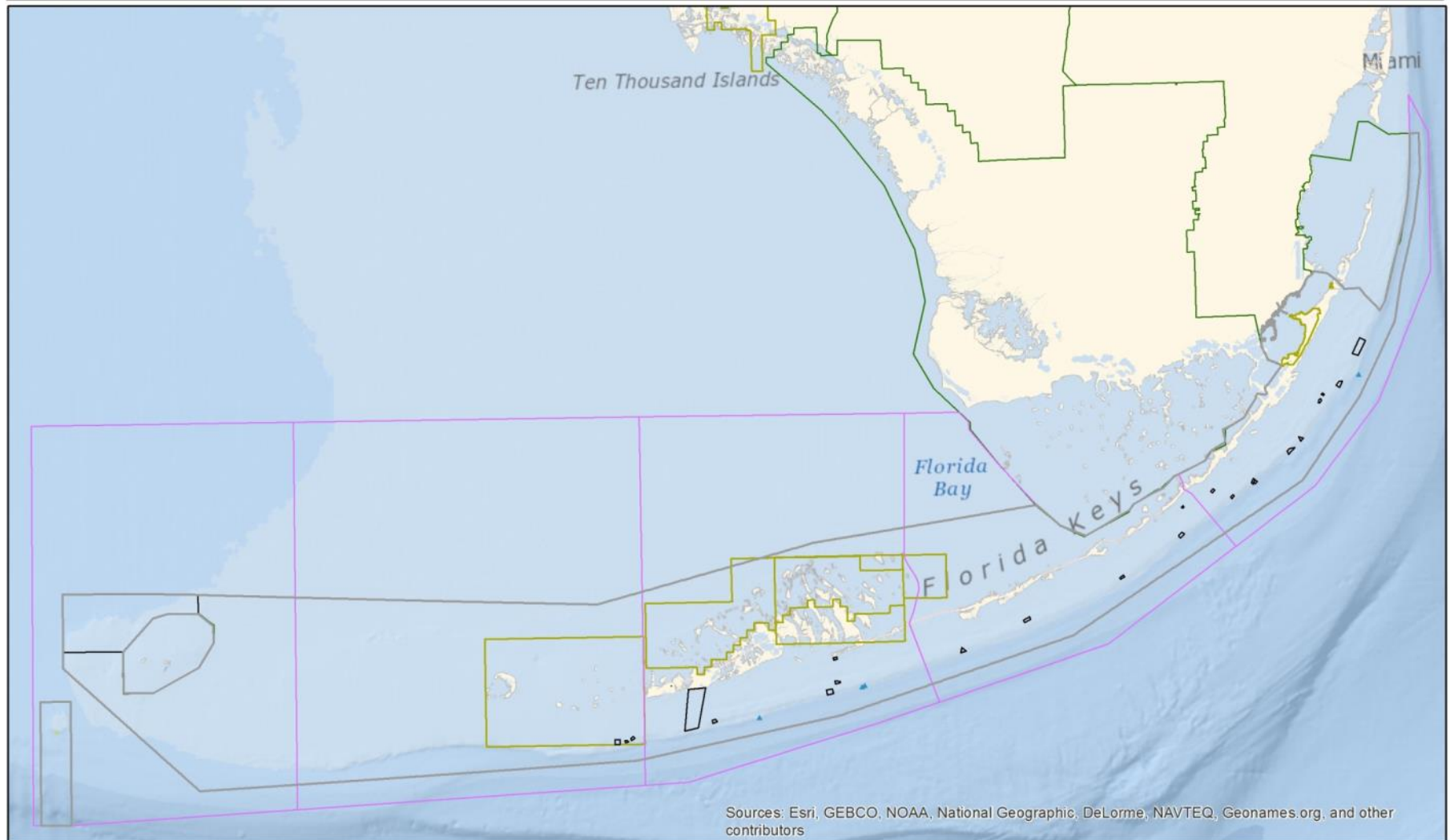
Fish Aggregations: Single Species



Fish Aggregations: Multi-Species

- | | | |
|-------------|------------------------|-----------------------------|
| ▲ Present | □ FKNMS | □ National Park |
| ★ Probable | □ SPAs, ERs and SUAs | □ National Wildlife Refuges |
| ▲ Potential | □ Florida Keys Regions | |
| ▲ Reported | | |

0 12.5 25 50 Miles

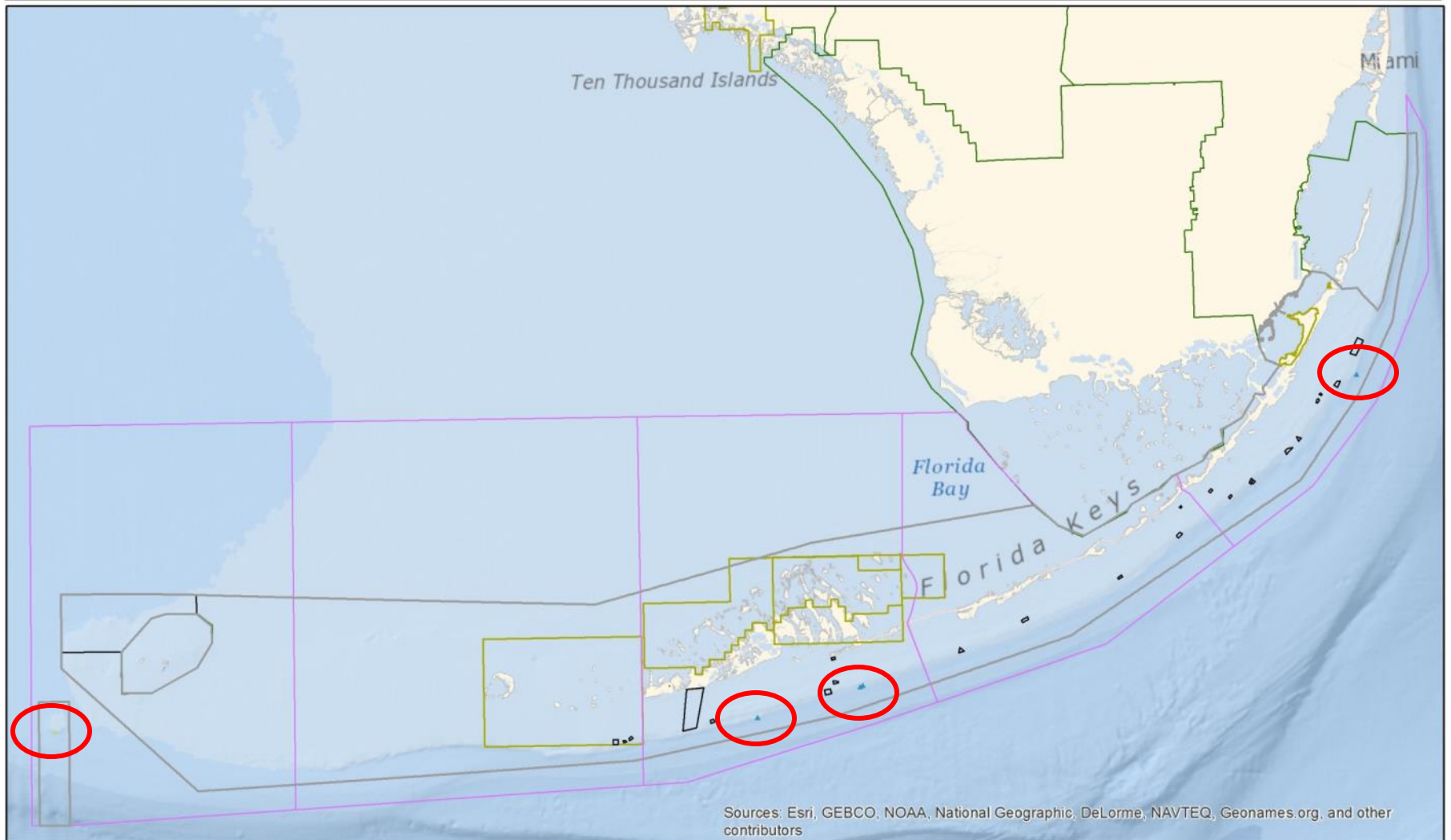


Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Fish Aggregations: Multi-Species

- | | | |
|-------------|------------------------|-----------------------------|
| ▲ Present | □ FKNMS | □ National Park |
| ★ Probable | □ SPAs, ERs and SUAs | □ National Wildlife Refuges |
| ▲ Potential | □ Florida Keys Regions | |
| ▲ Reported | | |

0 12.5 25 50 Miles



Fish Aggregations

Single Species

- Present
- Probable
- Potential
- Reported

Multi-Species

- ▲ Present
- ▲ Probable
- ▲ Potential
- ▲ Reported

FKNMS

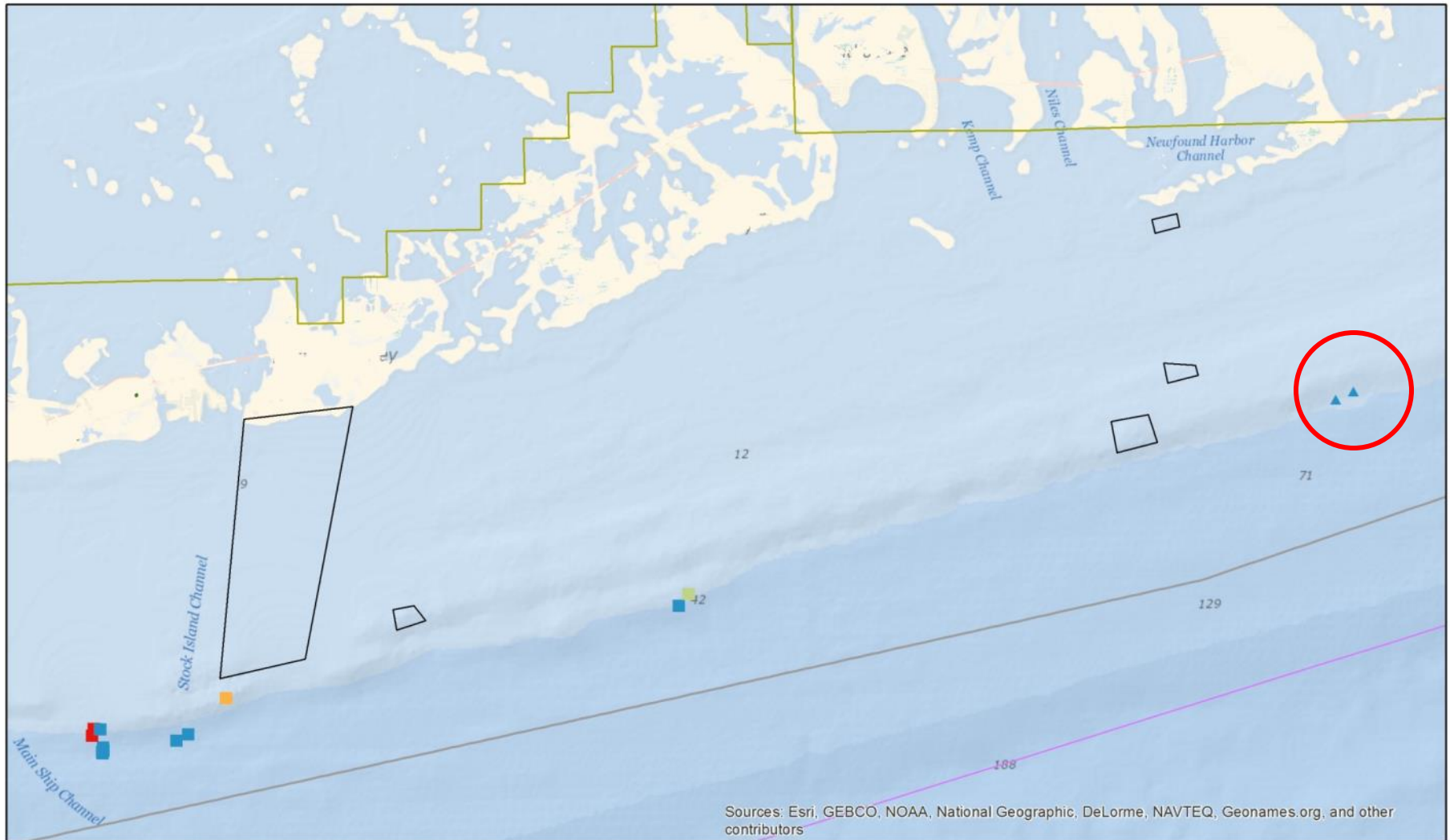
SPAs, ERs and SUAs

Florida Keys Regions

National Park

National Wildlife Refuges

0 2.25 4.5 9 Miles



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors



Other Fauna

Queen Conch

Data source

FWC

Survey method

Diver surveys

Discussions with local fishers

Metric

Polygons of dense offshore
aggregations of queen conch
(*Strombus gigas*)



Queen Conch

Present

FKNMS

National Park

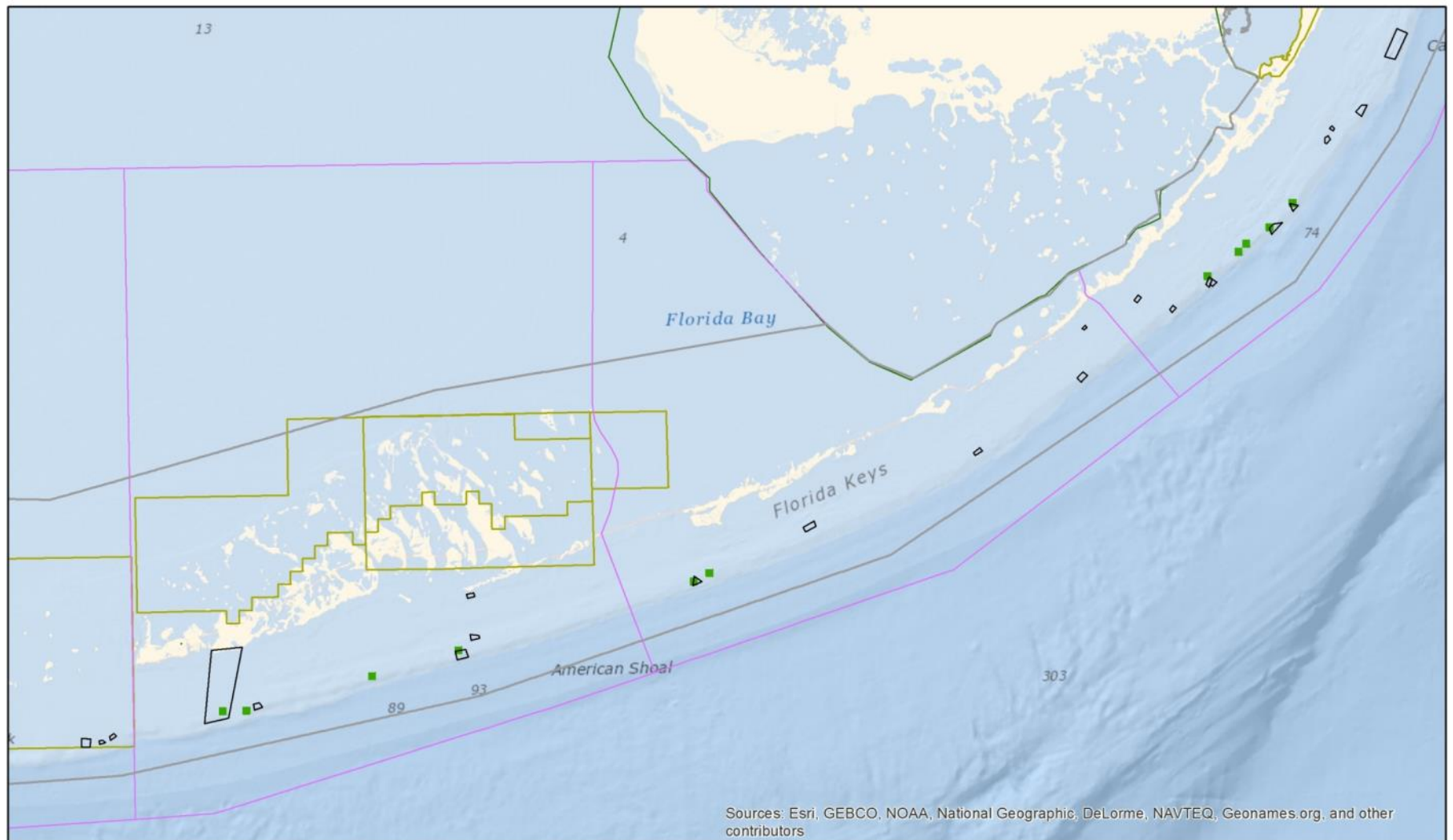
SPAs, ERs and SUAs

National Wildlife Refuges

Florida Keys Regions



0 5 10 20 Miles



Datasets: Natural Resources

Metrics

- Habitat
 - Patch & aggregated reef
 - High relief reefs
 - Turtle grass density
- Coral
 - Stony coral
 - Soft coral
 - Resilient reefs
- Fish
 - Reef fish
 - Fish aggregations
- Fauna
 - Queen conch aggregations





Human Use

Datasets

Human use

- **Commercial Fishing**
 - Density of Commercial Fishers
 - Distribution of Commercial Fishing Landings
- **Recreational Fishing**
 - Distribution of Recreational and Charter Fishing Vessels
- **Diving Activity**
 - Distribution of Dive Boats
 - Distribution of Recreational Divers
- **Marine Debris**
- **Vessel Groundings**
- **Watercraft Infrastructure**
 - *Location of Marinas*
 - *Location of Watercraft-Related Businesses*



Photos courtesy of NOAA photo library and FKNMS

Commercial Fishing



Data source

Manoj Shivlani et al (2008). Knowledge Attitudes and Perceptions of Management Strategies and Regulations of the Florida Keys National Marine Sanctuary by Commercial Fishers, Dive Operators, and Environmental Group Members: A Baseline Characterization and 10-year Comparison.

Metrics

- Density of Commercial Fishers per 1 nautical mile-squared (2004-2005):
 - Spiny Lobster, Stone Crab, Reef Fish (Snapper/Grouper), King Mackerel, Spanish Mackerel, Other Pelagics (Cobia, Dolphin, Wahoo), Bait Fish, Shrimp and Total Fishers
- Relative Distribution of Commercial Fishing Landings (2004-2005)
 - Spiny Lobster, Stone Crab, Reef Fish (Snapper/Grouper), King Mackerel, Spanish Mackerel, Other Pelagics (Cobia, Dolphin, Wahoo), Bait Fish, Shrimp and Total Landings

Commercial Fishing Surveys

Data Collection: 294 commercial fishers from the Florida Keys completed surveys about their fishing activity.

Purpose: Survey questions gathered:

- General demographic information,
- Economic information,
- Fishery information including use patterns,
- Commercial fishers' knowledge, attitudes, perceptions and beliefs regarding the FKNMS

Fishery Information:

Effort (# Trips)

Landings (Lbs)

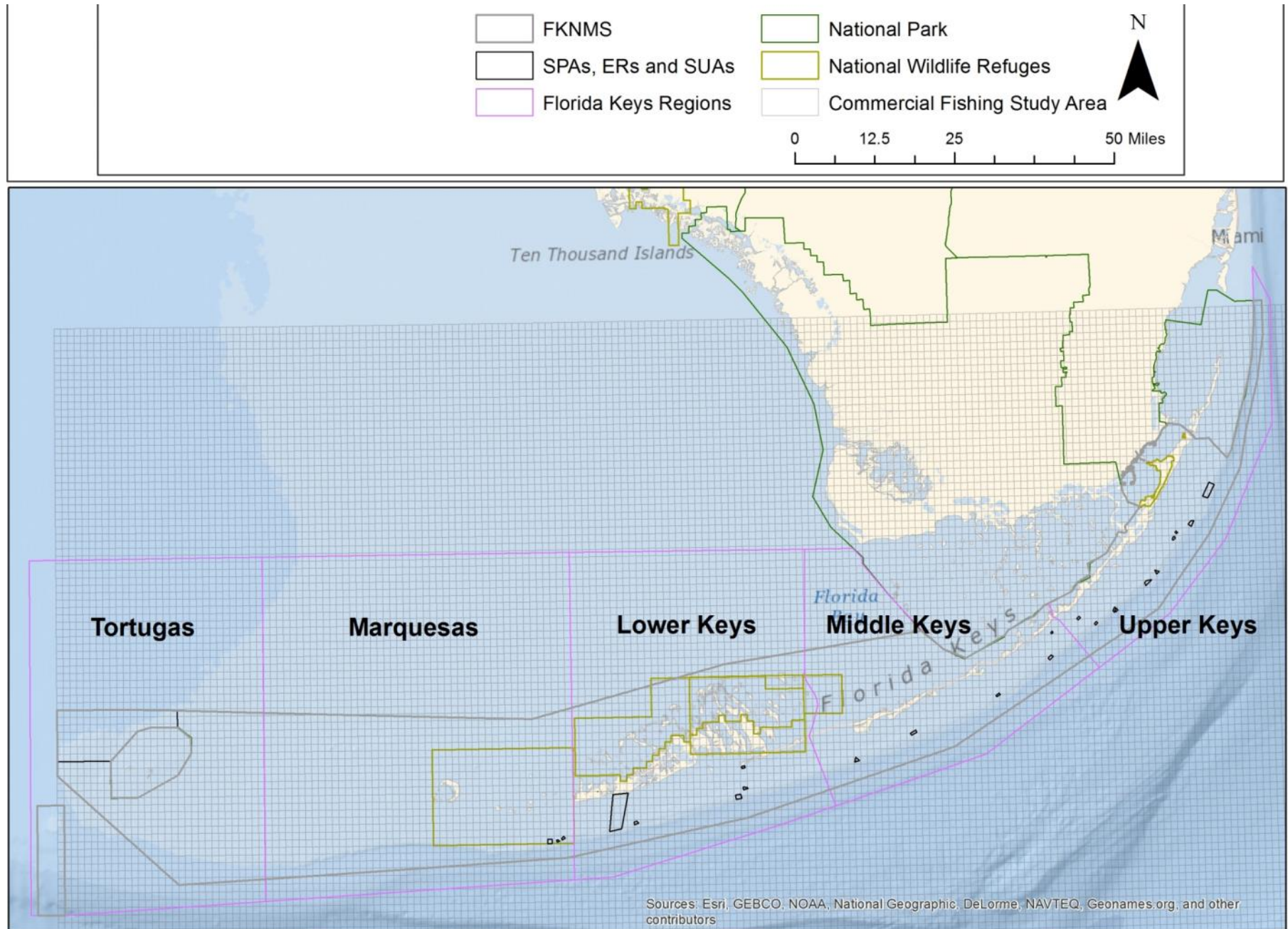
Cost per Trip

Use Patterns

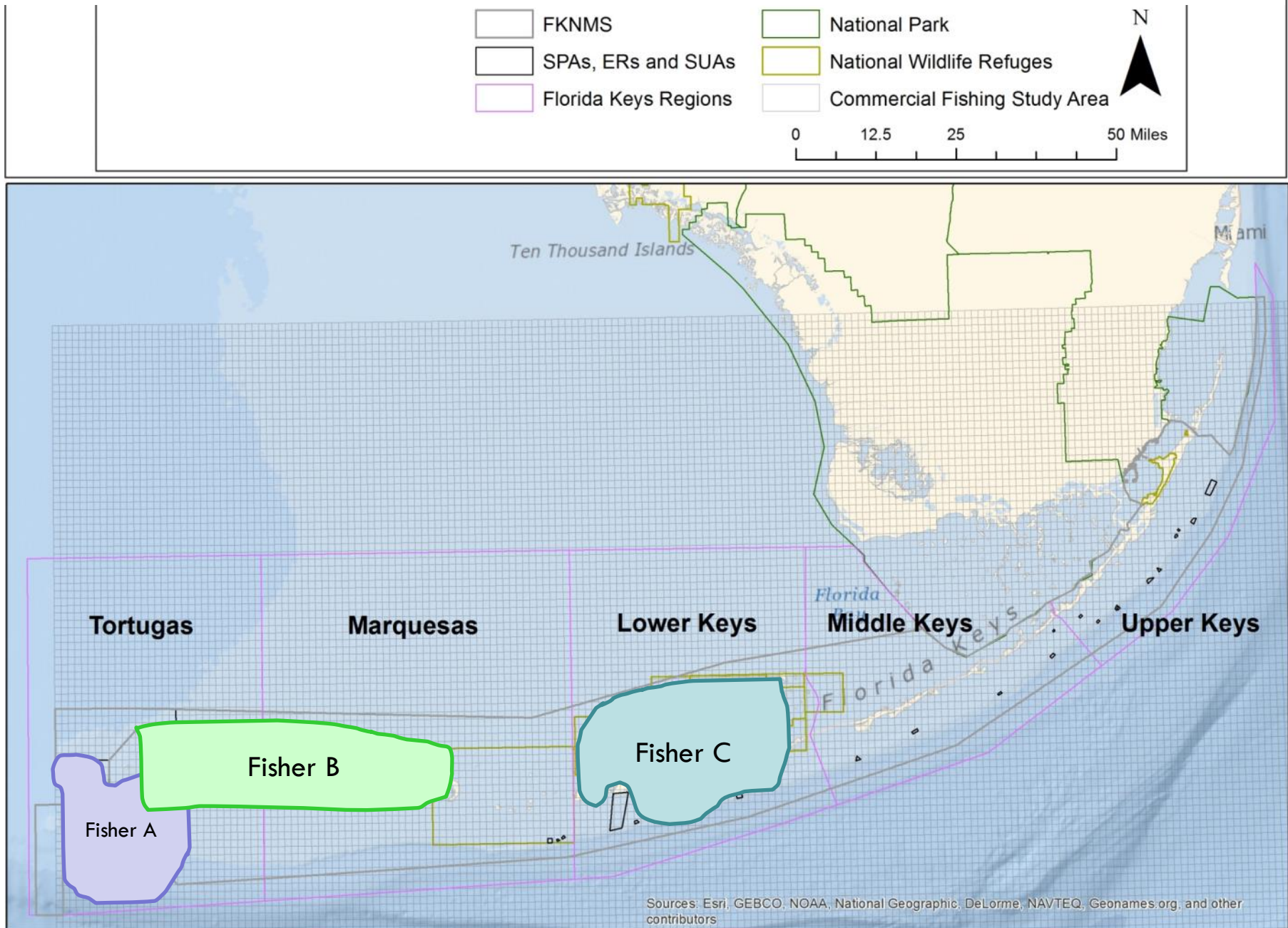
Time Period: 2004-2005

Availability: Spatial information is available for 270 of the 294 fishers.

Surveys gathered spatial data on where each fisher fished:



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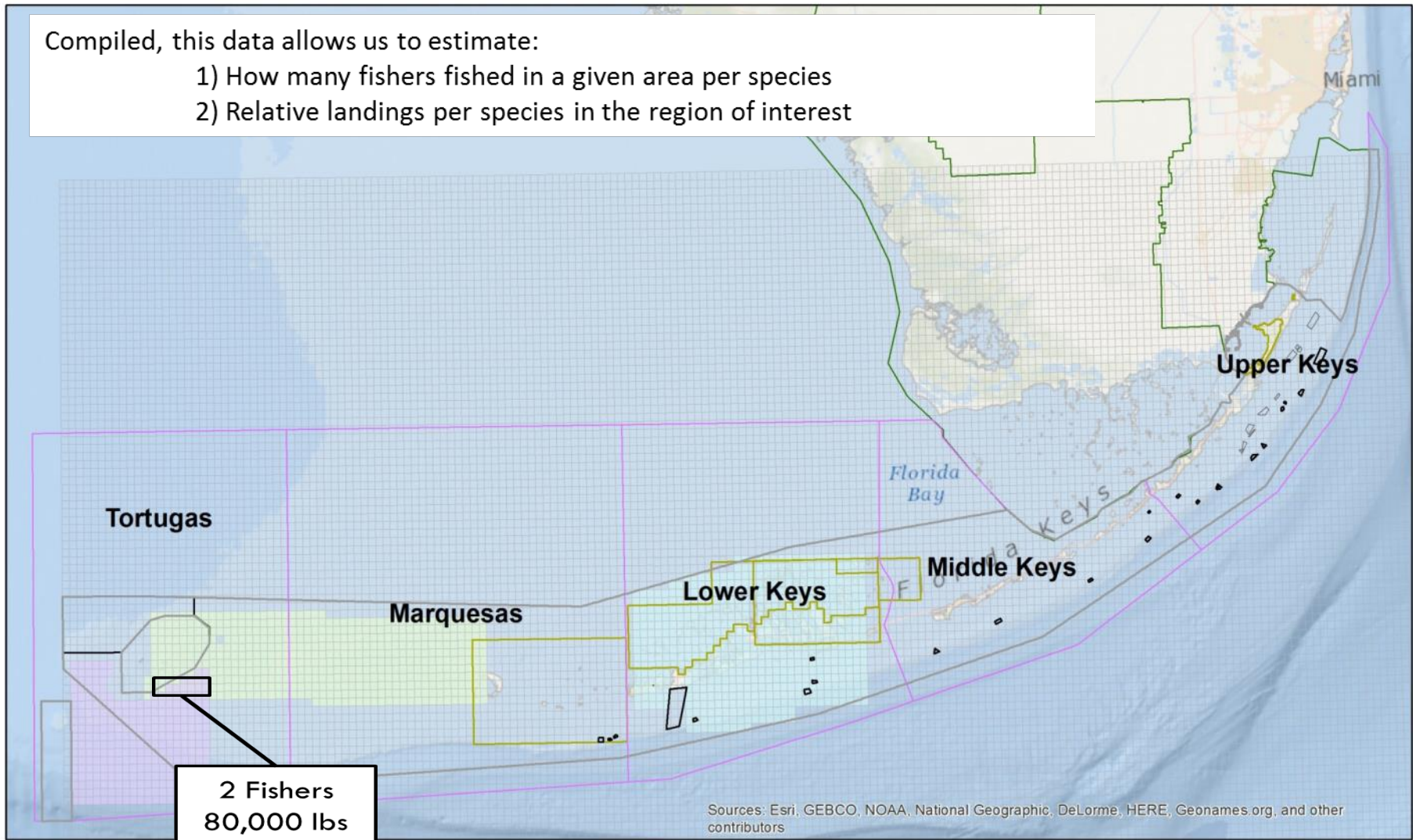


Surveys gathered spatial data on where each fisher fished:

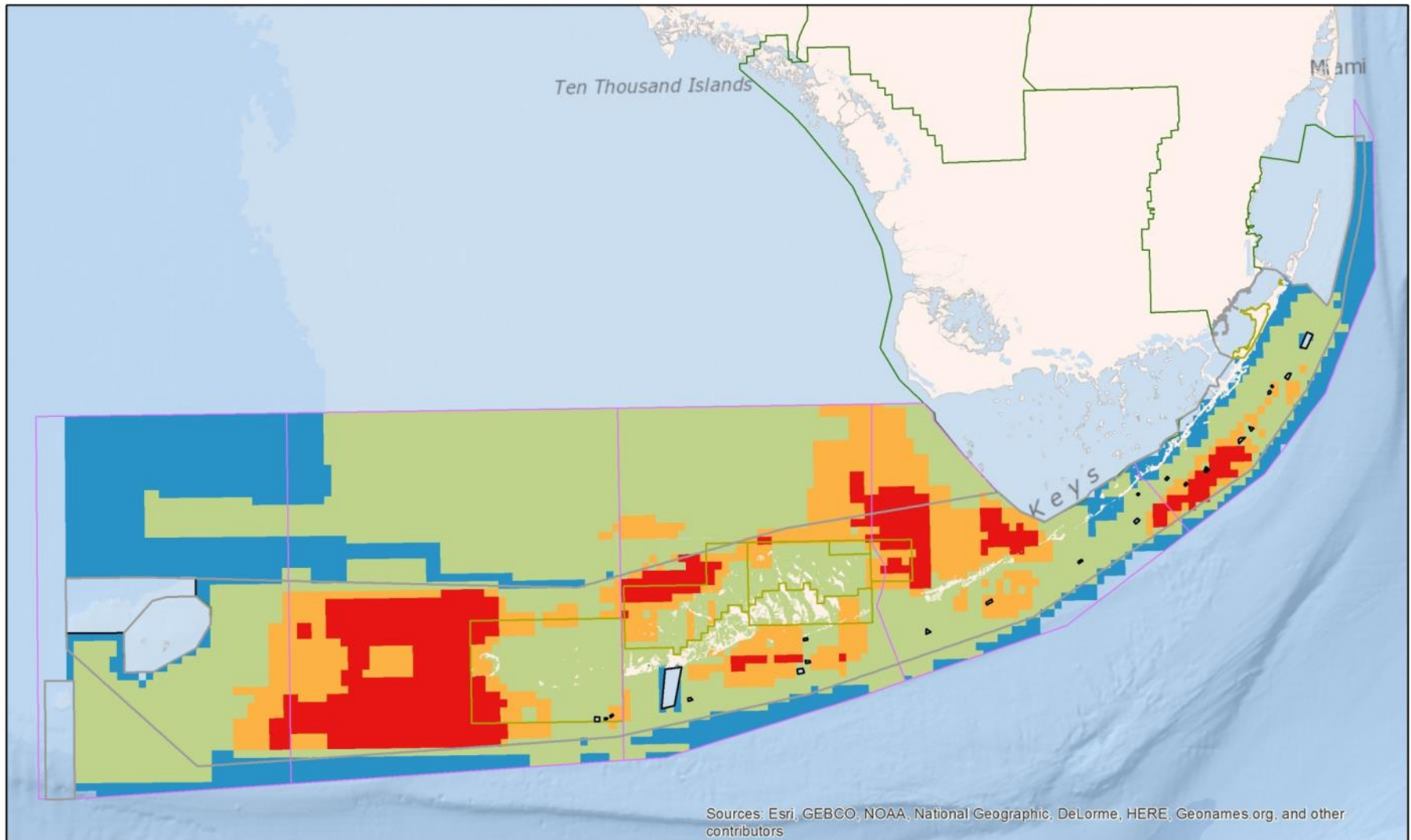
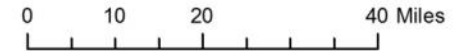
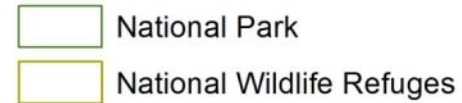
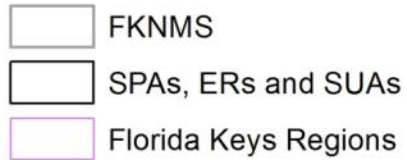


Compiled, this data allows us to estimate:

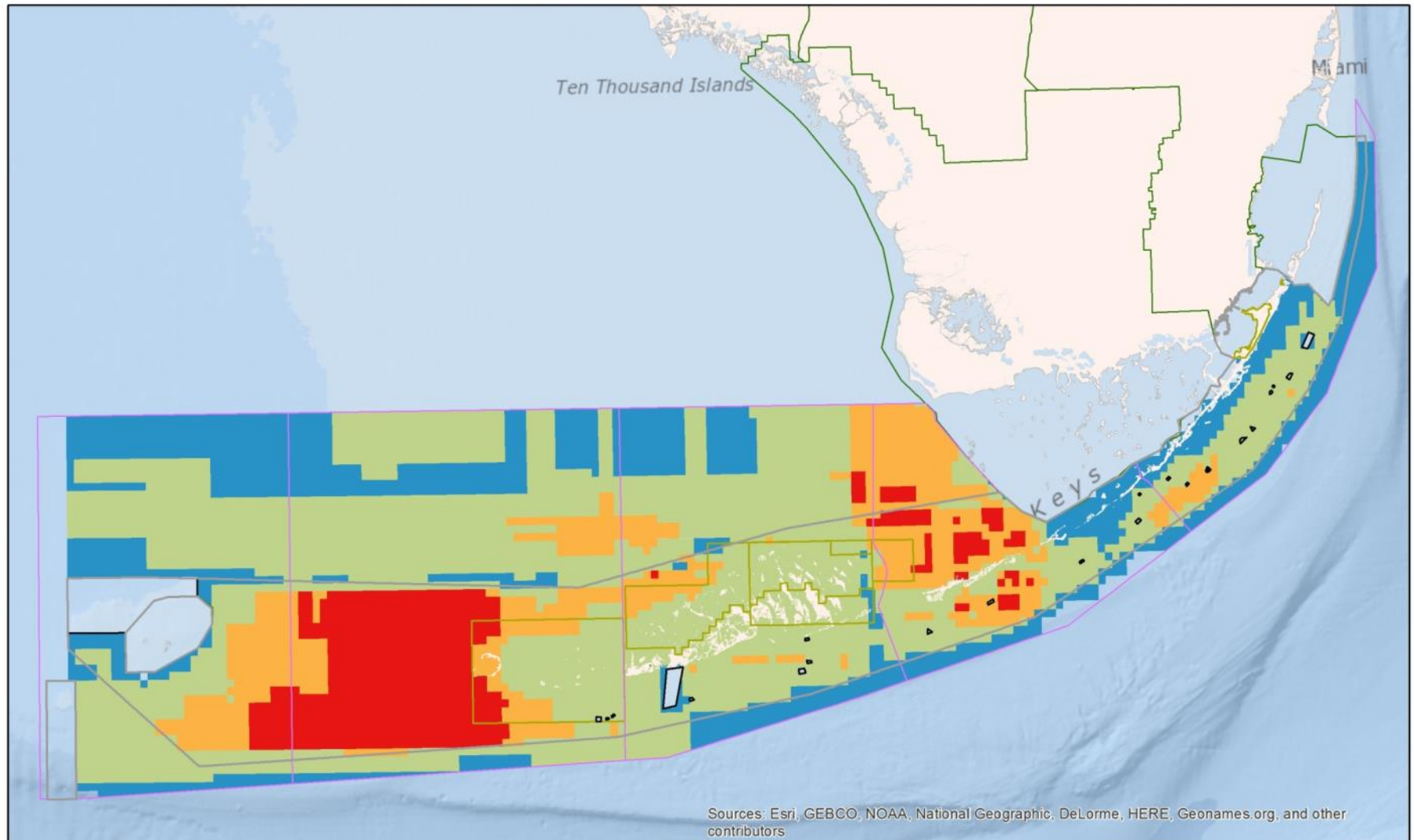
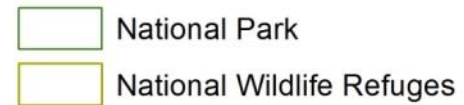
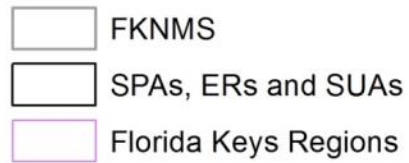
- 1) How many fishers fished in a given area per species
- 2) Relative landings per species in the region of interest



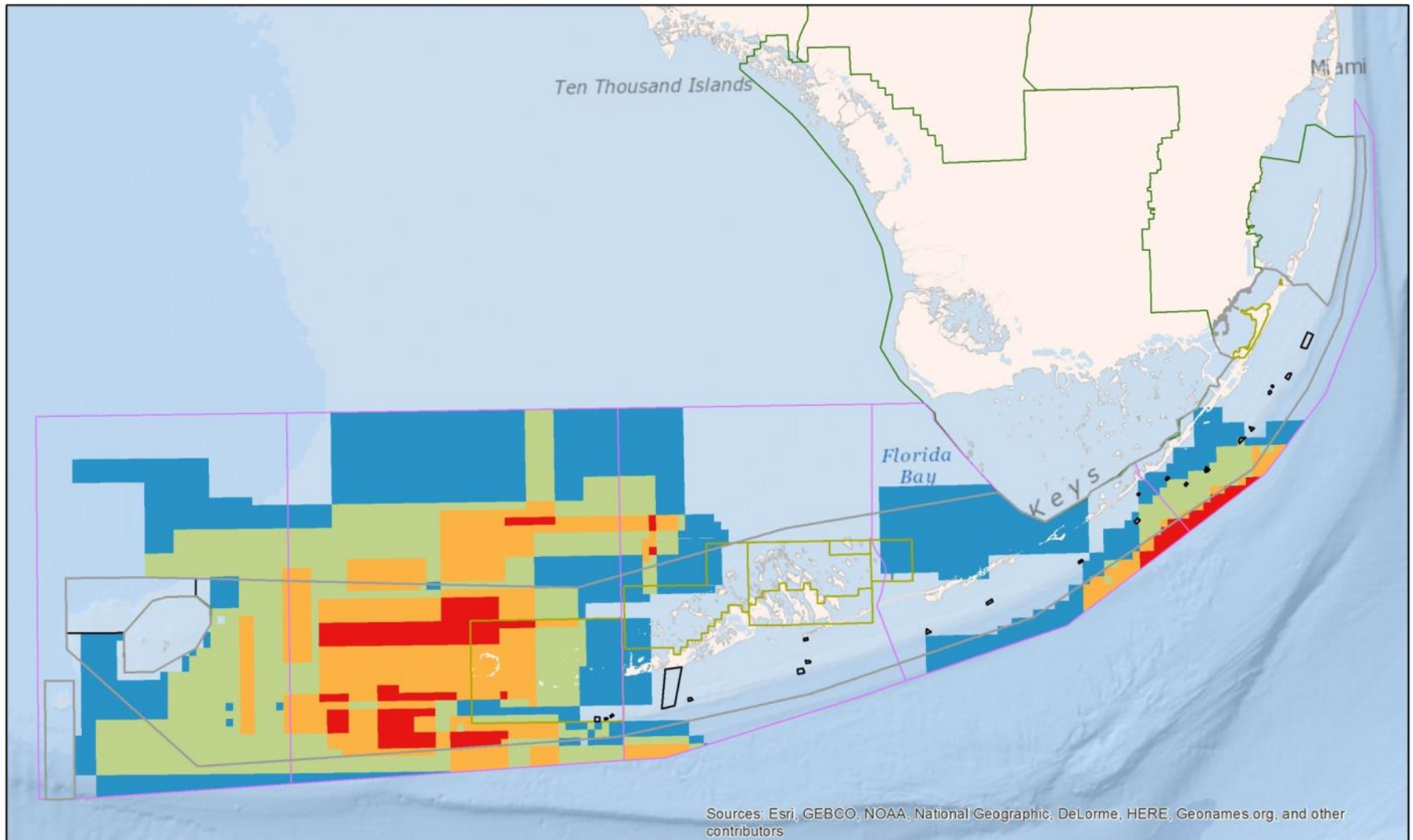
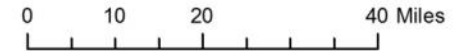
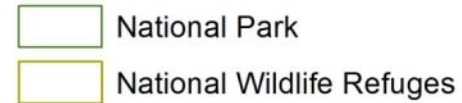
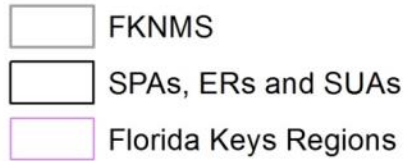
Commercial Fishing: Number of Fishers for Spiny Lobster per nautical mile²



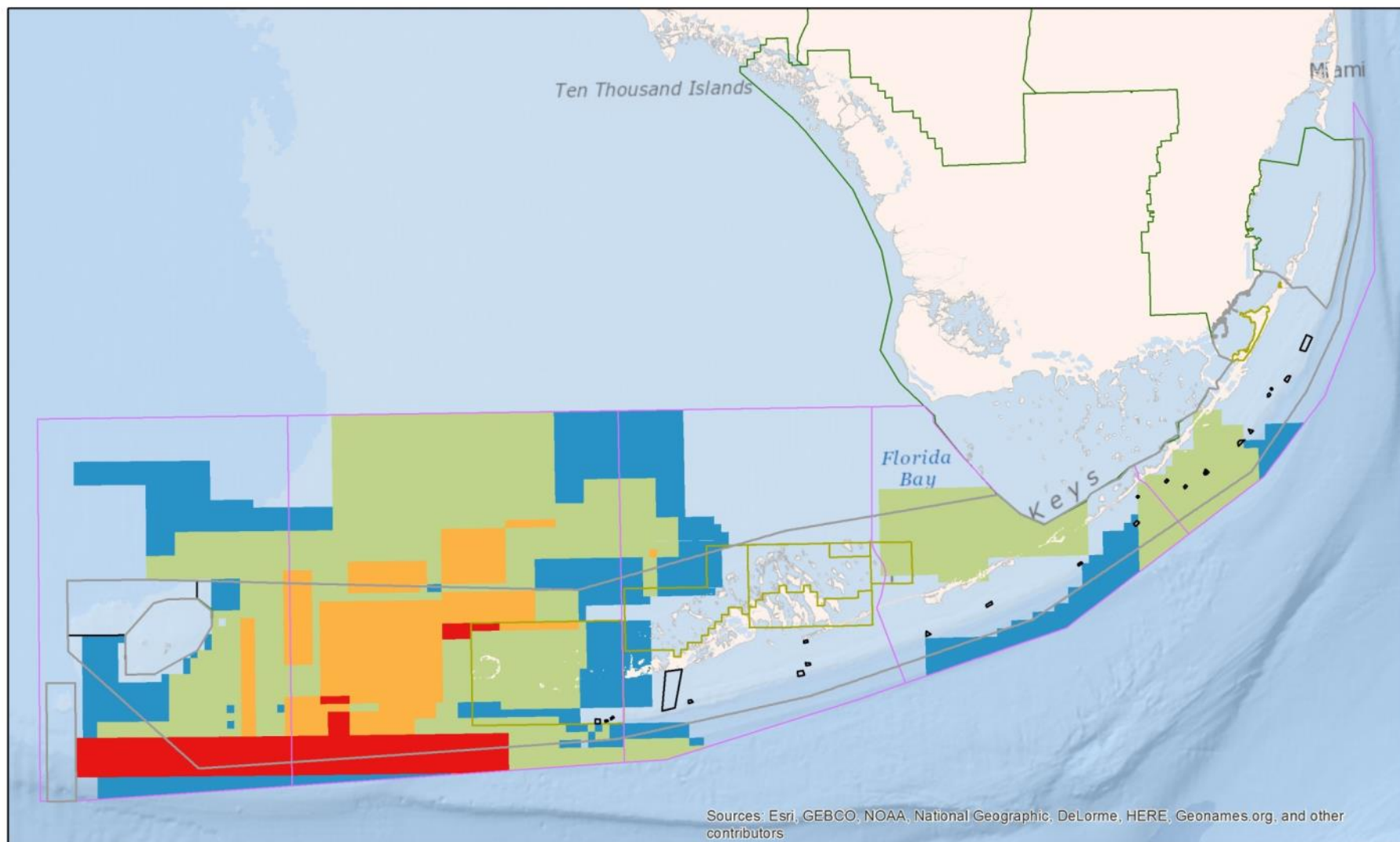
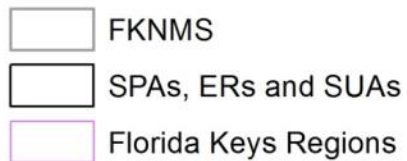
Commercial Fishing: Relative Landings for Spiny Lobster



Commercial Fishing: Number of Fishers for King Mackerel per nautical mile²



Commercial Fishing: Relative Landings for King Mackerel



Commercial Fishing: Number of Fishers per 1 nautical mile²

Very High (30 - 46)

High (24 - 29)

Medium (11 - 23)

Low (1 - 10)

FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

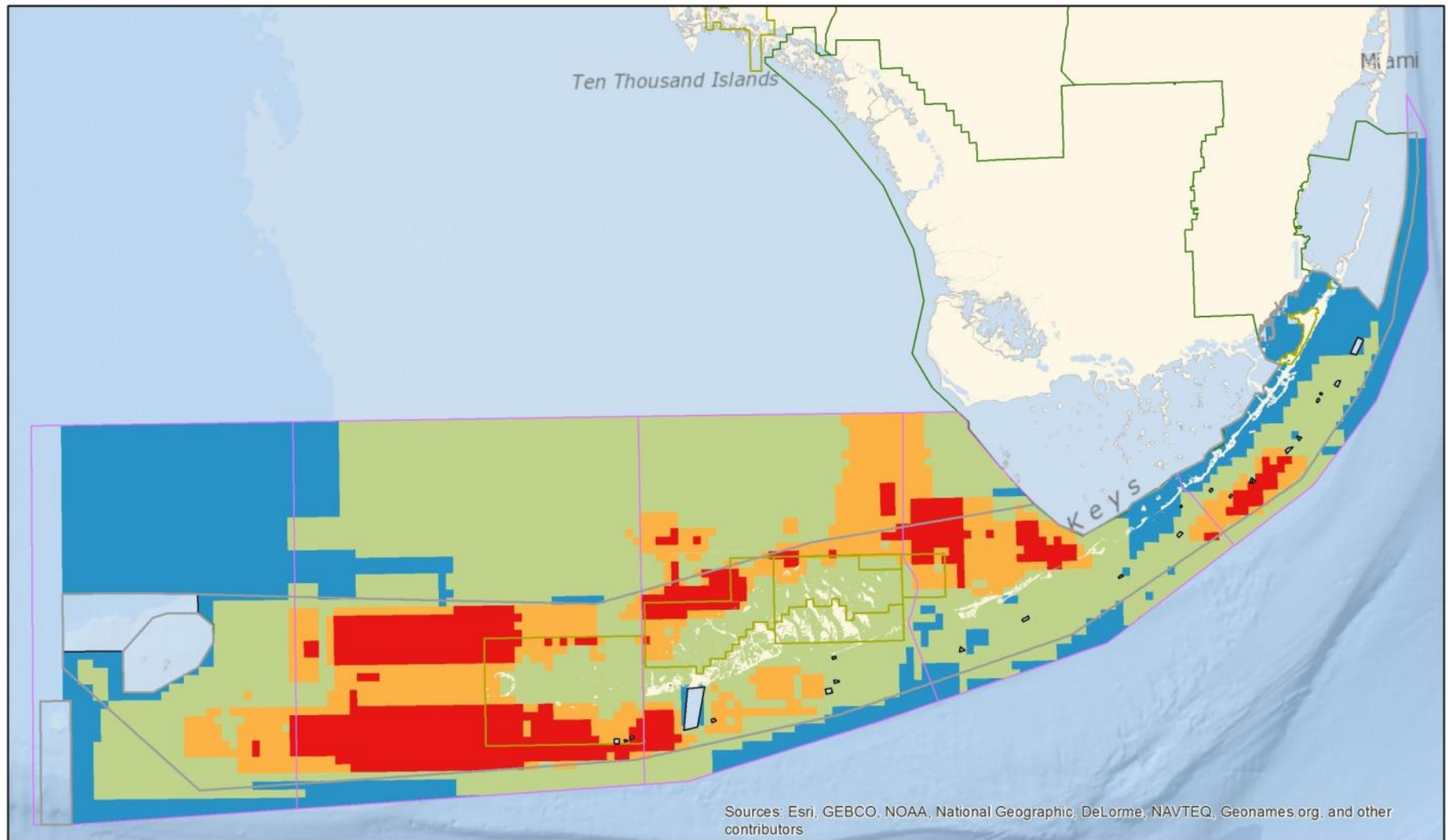
National Park

National Wildlife Refuges

N



0 12.5 25 50 Miles



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

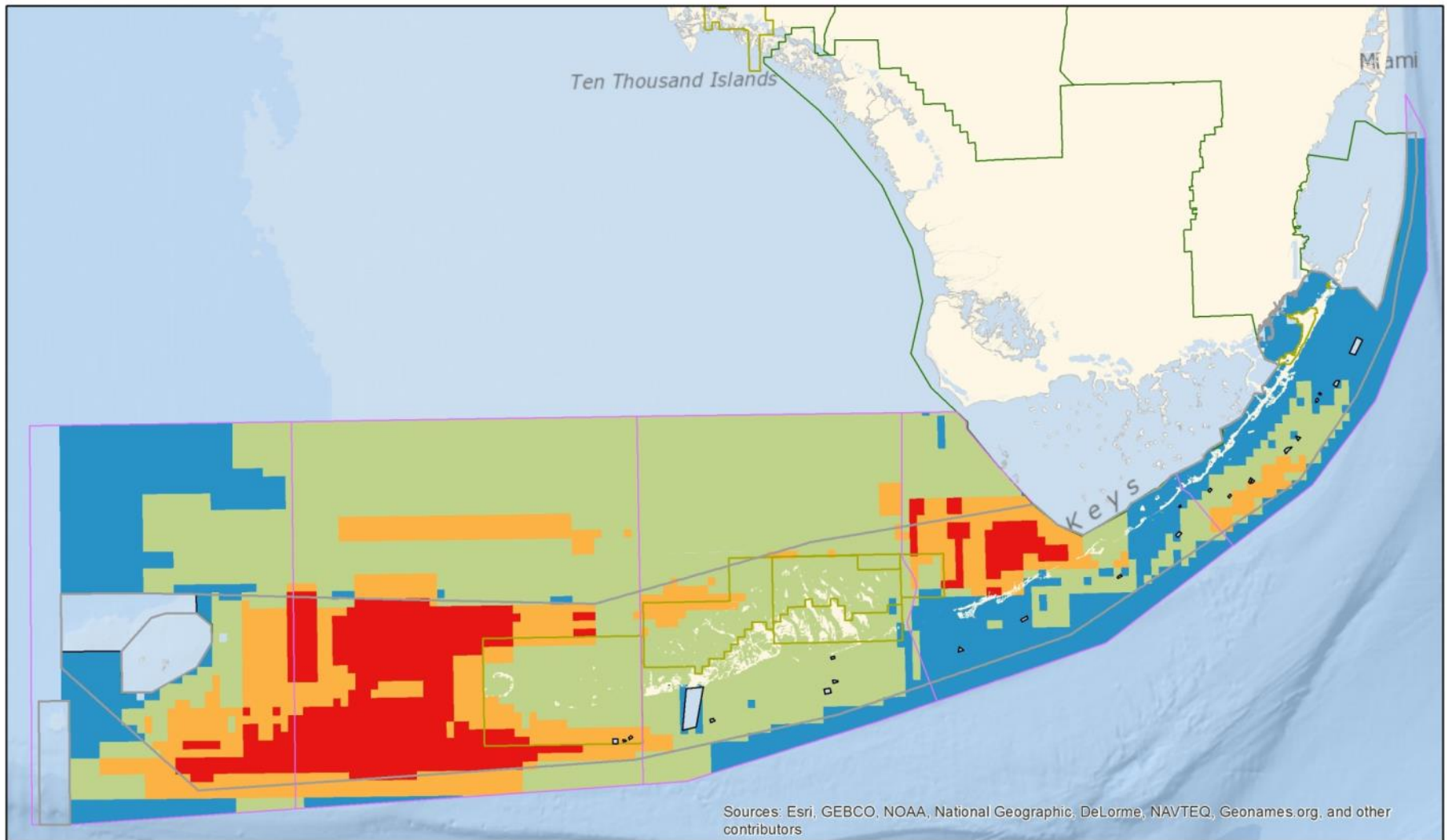
Commercial Fishing: Relative Landings in the Florida Keys Region

Very High
High
Medium
Low

FKNMS
SPAs, ERs and SUAs
Florida Keys Regions

National Park
National Wildlife Refuges

0 12.5 25 50 Miles



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Recreational and Charter Fishing



Data source

FWC, Aerial surveys of the Florida Keys Reef Tract.

Metric

- Density of Recreational and Charter Fishing Vessels Observed per 200 meters², May – August 2010-2012

Aerial Surveys – Recreational and Charter Fishing Vessels



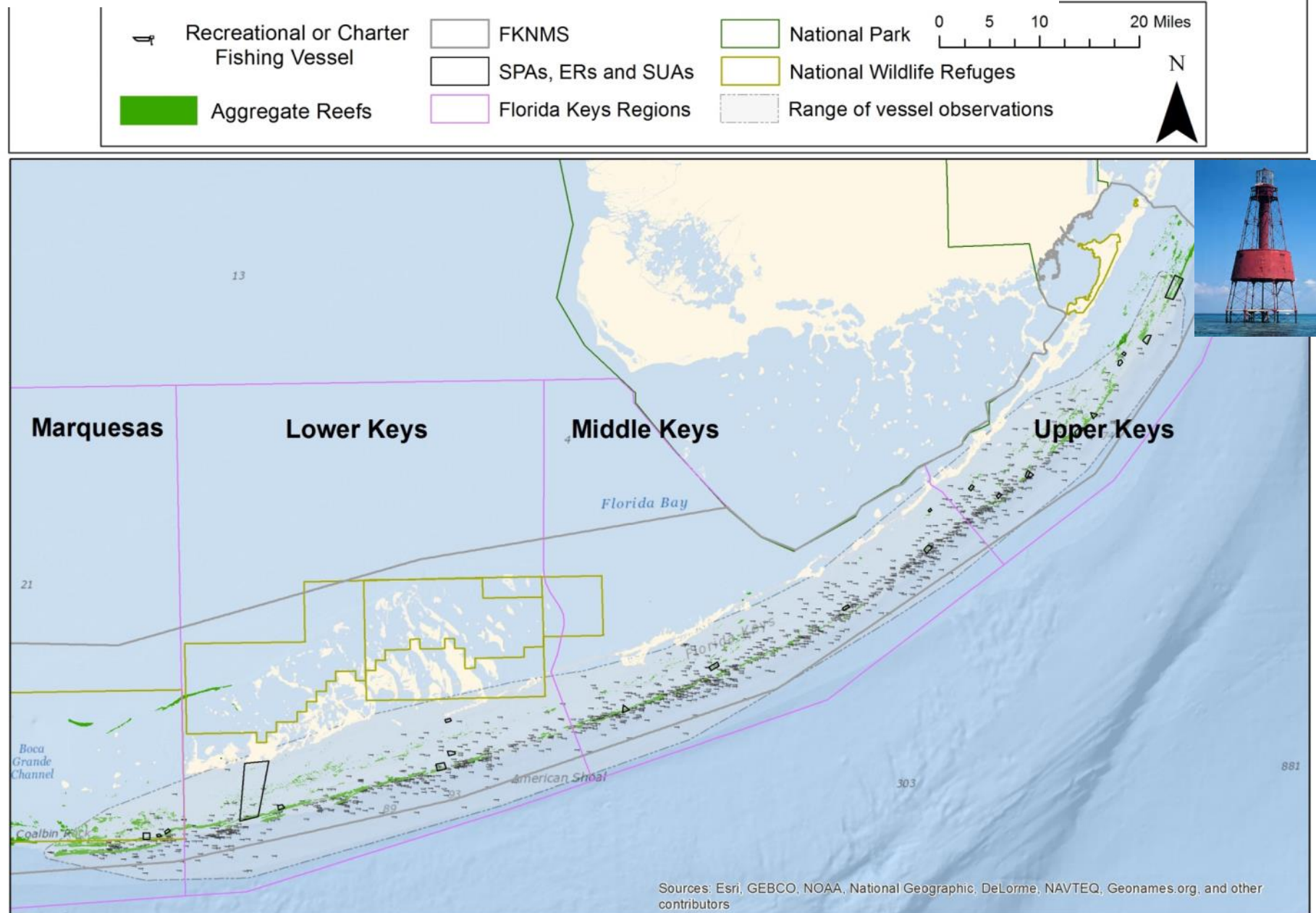
Data Collection: Aerial surveys were conducted by plane over the Florida Keys reef tract. Surveyors counted the number of vessels at a given coordinate location, and also documented the activity type.

Purpose: To quantify fishing pressure on historically known mutton snapper spawning aggregation sites, and locate other areas experiencing elevated fishing pressure.

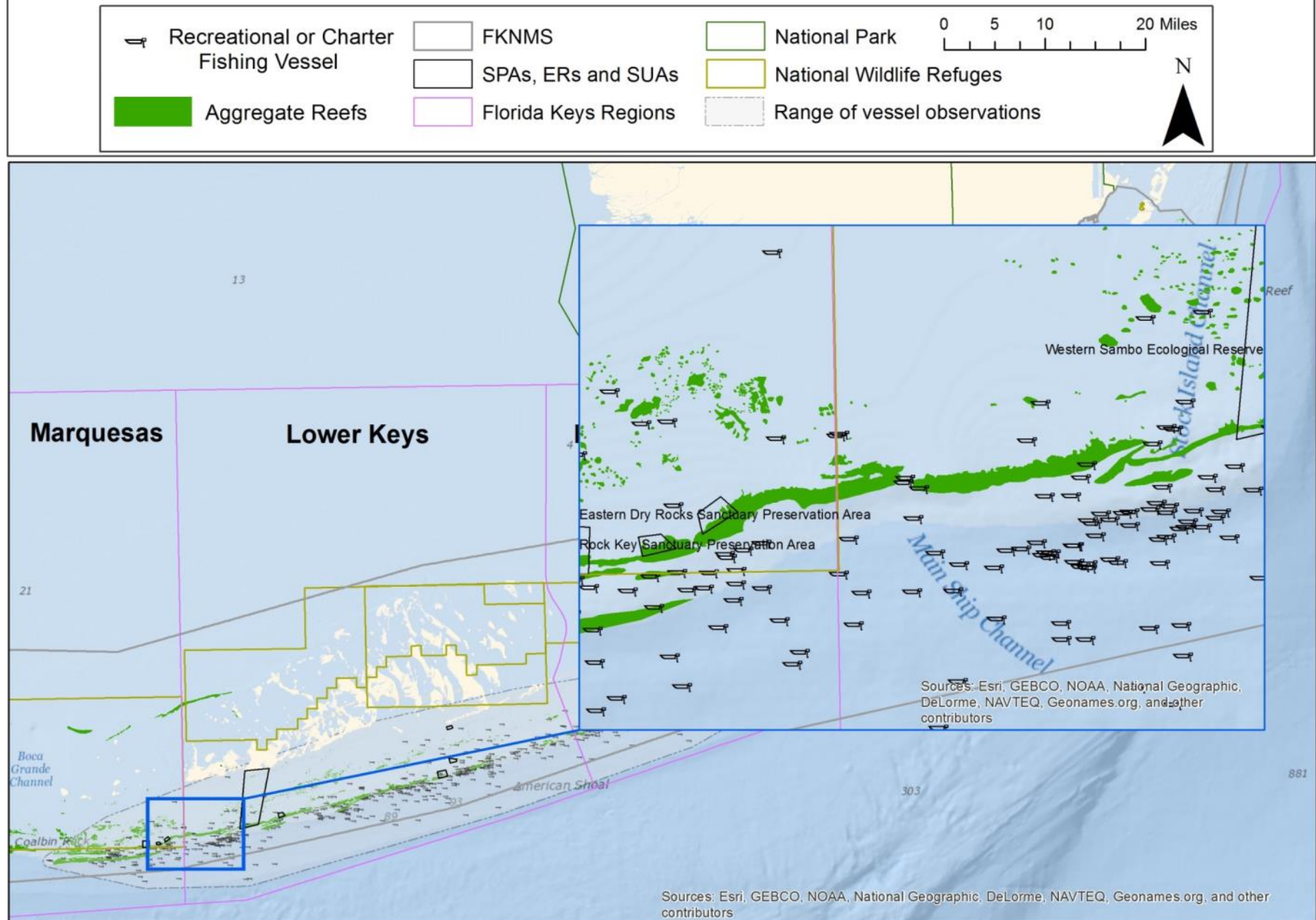
Time Period: Day before, day of, and day after full moon cycles in May – August of 2010, 2011 and 2012.

Availability: 1355 of 1692 observations were recorded as being recreational or charter fishing vessels.

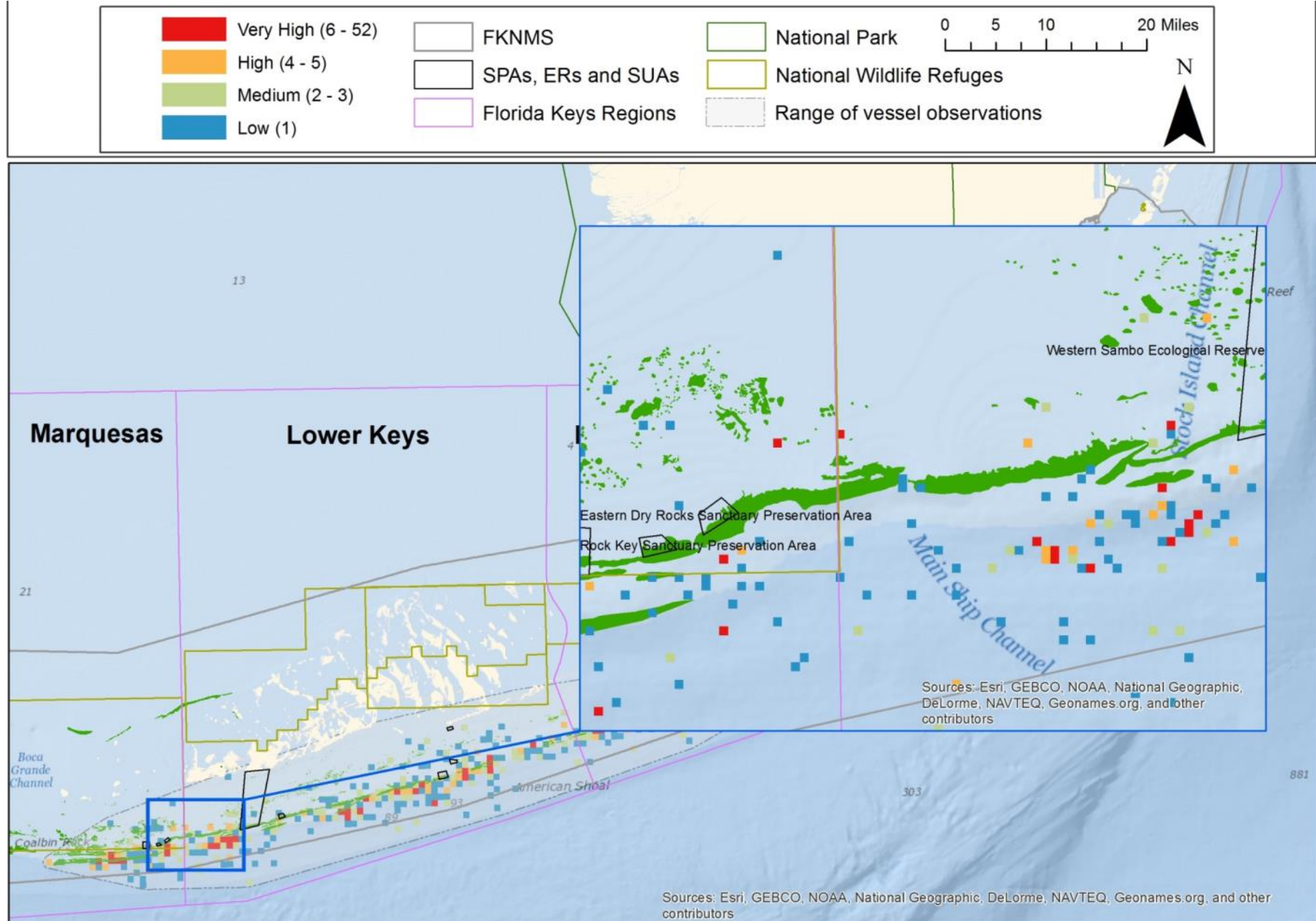
Aerial surveys took place over the Florida Keys reef tract, extending from Carysfort Lighthouse to Western Dry Rocks



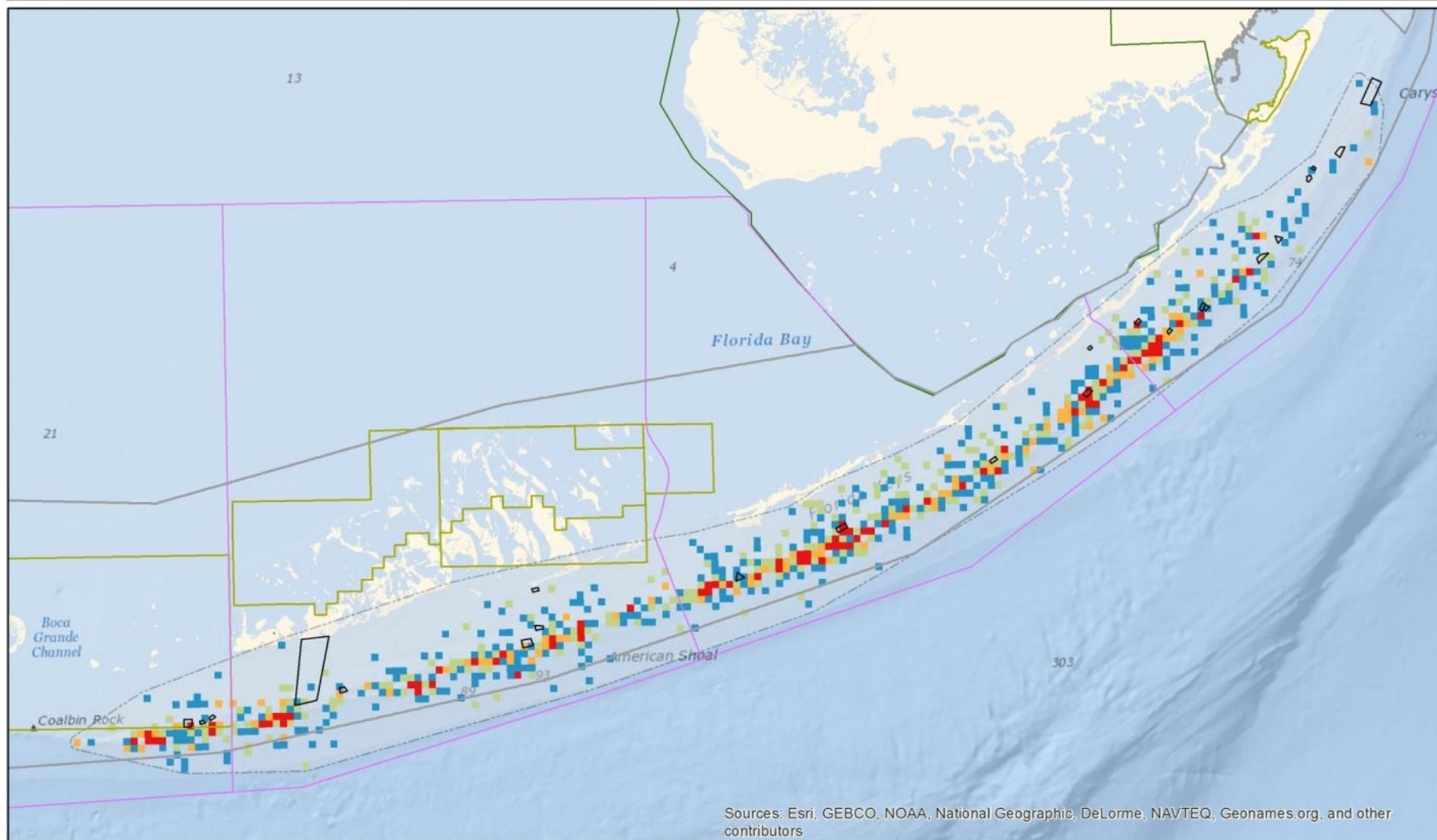
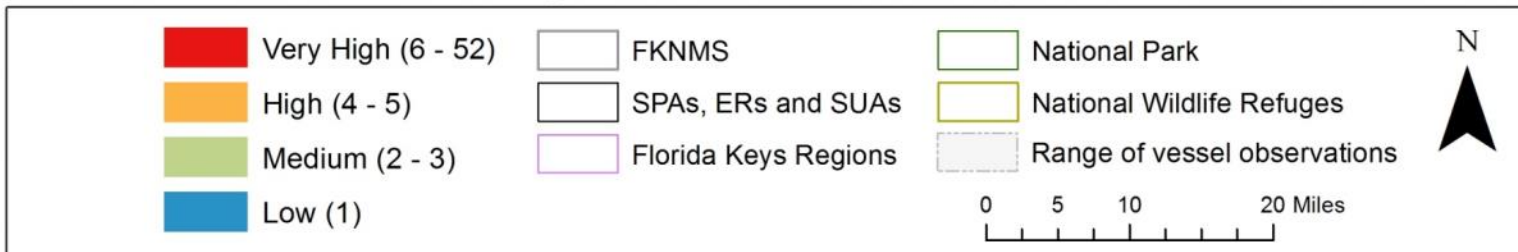
The date, time, coordinates, number of vessels, and type of vessel were recorded for each location where a vessel or group of vessels was observed.



This information was then translated into 200 meters² grid format, with red representing the most vessels per 200 meters², and blue the fewest vessels observed in that area.



Recreational & Charter Fishing: Number of Vessels per 1 km² over the Reef Tract



A diver is seen from behind, swimming towards the right side of the frame. They are wearing a full diving suit, including a mask, snorkel, and fins. The diver is positioned near a large, dark, branching coral structure that dominates the left side of the image. The water is a deep blue, and the lighting suggests a bright day. The title 'Diving Activity' is overlaid in white text on the left side of the image.

Diving Activity

Data sources

-FWC, Aerial surveys of the Florida Keys Reef Tract.

-Manoj Shivilani et al (2008). Knowledge Attitudes and Perceptions of Management Strategies and Regulations of the Florida Keys National Marine Sanctuary by Commercial Fishers, Dive Operators, and Environmental Group Members: A Baseline Characterization and 10-year Comparison.

Metrics

- Dive Boats with Dive Flags Observed, May – August 2010-2012
- Density of Divers on Commercial Dive Boats per 1 nautical mile², 2005

Aerial Surveys – Dive Boats



Data Collection: Aerial surveys were conducted by plane over the Florida Keys reef tract.

Time Period: Surveys were conducted the day before, day of, and day after full moon cycles in May – August of 2010, 2011 and 2012.

Availability: Recreational diving vessels were observed at 151 of 1692 locations

Diving: Number of Vessels per 1 kilometer² over the Reef Tract

Very High (6 - 17)

High (4 - 6)

Medium (2 - 3)

Low (1)

FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

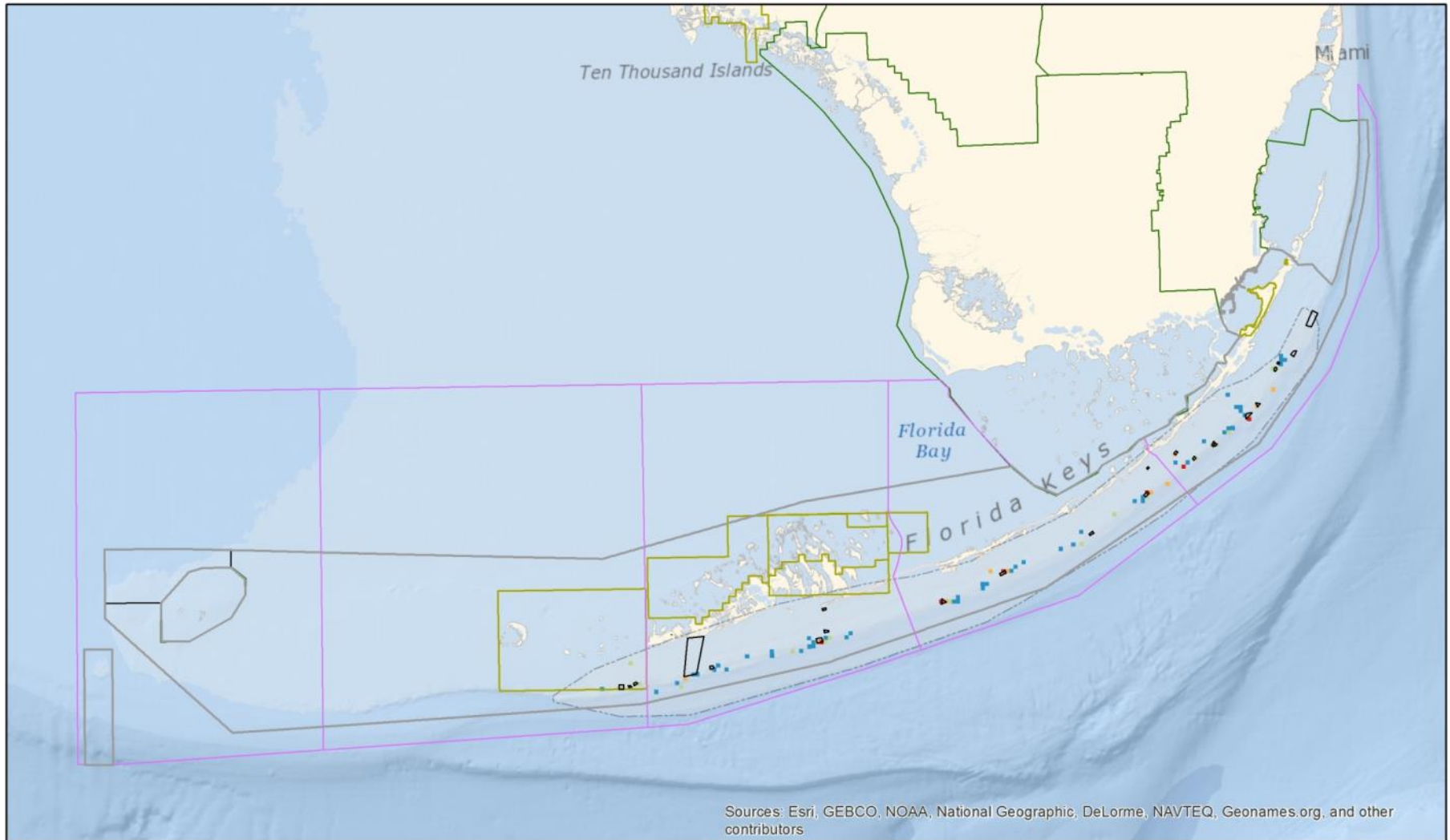
National Park

National Wildlife Refuges

Range of vessel observations

0 15 30 60 Miles

N



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Dive Operator Surveys

Data Collection: 69 commercial dive operators were surveyed in the Keys about their diving activity in 2005.

Purpose: Survey questions gathered:

- General demographic information,
- Economic information,
- Dive operator trip information,
- Commercial dive operators' knowledge, attitudes, perceptions and beliefs regarding the FKNMS

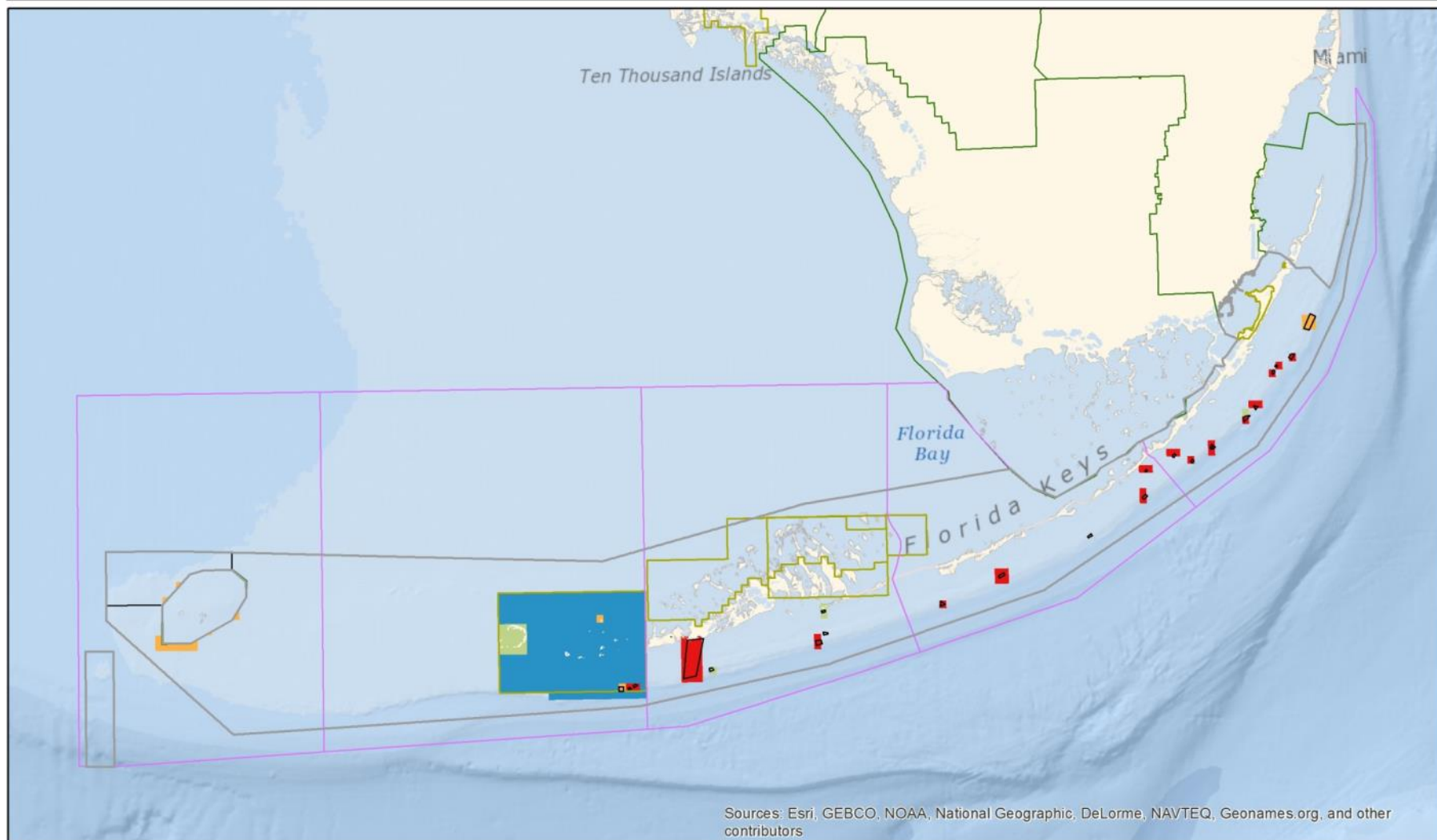
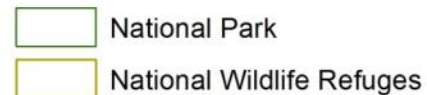
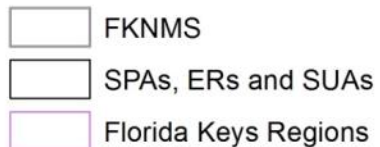
Trip Information:

Total Trips (Annually)
Number of Divers
Dive Site Locations

Time Period: 2005

Availability: Spatial information is available for 56 of the 69 commercial dive operators.

Diving: Number of Divers on Commercial Dive Vessels



Marine Debris

Data sources

Nova Southeastern University

Metric

- Average Marine Debris Density per 200 meters², 2000-2012



Marine Debris



Data Collection: Researchers conducted surveys of marine debris during their assessments of corals, sponges and other marine life.

Purpose: To document the *type, distribution, weight* and *length* of several types of marine debris, in order to assess the environmental impact of debris, and to determine the prevalence of debris inside and outside of protected areas.

Time Period: 2000-2001, 2008, 2010-11 and 2012.

Availability: 813 records for marine debris include the density, weight and length of the following debris types: hook-and-line angling gear, lobster/crab trap debris, and other debris (glass, plastics, metals, etc).

Marine Debris: Density per 200 meter²

Very High (10 - 62)

High (5 - 9)

Medium (2 - 5)

Low (0.3 - 2)

FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

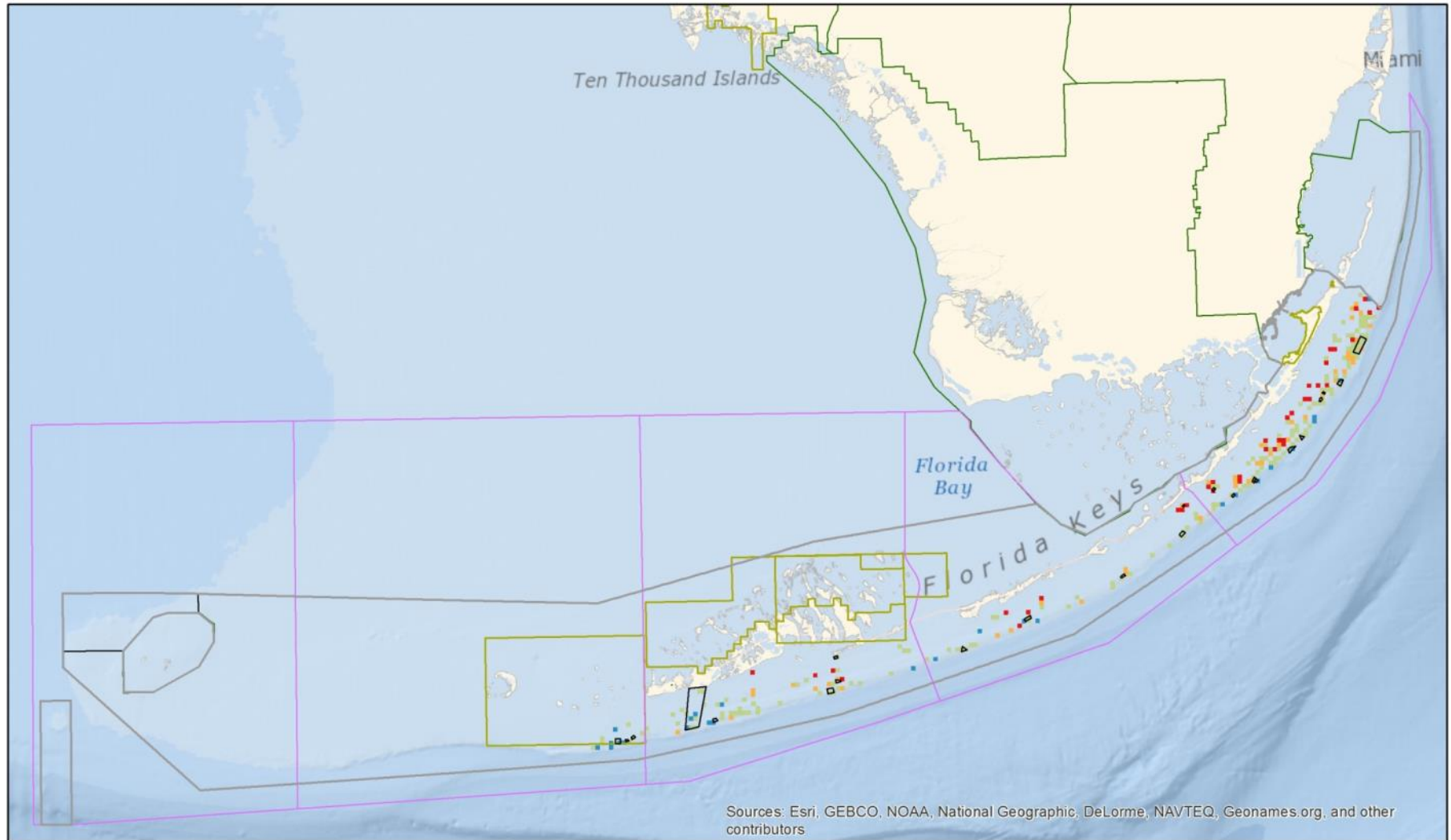
National Park

National Wildlife Refuges

N



0 12.5 25 50 Miles



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Vessel Groundings

Data source

Florida Keys National Marine Sanctuary

Metric

- Density of Reported Vessel Groundings per 200 meters², 2000-2012



Vessel Groundings

Data Collection: The Florida Keys National Marine Sanctuary keeps records of reported and assessed vessel groundings. Where possible, the coordinates, habitat type, vessel length and vessel type are recorded for each vessel grounding, among other information.

Purpose: To track groundings in order to assess fines and recover the cost of damages from responsible parties, in order to potentially implement restoration and monitoring activities at grounding sites.

Time Period: Spatial information (records with lat/long coordinates) is available for records between January 2000 and April 2012.

Availability: 935 of 948 records contained accurate spatial information for the years 2000 - 2012. 1471 total records exist, going back to 1980. Spatial data was not gathered consistently until 2000.

Vessel Groundings: Number of Reported Vessel Groundings per 1 kilometer²



FKNMS

SPAs, ERs and SUAs

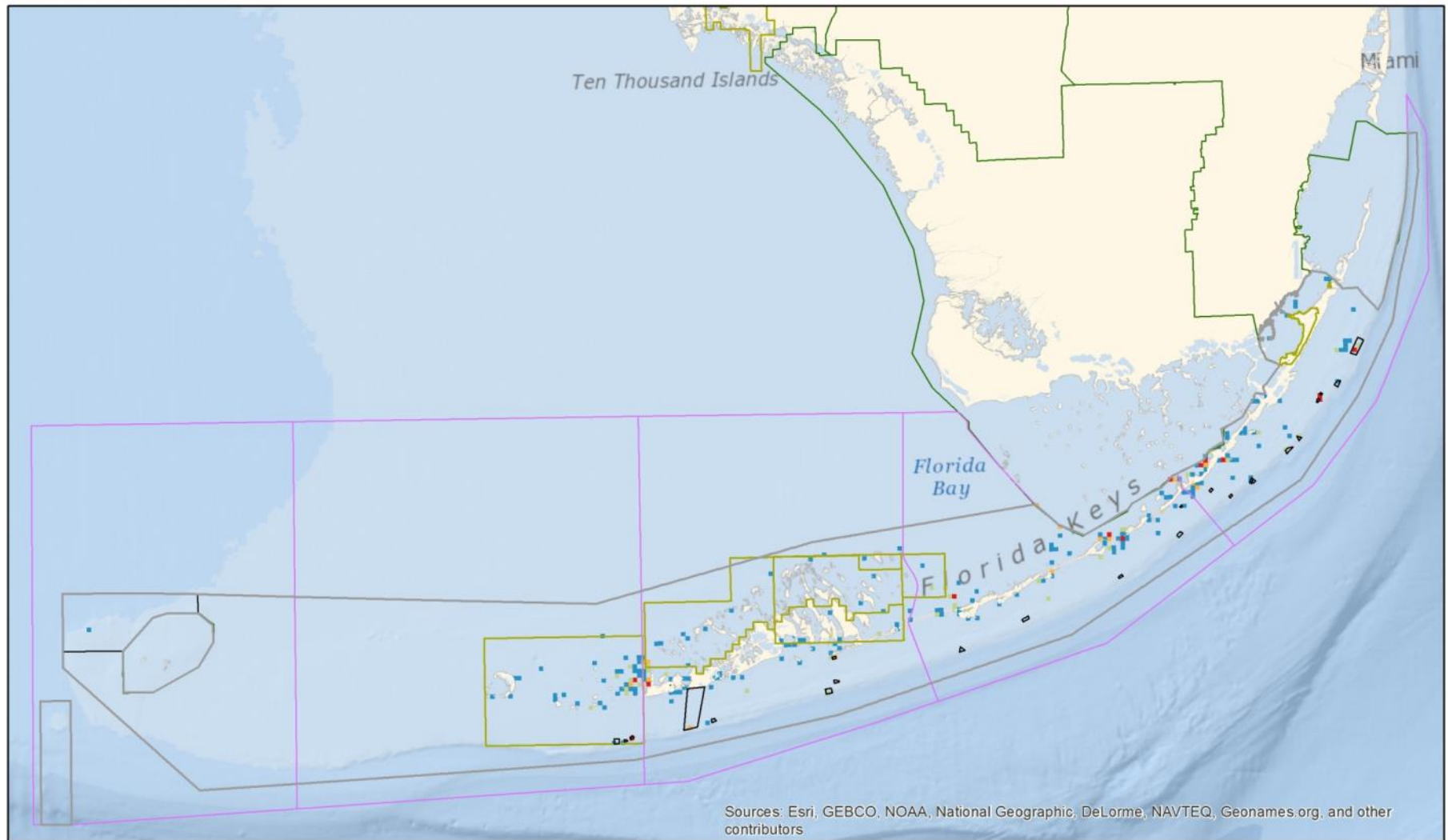
Florida Keys Regions

National Park

National Wildlife Refuges



0 12.5 25 50 Miles



Vessel Groundings: Number of Reported Vessel Groundings per 200 meters²



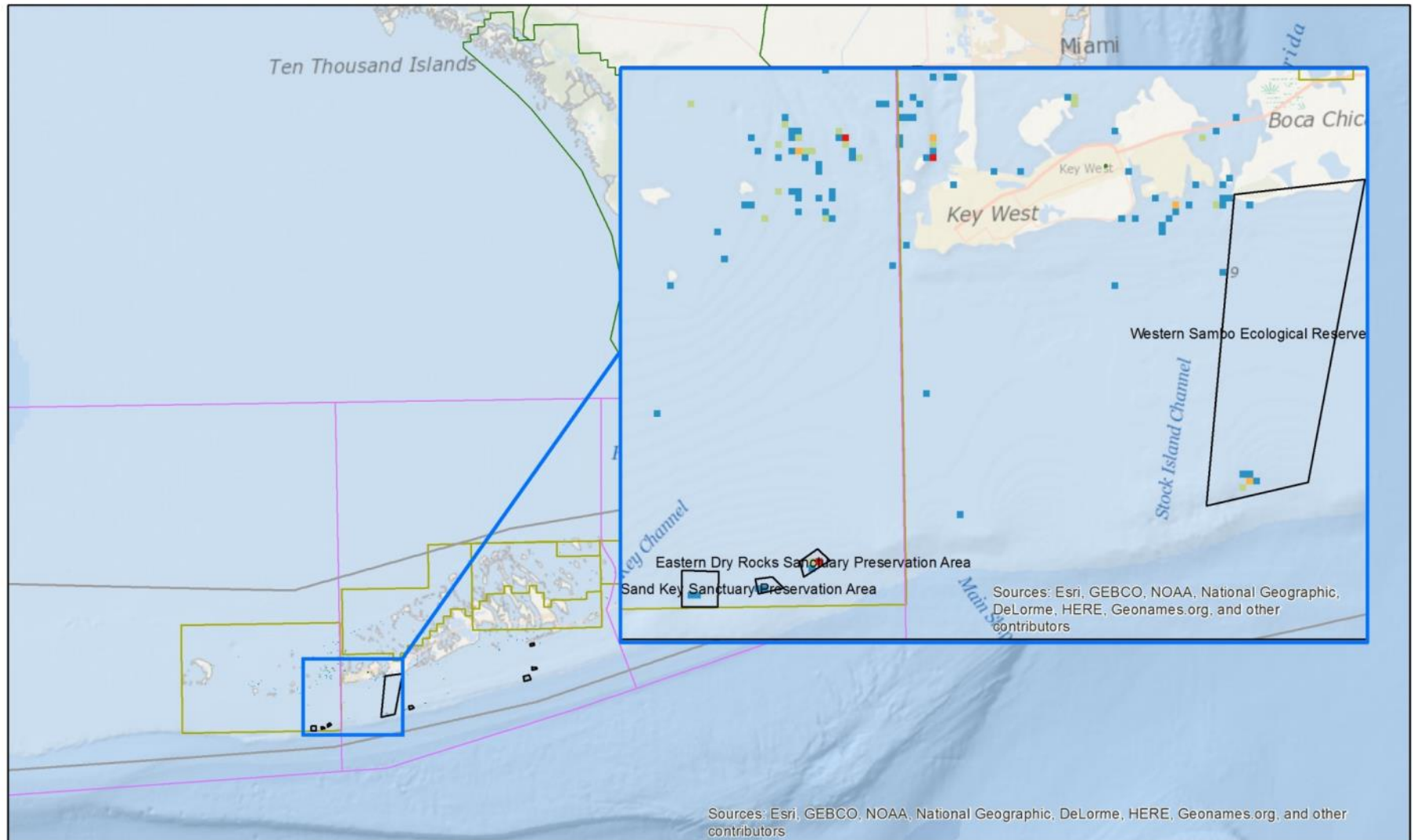
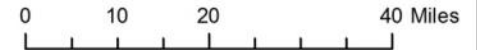
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Watercraft Infrastructure

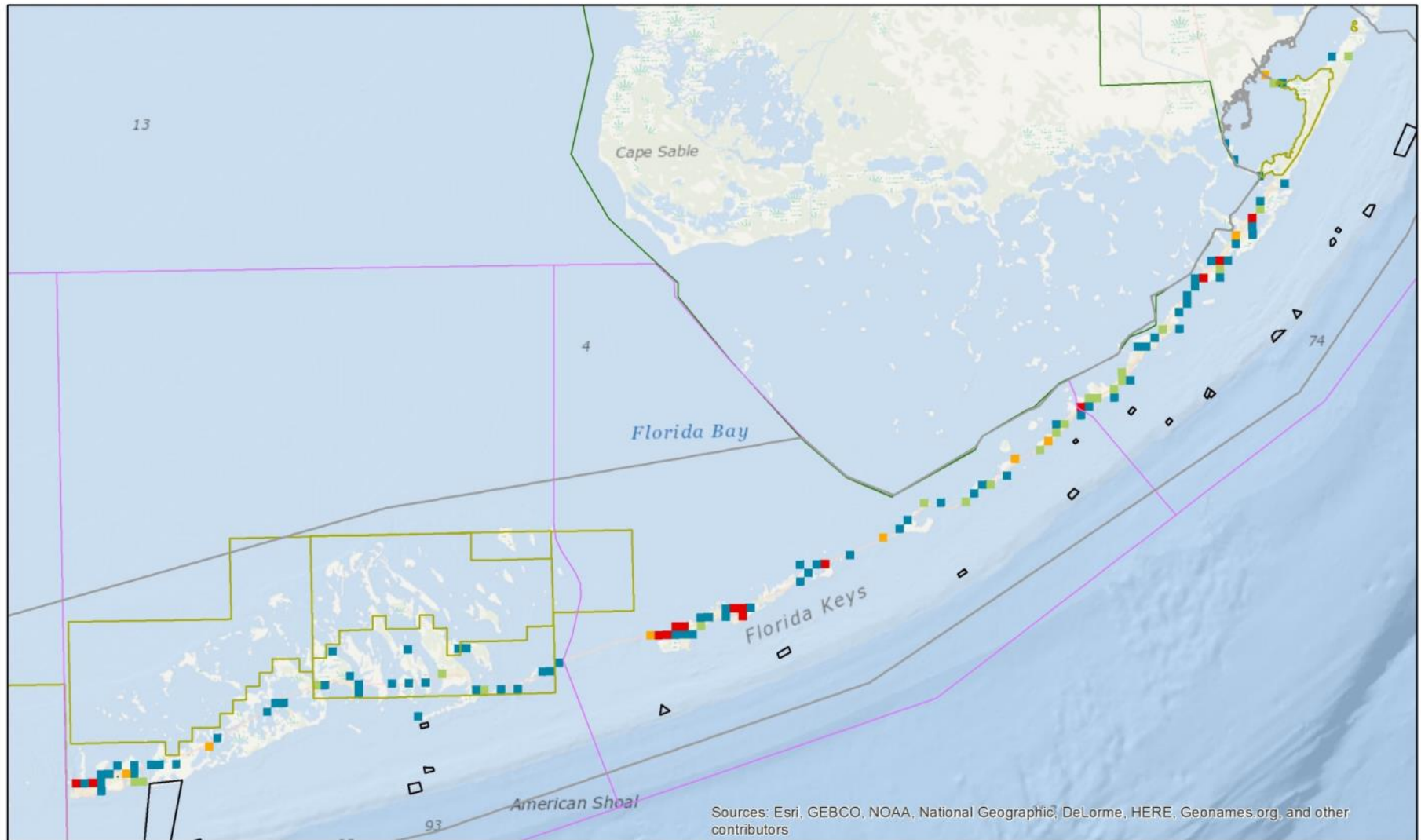
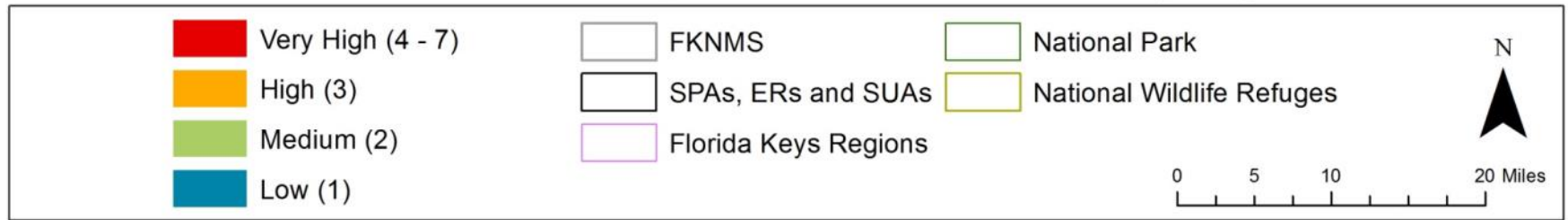
Data source

FWC and USAInfo

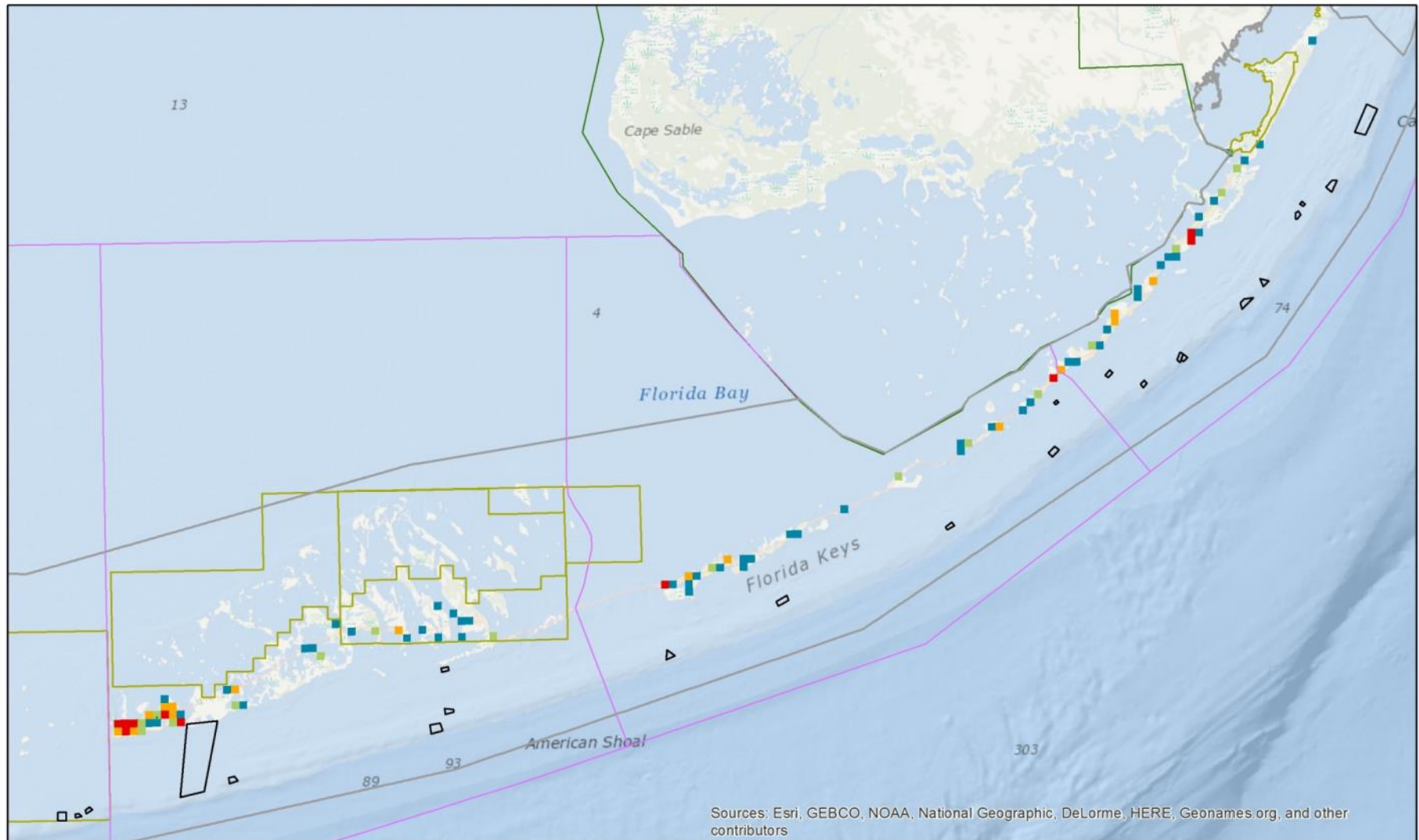
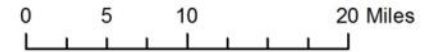
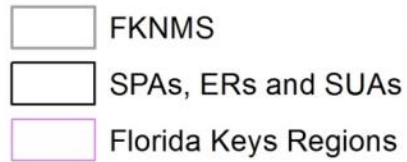
Metric

- Number of Marinas per 1 km² in the Florida Keys Region
- Number of Watercraft-Related Businesses per 1 km² in the Florida Keys Region

Number of Marinas per 1 kilometer² in the Florida Keys Region



Number of Watercraft-Related Businesses per 1 kilometer² in the Florida Keys Region



Thank You!



Photo courtesy of FKNMS

How to keep engaged and where to find more information:

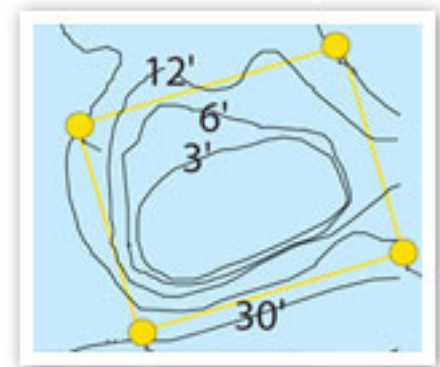


Visit our website at floridakeys.noaa.gov

Contact your Sanctuary Advisory Council Member:
<http://floridakeys.noaa.gov/sac/members.html?s=sac>

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Contact us at:
sean.morton@noaa.gov
Beth.dieveney@noaa.gov



MARINE ZONING &
REGULATORY REVIEW

