

Biogeographic Assessment of Florida Keys National Marine Sanctuary

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





Where are locations of ‘special places’?

FKNMS

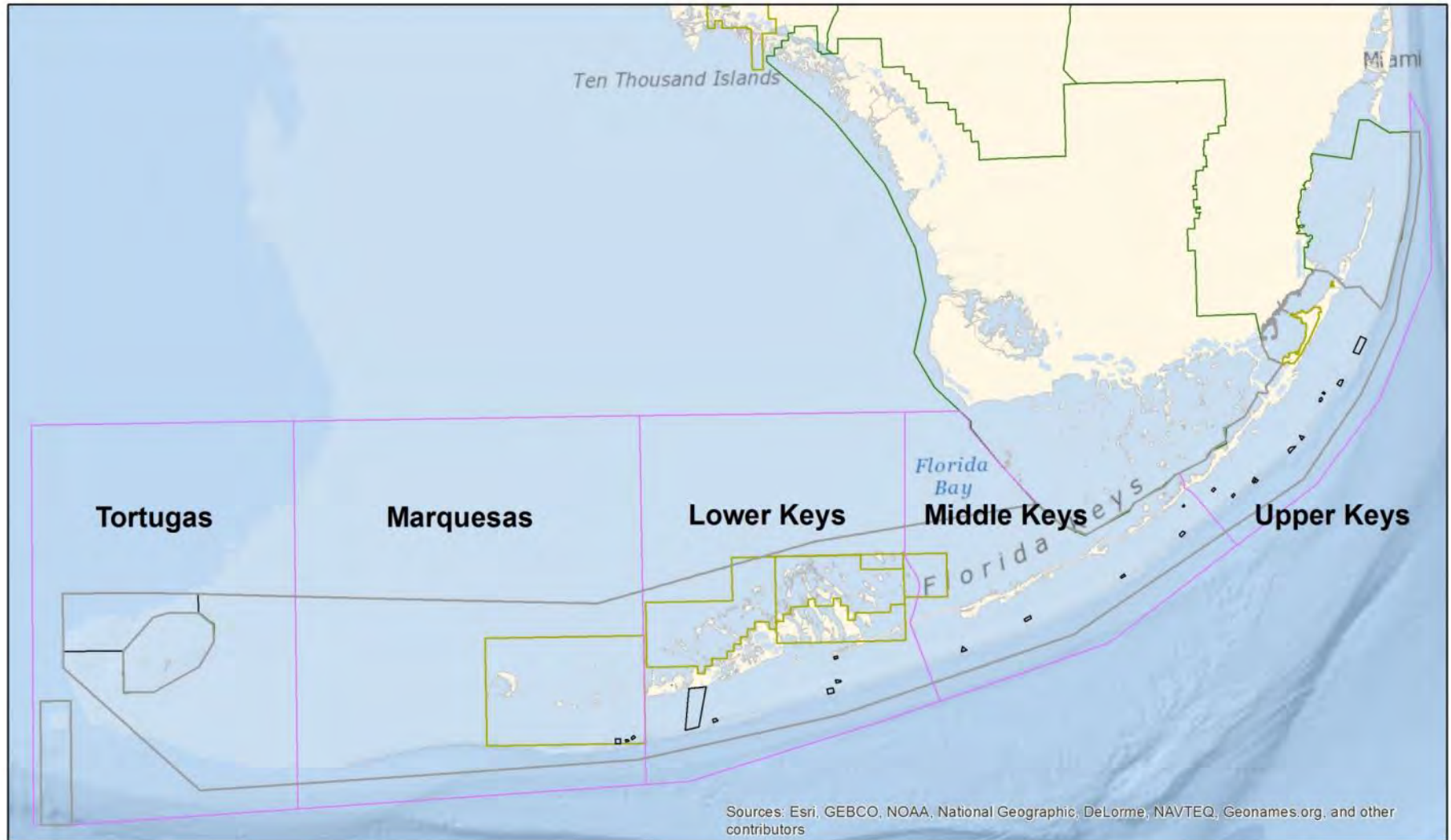
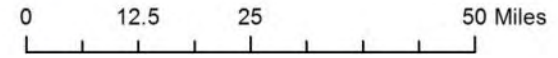
SPAs, ERs and SUAs

Florida Keys Regions

National Park

National Wildlife Refuges

N



FKNMS

SPAs, ERs and SUAs

Florida Keys Regions

State Park

National Park

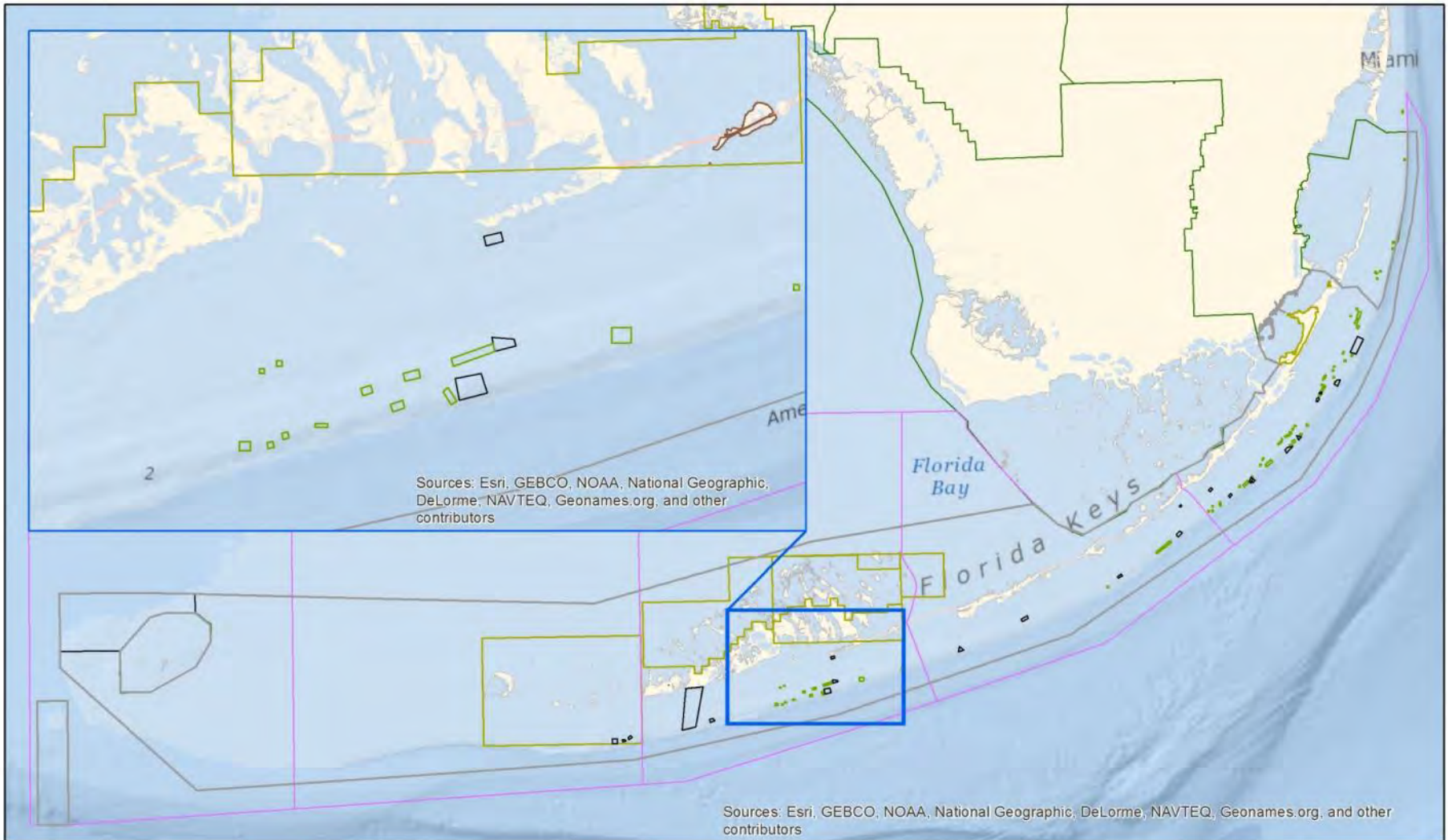
National Wildlife Refuges

Lobster Trap Exclusion Area

N



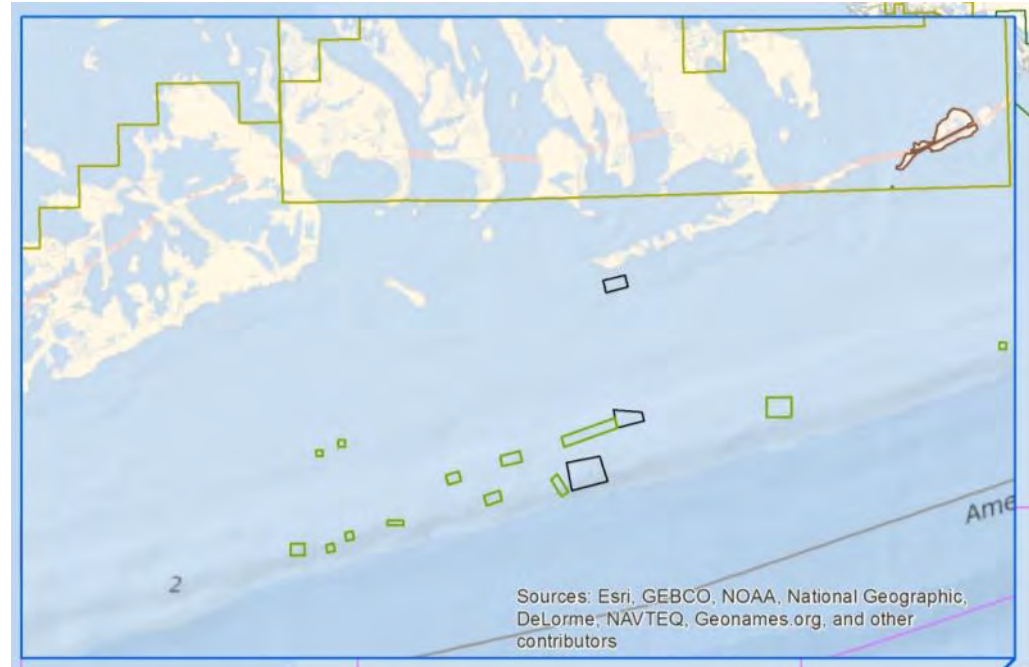
0 12.5 25 50 Miles



Spatial Data and GIS

Spatial Data

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

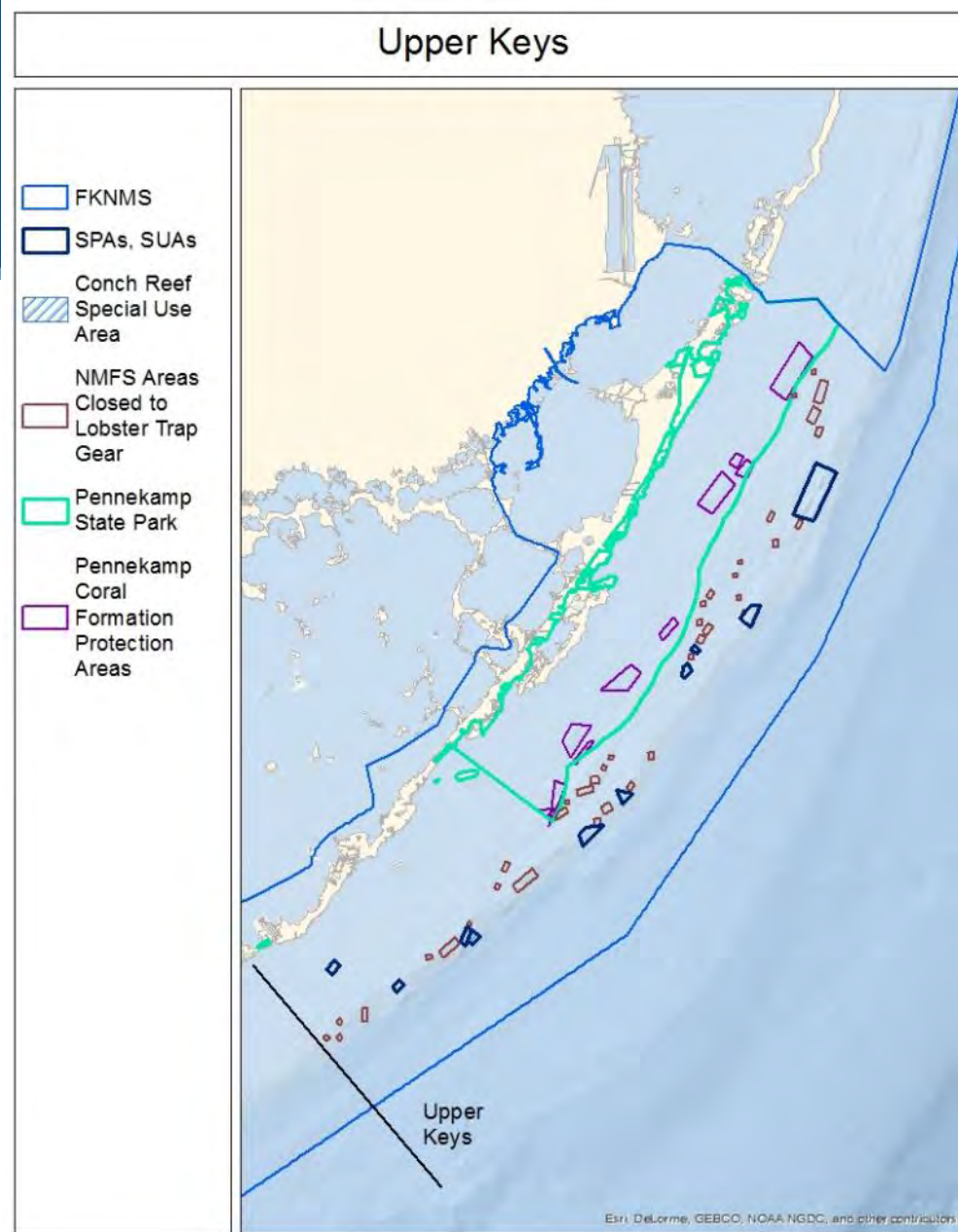
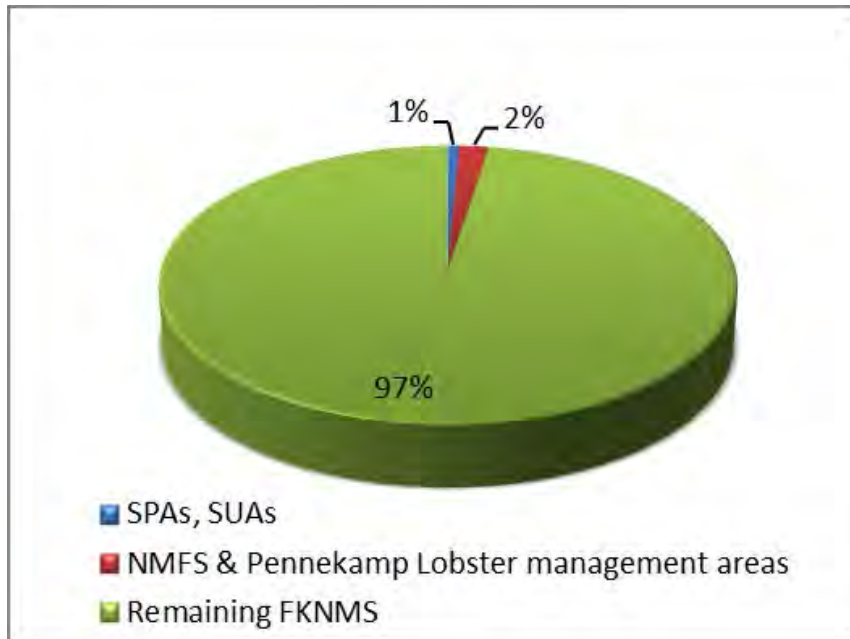


Geographic Information System (GIS)

- Computer system that enables *organization, queries, analyses* of spatial data
- Uses: allows us to ask *how much* and *where*

How much area is currently within zones?

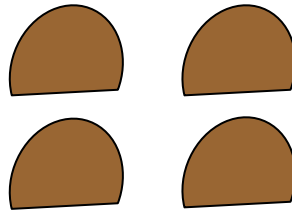
Management Zone	Area (km ²)
SPAs, SUAs	10
NMFS & Pennekamp Lobster management areas	26
Remaining FKNMS	1373
Resource Total	1409



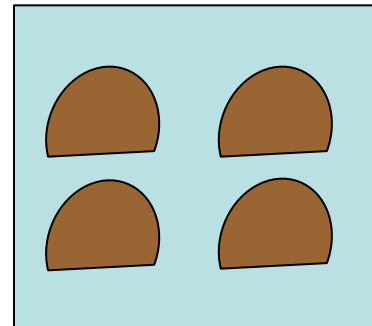
Natural resources

Terminology

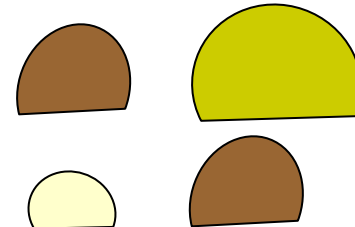
Abundance = counts



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



Species richness = number of different species



Datasets: Natural Resources

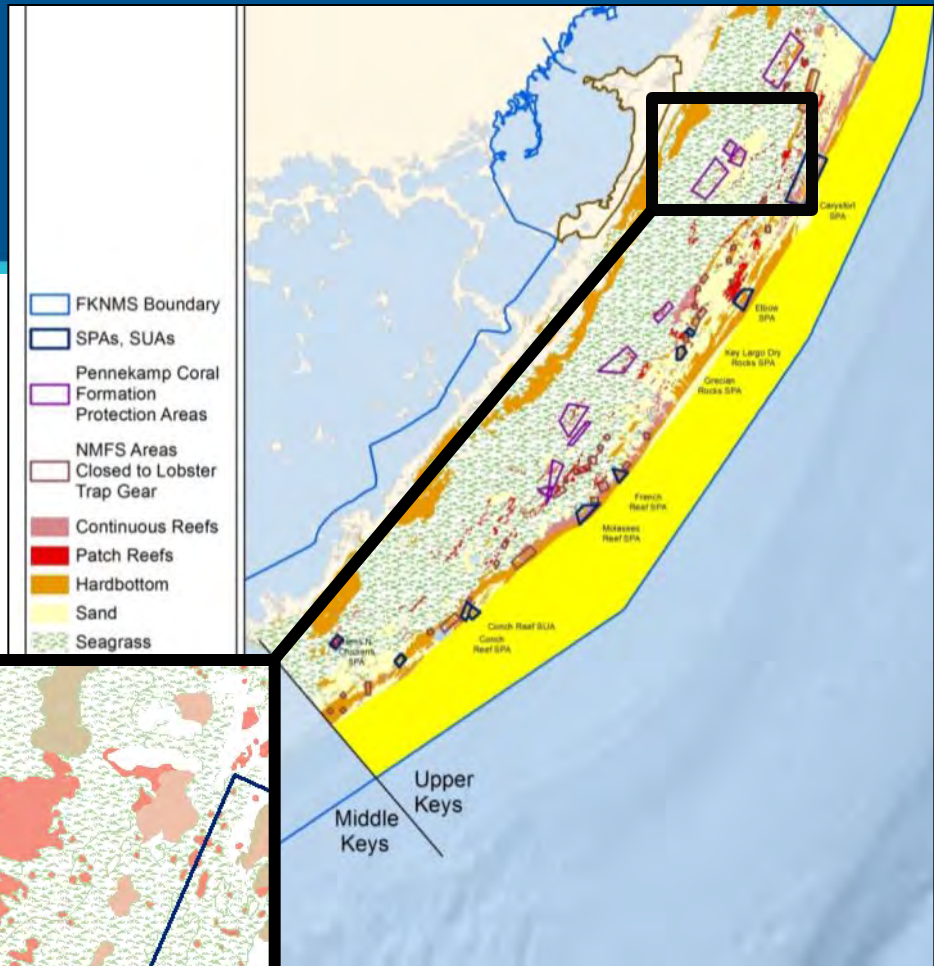
Metrics

- Habitat
 - Habitat types
 - Turtle grass density
 - High relief reefs
 - Resilient reefs
- Coral
 - ESA species
 - Stony coral
 - Soft coral
- Fish
 - Fish
 - Fish aggregations
- Fauna
 - Conch

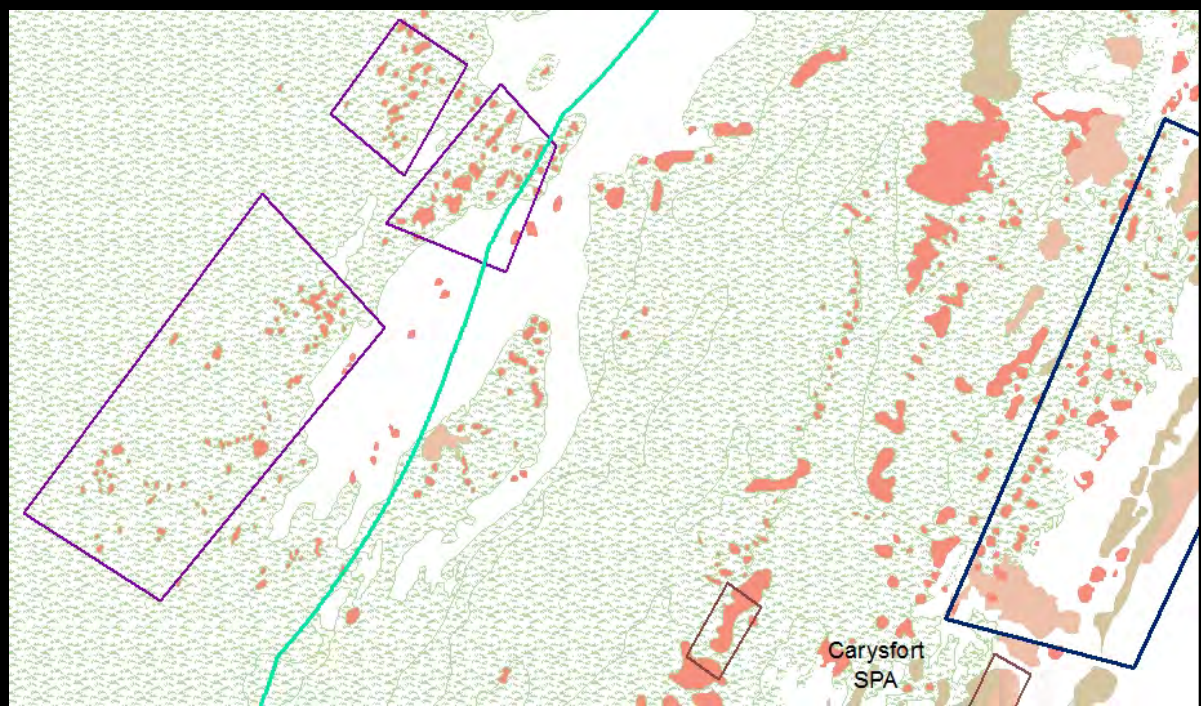


Habitat

How are habitats distributed?



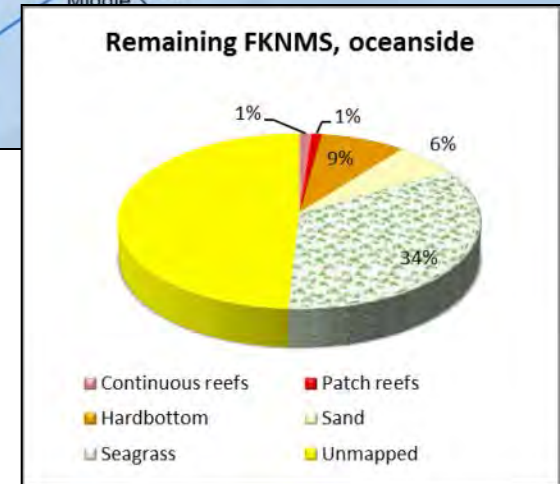
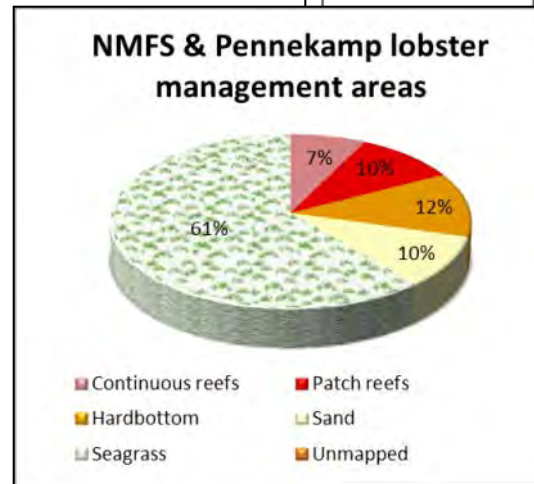
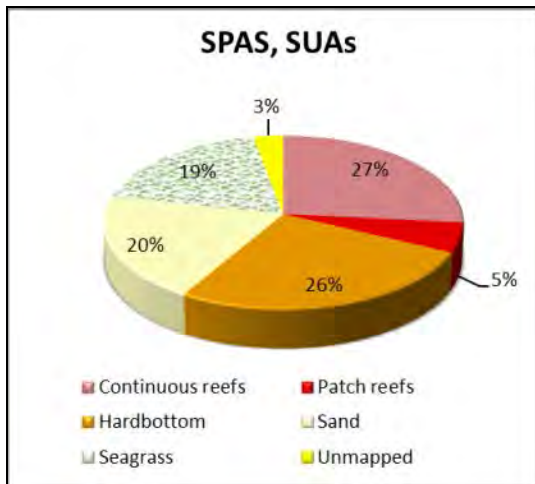
Upper Keys
Middle Keys



How are habitats distributed?

Habitats	Area (Km ²)		
	SPAS, SUAs	NMFS & Pennekamp lobster management areas	Remaining FKNMS, oceanside
Continuous reefs	3	2	19
Patch reefs	1	3	16
Hardbottom	3	3	134
Sand	2	2	100
Seagrass	2	15	550
Unmapped	0.3	0	789

- FKNMS Boundary
- SPAs, SUAs
- Pennekamp Coral Formation Protection Areas
- NMFS Areas Closed to Lobster Trap Gear
- Continuous Reefs
- Patch Reefs
- Hardbottom
- Sand
- Seagrass
- Unknown



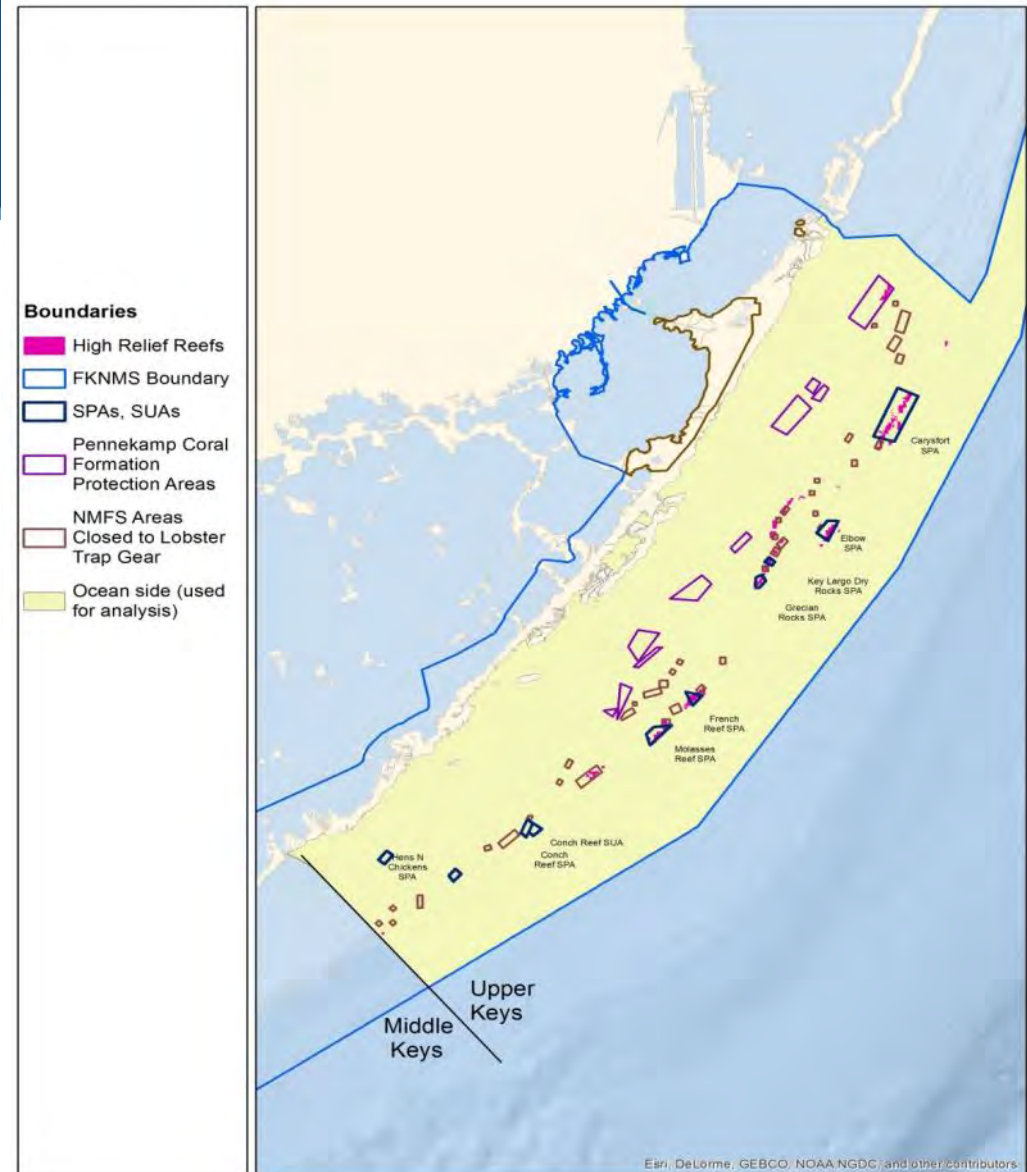
Where are locations of high relief reefs?

Data source

- NMFS diver surveys

Metric

- High relief reef



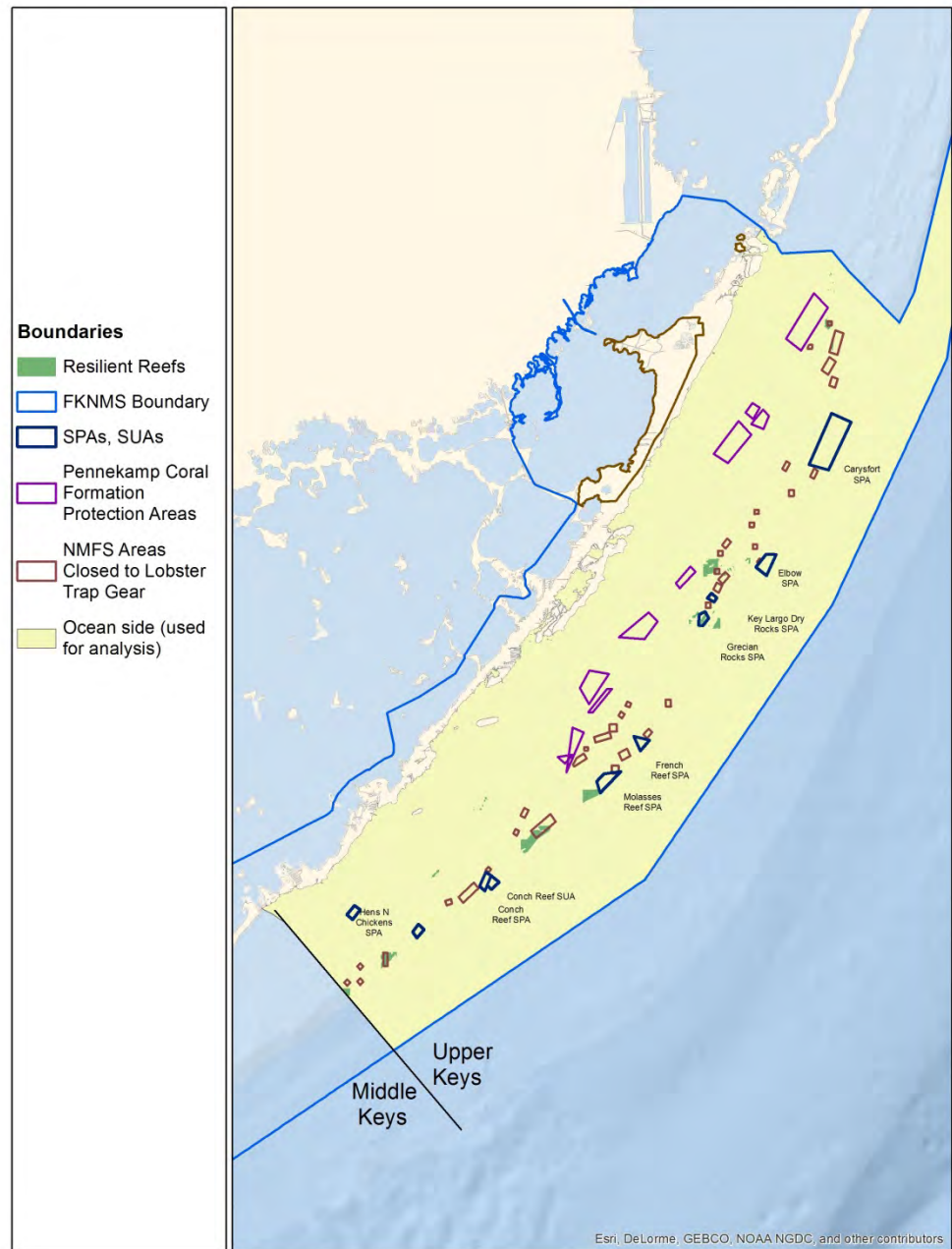
Where are locations of resilient reefs?

Data source

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

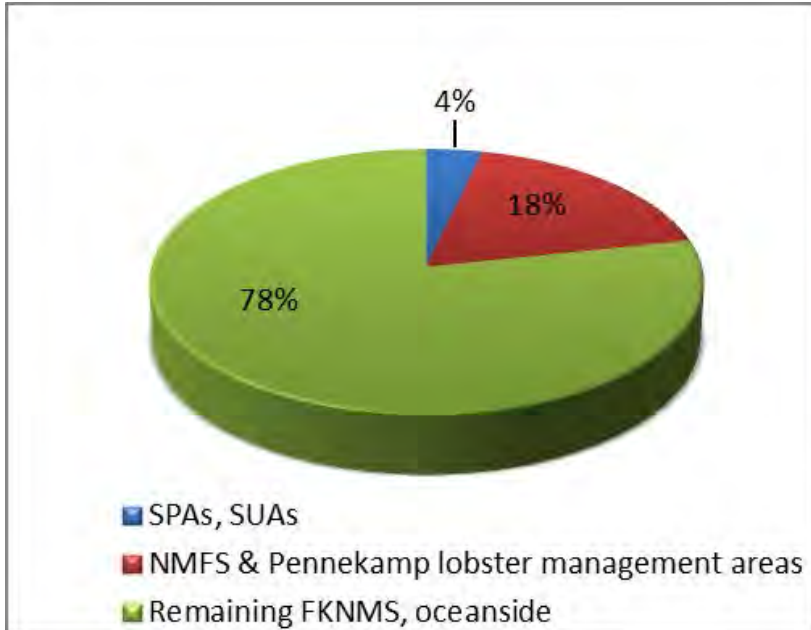
Study Methods

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



Where are locations of resilient reefs?

Management Zone	Area (km ²)
SPAs, SUAs	0.02
NMFS & Pennekamp lobster management areas	0.10
Remaining FKNMS, oceanside	0.42
Resource Total	0.54



- Boundaries**
- Resilient Reefs
 - FKNMS Boundary
 - SPAs, SUAs
 - Pennekamp Coral Formation Protection Areas
 - NMFS Areas Closed to Lobster Trap Gear
 - Ocean side (used for analysis)



Species level information



Coral current and candidate ESA species

Data sources

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

Species

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

Metrics

- presence/absence

Threatened Coral Species



Threatened coral species

staghorn

+ present

elkhorn

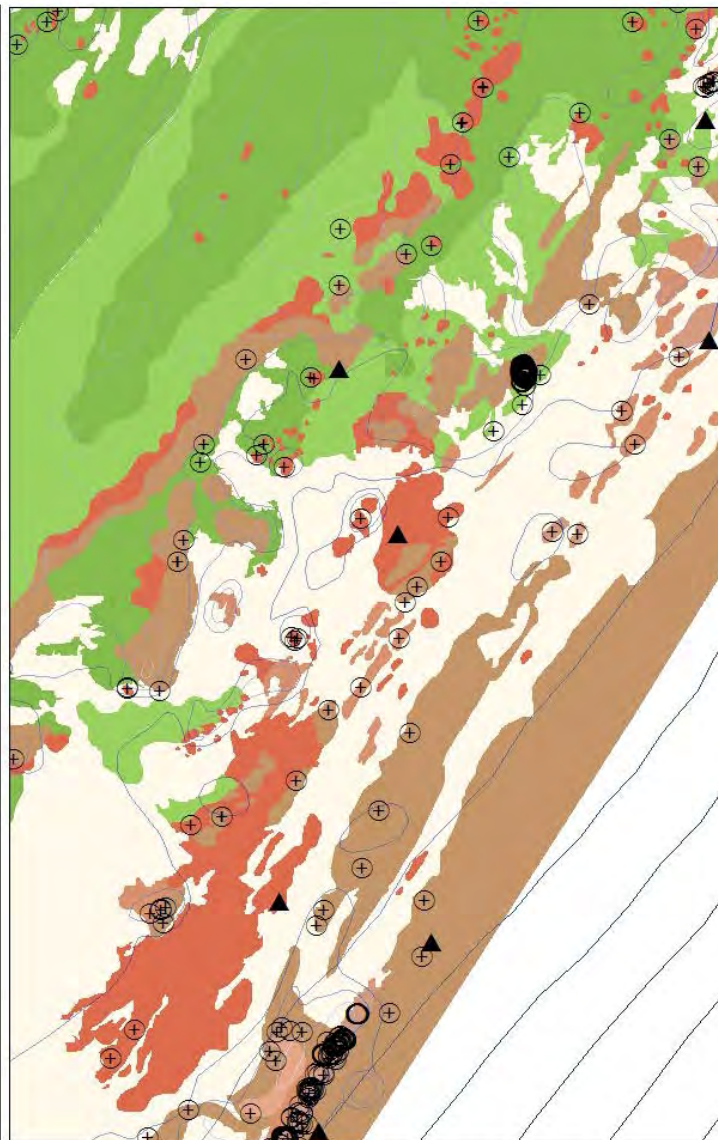
○ present

pillar

▲ present

Benthic Habitat Map

-  Patch Reefs
-  Linear Reef
-  Hard Bottom
-  Seagrass
-  Seagrass Sand



What proportions of sites with ESA coral species are present in current zones?



What proportion of sites with Threatened Pillar corals are present in current zones?

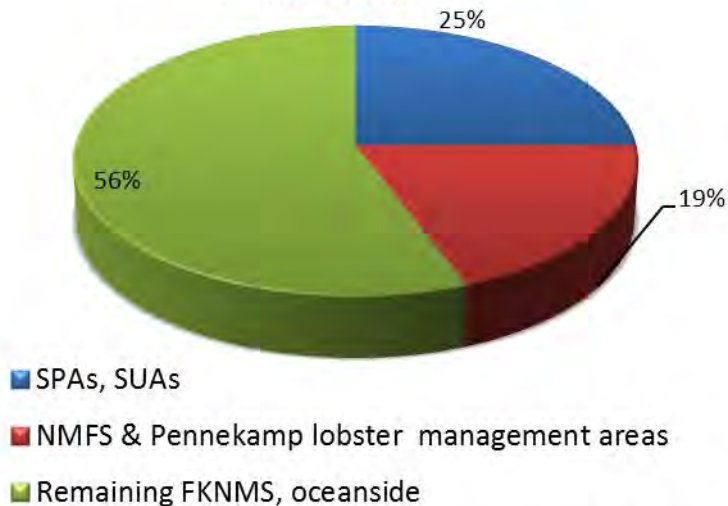


Threatened status – State of FL; ESA candidate Endangered species
81 known sites with pillar coral present in the Florida Coral Reef Tract.
52 of these are in the Upper Keys Region. *Source: FWC*

What proportion of Threatened Pillar corals are present in current zones?

Management Zone	Locations (#)
SPAs, SUAs	13
NMFS & Pennekamp lobster management areas	10
Remaining FKNMS, oceanside	29
Resource Total	52

Pillar Coral



Pillar Coral Presence

Pillar

▲ present

Boundaries

- FKNMS Boundary
- SPAs, SUAs
- Pennekamp Coral Formation Protection Areas
- NMFS Areas Closed to Lobster Trap Gear
- Ocean side (used for analysis)



Fish Aggregations

Data sources

NOAA & FWC

Study Methods

FSA locations for snappers and groupers collected from interviews with fishers, reports and field surveys from Key Largo to Marquesas and Dry Tortugas

Metrics

- Fish Aggregations
 - Single species, multi-species
 - Present, probable, potential, reported



Fish spawning aggregations

Where are locations of known fish aggregations?

Fish aggregations

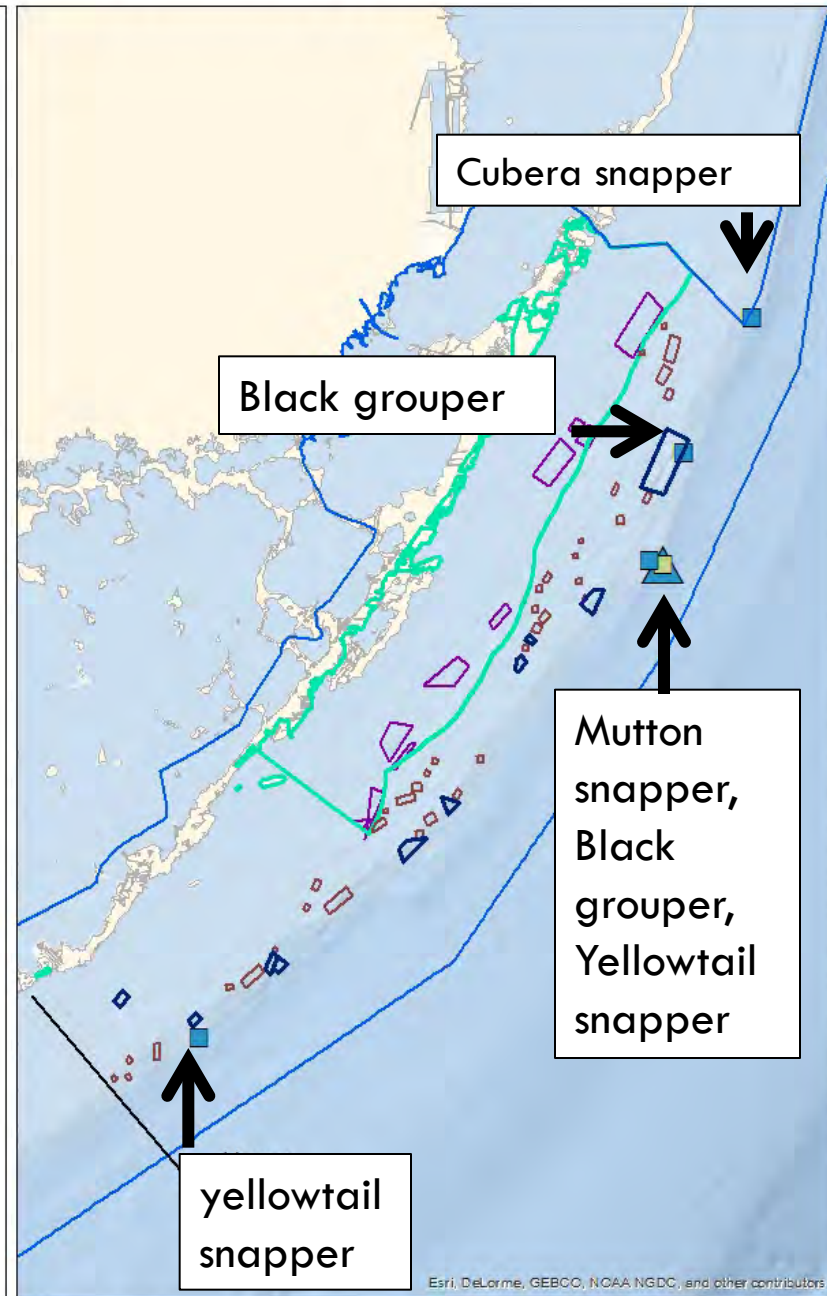
Single Species

- Present
- Probable
- Potential
- Reported

Multi Species

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

- FKNMS
- SPAs, SUAs
- Conch Reef Special Use Area
- NMFS Areas Closed to Lobster Trap Gear
- Pennekamp State Park
- Pennekamp Coral Formation Protection Areas



Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Coral reef community





Reef fish visual census

Data sources

NOAA NMFS and partners including University of Miami, FWC

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

Coral



Data sources

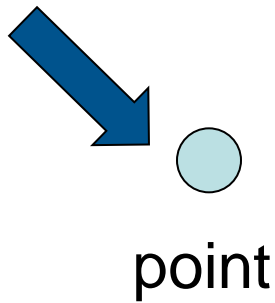
- Nova Southeastern University (SCREAM)
- Florida Reef Resilience Program (FRRP)
- Coral Reef Ecosystem Monitoring Program (CREMP), FWC

Metrics

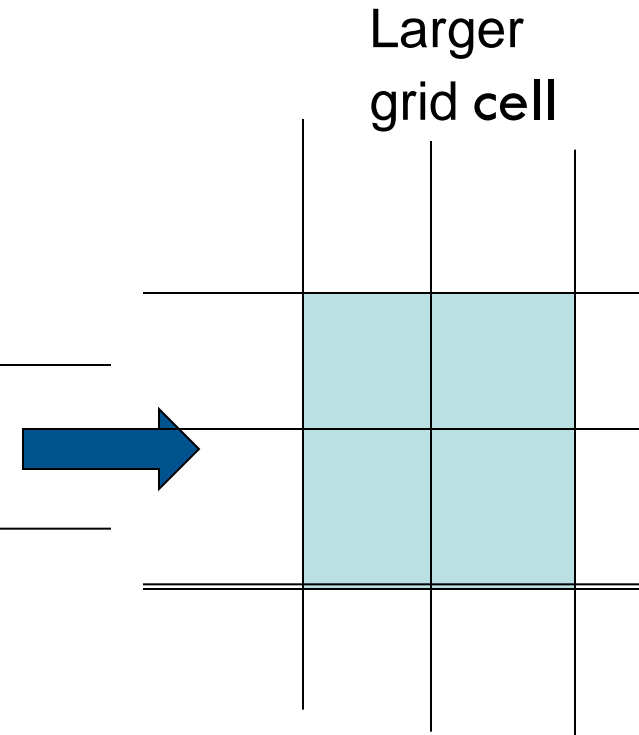
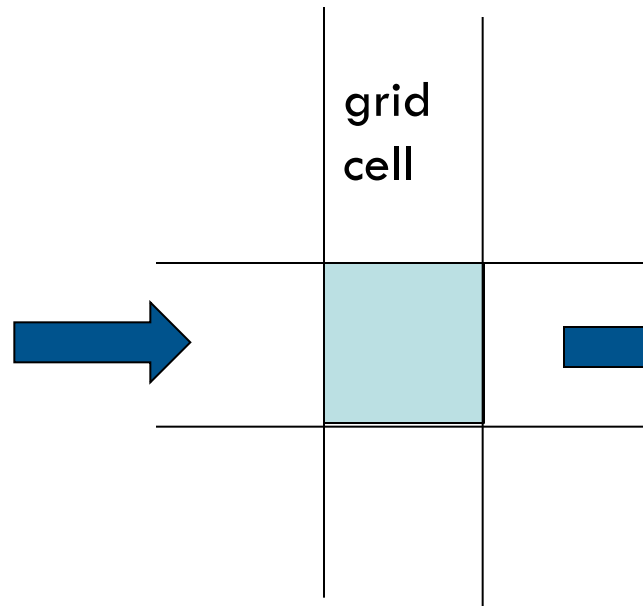
- Stony coral
 - Benthic cover (%)
 - Density
 - Species richness
- Soft Coral (Octocoral)
 - Density
 - Species richness

GIS Overview

From field sampling...



... to spatial data



How can we tell what areas are good?

Rank survey site relative to other sites
in upper Keys

High

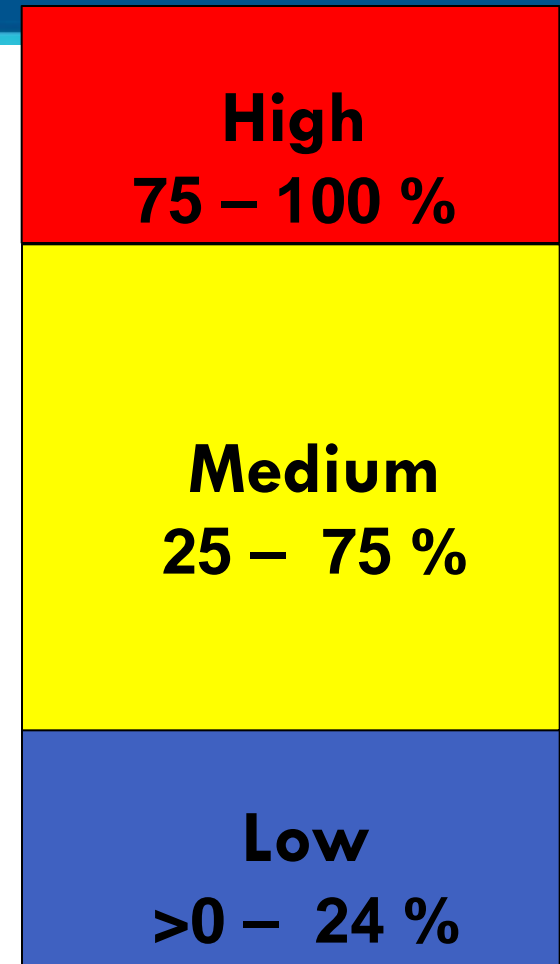
Medium

Low

Top 25%

Middle

Bottom 25%



Fish Metrics

- **Fish abundance:** How many fish?
- **Fish diversity:** How many species of fish?



Photo credit: FWC

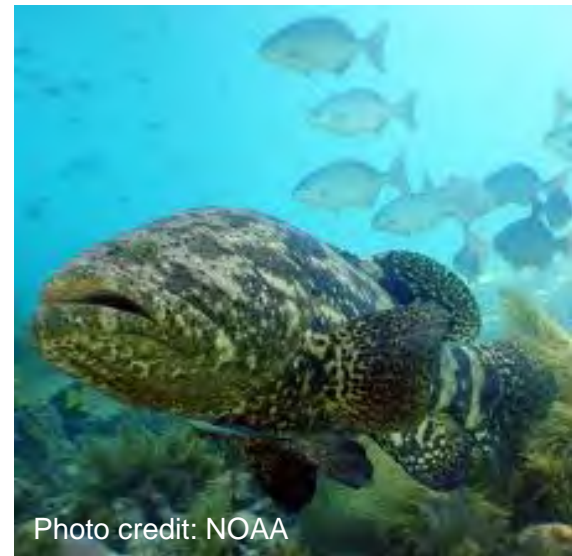
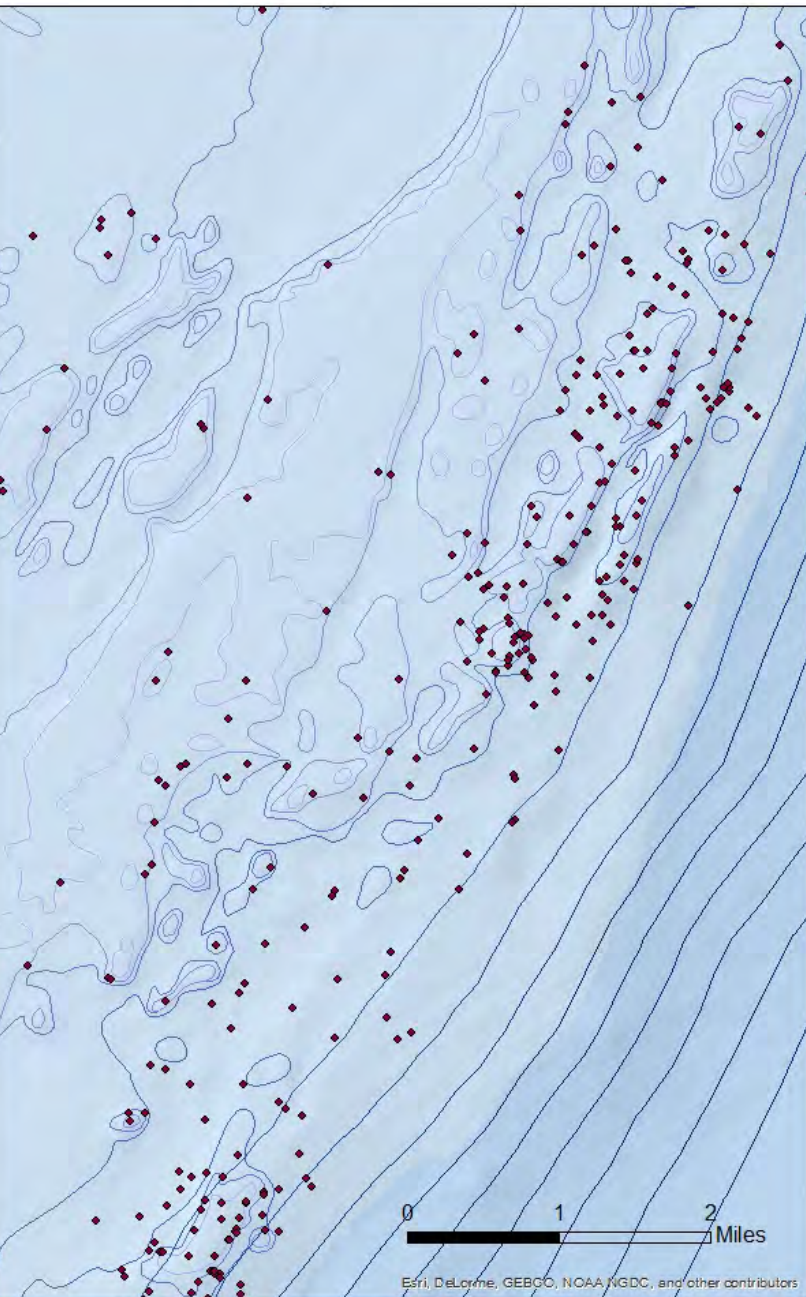


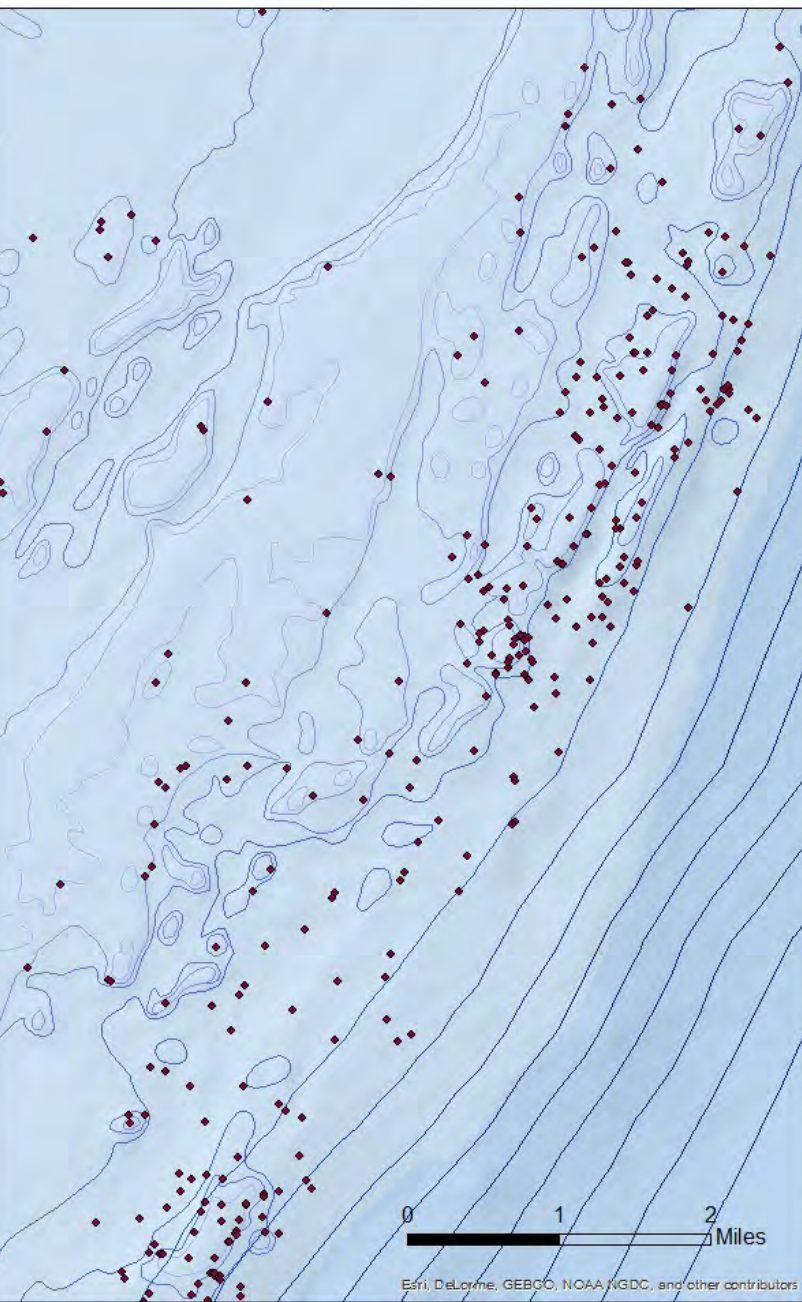
Photo credit: NOAA

Fish species richness

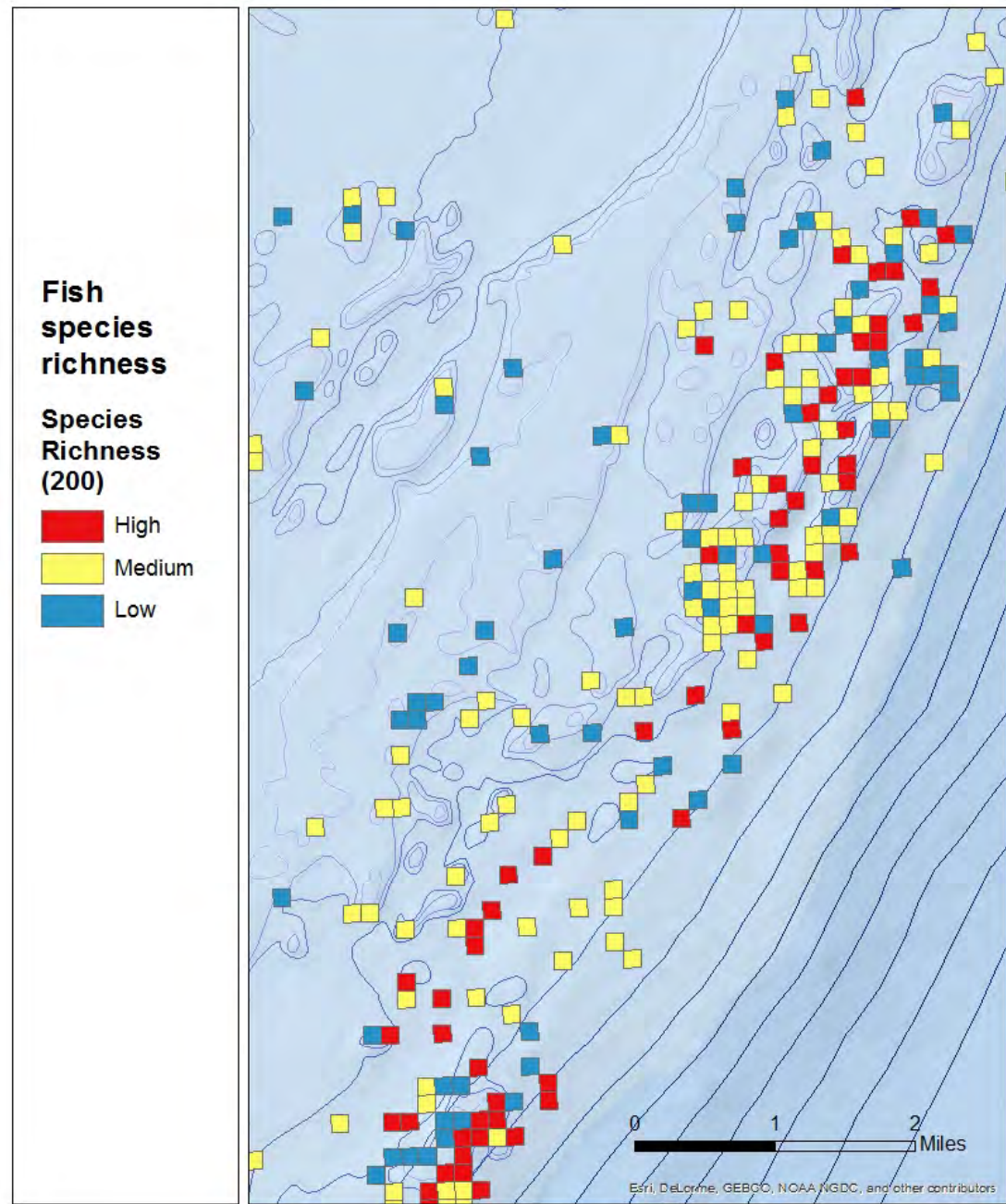


Where are locations of high fish species richness?

Fish species richness

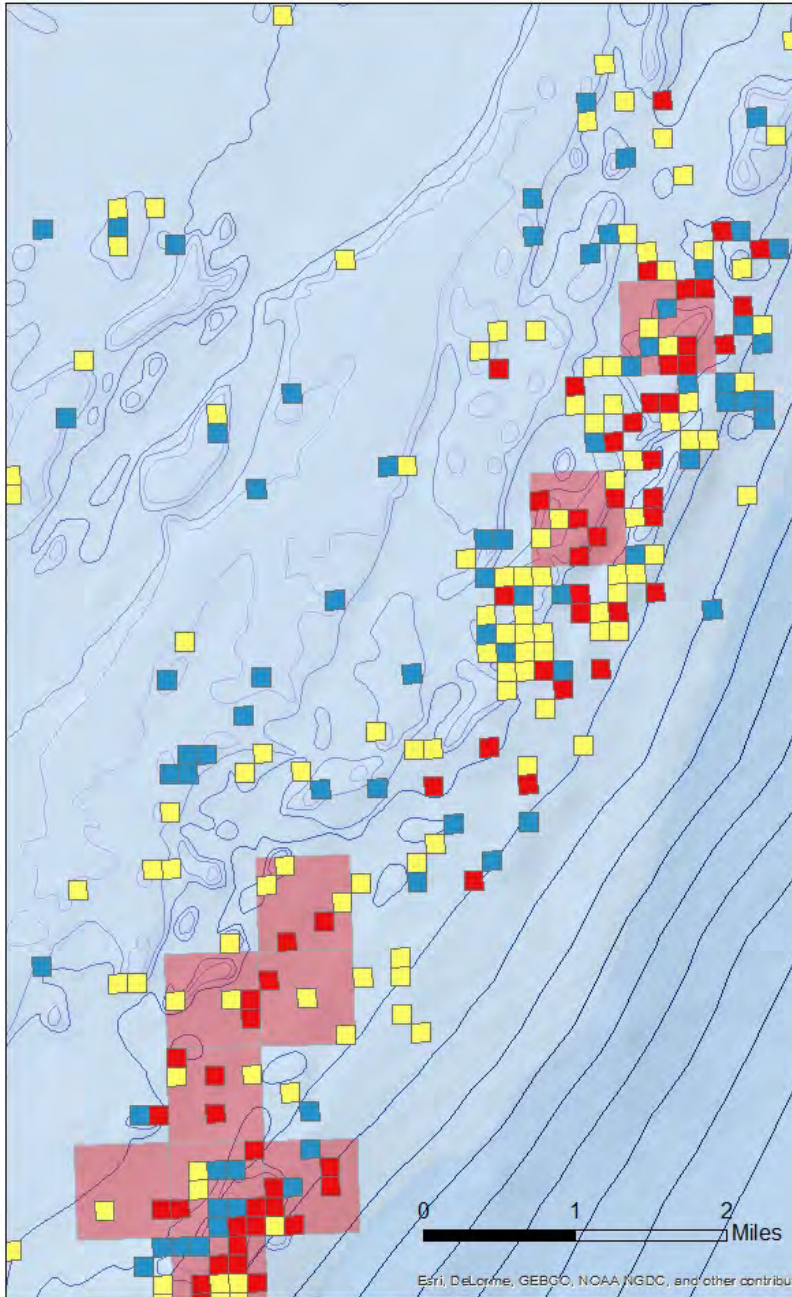
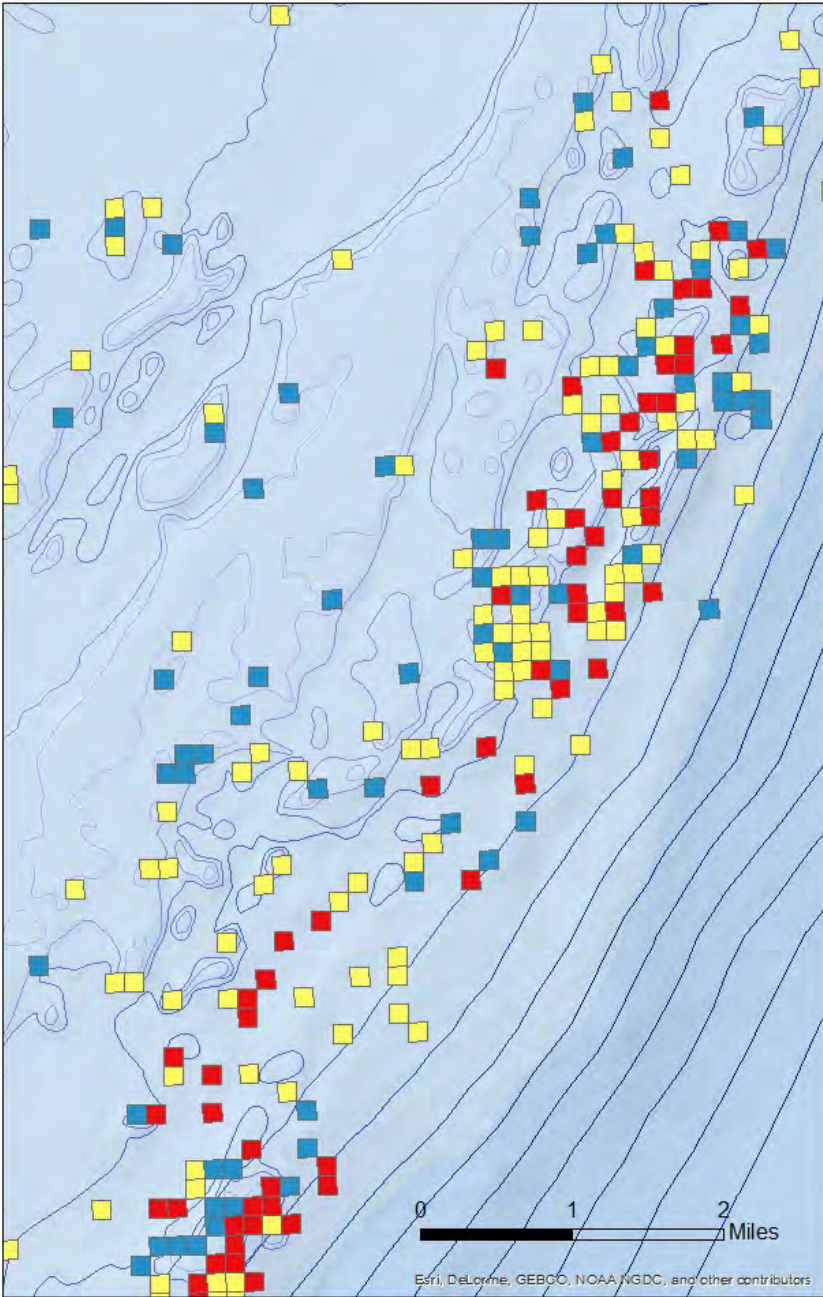


Fish species richness



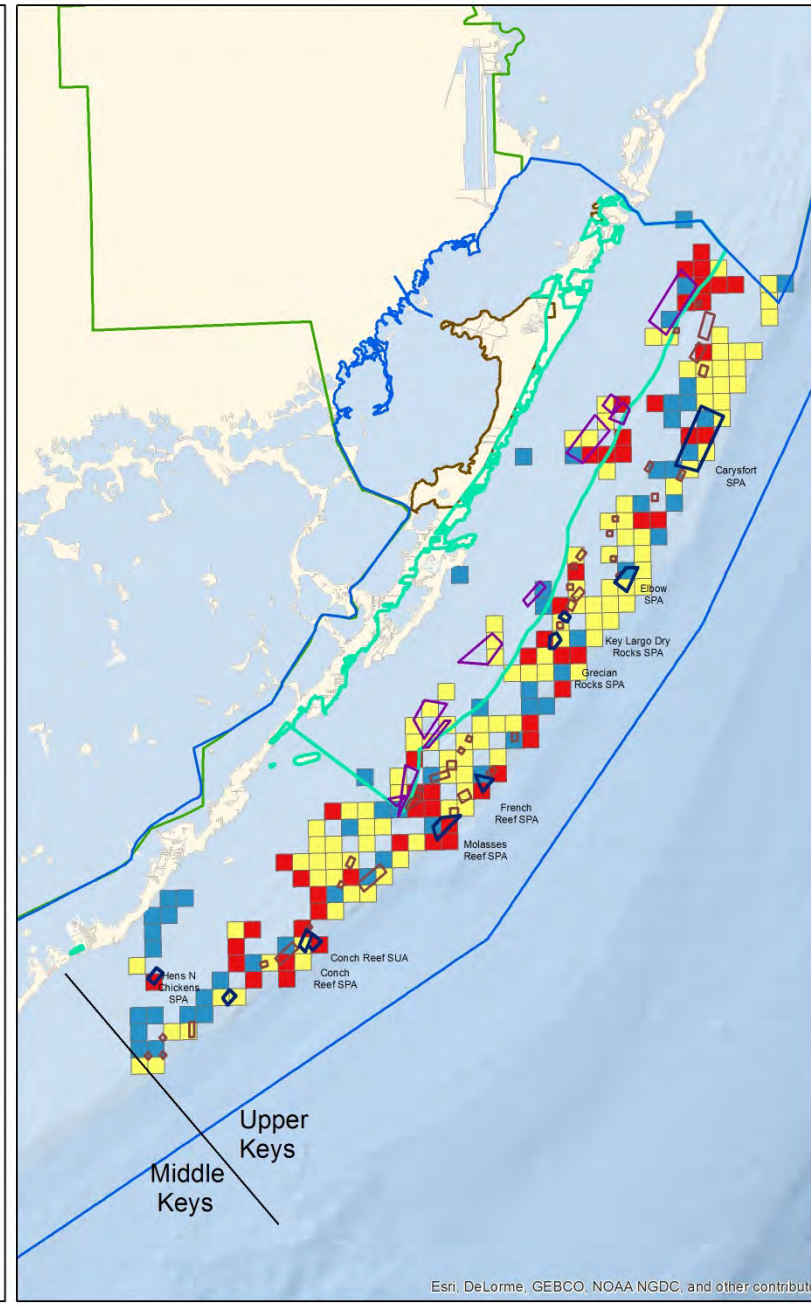
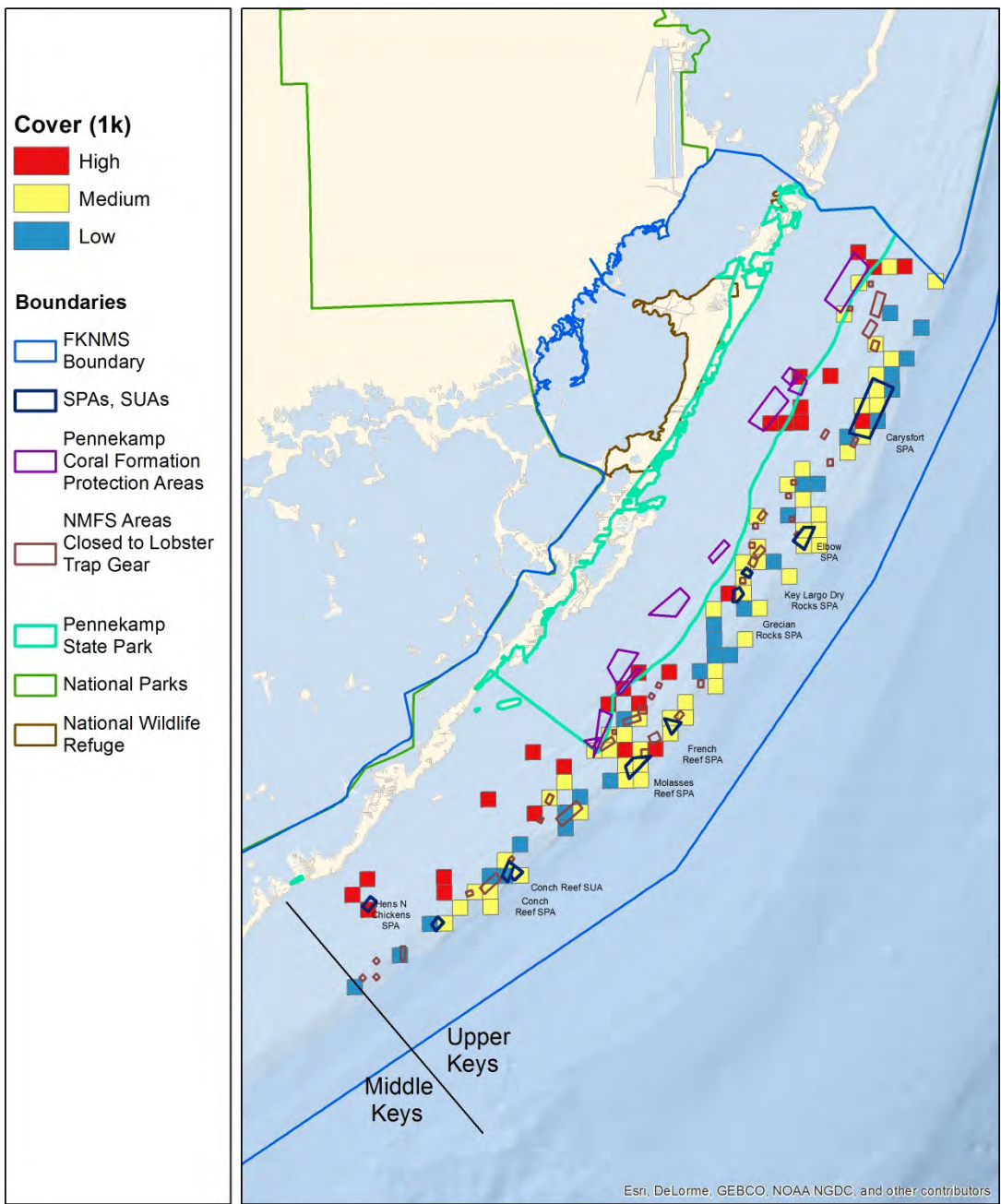
Fish species richness

Fish species richness



Stony Coral Cover

Stony Coral Species Richness



Stony Coral Cover

Cover (200)

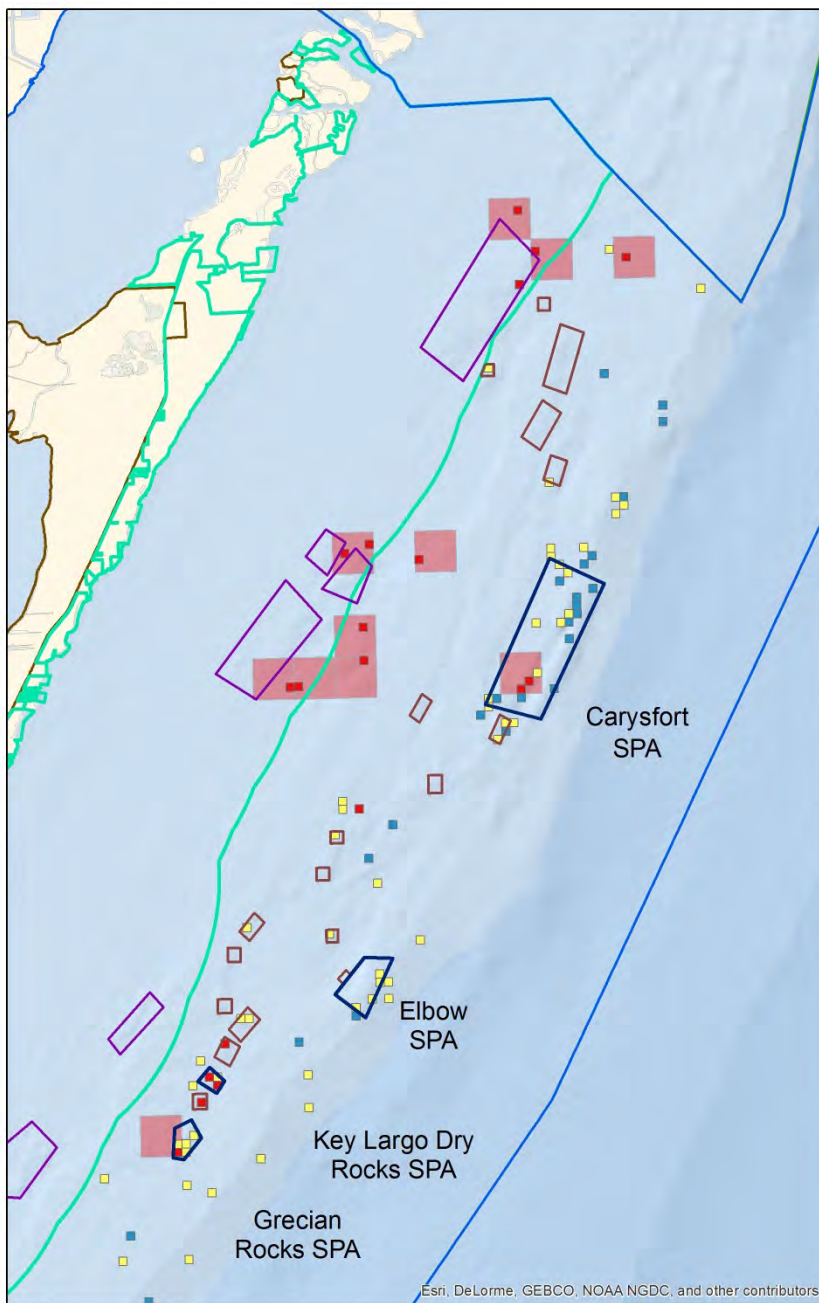
- High
- Medium
- Low

Cover (1k)

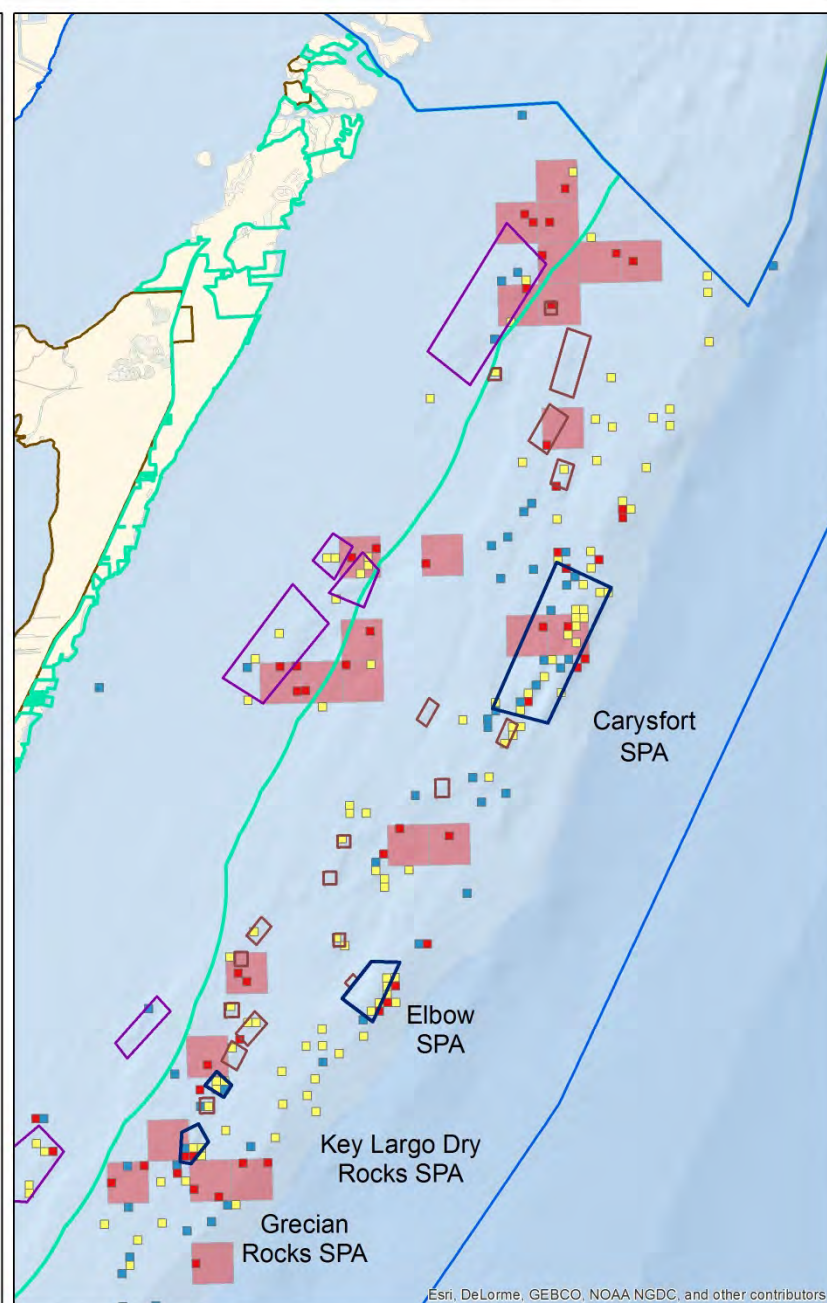
- High

Boundaries

- FKNMS Boundary
- SPAs, SUAs
- Pennekamp Coral Formation Protection Areas
- NMFS Areas Closed to Lobster Trap Gear
- Pennekamp State Park
- National Parks
- National Wildlife Refuge



Stony Coral Species Richness



Human Use

Datasets



Human use

- **Commercial Fishing**
 - Distribution 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**



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):
- 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

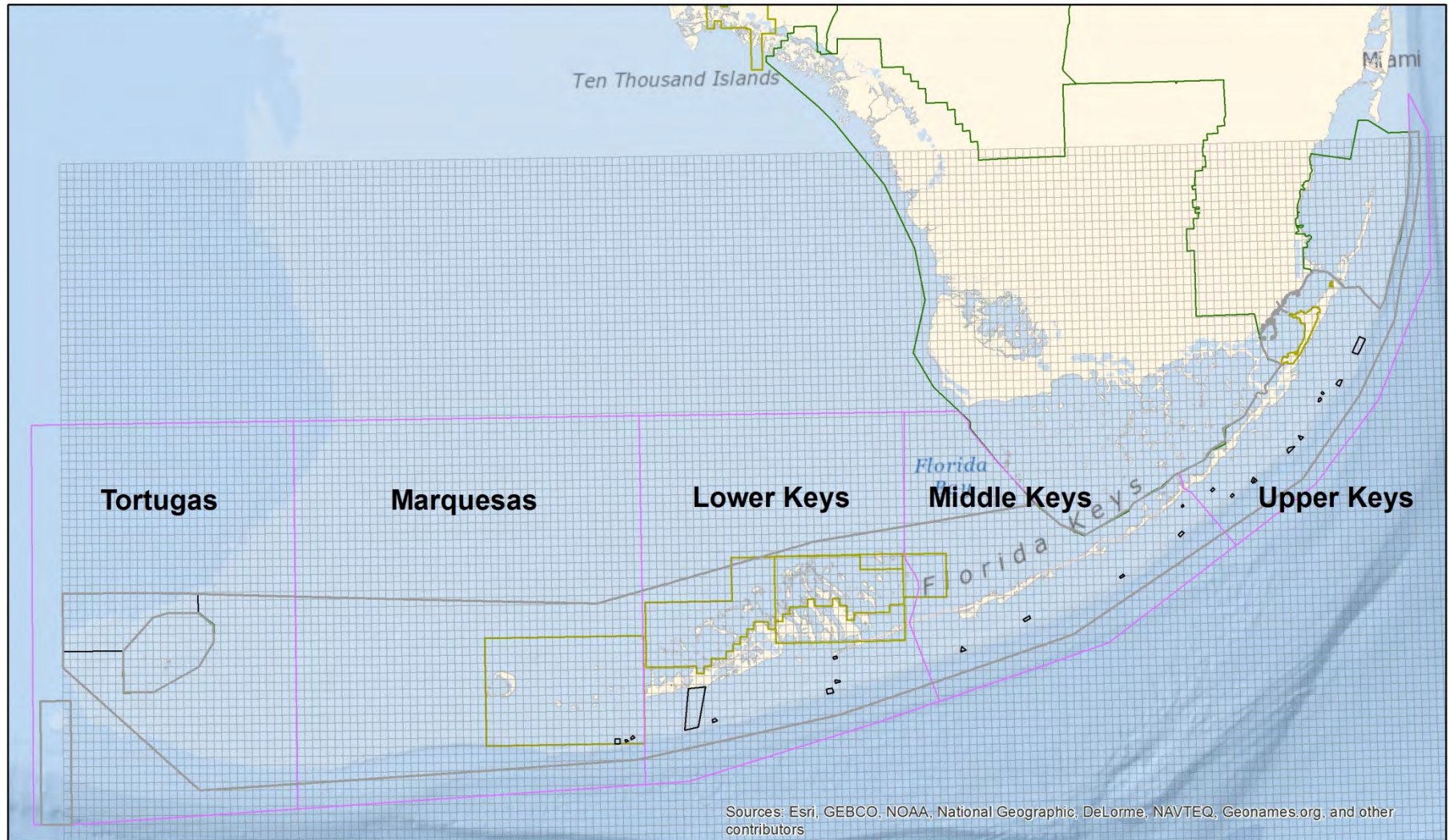
Availability: Spatial information is available for 270 of the 294 fishers.

Surveys gathered spatial data on where each fisher fished:

-  FKNMS
-  National Park
-  SPAs, ERs and SUAs
-  National Wildlife Refuges
-  Florida Keys Regions
-  Commercial Fishing Study Area

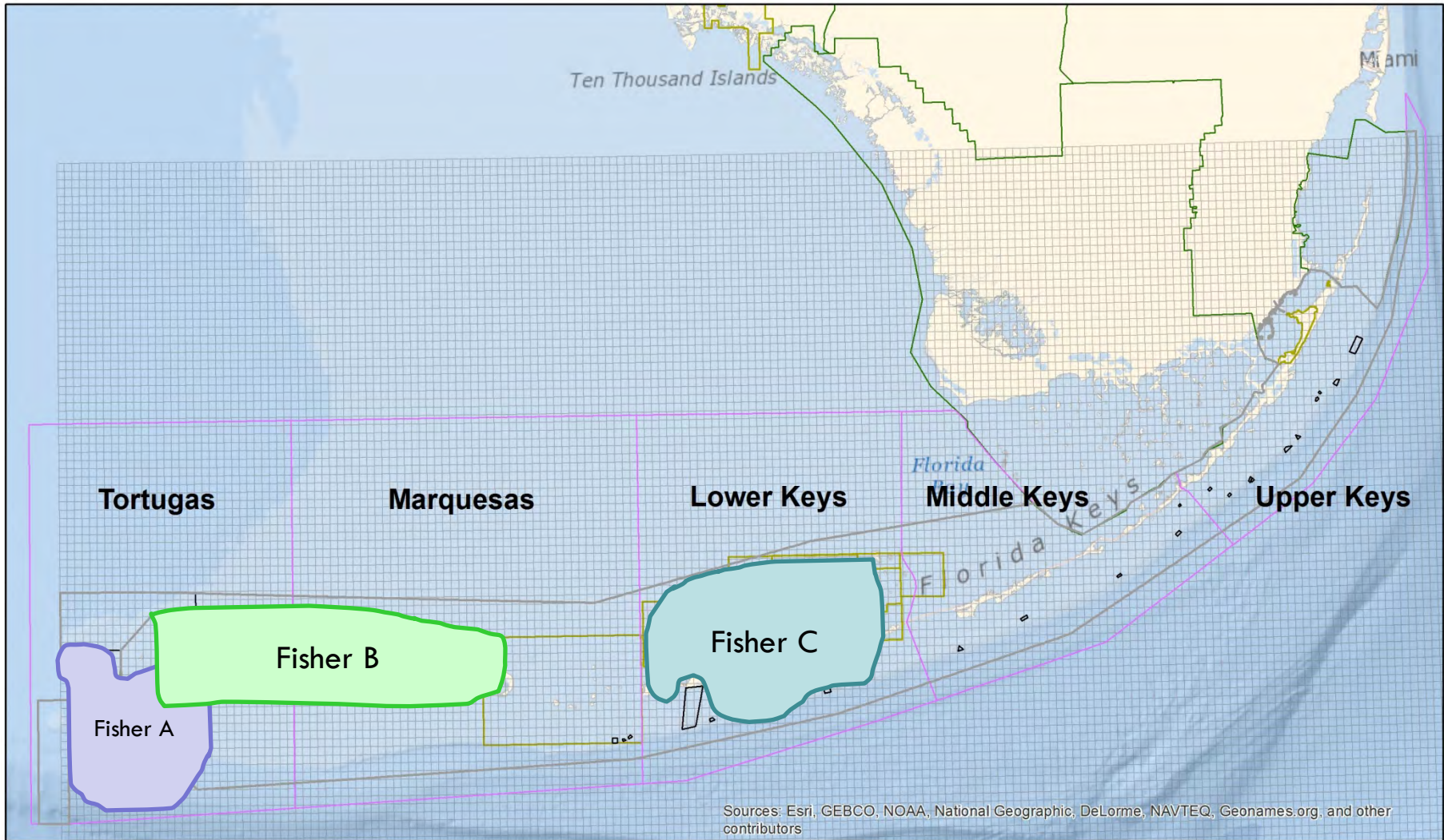
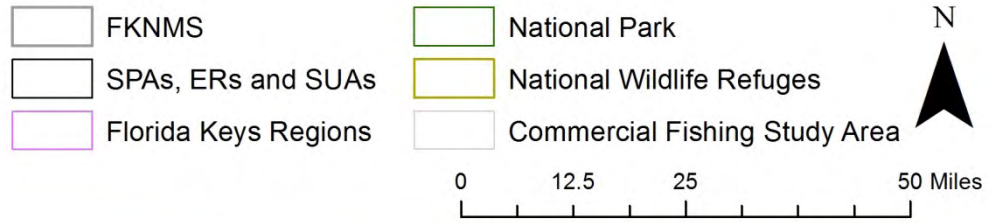


0 12.5 25 50 Miles

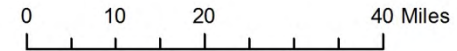


Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Surveys gathered spatial data on where each fisher fished:

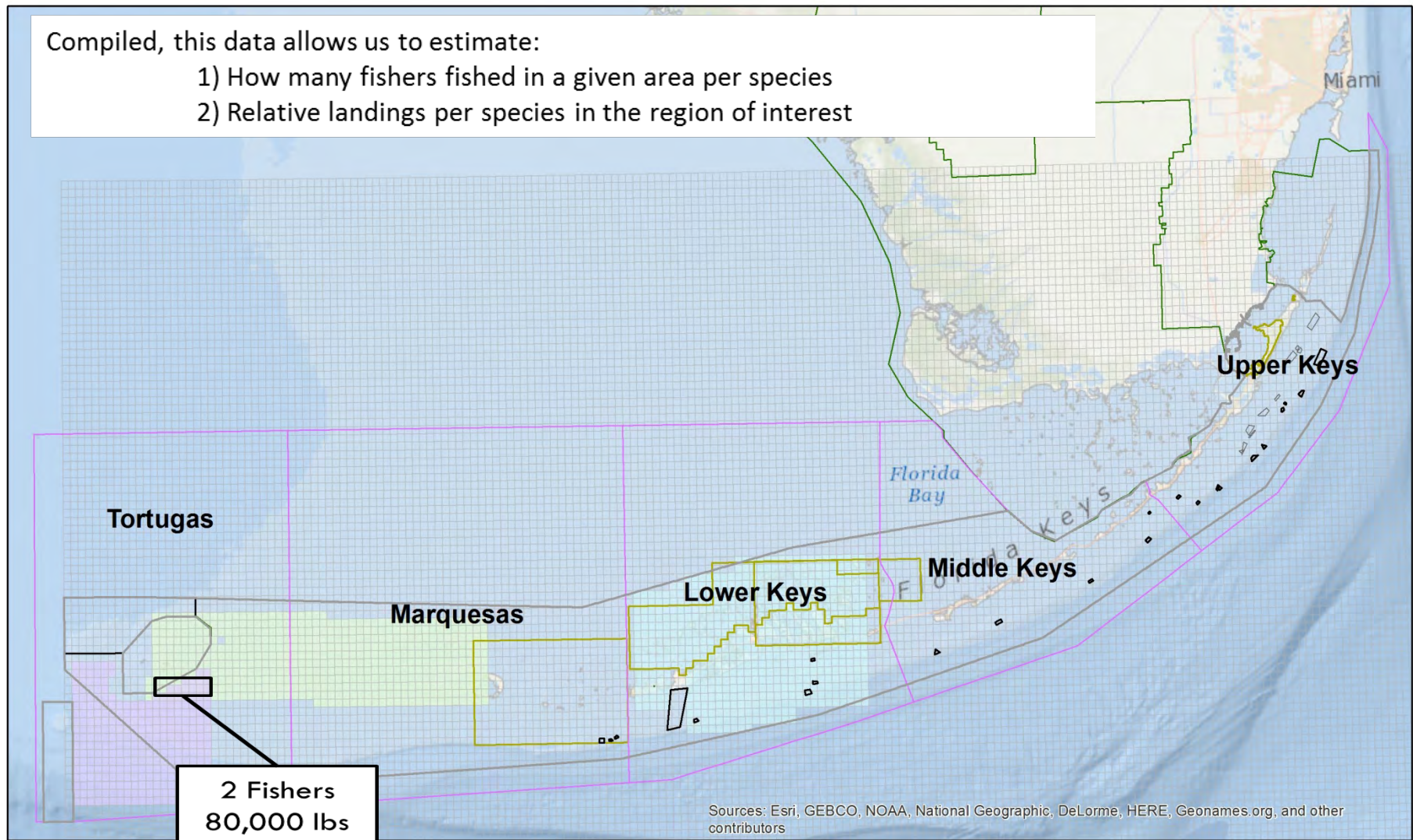


Surveys gathered spatial data on where each fisher fished:



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



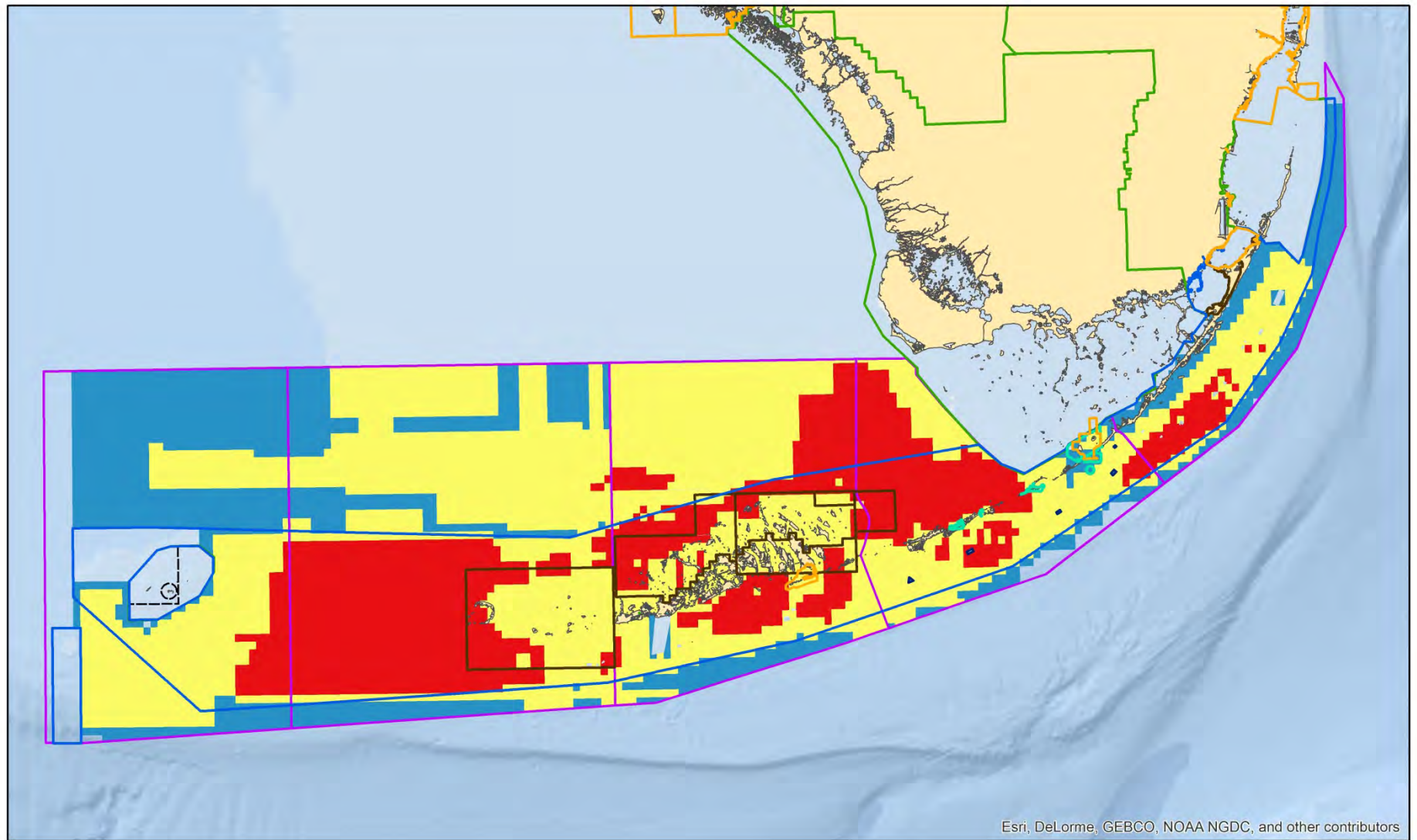
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors

Number of Spiny Lobster Fishers per nautical mile²

Number of Fishers

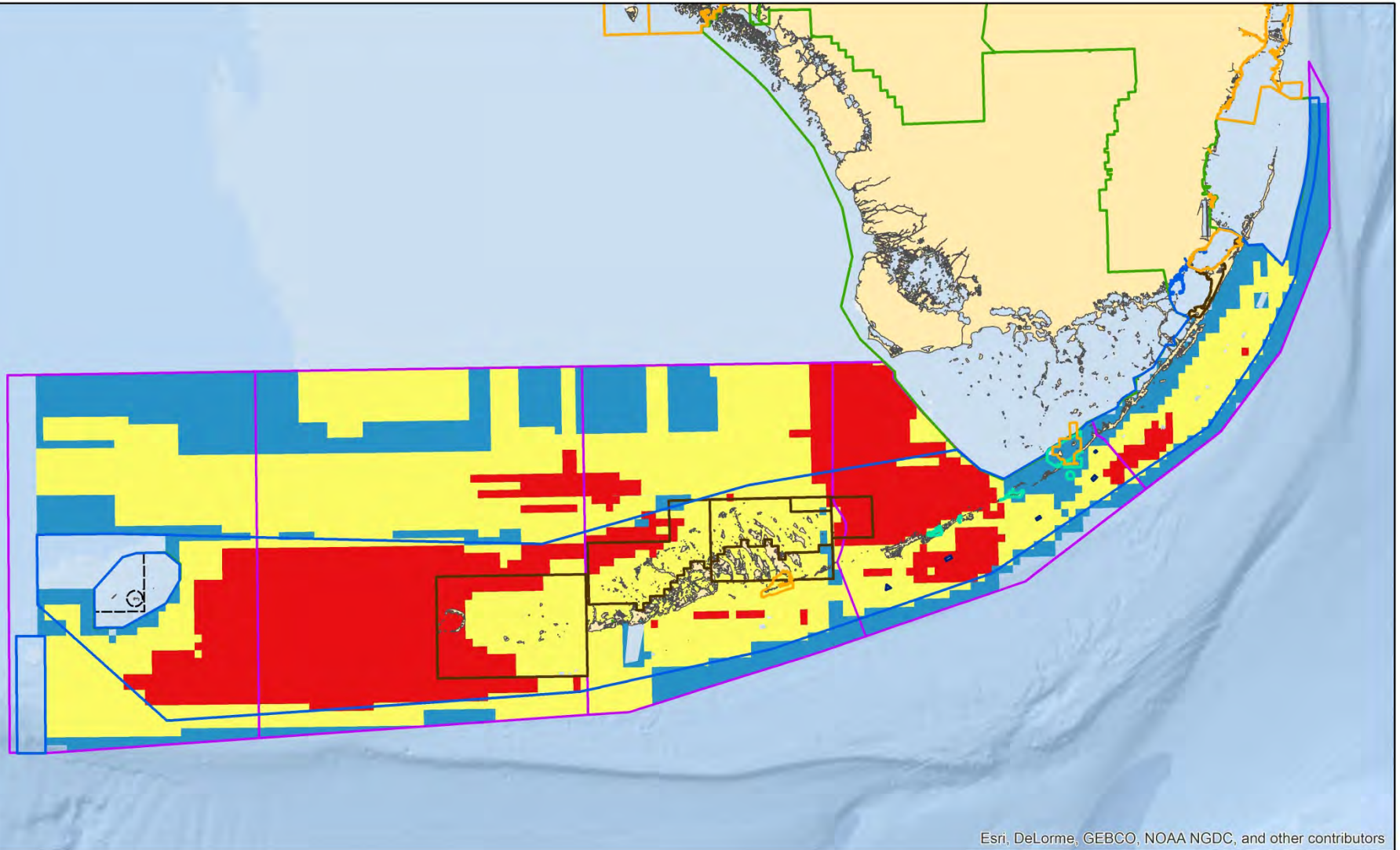
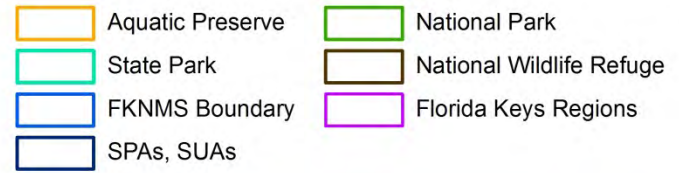
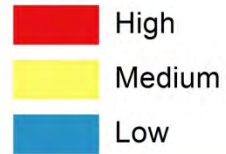
- High
- Medium
- Low

- Aquatic Preserve
- State Park
- FKNMS Boundary
- SPAs, SUAs
- National Park
- National Wildlife Refuge
- Florida Keys Regions



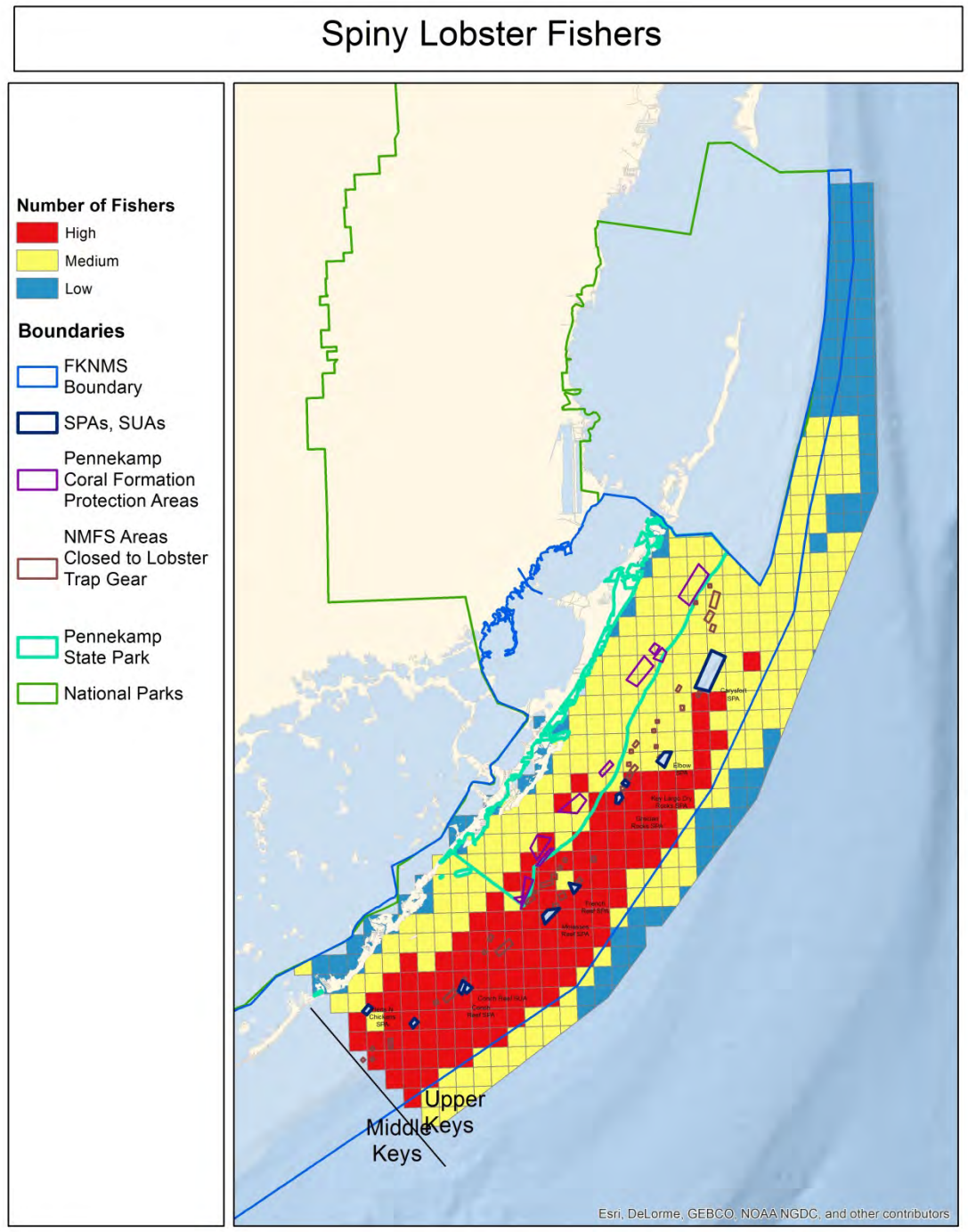
Relative Landings for Spiny Lobster

Landings



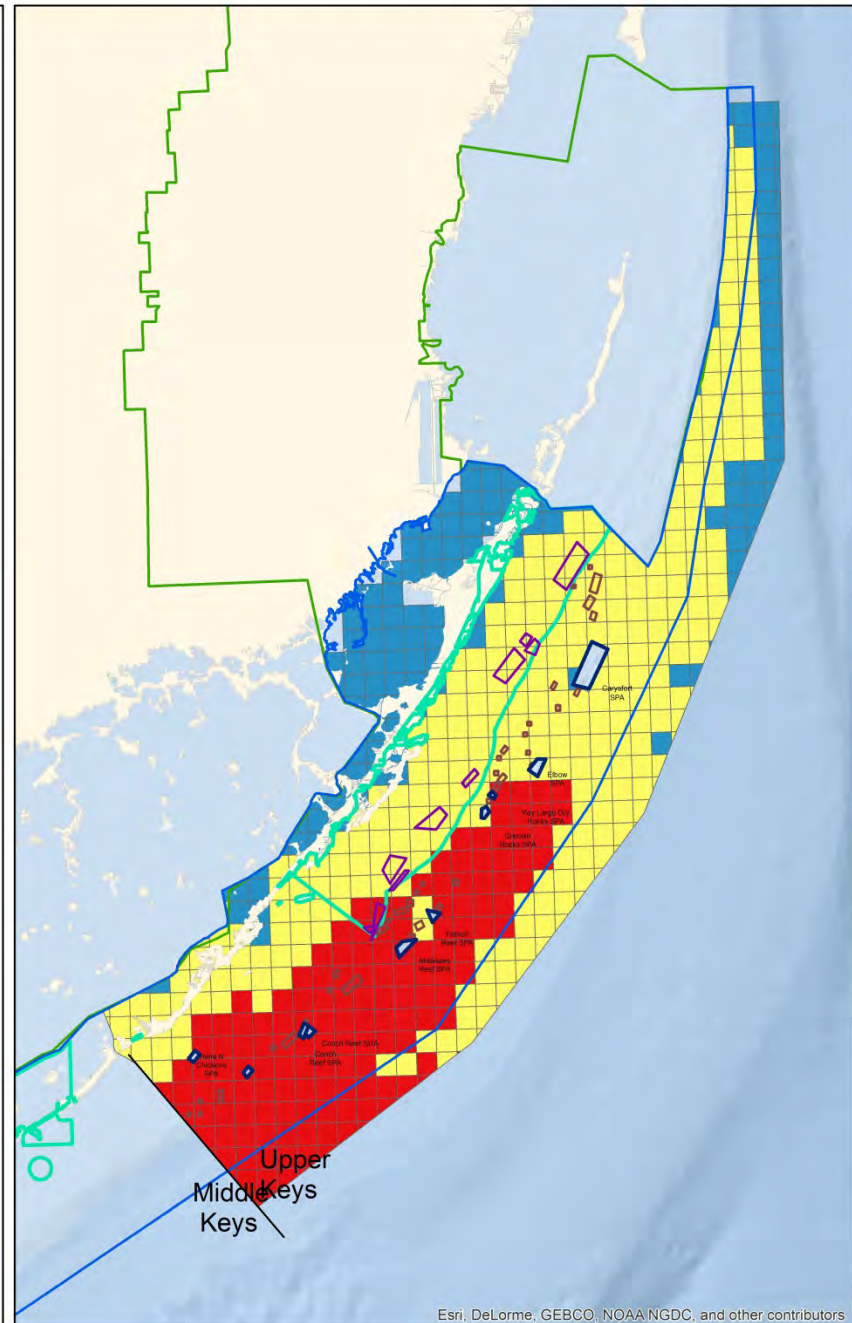
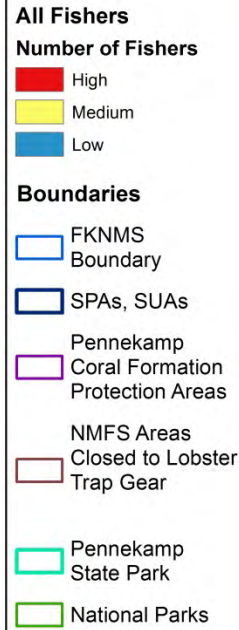
Upper Keys

Spiny Lobster Fishers



Upper Keys — All Commercial Fishers

Commercial Fishers



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 1nm², May – August 2010-2012

Aerial Surveys

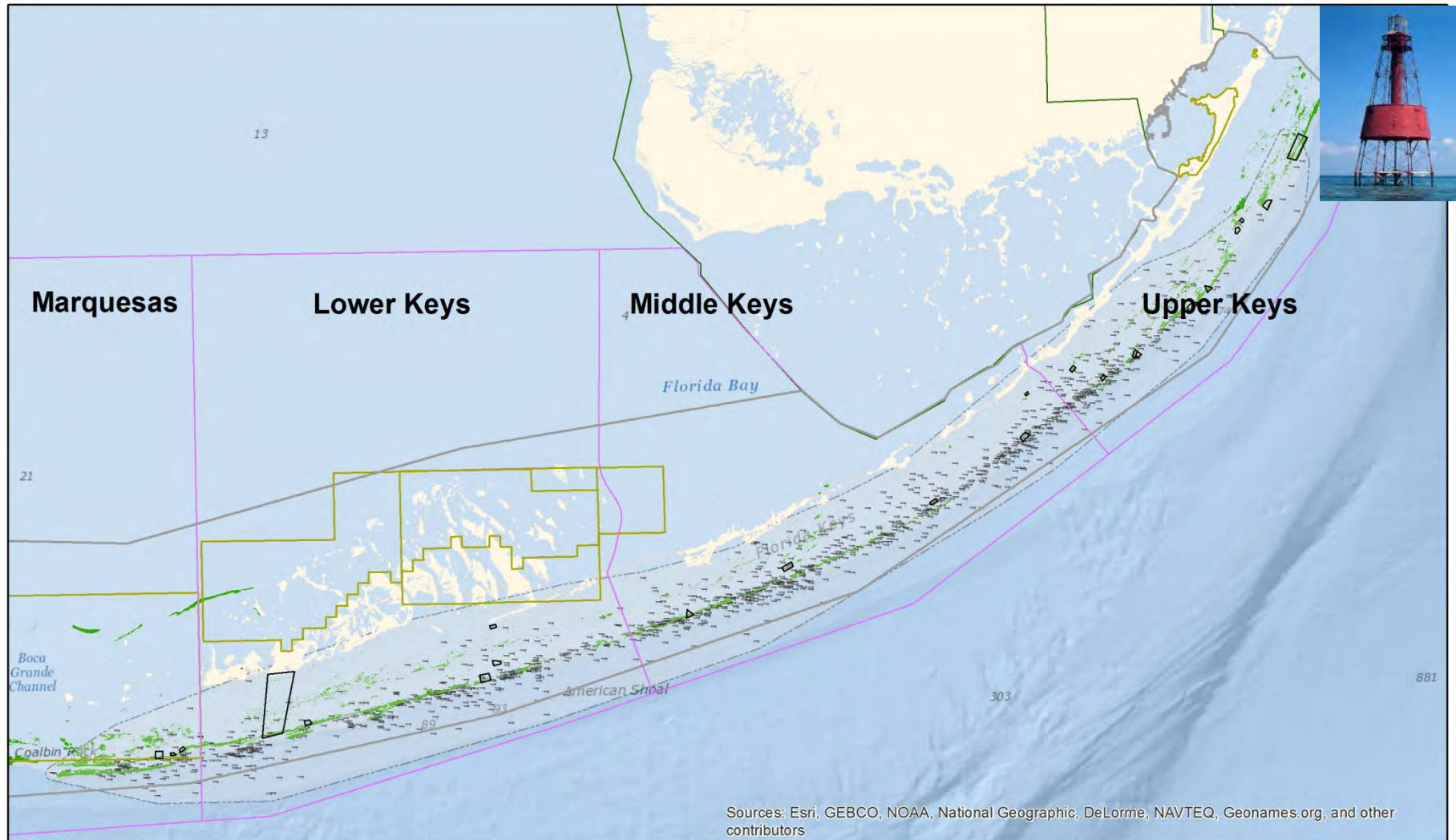


Data Collection: During flyovers of the reef tract, surveyors counted the number of vessels at a given coordinate location, and documented the types of activities people were engaged in.

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.

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

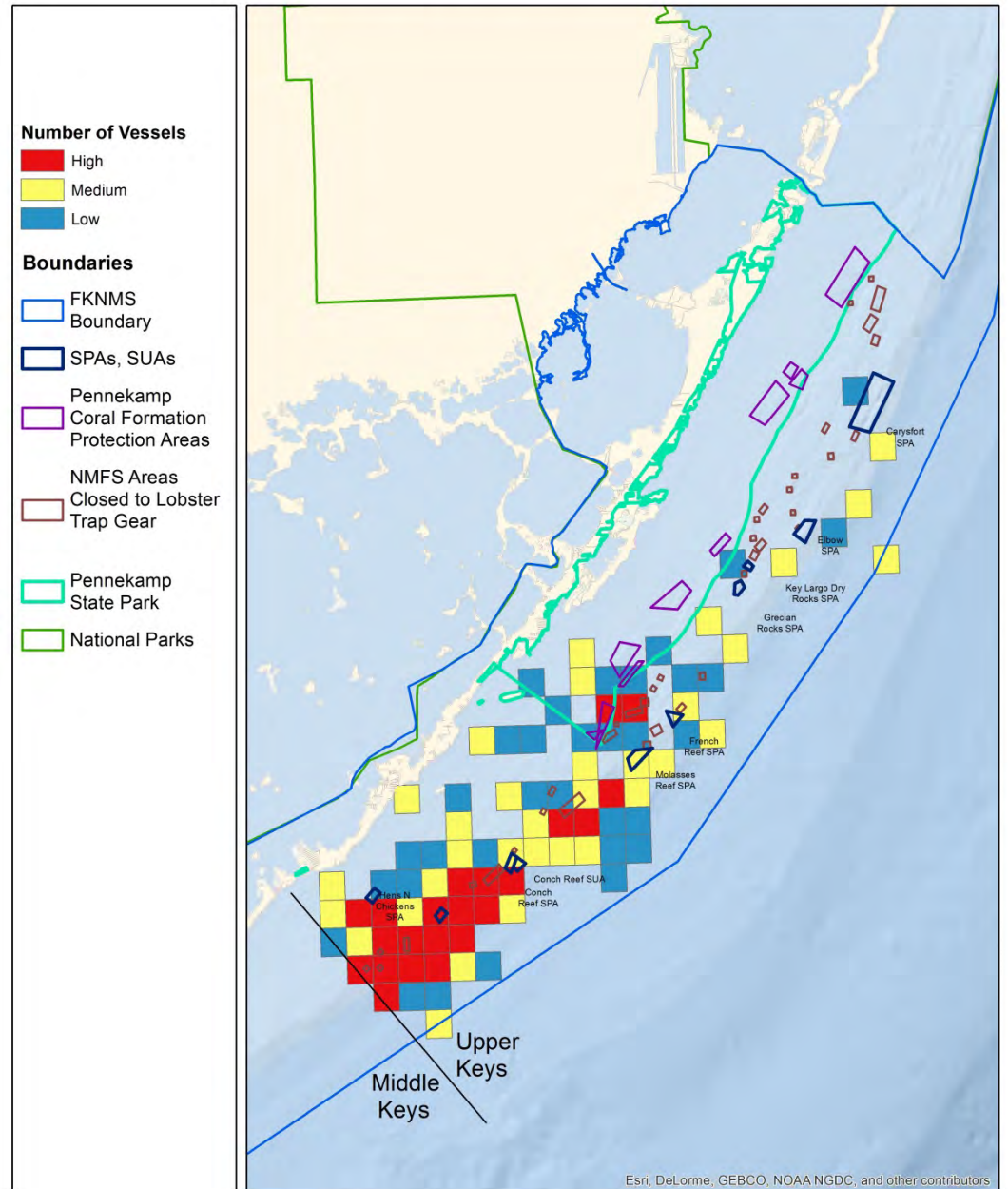


Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

Upper Keys

Recreational and Charter Fishing Boats (1 nautical mile²)

Recreational and Charter Fishing





Diving Activity

Data sources

-FWC. Aerial surveys of the Florida Keys reef tract.

-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

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

Aerial Surveys – Dive Boats



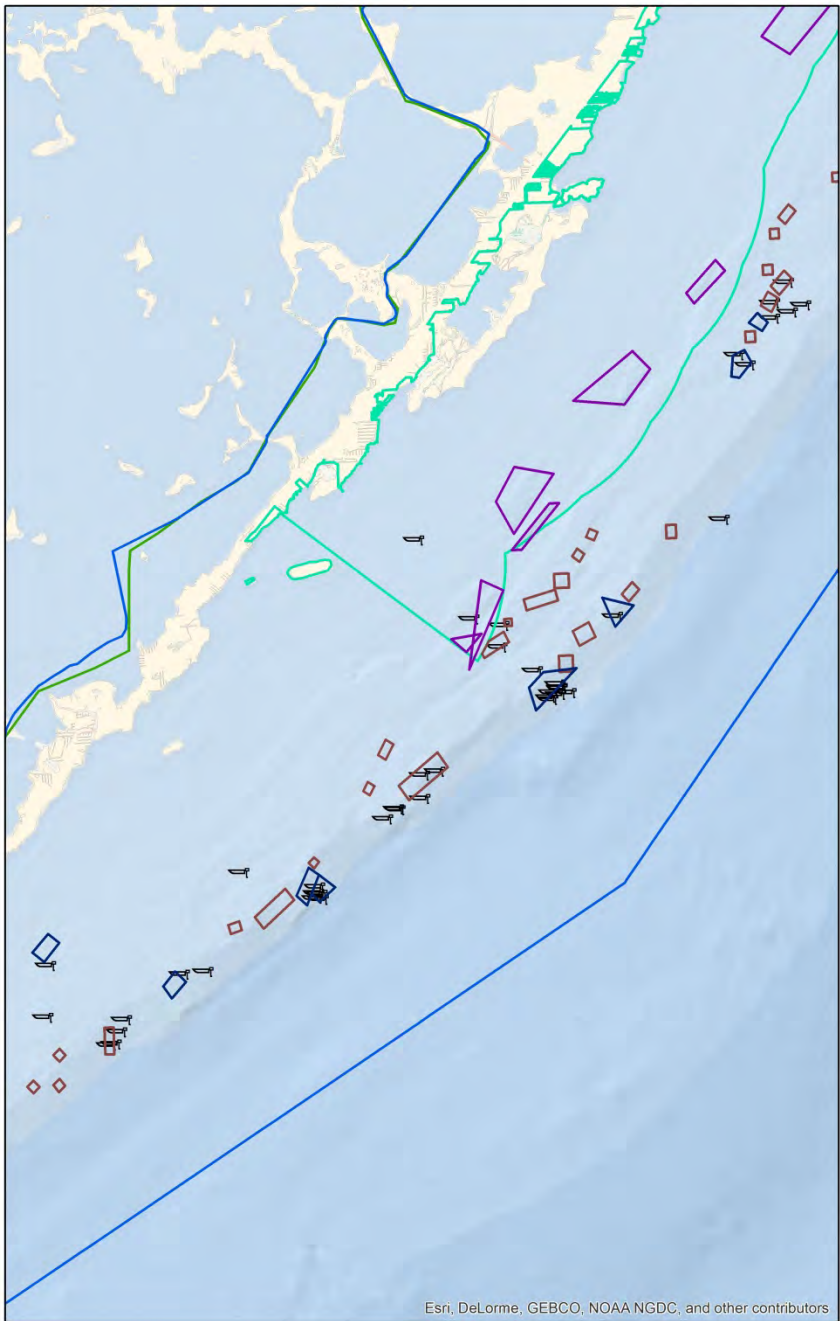
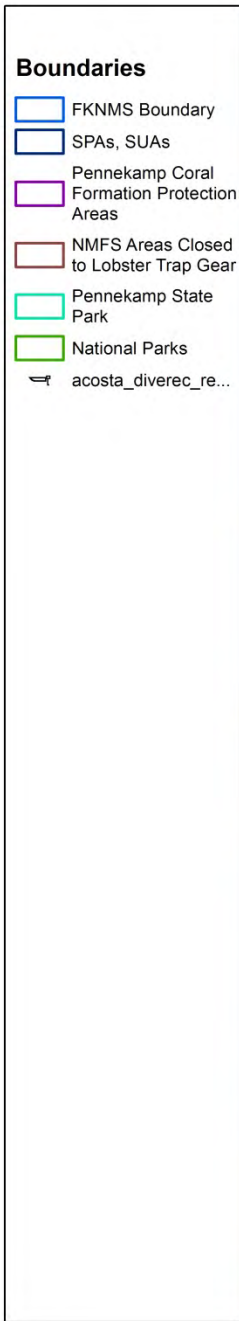
Data Collection: Aerial surveys were conducted by plane over the Florida Keys reef tract.

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

Upper Keys — Dive Boat Locations

Dive Boats - Upper Keys



Dive Operator Surveys

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

Purpose: Survey questions gathered:

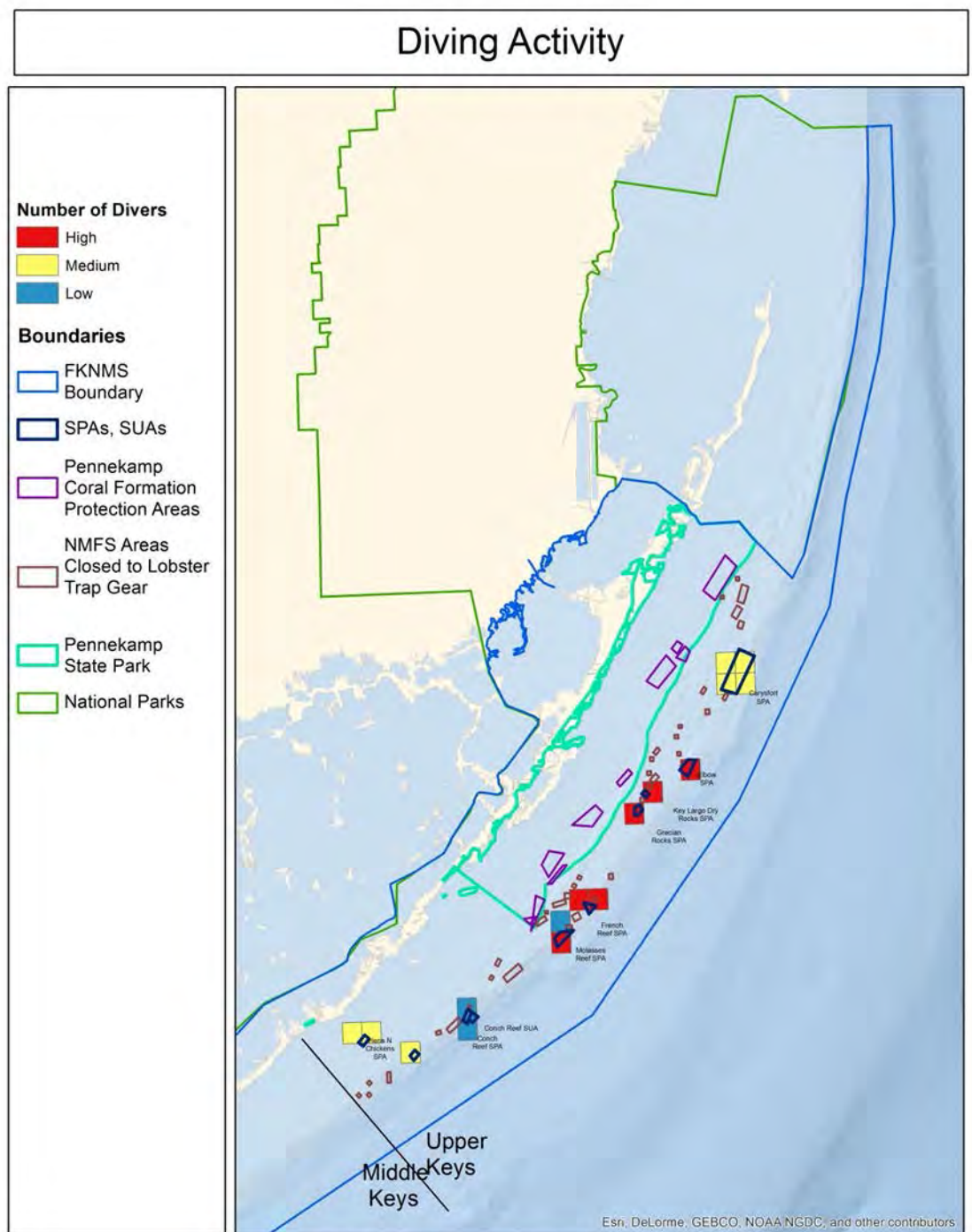
- General demographic information,
- Economic information,
- Dive operator trip information,
- Commercial dive operators' knowledge, attitudes, perceptions and beliefs regarding the FKNMS

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.

Upper Keys — Number of Divers



Marine Debris

Data sources

NOVA Southeastern University (SCREAM)

Metric

- 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.

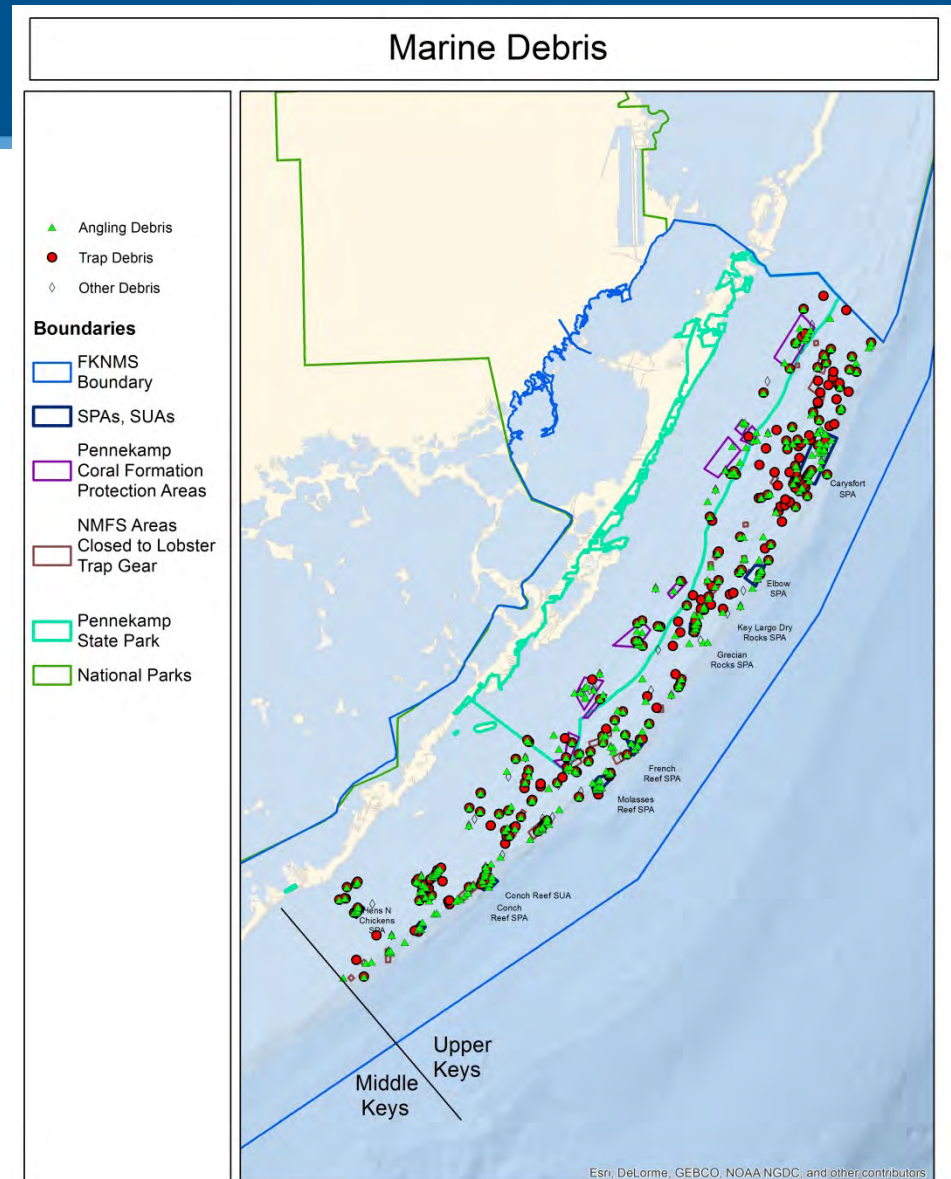
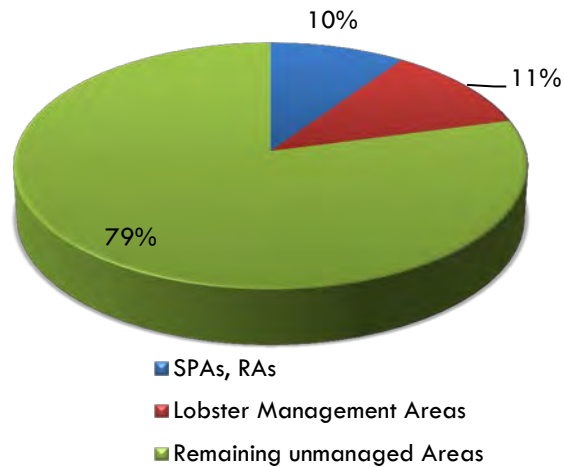
Purpose: To document the *type, distribution, weight and length* of several types of marine debris

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

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

Impacts – Marine Debris

Management Zone	Area (km ²)
SPAs, SUAs	3.70
NMFS and Pennekamp lobster management areas	4.38
Remaining FKNMS, oceanside	30.71
Total	38.79



Vessel Groundings

Data source

Florida Keys National Marine Sanctuary

Metric

- Distribution of Reported Vessel Groundings, 2000-2012



Vessel Groundings

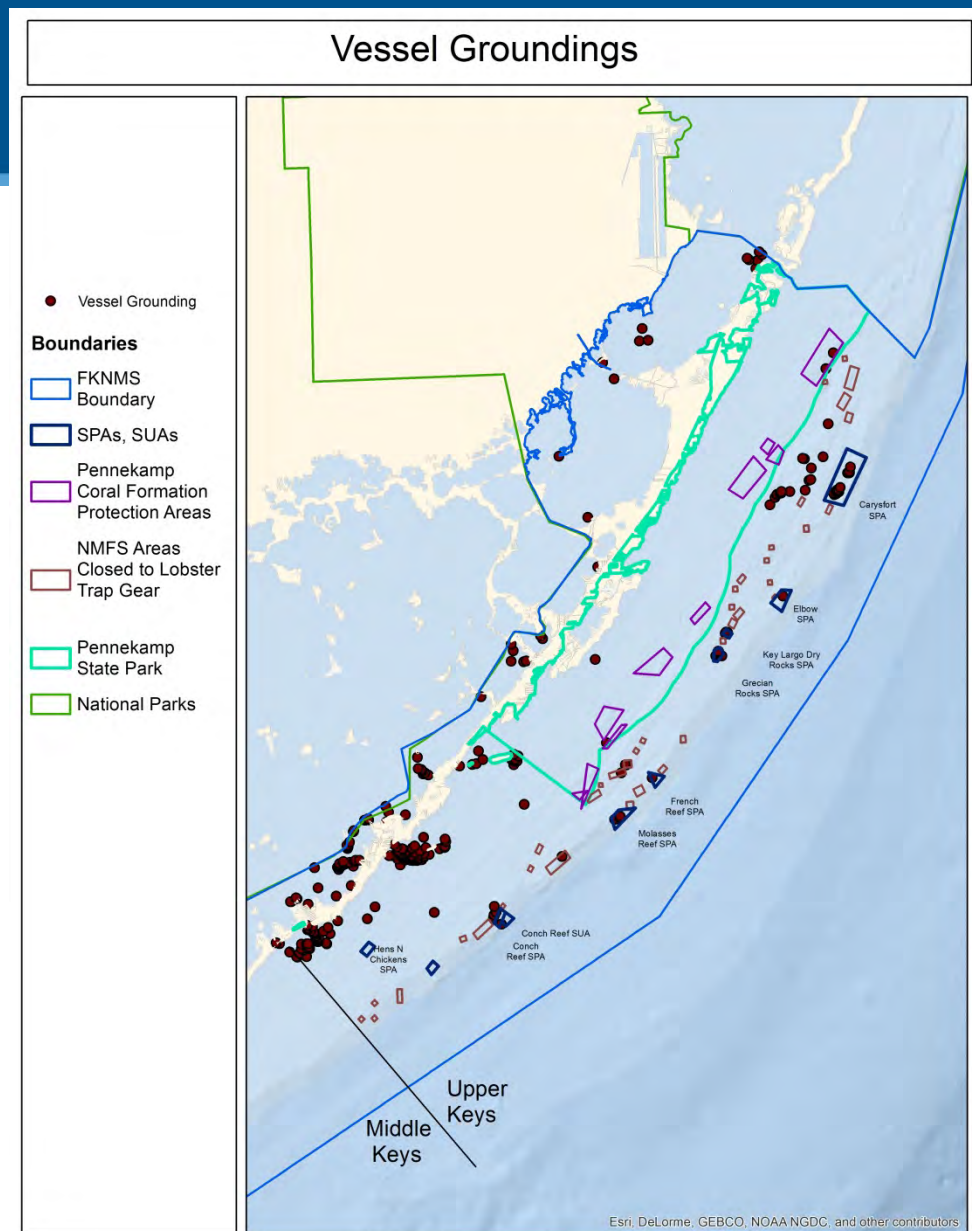
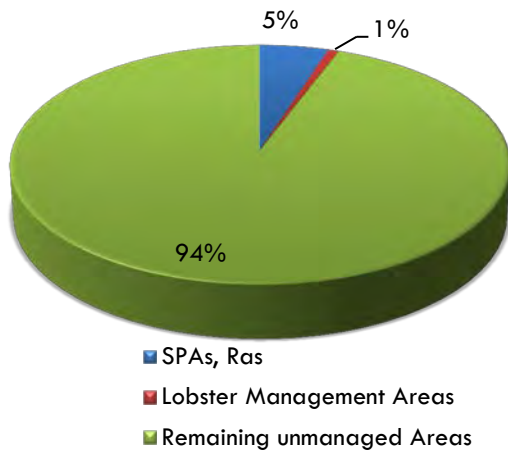
Data Collection: Where possible, the coordinates, habitat type, vessel length and vessel type are recorded for each vessel grounding, among other information.

Purpose: To track groundings in order to assess fines and recover the cost of damages from responsible parties.

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

Impacts – Vessel Groundings

Management Zone	Groundings (#)
SPAs, SUAs	47
NMFS and Pennekamp lobster management areas	7
Remaining FKNMS, oceanside	885
Total	939



Thank You!



Photo courtesy of FKNMS