How can you use the spatial information for the Upper Keys?

- natural resources -

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

Photos courtesy of NOAA photo library
Where are locations of ‘special places’?
Natural Resource Info

Metrics

• Habitat
  • Habitat types
  • Patch & linear reef
  • High relief reefs
  • Turtle grass density

• Coral
  • Stony coral
  • Soft coral
  • Resilient reefs

• Fish
  • Reef fish surveys
  • Fish aggregations

• Fauna
  • Conch aggregations

Photos courtesy of NOAA photo library
Depth Contours

**DEPTH (FT)**
- 3
- 6
- 12
- 18
- 30
- >33

Carysfort SPA

Esri, DeLorme, GECO, NOAA NGDC, and other contributors
How much area is currently within zones?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>10</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>26</td>
</tr>
<tr>
<td>Remaining FKNMS</td>
<td>1373</td>
</tr>
<tr>
<td>Resource Total</td>
<td>1409</td>
</tr>
</tbody>
</table>

![Map of Upper Keys showing management zones]

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

<table>
<thead>
<tr>
<th>Habitats</th>
<th>SPAS, SUAs</th>
<th>NMFS &amp; Pennekamp lobster management areas</th>
<th>Remaining FKNMS, oceanside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous reefs</td>
<td>3</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>Patch reefs</td>
<td>1</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Hardbottom</td>
<td>3</td>
<td>3</td>
<td>134</td>
</tr>
<tr>
<td>Sand</td>
<td>2</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Seagrass</td>
<td>2</td>
<td>15</td>
<td>550</td>
</tr>
<tr>
<td>Unmapped</td>
<td>0.3</td>
<td>0</td>
<td>789</td>
</tr>
</tbody>
</table>
Where are locations of high relief reefs?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>0.23</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>0.13</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>0.14</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>0.50</strong></td>
</tr>
</tbody>
</table>

Note: Area refers specifically to reef area.
Where are locations of known fish spawning aggregations?
Carysfort survey results

SPA border

Modern (Holocene) Reef: too shallow to survey

Aggregation Site

30 m Outlier reef

30 m ridge

36 m ridge

50 m Outlier reef

Shaded relief from bathymetry
Seabed type from echo shape

- Hardbottom (reef)
- Mixed rock/sediment
- Sediment

30 m & 36 m ridges

30 m Outlier

50 m Outlier

Distance along transect (m)

Depth (m)
What proportions of sites with ESA coral species are present in current zones?
Threatened Coral Species

Threatened coral species

- **Staghorn**
  - Present: +

- **Elkhorn**
  - Present: ○

- **Pillar**
  - Present: ▲

**Benthic Habitat Map**
- Red: Patch Reefs
- Orange: Linear Reef
- Brown: Hard Bottom
- Green: Seagrass
- Light Green: Seagrass
- Sand:
What proportion of sites with Threatened Staghorn corals are present in current zones?

Greatest colony densities and sizes in mid-channel & offshore patch reefs.
What proportion of sites with Threatened Staghorn corals are present in current zones?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>322</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>964</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>484</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>1770</strong></td>
</tr>
</tbody>
</table>
In 2012, nearly 80% of colonies were found in high-relief spur & groove reefs and offshore patch reefs. Coral density, size and occurrence were higher inside SPAs. 

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

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (＃)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>1,696</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>944</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>387</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>3027</strong></td>
</tr>
</tbody>
</table>

![Pie chart showing the proportion of sites with Elkhorn corals in current zones](chart.png)

- **56%**: SPAs, SUAs
- **31%**: NMFS & Pennekamp lobster management areas
- **13%**: Remaining FKNMS, oceanside

![Map of Elkhorn Coral Presence](map.png)

**Boundaries**
- FKNMS Boundary
- SPAs, SUAs
- Pennekamp
- Coral Formation Protection Areas
- NMFS Areas
- Closed to Lobster Trap Gear
- Ocean side (used for analysis)
What proportion of sites with Threatened Pillar corals are present in current zones?

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?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>13</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>10</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>29</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>52</strong></td>
</tr>
</tbody>
</table>

### Pillar Coral Presence

- **Present**: 25%
- **56%**: SPAs, SUAs
- **19%**: NMFS & Pennekamp lobster management areas
- **Remaining FKNMS, oceanside**

*Map: Data source: DEBCO, NOAA-NGDC, and others*
What proportions of sites with Candidate ESA coral species are in current zones?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>14</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>6</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>22</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

![Pie chart showing 53% SPAs, SUAs, 33% NMFS & Pennekamp lobster management areas, and 14% Remaining FKNMS, oceanside.]

![Candidate Coral Presence map showing boundaries and locations of candidate coral species.]

Legend:
- SPAs, SUAs
- NMFS & Pennekamp lobster management areas
- Remaining FKNMS, oceanside
Where are locations of resilient reefs?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>0.02</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>0.10</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>0.42</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>0.54</strong></td>
</tr>
</tbody>
</table>

Note: Area refers to specifically to reef area.

Diagram showing map of the Florida Keys with boundaries and percentages of resilient reefs.
Other ecosystem metrics

- Fish abundance
- Fish diversity
- Stony Coral cover
- Stony Coral diversity
- Soft Coral cover
- Soft Coral diversity
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%

High
75 – 100 %

Medium
25 – 75 %

Low
>0 – 24 %
Fish Metrics

- Fish abundance: How many fish?
- Fish diversity: How many species of fish?
Where are locations of high fish abundance?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>186</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp lobster management areas</td>
<td>29</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>132</td>
</tr>
<tr>
<td>Resource Total</td>
<td>347</td>
</tr>
</tbody>
</table>

- SPAs, SUAs: 38%
- NMFS & Pennekamp lobster management areas: 54%
- Remaining FKNMS, oceanside: 8%

![Fish Total Abundance (200m)](image)
Where are locations of high fish species richness?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>220</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>32</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>100</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>352</strong></td>
</tr>
</tbody>
</table>
Now we have info on fish abundance and species richness

Let’s look at them side by side
Fish Species Richness

Upper 1/3 of Upper Keys region

Fish Total Abundance
middle 1/3 of Upper Keys region
lower 1/3 of Upper Keys region
Hard Corals

- Stony Coral cover: How much of the hard bottom is covered in coral?
- Stony Coral diversity: How many species?
What are temporal trends in coral?

![Graph showing temporal trends in coral cover]

Source: FWC CREMP
Where are locations of high coral cover?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (♯)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>24</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>29</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>30</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>83</strong></td>
</tr>
</tbody>
</table>

Stony Coral Cover

- **Cover**
  - High

- **Boundaries**
  - FKNMS Boundary
  - SPAs, SUAs
  - Pennekamp Coral Formation Protection Areas
  - NMFS Areas Closed to Lobster Trap Gear

- Pie chart showing:
  - 36% SPAs, SUAs
  - 29% NMFS & Pennekamp Lobster management areas
  - 35% Remaining FKNMS, oceanside
Where are locations of high coral species richness?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>64</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>27</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>64</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>155</strong></td>
</tr>
</tbody>
</table>

**Species Richness**

- **High**

**Boundaries**
- FKNMS Boundary
- SPAs, SUAs
- Pennekamp Coral Formation Protection Areas
- NMFS Areas Closed to Lobster Trap Gear

**Pie Chart**

- SPAs, SUAs: 41%
- NMFS & Pennekamp Lobster management areas: 41%
- Remaining FKNMS, oceanside: 18%
Stony Coral Species Richness

Upper 1/3 of Upper Keys region
Stony Coral Species Richness

Species Richness (200)
- High
- Medium
- Low

Species Richness (1k)
- High

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

Stony Coral Cover

Middle 1/3 of Upper Keys region
Soft Coral

- Soft Coral cover: How much of the hard bottom is covered in soft coral?
- Soft Coral diversity: How many species?
Where are locations of high soft coral cover?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>26</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>19</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>20</td>
</tr>
<tr>
<td><strong>Resource Total</strong></td>
<td><strong>65</strong></td>
</tr>
</tbody>
</table>

![Map of Soft Coral Cover](image)

- **Cover**
  - High

- **Boundaries**
  - FKNMS Boundary
  - SPAs, SUAs
  - Pennekamp Coral Formation Protection Areas
  - NMFS Areas Closed to Lobster Trap Gear

- **Areas**
  - Carysfort SPA
  - Elbow SPA
  - Key Largo Dry Rocks SPA
  - Grecian Rocks SPA
Where are locations of high soft coral species richness?

<table>
<thead>
<tr>
<th>Management Zone</th>
<th>Locations (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPAs, SUAs</td>
<td>15</td>
</tr>
<tr>
<td>NMFS &amp; Pennekamp Lobster management areas</td>
<td>13</td>
</tr>
<tr>
<td>Remaining FKNMS, oceanside</td>
<td>34</td>
</tr>
<tr>
<td>Resource Total</td>
<td>62</td>
</tr>
</tbody>
</table>

**Soft Coral Species Richness**

- **Species Richness**
  - High

**Boundaries**
- FKNMS Boundary
- SPAs, SUAs
- Pennekamp Coral Formation Protection Areas
- NMFS Areas Closed to Lobster Trap Gear

- **Locations**
  - Carysfort SPA
  - Elbow SPA
  - Key Largo Dry Rocks SPA
  - Grecian Rocks SPA
Soft coral species richness

Species Richness (200)
- High
- Medium
- Low

Species Richness (1k)
- High

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

middle 1/3 of Upper Keys region
Soft coral species richness

**Species Richness (200)**
- High
- Medium
- Low

**Species Richness (1k)**
- High

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

**Soft Coral Cover**

**lower 1/3 of Upper Keys region**