

Integrating the newly mapped areas in the Tortugas Bank and Riley’s Hump with the Unified Reef Map:

The Unified Reef Map (URM) was developed to provide one continuous and seamless map for all existing benthic maps from Martin County to the Dry Tortugas. However, current benthic habitat maps do not extend beyond the 20 m depth contour. Beyond the extent of the original URM, NOAA’s National Centers for Coastal Ocean Science (NCCOS) produced seafloor maps of the previously unmapped portions of the Tortugas Ecological Reserves adjacent to Dry Tortugas National Park, specifically areas in Tortugas Bank and Riley’s Hump. NCCOS assembled an inventory of mapping data from hydrographic multibeam sonar surveys collected from 2004 to 2018 and mapped approximately 147 square nautical miles of habitat in both the Dry Tortugas Ecological Reserve North and South. The mapping efforts from NCCOS slightly overlap with the extent of the URM map at the site of the 2010 Dry Tortugas National Park Benthic Habitat Map, and any discrepancies in overlapping areas should be resolved either with ancillary or ground truth data to best integrate the newly mapped areas with the URM.

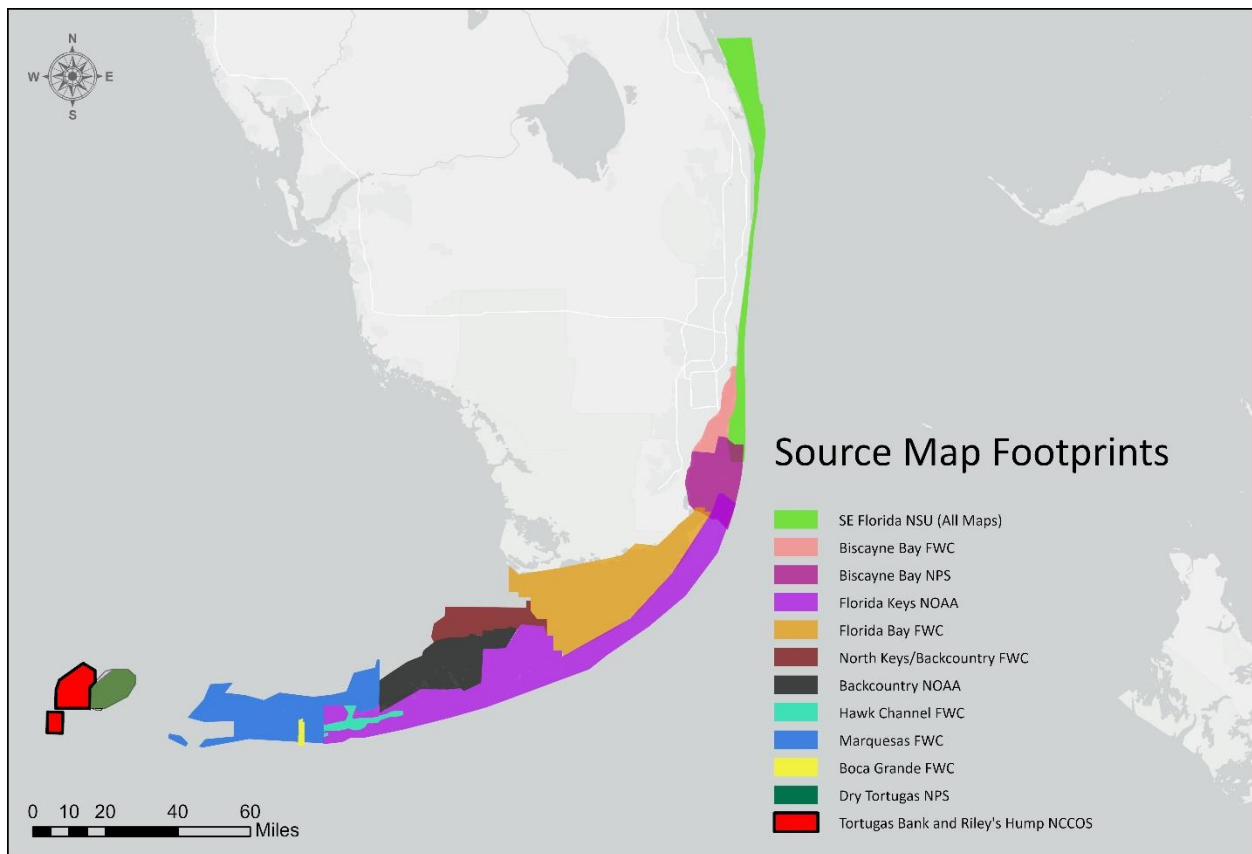


Figure 1: Map showing the footprints of mapped areas in the URM including the newly mapped areas: Tortugas Bank and Riley's Hump.

The overlapped areas make up just over 3 square nautical miles or approximately 2744 acres. Below is a map comparison analysis between the NCCOS and NPS overlapping maps. The total agreement between the overlapping areas is approximately 64.2%; it is important to note that the URM map did not classify any Pavement or Scattered Coral/Rock in Unconsolidated Sediment within the overlap area whereas the NCCOS map has both classes present in this area. The class with the least agreement was the individual or aggregated patch reef and the classes with the most agreement between both maps were Unconsolidated Sediment, followed by Aggregate Reef.

Table 1: Comparison analysis in the overlap area of the URM map and the newly mapped areas in Tortugas Bank and Riley's Hump

Map 1 \ Map 2		Map 1: NPS (ha)					NOAA/NCCOS Total Area (ha)	NOAA/NCCOS Agreement (%)
		Aggregate Reef	Individual or Aggregated Patch Reef	Scattered Coral/Rock in Unconsolidated Sediment	Unconsolidated Sediment	Pavement		
Map 2: NOAA/NCCOS (ha)	Aggregate Reef	256.4	52.1	0	25.4	0	333.9	76.8
	Individual or Aggregated Patch Reef	3.1	5.2	0	13.3	0	21.6	24.1
	Scattered Coral/Rock in Unconsolidated Sediment	52.8	23.1	0			161.2	0.0
	Unconsolidated Sediment	16	8.3	0	450.9	0	475.2	94.9
	Pavement	50.5	45.8	0	21.9	0	118.2	0.0
NPS Total Area (ha)		378.8	134.5	0	596.8	0	Total Agreement = 64.2%	
NPS Agreement (%)		67.7	3.9	0.0	75.6	0.0		

Below are maps showing the specific locations where classes agree and disagree between both maps (NPS Dry Tortugas and NCCOS newly mapped area) by specific class.

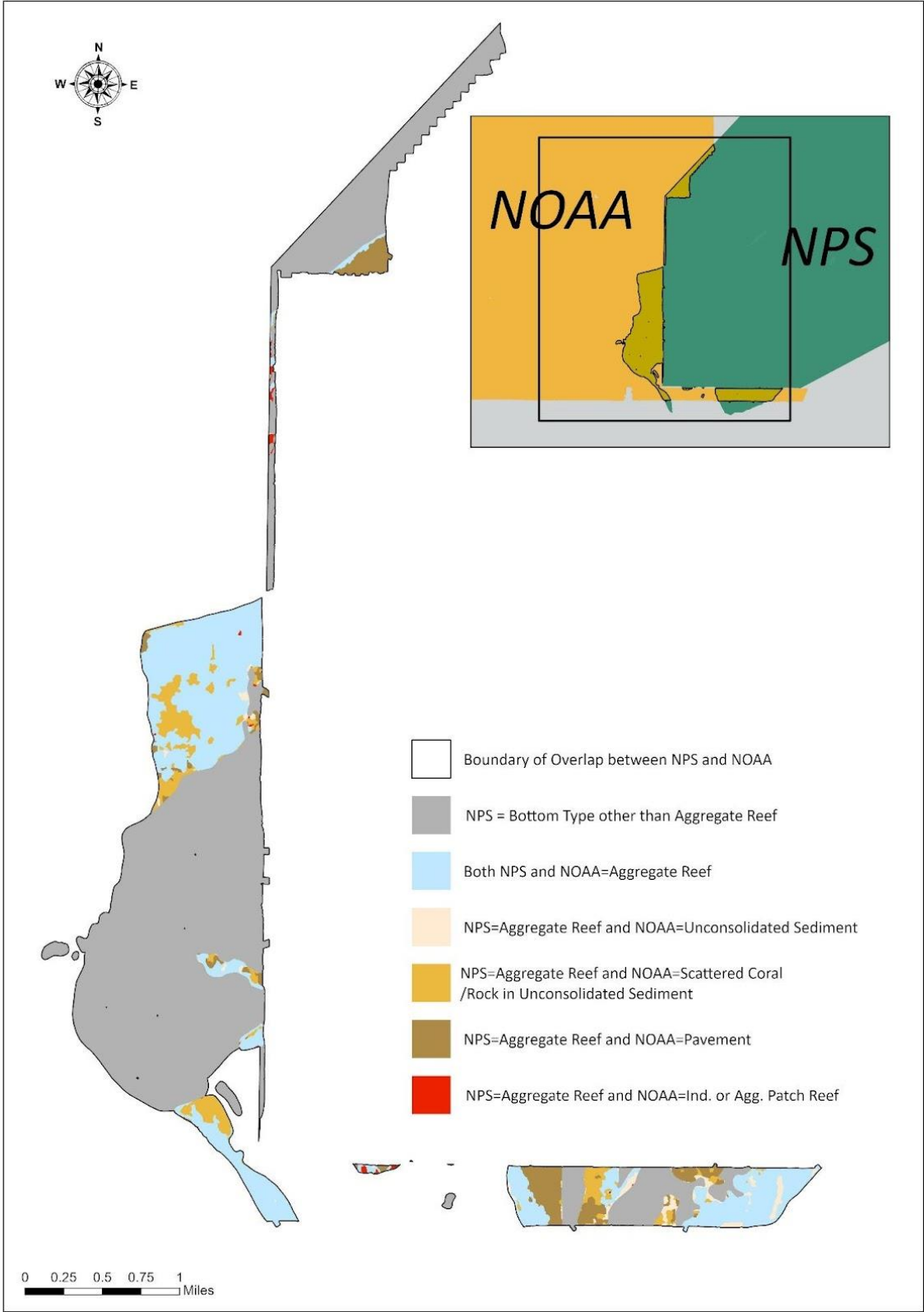


Figure 2: Map comparing the Aggregate Reef classification between the NPS benthic map and the NCCOS map.



Figure 3: Map comparing the Individual or Aggregate Patch Reef classification between the NPS benthic map and the NCCOS map.

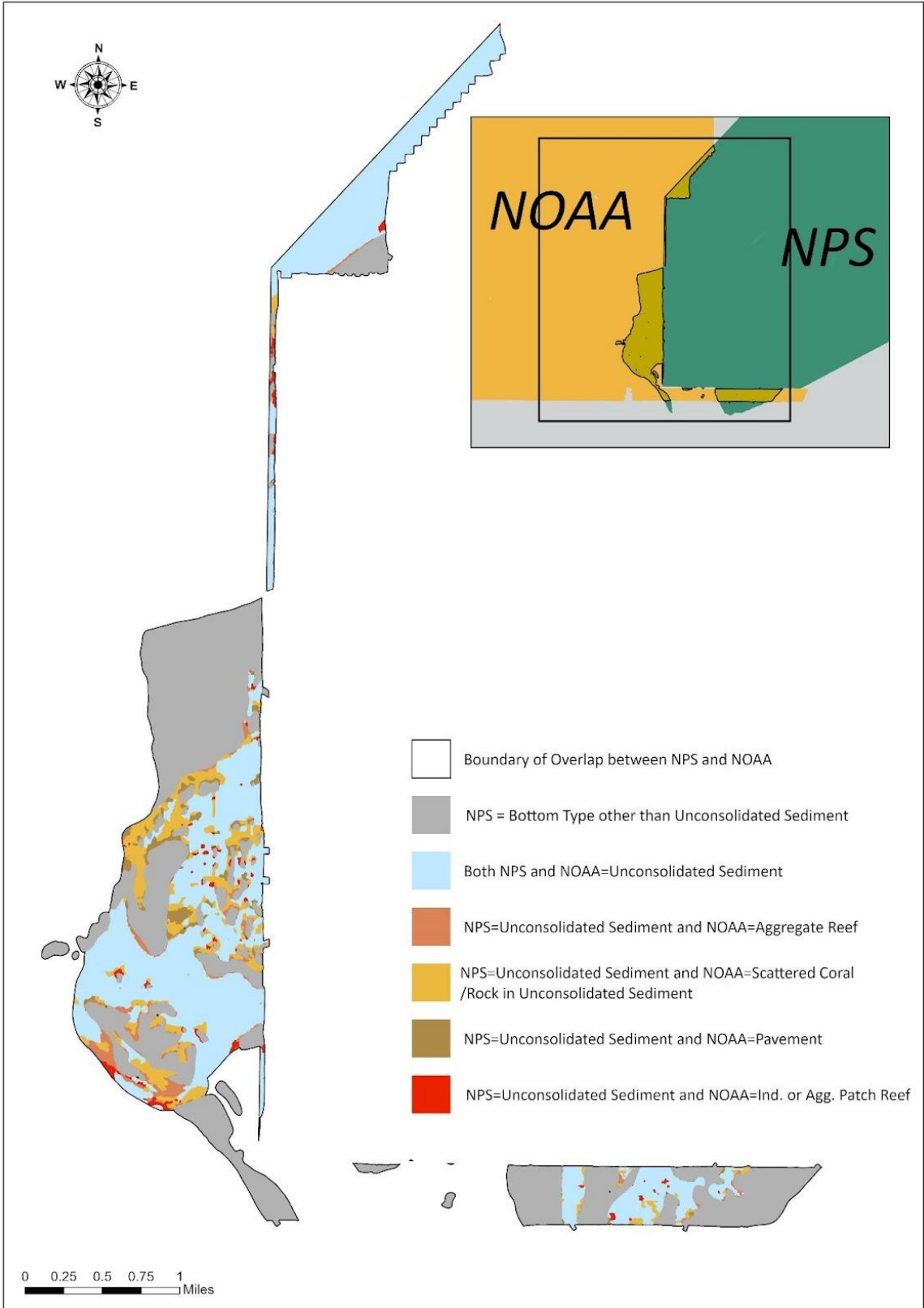


Figure 4: Map comparing the Unconsolidated Sediment classification between the NPS benthic map and the NCCOS map.

One of the main differences between both maps is how the benthic habitat was classified; the NPS Dry Tortugas map manually delineated features using high resolution aerial imagery, ground truth videos and pictures, as well as side scan sonar bathymetry. Whereas the NCCOS map was classified using a segmentation and classification software called eCognition, the scale of the digitization is not applicable for comparison since the authors used a different method. So far, none of the other maps that were integrated together for the URM used machine learning/object detection software, but specific standards and parameters used to run these tools may be something that should be added to future guidelines for the URM since these methods of classification are gaining in popularity. The classification was run on a 3 band Principal Component Analysis (PCA) of eight complexity surfaces (bathymetry mean, bathymetry stdev, curvature, curvature plan, curvature profile, rugosity, slope, and slope of slope). Below is a table detailing some of the differences between both maps:

Table 2: Methodology comparison in the overlap area of the URM map and the newly mapped areas in Tortugas Bank and Riley's Hump.

URM Name	Data provider	Source Imagery	MMU	Scale	Projection
Dry Tortugas (v2010)	NPS	NAIP, 2007 (1m) IKONOS, 2006 (4m) LiDAR, 2004 (1m) Side scan, 2008 (30cm)	~1 acre (?) and all discernible patch reefs	Not specified by data provider	URM projection: NAD_1983_Albers
Tortugas North and Riley's Hump/ <i>Tortugas Ecological Reserve North and South</i>	NOAA/NCCOS	Multibeam Bathymetry data (collected between 2004 and 2016) (2m) PCA derived from Multibeam Sonar	1 acre (p.c.)	Not applicable since features were not digitized	NAD 1983 UTM Zone 17N

		(bathymetry mean, bathymetry standard deviation, curvature, curvature plan, curvature profile, rugosity, slope and slope of slope) (2m)			
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One thing that machine learning classifiers do not always do well is differentiate between artifacts and on the ground features. Therefore, some obvious features that seemed to be a result of artifacts in the multibeam sonar data were changed to a more appropriate class (an example of this polygon is shown below). Dates the features were modified, types of modification and justification for changes are all noted in the attribute table in newly added fields.

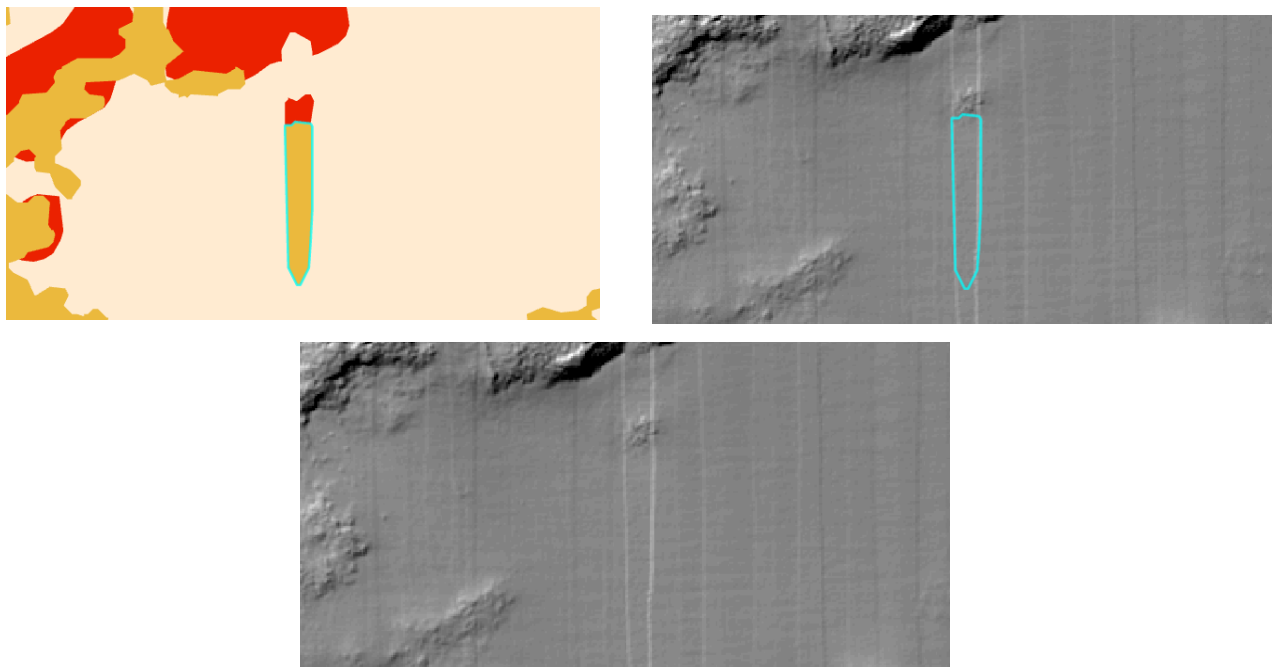


Figure 5: Example of feature that was most likely misclassified as “Scattered Coral/Rock in Unconsolidated Sediment” due to an artifact in the multibeam data. This polygon was changed to “Unconsolidated Sediment”.