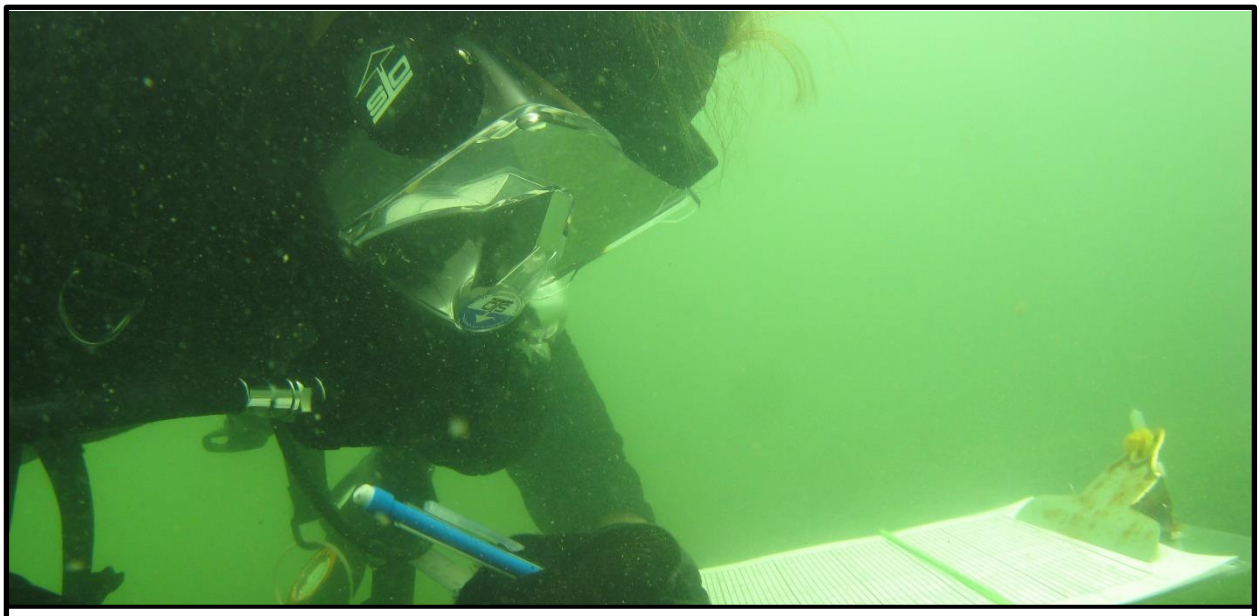
BENTHIC ASSESSMENT AND RESOURCE SURVEY ASSOCIATED WITH POTENTIAL ICWW CHANNEL DEEPENING DREDGE ACTIVITIES PALM BEACH COUNTY, FLORIDA

FINAL

26 October 2016



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1.0 INTRODUCTION

Pinnacle Ecological, Inc. (Pinnacle) was contracted by Florida Inland Navigation District (FIND) to conduct a benthic assessment and resource survey in support of permit requirements associated with potential channel deepening dredge activities in the Intracoastal Waterway (ICWW) and the Palm Beach Channel (also referred to as East Secondary Channel) through portions of Lake Worth Lagoon in Palm Beach County, Florida. **Figure 1** is an index for **Figures 2** and **3** which provide an overview of the survey area in Lake Worth Lagoon. The survey area included a primary area located along the ICWW starting south of Peanut Island and extending 7.7 kilometers (4.8 miles) south past Royal Park Bridge near downtown West Palm Beach, Florida. The secondary survey area included the Palm Beach Channel which parallels the west shoreline of Palm Beach Island from the Port of Palm Beach south 2,575 meters (1.6 miles) where it reconnects with the ICWW adjacent to the Rybovich Boat Yard and Superyacht Marina. Due to its overall length, the ICWW survey area was divided into separate northern and southern areas to better detail the differences observed in water quality and the presence and/or absence of resources occurring along the ICWW. The survey area included the federal channel and a 30.5-meter (100-foot) buffer area positioned on either side of the channel extending 30.5 meters (100 feet) from the navigational channel design template equilibrium top of slope (**Figure 4**). The objective of the benthic assessment and resource survey was to delineate and map benthic habitats in the survey area including seagrass and hardbottom habitats and to identify and quantify resources occurring in these habitats. Stony corals were identified and mapped on hardbottom habitats to determine their location relative to the ICWW channel and Palm Beach Channel, channel slope, and a minimum of 3.0 meters (10 feet) beyond the equilibrium top of slope. Additionally, Pinnacle's team of marine scientists conducted *in situ* identifications of marine flora and fauna observed during the benthic assessment survey with the intention of producing a comprehensive list of species observed during the field study. The benthic assessment survey identified benthic habitats and associated marine resources in vicinity of the proposed project which could be impacted by dredging and dredging related activities; including dredge pipeline placement, anchor placement, vessel operations, and/or excessive turbidity. The benthic assessment and resource surveys were conducted from 13 June through 8 July 2016 with additional field surveys conducted from 1 through 13 September 2016 specifically to further document the presence of stony corals in delineated hardbottom habitat. The following report provides a summary of survey and sampling methods used during field activities. Additionally, the report presents the survey results and a discussion of qualitative and quantitative observations collected during the benthic assessment and resource survey. Representative photos have been provided in the **ATTACHMENT**. Navigational data including shapefiles of mapped resources and copies of video and still photographic data collected during in-water surveys have been provided on separate digital media devices.

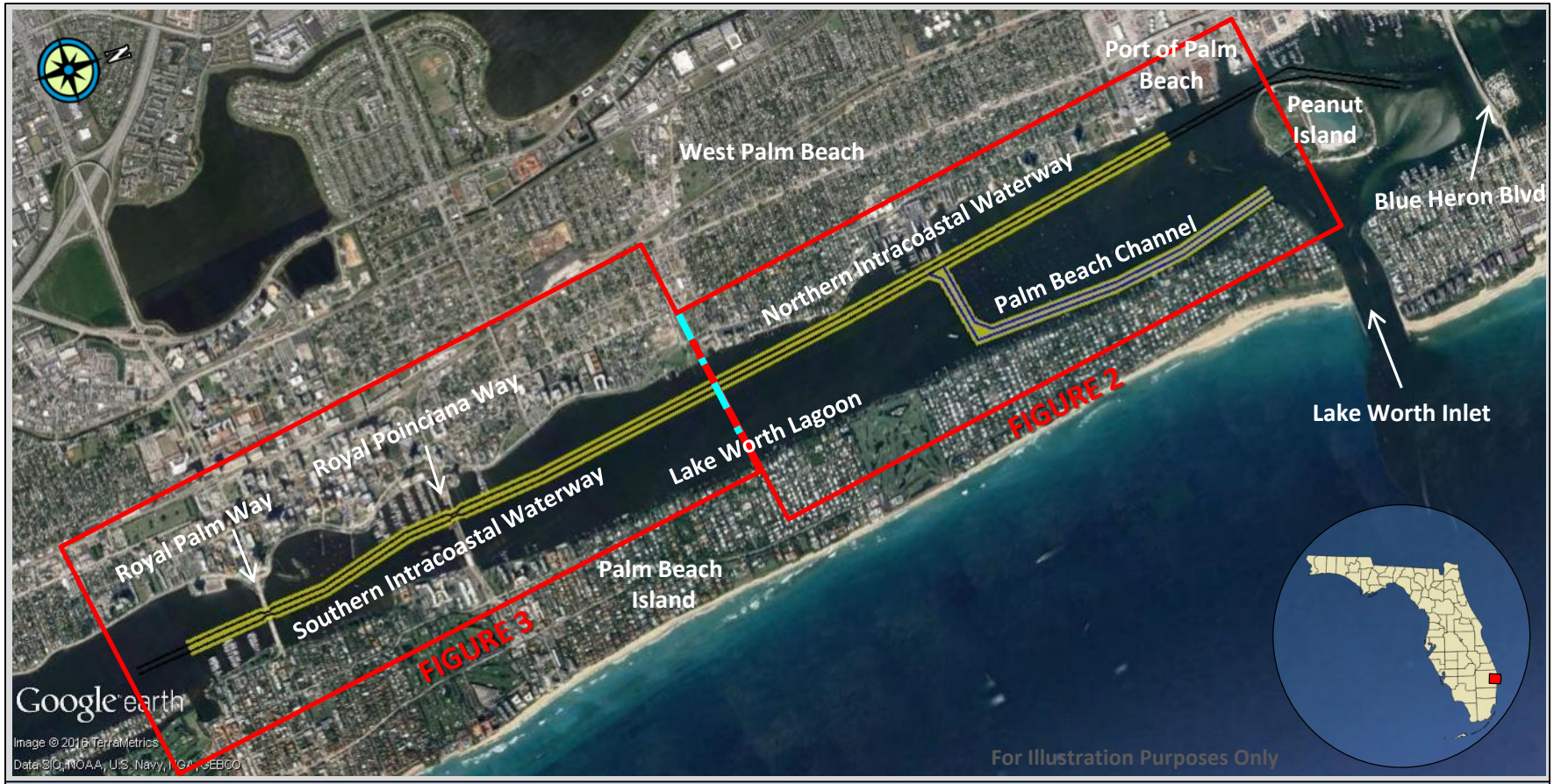

Figure 1 An index for figures showing the location of the survey area for the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

Figure 2 Location of the Palm Beach Channel and Northern ICWW survey areas for the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

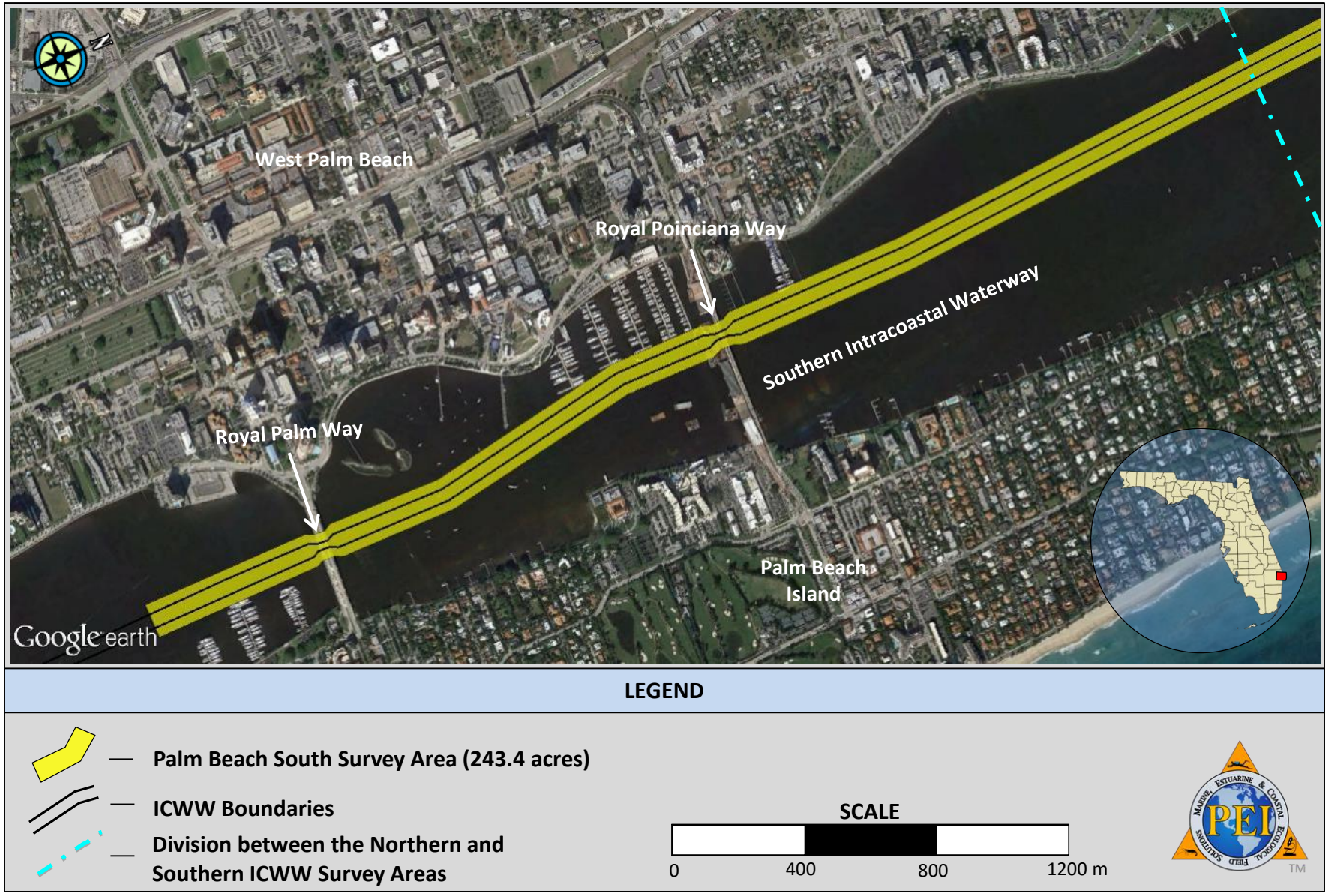

Figure 3 Location of the Southern ICWW survey area for the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

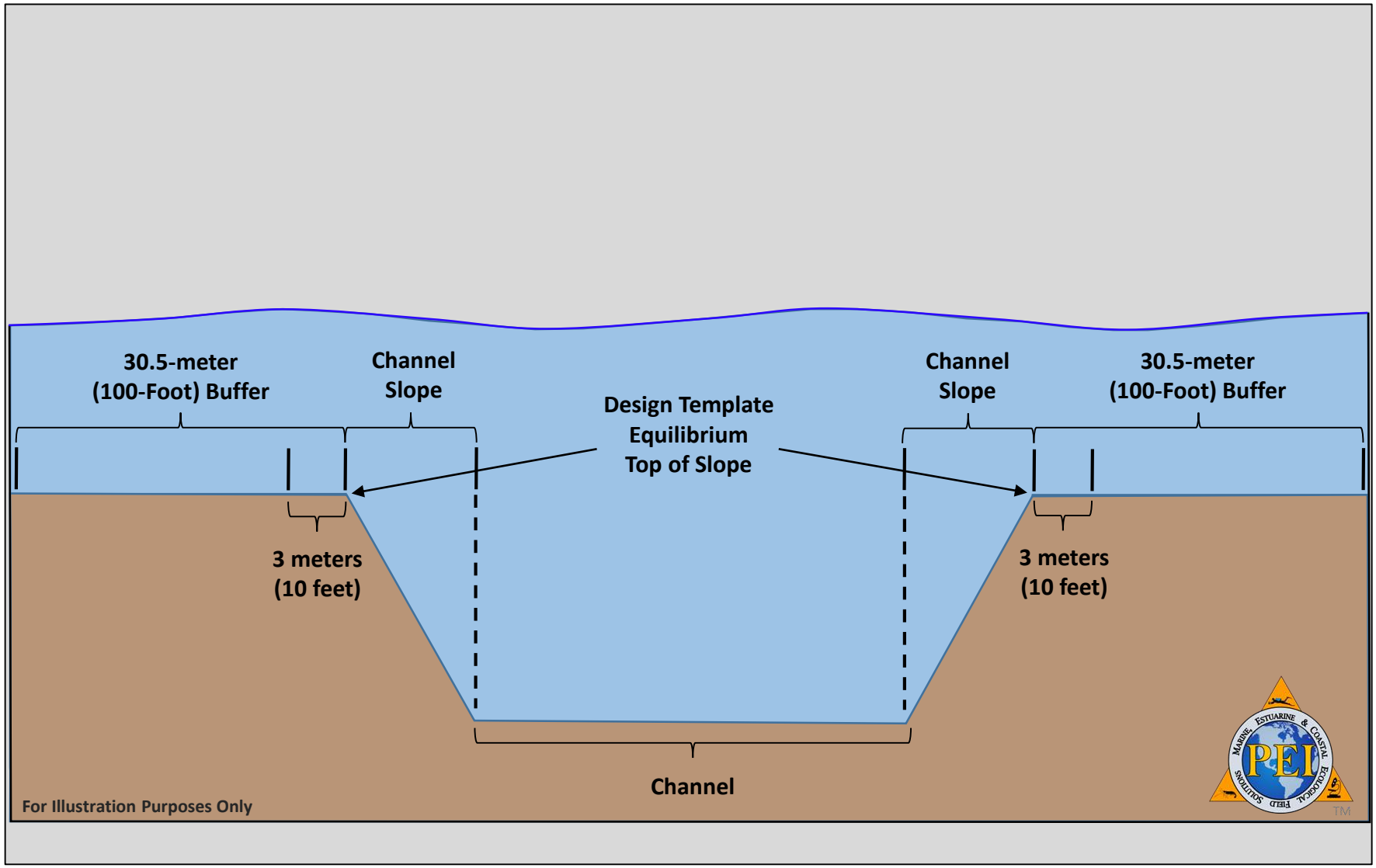

Figure 4. Representative diagram of the ICWW channel showing different channel features and areas adjacent to the channel covered during the benthic assessment survey.

2.0 BACKGROUND

Lake Worth Lagoon is an important estuarine resource in the coastal ecosystem of Palm Beach County and South Florida. Historically, Lake Worth Lagoon was a predominantly freshwater embayment with no permanent oceanic connections, except for seasonal and episodic events from periodic storm surge creating ephemeral inlets. In 1877, the first permanent and navigable inlet was created opening the Lagoon to the tidal influence of saline oceanic water. In 1910, the ICWW was extended from Lake Worth Lagoon to Biscayne Bay. Today, FIND and the United States Army Corp. of Engineers (USACE) are responsible for maintaining the Federal navigation channel (ICWW) between Jacksonville and Miami, Florida. After reviewing historical records, Paul DeMarco (USACE) (personal communication, 23 August 2016) reported that the ICWW in vicinity of FIND's potential channel deepening dredge project area located in Lake Worth Lagoon from the Port of Palm Beach south 7.7 kilometers (4.8 miles) past Royal Park Bridge near down town West Palm Beach, was dredged between 1961 and 1966. Additional maintenance dredging occurred near the north end of the project area within Cuts P-36 and P-37 in 1968 and 1988, respectively.

Seagrass communities play an important role in the marine ecosystems of Florida. The range of seagrass growth is limited by light availability, and typically occurs in water less than 10-15 meters (32.8-49.2 feet) in depth (Zieman, 1982). Seven species of seagrass have been identified in Lake Worth Lagoon, including shoal grass (*Halodule wrightii*), turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*) (Yarbro and Carlson, 2011). Three of these species; shoal grass (*H. wrightii*), paddle grass (*H. decipiens*), and Johnson's seagrass (*H. johnsonii*) were found in a previous survey located in the vicinity of the proposed dredging area (Scheda and Pinnacle, 2012). Seagrasses are sensitive to environmental changes including decreases in light availability and dredging of sandy and muddy bottoms (Fourqurean et al., 2001). Seagrasses serve as essential habitat supporting diverse assemblages of recreational and commercially important fishes and invertebrates. They also provide habitat for the Florida manatee (*Trichechus manatus*), which is federally listed as an endangered species under the Endangered Species Act (ESA) and has been reported to occur in vicinity of the project area.

The Magnuson-Stephens Fishery Conservation and Management Act (MSFCMA) defines Essential Fish Habitat (EFH) as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." This includes substrate such as sediments supporting seagrass habitat, rock rubble and hardbottom with associated biological communities (National Marine Fisheries Service (NMFS), 1999). Conservation of EFH is essential to support local fish populations that utilize these areas throughout their life history. Hardbottom communities are made up of epibenthic fauna on exposed areas of rock or consolidated sediments. Areas of hardbottom can be found throughout coastal Florida. Communities are generally characterized by a combination of algae, sponges, octocorals, and stony corals. Hardbottom is used by a variety of fishes, sea turtles, and other species of special concern. Risks to hardbottom habitat include sediment accretion and damage from vessel groundings and anchors. Other environmental impacts to habitats and marine resources occurring in Lake Worth Lagoon include storm water drainage, pollution, dredging, shoreline alteration, and shoreline development.

3.0 TECHNICAL APPROACH

3.1 Survey Area

The survey area included a primary area located along the ICWW starting south of Peanut Island and extending 7.7 kilometers (4.8 miles) south past Royal Park Bridge near downtown West Palm Beach, Florida (**Figures 1**, **2** and **3**). The secondary survey area included the Palm Beach Channel which parallels the west shoreline of Palm Beach Island from the Port of Palm Beach south 2,575 meters (1.6 miles) where it reconnects with the ICWW adjacent to the Rybovich Boat Yard and Superyacht Marina. Due to its overall length, the ICWW survey area was divided into separate northern and southern areas to better detail the differences observed in water quality and the presence and/or absence of resources occurring along the ICWW. The survey area covered the navigation channel and channel slope with 30.5-meter (100-foot) buffer areas positioned on either side of the channel (**Figure 4**). A total of 985,158 meters^2 (243.4 acres) of benthic habitat was surveyed during the study. Pinnacle delineated and mapped seagrass and hardbottom habitats and quantified marine resources associated with each habitat. Stony corals were identified and mapped on hardbottom habitats to determine their location relative to the ICWW channel or Palm Beach Channel, channel slope, and a minimum distance of 3.0 meters (10 feet) beyond the equilibrium top of slope. Occasionally habitats and associated resources delineated in the survey area also extended across the survey area boundary. These habitats were mapped and characterized to provide as complete assessment of the habitat and associated resources as possible. When possible, field surveys were scheduled during high tide events to take advantage of clearer water and improved visibility. Periodically, conditions of low underwater visibility occurred in portions of the survey area. Precautions were exercised to avoid disturbing the silty/sand sediment in certain areas to prevent suspension of fine sediments causing increased turbidity and further reducing underwater visibility. Areas where conditions of low underwater visibility precluded safe diving operations or impaired the diver's ability to identify seagrass and hardbottom resources were revisited during periods of high tide with better visibility to complete the assessment survey in those areas.

3.2 Survey Methods

Pinnacle followed guidelines set forth by the NMFS (Karazsia, 2010 and NMFS, 2002), USACE, the Florida Department of Environmental Protection (FDEP) (Kosmynin et al., 2016), and the Florida Fish and Wildlife Conservation Commission (FWC) (FWC, 2011) for benthic assessments and seagrass surveys. The survey was conducted during seagrass growing season (i.e., June 1st through September 30th, Karazsia, 2010 and April 1st through August 31st, FWC, 2011). The benthic assessment was conducted by a survey team consisting of scientific divers with experience conducting resource assessments of habitats similar to those found in Lake Worth Lagoon. The survey was approached in two phases in accordance with recommendations by the NMFS (2002) recovery plan for Johnson's Seagrass. During Phase I, Pinnacle's scientific dive team conducted a thorough visual assessment of the survey area providing comprehensive coverage of the proposed project area to accurately delineate existing seagrass and hardbottom habitat boundaries. Phase II involved detailed qualitative and quantitative sampling of marine resources occurring in areas previously identified as seagrass and hardbottom habitat.

3.2.1 Phase I

Habitat and Resource Mapping

The first phase started with an initial reconnaissance of the survey area to identify and delineate existing marine resources including seagrass and hardbottom habitat. The survey area included the proposed dredging area and a 30.5-meter (100-foot) buffer area adjacent to each side of the channel. Pinnacle plotted a series of track-lines to ensure that the benthic assessment survey would provide comprehensive coverage of the survey area. Track-lines were aligned parallel to the ICWW or Palm Beach Channel and designed with 14 to 30.5-meter (46 to 100-foot) line spacing. **Figure 5** is an index for **Figures 6** and **7** which provide an overview of the track-lines used to conduct the delineation and mapping survey. Line-spacing between track-lines allowed for full visual coverage of benthic resources in most areas with adequate underwater visibility. Additional track-lines were added in areas where seagrass and hardbottom habitat was observed more frequently and in areas with low underwater visibility. Seven track-lines with 14 to 18-meters (46 to 59-foot) line spacing were utilized to survey the northwest portion of the survey area to more accurately delineate and map marine resources. This approach provided adequate coverage to identify and delineate marine resources in the proposed dredging area and surrounding 30.5-meter (100-foot) buffer area. The total area surveyed was over 985,158 meters^2 (243.4 acres).

The resource delineation and mapping surveys were conducted by employing a modified line-intercept method. The survey was implemented by towing a scientific diver experienced at identifying seagrasses, particularly *Halophila* spp., under similar conditions, along each survey track-line. Divers were towed at speeds of 0.26 to 0.52 meters/second (0.5 to 1.0 knot) to provide maximum opportunity for divers to accurately identify and report the occurrence of marine resources. While traversing the survey area scientific divers wore full-faced masks equipped with wireless underwater telecommunications, which allowed the diver to report real-time observations and the occurrence of marine resources to surface support personnel. The scientific diver towed a surface buoy equipped with a Differential Global Positioning System (DGPS) navigation receiver antenna. The diver towed DGPS antenna provided an accurate and continual position of the diver throughout the survey. Divers reported observations to a team of surface support scientists who would record the location of observations to delineate habitat boundaries or mark areas for further investigation. Detailed navigational positions were recorded to document habitat boundaries observed along each survey track-line. Navigational positions were collected in Datum WGS-1984 with units of measure in US feet. Delineated habitats occurring adjacent to one another, but on separate track-lines were extrapolated and mapped as a contiguous habitat as long as the same species and environmental conditions were present at each location. Additional survey track-lines were added in some areas to provide more detail regarding the boundaries of specific habitats.

Additional information recorded from diver observations included descriptions of substrate, water depth, water temperature, underwater visibility and general water quality, and the general health of marine resources. Scientific divers reported all occurrences of seagrass and hardbottom habitats. In areas delineated as seagrass habitat, divers reported the species present, depth, relative abundance, and general health, when possible. When hardbottom habitat was encountered during the delineation survey the towed scientific diver further classified the habitat as hardbottom outcrop, emergent rock, scattered rock with sand, or isolated rock. Biota observed colonizing hardbottom habitat was identified to the lowest practical level. Representative habitats occurring in distinctly different substrate and/or water quality conditions were surveyed in more detail during Phase II of the field effort.

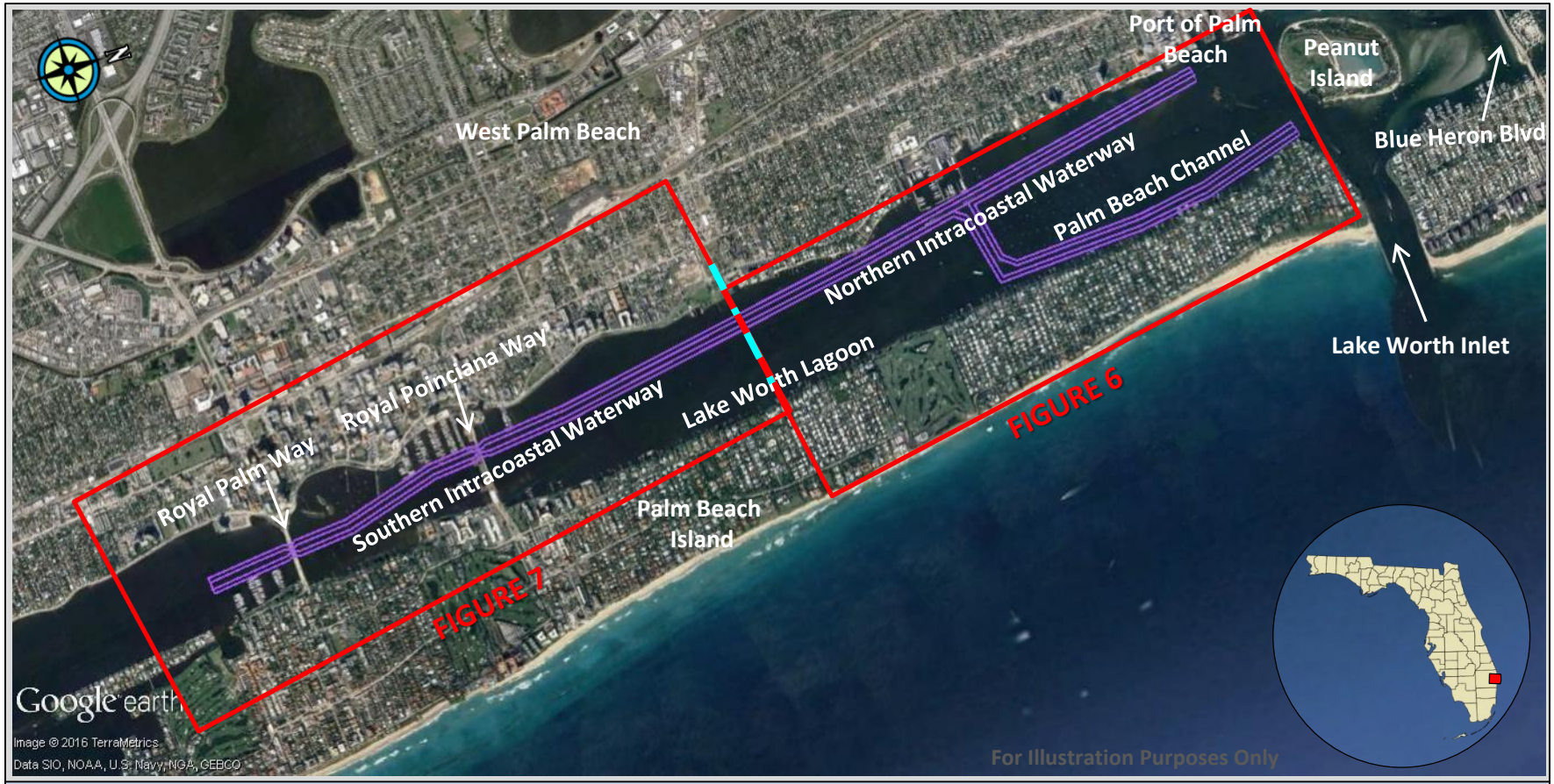

Figure 5 An index for figures showing the towed diver track-lines for the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

Figure 6 Towed diver track-lines for the Palm Beach Channel and Northern ICWW survey areas of the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

LEGEND

— **Towed Diver Track-Lines**

— **Division between the Northern and Southern ICWW Survey Areas**

SCALE

0 400 800 1200 m

Figure 7 Towed diver track-lines for the Southern ICWW survey area of the Palm Beach South benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

3.2.2 Phase II

Quantitative Data Collection

The second phase was used to determine the percent cover, density (shoots/meter^2), and frequency of occurrence for seagrass and other marine resources using quantitative sampling methods. Quantitative data was collected along modified belt-transects deployed at sampling stations distributed across seagrass and hardbottom habitats previously delineated during Phase I. Specific sample quadrats were used during quantitative data collection in seagrass and hardbottom habitats. Quadrat sampling station locations were determined using a stratified random sampling design. Previously mapped seagrass and hardbottom habitats were stratified into seven (7) equally sized areas with a randomly selected sample station location positioned within each stratified area. A power of analysis was performed to determine the number of transects and quadrats sampled at each station necessary to sufficiently establish percent cover, density, and frequency of occurrence for marine resources occurring in seagrass and hardbottom habitats throughout the survey area.

Seagrass

At seagrass habitat locations modified belt-transects were conducted *in situ* by a scientific diver equipped with a 1.0-meter^2 (10.8-feet^2) quadrat. **Figure 8** provides an overview of a representative seagrass sample station. Two modified belt-transects, each consisting of a reel tape extending to 10 meters (32.8 feet), were deployed at each sample station location. Scientific dive teams deployed sample quadrats along each transect collecting percent cover, density, and frequency of occurrence data. A total of fourteen (14) transects were sampled with a total cover of 1.0 % of specific seagrass habitats observed during Phase I. Frequency of occurrence data was collected by recording the total number of 10 x 10-centimeter (3.9 x 3.9-inch) sub-cells containing seagrass within each 1.0-meter^2 (10.8-feet^2) quadrat. Scientific divers also collected species composition, shoot density (shoots/meter^2) and blade length while noting the presence of flowering and general health of seagrasses. Shoot density (shoots/meter^2) was collected from multiple randomly selected 10 x 10-centimeter (3.9 x 3.9-inch) sub-cells within each 1.0-meter^2 (10.8-feet^2) quadrat. Percent cover data for marine resources including seagrasses, macroalgae, corals, and sponges was recorded using the Braun-Blanquet scale of abundance (Braun-Blanquet, 1932; Fourqurean et al., 2001; Kenworthy and Schwarzchild, 1998). The percent cover values were based on the Braun-Blanquet (1932) scale of abundance: 0.0 = not present; 0.1 = solitary specimen; 0.5 = few with small cover; 1.0 = numerous but less than 5% cover; 2.0 = 5-25% cover; 3.0 = 25-50% cover; 4.0 = 50-75% cover; and 5.0 = 75-100% cover. In order to determine the percent cover per individual species, as well as total seagrass cover, the Braun-Blanquet scores by species and total cover were averaged for all the quadrats assessed. The scores were calculated based on an interpolation of the mid-point from the percentage ranges defined above. The scores were used to estimate biotic cover and general conditions of the seagrass habitat in the survey area.

Hardbottom

Dive teams collected quantitative still photographs along a 20 to 24-meter (65.6 to 78.7-feet) modified belt-transect. The camera was mounted on a framer at a fixed height of 40 centimeters (15.7 inches) above a 0.25-meter^2 (2.7-feet^2) quadrat. Data were collected along seven (7) 20 to 24-meter (65.6 to 78.7-feet) transects positioned at seven (7) randomly selected hardbottom sample stations. Non-overlapping photos were collected along the entire length of each transect.

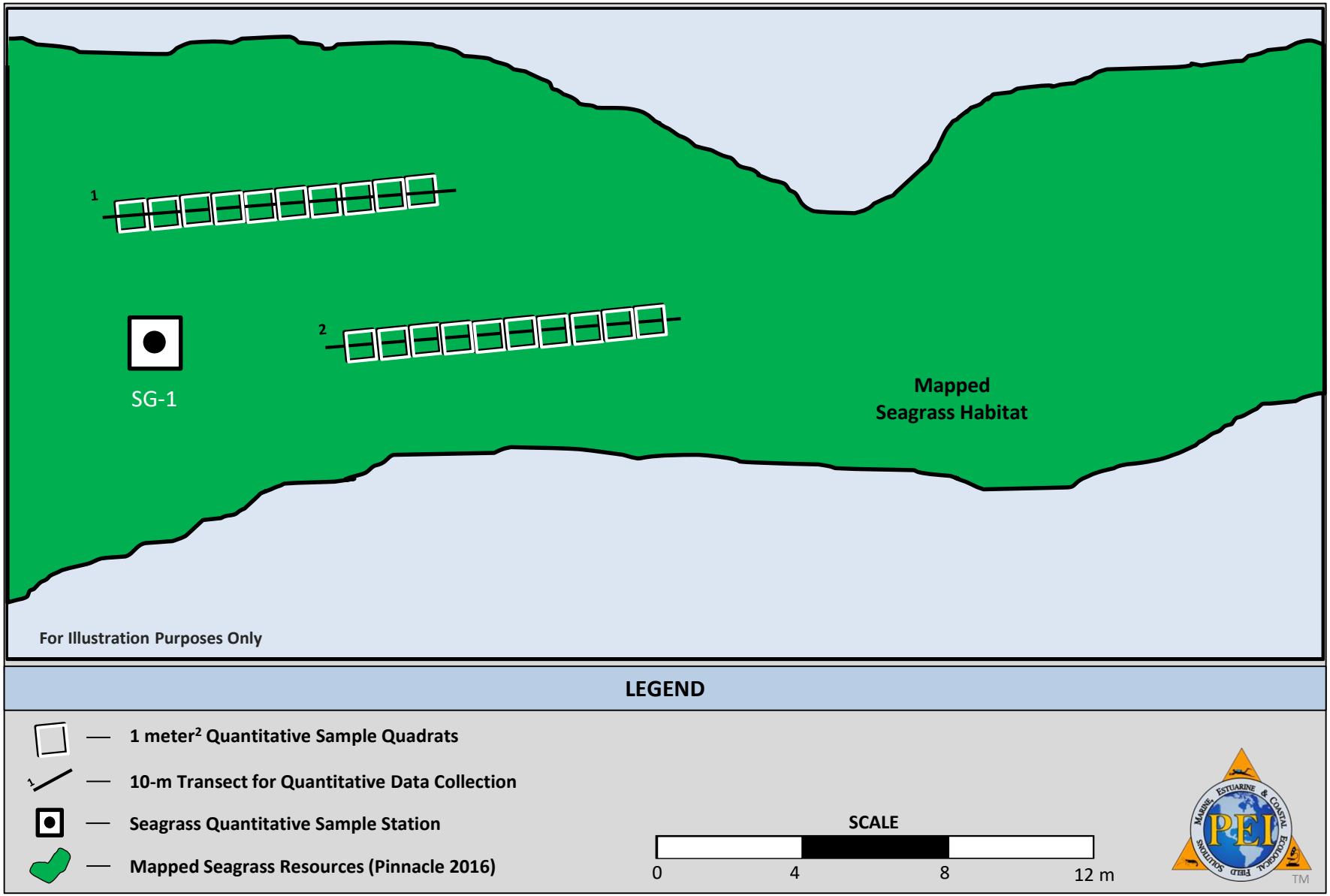

Figure 8. Representative seagrass sample station located in mapped seagrass habitat. Sample quadrats were deployed along each transect collecting percent cover, density and frequency of occurrence data.

Still photographic data were analyzed to determine percent cover of benthic resources in hardbottom habitat. Percent cover was estimated using random point count software and included stony corals, soft corals, macroalgae, sponges, seagrass, and other biota. Quantitative still photographic data were analyzed using Coral Point Count with Excel (CPCe) software version 4.1 (Kohler and Gill, 2006). The CPCe software was originally based on the random point method described by Bohnsack (1979) for accurately estimating percent coverage of benthic organisms and associated substrate from digital underwater images. A minimum of 40 non-overlapping still images were analyzed for each hardbottom sample station. The video frames were analyzed using 50 randomly generated points superimposed over each image. The biota or substrate beneath each point was identified to the lowest practical level, and data from the photo quadrats were incorporated into transect specific spreadsheets. Percent cover calculations were then made for biota identified along each transect.

Additional data collected included the identification, location, and size of stony corals observed within hardbottom habitats delineated in survey areas including, but not limited to, the ICWW or Palm Beach Channels, channel slope, and a minimum distance of 3.0 meters (10 feet) beyond the equilibrium top of slope. Stony corals were mapped using a modified wish-bone mapping method (Hudson and Goodwin, 2001).

3.2.3 Qualitative Data Collection

Scientists conducted *in situ* identifications of biota observed during the benthic assessment survey. Representative still photographs and/or video were collected to document environmental conditions, substrate, and dominant biota observed in seagrass and hardbottom habitats occurring in the survey area. Photographs and video data collected during the field survey were also used to support identification of biota observed during the survey including stony corals, octocorals, macroalgae, sponges, and fishes. Sightings and encounters of species of special concern including marine mammals and sea turtles were documented during field activities. Additional data collected included species identification, location of sighting or encounter, size of animal and estimate of whether juvenile or adult, observed activity at the time of sighting, and direction of travel if determined.

4.0 RESULTS AND DISCUSSION

4.1 Habitat and Resource Mapping

Phase I of the benthic assessment survey was conducted to provide a general description of the proposed project area, delineate and map the presence of seagrass and hardbottom habitats, and identify associated marine resources in Lake Worth Lagoon. Classified as a Class III (M) body of water by FDEP, Lake Worth Lagoon can be described as an urban marine landscape with frequent commercial and recreational vessel traffic, commercial marinas, and private docks visible along the shoreline. Survey areas included the ICWW and the Palm Beach Channel, the channel slope, and 30.5-meter (100-foot) buffer areas positioned on either side of each channel.

The predominant substrates observed during the survey included sand, sand and shell, and silty-sand. Sand, coarse sand, and shell substrates were observed most frequently on the north end of the survey area closer to the port and inlet, in narrow areas of Lake Worth Lagoon and near bridges. Strong water currents resulting from tidal flow were encountered in narrow areas of Lake Worth Lagoon and near bridges. Dive teams reported observations of sand waves on the sediment surface in these areas which can be indicative of strong current conditions. Silty sediments were more commonly observed in wider and deeper areas of Lake Worth Lagoon where water currents were slower, allowing more deposition of finer sediments. Scientific dive teams exercised considerable care during survey operations in an effort to avoid disturbing bottom sediments in areas with more silt deposition to reduce resuspension of fine sediments and to preserve visibility. Underwater visibility during the field survey fluctuated with tide cycles, but ranged from 0.6 to 12.2 meters (2.0 to 40.0 feet). Visibility was better on the north end of the survey area near the inlet and during flood-tide conditions.

4.1.1 ICWW

The survey along the ICWW started south of Peanut Island and extended 7.7 kilometers (4.8 miles) south past Royal Park Bridge near downtown West Palm Beach, Florida. Due to its overall length, the ICWW survey area was divided into separate northern and southern areas to better detail the differences observed in water quality and the presence and/or absence of resources occurring along the ICWW. The Northern ICWW was 339,755 meters^2 (83.9 acres) of which 39% (131,253 meters^2 (32.4 acres)) occurred within the channel and channel slope and 61% (208,502 meters^2 (51.5 acres)) occurred within the 30.5-meter (100-foot) buffer area. The total area surveyed along the Southern ICWW was 384,708 meters^2 (95.1 acres) of which 39% (148,808 meters^2 (36.8 acres)) occurred within the channel and channel slope and 61% (235,900 meters^2 (58.3 acres)) occurred within the 30.5-meter (100-foot) buffer area. Water depths encountered during the assessment and mapping survey in the ICWW ranged from 0.8 to 6.7 meters (2.7 to 22.0 feet) with an average depth of 2.7 meters (8.9 feet).

Seagrass

Seagrass habitat was delineated in the Northern ICWW survey area. **Table 1** provides a list of delineated habitat classifications and the total area for each habitat. **Figure 8** is an index for **Figures 9** through **13** which provide maps of the habitats and marine resources delineated in the survey area along the ICWW. Although seagrasses were occasionally observed outside the survey area boundaries, no seagrass was identified within the Southern ICWW survey area. The absence of seagrass from the Southern ICWW survey area may be due to low water quality, limited light availability and/or freshwater runoff. Seagrass (97,989.3 meters^2 (24.2 acres)) was the most common habitat delineated along the Northern ICWW with

Table 1. Delineated habitat classifications and habitat area documented along the ICWW and Palm Beach Channel in Lake Worth Lagoon, Palm Beach County, Florida. Note: No seagrass was observed within the boundaries of the Southern ICWW survey area.

Northern ICWW Habitat Classifications		Area Within Channel ŧ		Area Within 100-ft Buffer		Total Delineated Area	
		meter^2	acres	meter^2	acres	meter^2	acres
Seagrass	*H. decipiens*	30,915.1	7.6	49,330.8	12.2	80,245.9	19.8
	H. johnsonii	-	-	2,128.0	0.5	2,128.0	0.5
	H. decipiens and *H. johnsonii*	1,546.5	0.4	9,704.9	2.4	11,251.4	2.8
	H. decipiens and *H. wrightii*	-	-	1,366.0	0.3	1,366.0	0.3
	H. decipiens, *H. johnsonii*, and *H. wrightii*	-	-	2,998.0	0.7	2,998.0	0.7
	Totals	32,461.6	8.0	65,527.7	16.2	97,989.3	24.2
Hardbottom	Emergent Rock Rubble w/Sand	2,595.8	0.6	3,434.2	0.9	6,030.0	1.5
	Hardbottom Outcrop w/ Scattered Rock	328.0	0.1	659.0	0.2	2,131.0*	0.5
	Hardbottom Ledge Habitat	395.0	0.1	292.0	0.1	687.0	0.2
	Totals	3,318.8	0.8	4,385.2	1.1	8,848.0	2.2
Southern ICWW Habitat Classifications		Area Within Channel ŧ		Area Within 100-ft Buffer		Total Delineated Area	
		meter^2	acres	meter^2	acres	meter^2	acres
Hardbottom	Emergent Rock Rubble w/Sand	4,890.0	1.2	1,645.0	0.4	6,535.0	1.6
	Hardbottom Outcrop w/ Scattered Rock	-	-	57.7	0.01	57.7	0.01
	Totals	4,890.0	1.2	1,702.7	0.4	6,592.7	1.6
Palm Beach Channel Habitat Classifications		Area Within Channel ŧ		Area Within 100-ft Buffer		Total Delineated Area	
		meter^2	acres	meter^2	acres	meter^2	acres
Seagrass	*H. decipiens*	12,048.7	3.0	33,475.9	8.3	45,524.6	11.2
	Totals	12,048.7	3.0	33,475.9	8.3	45,524.6	11.2
Hardbottom	Emergent Rock Rubble w/Sand	10,729.0	2.7	4,788.5	1.2	15,517.5	3.8
	Hardbottom Outcrop w/ Scattered Rock	44.0	0.01	1,428.0	0.4	1,688.0	0.42
	Hardbottom Ledge Habitat	-	-	368.0	0.09	368.0**	0.09
	Totals	10,773.0	2.7	6,584.5	1.6	17,573.5	4.3

* = Total delineated area includes 1,144 meters^2 (0.3 acres) delineated outside the survey area boundaries.
** = Total delineated area includes 216 meters^2 (0.1 acres) delineated outside the survey area boundaries.
ŧ = Channel refers to channel with slope.

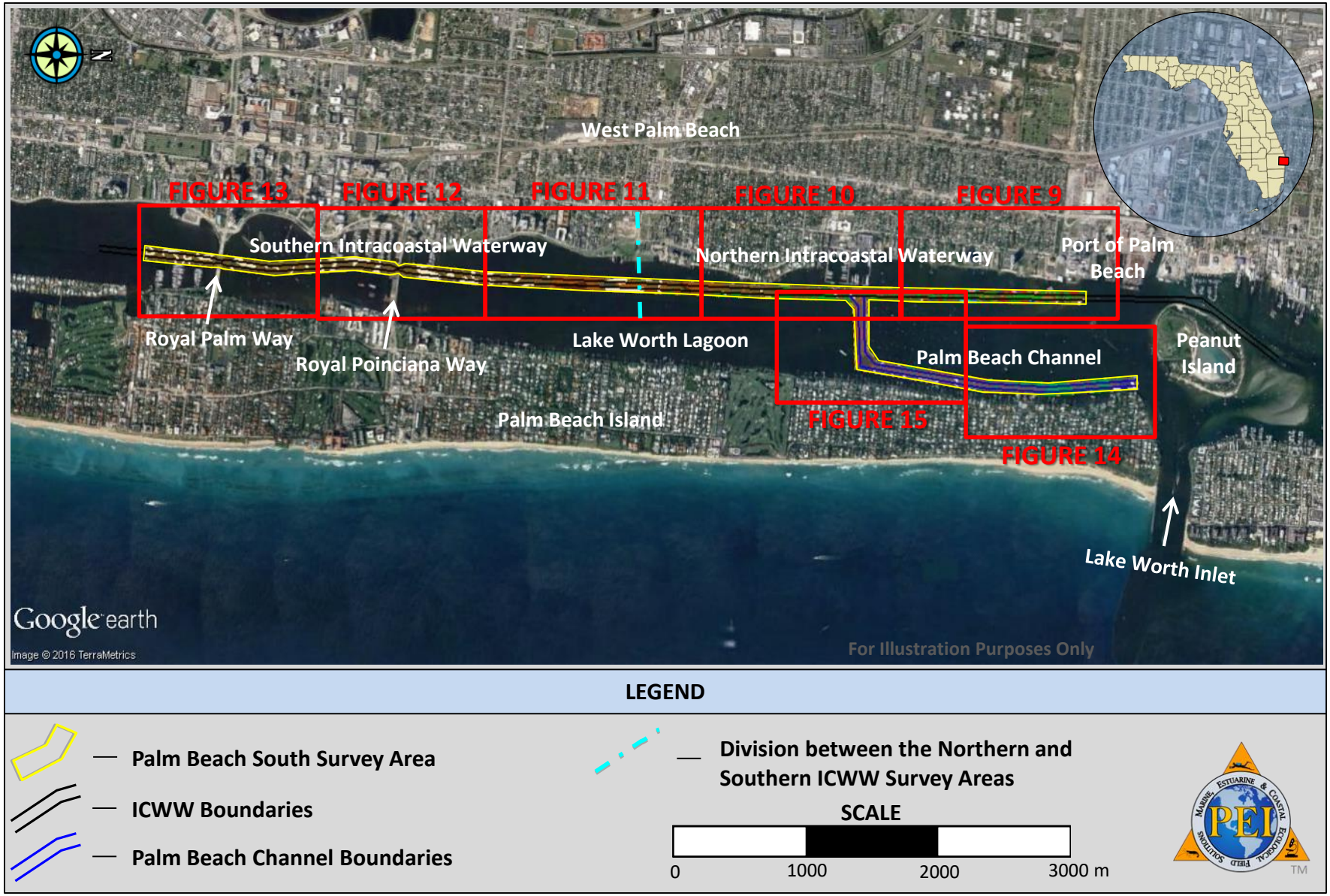

Figure 9 An index for figures showing the habitat and substrate types mapped during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

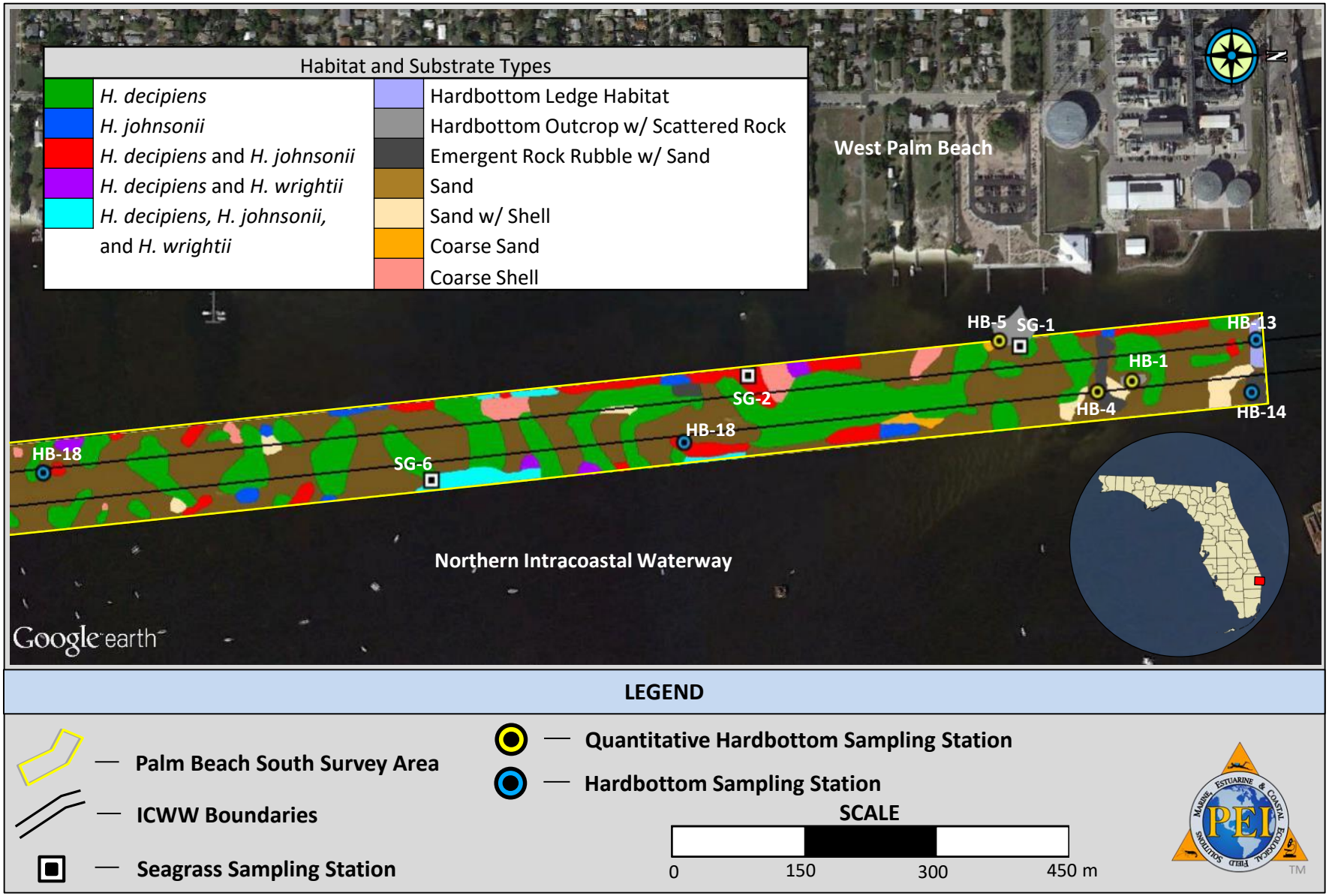

Figure 10 Seagrasses, hardbottom habitat, and substrate types mapped in the Northern ICWW survey area during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

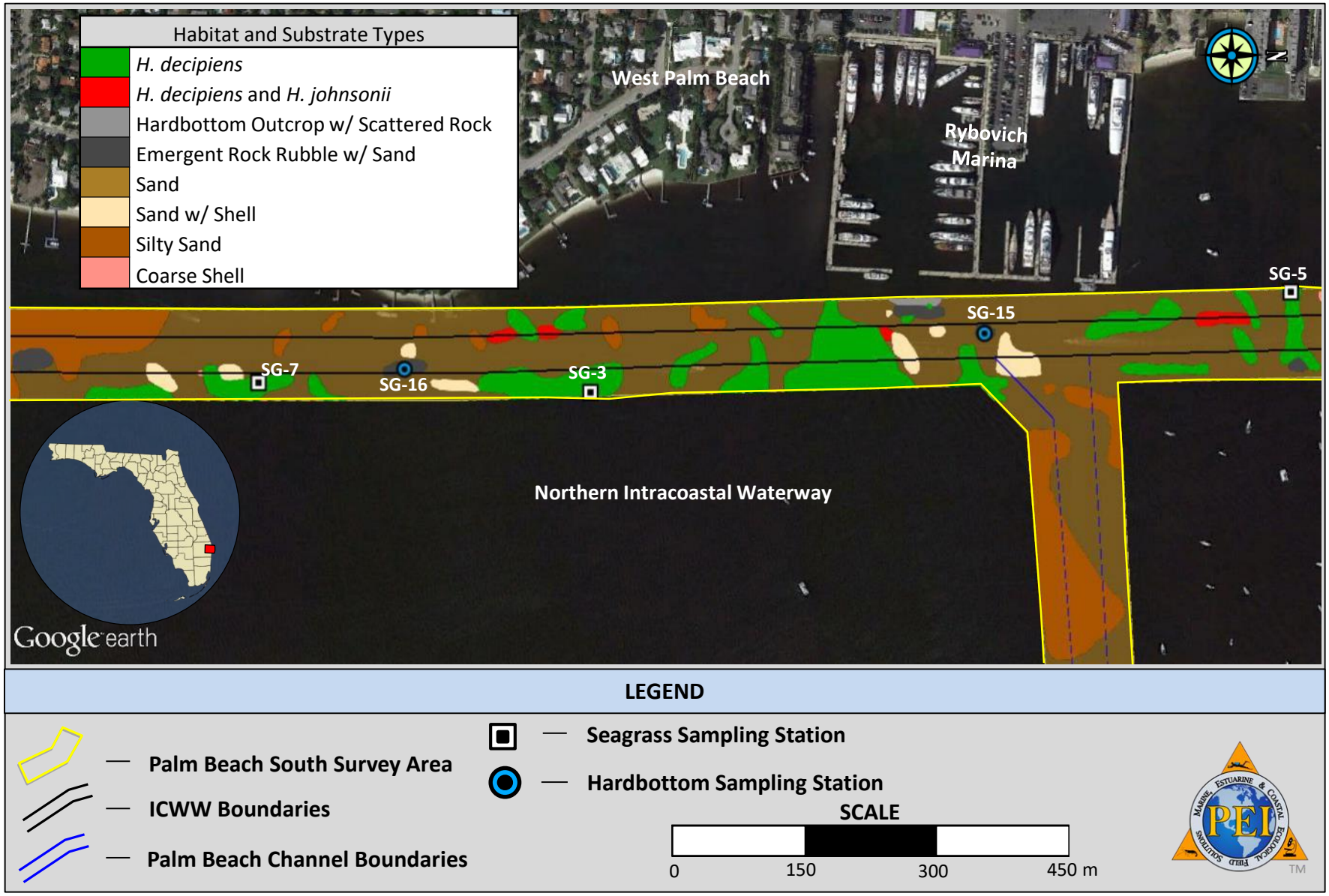

Figure 11 Seagrasses, hardbottom habitat, and substrate types mapped in the Northern ICWW survey area during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

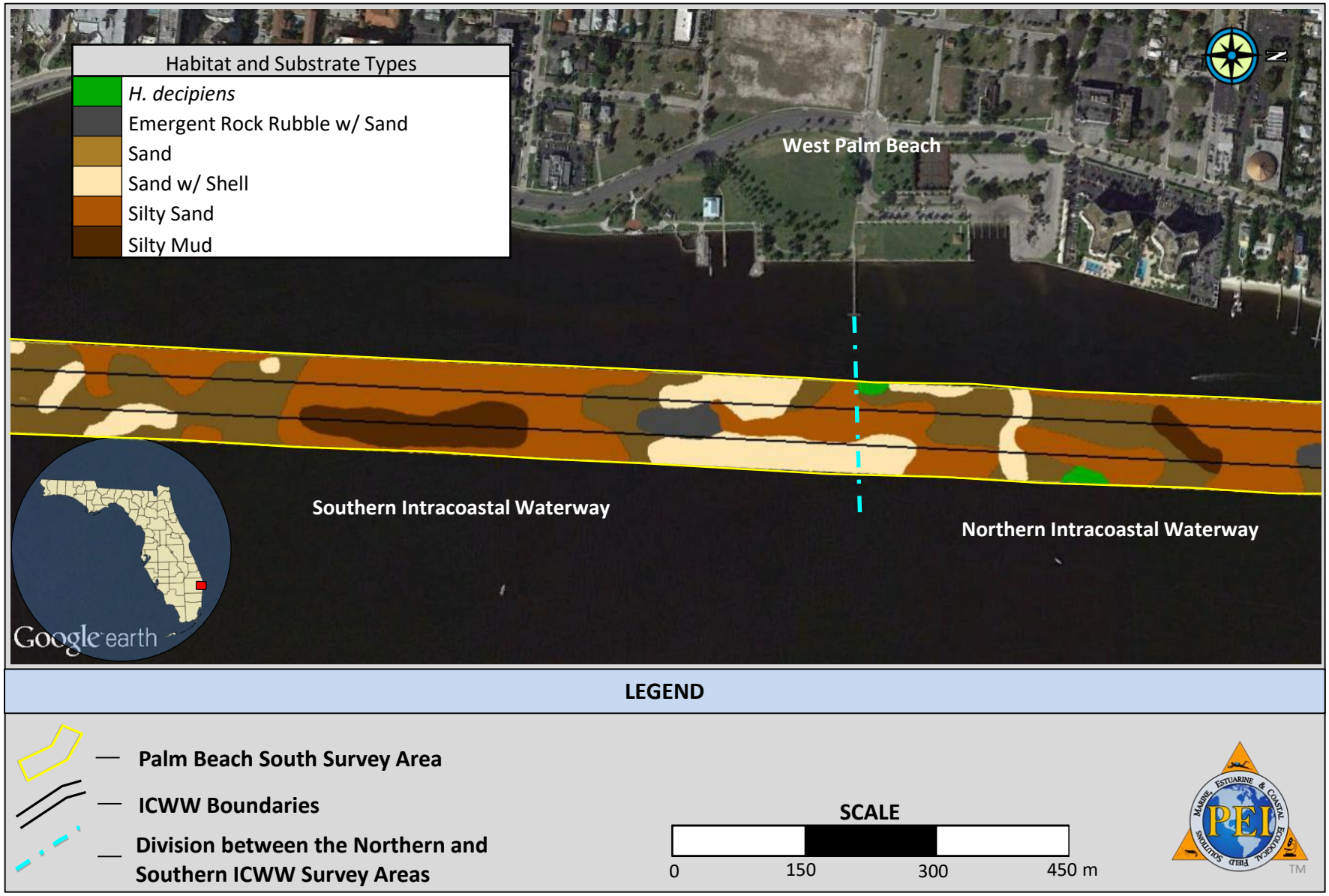

Figure 12 Seagrasses, hardbottom habitat, and substrate types mapped in the Northern and Southern ICWW survey areas during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

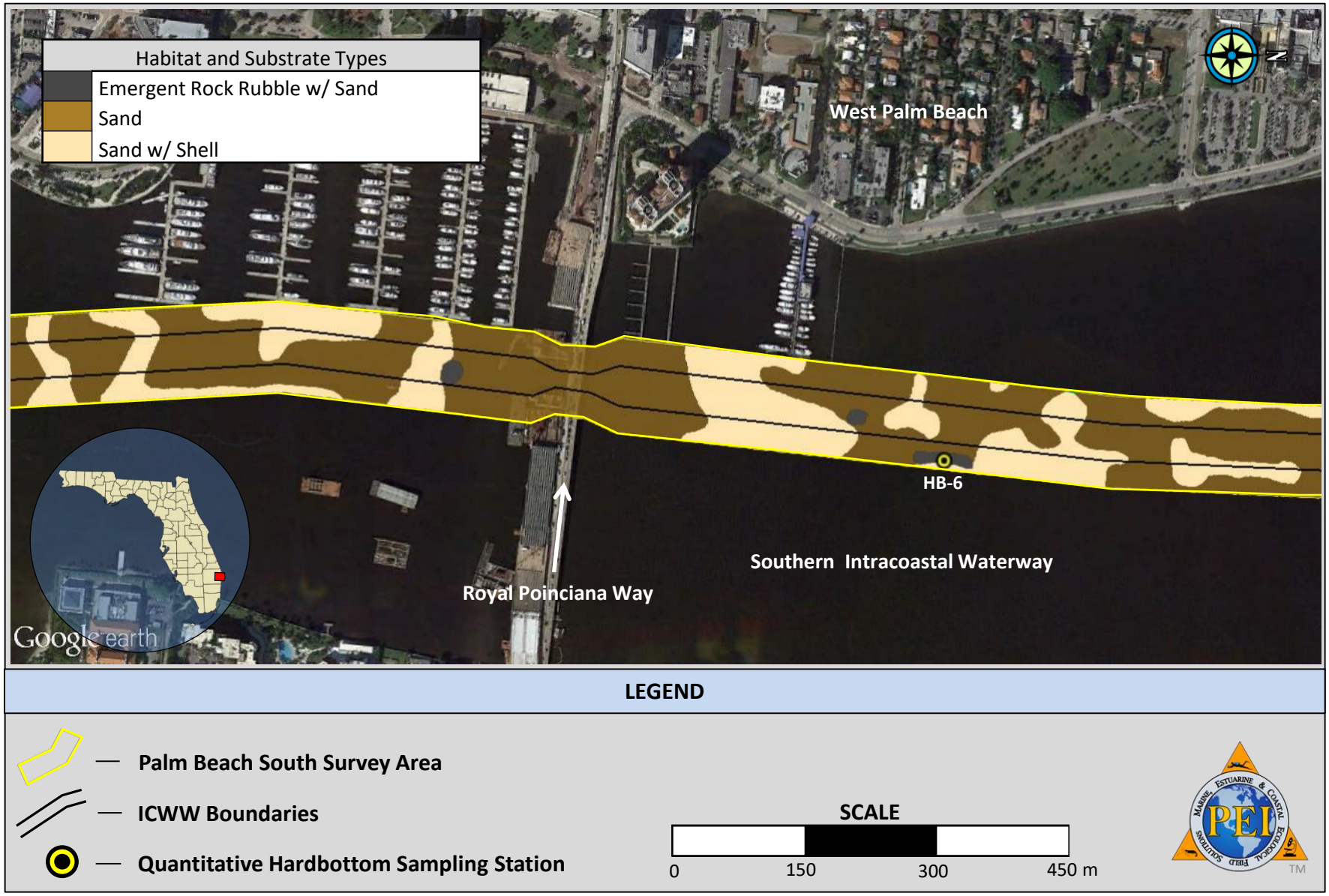

Figure 13 Hardbottom habitat and substrate types mapped in the Southern ICWW survey area during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

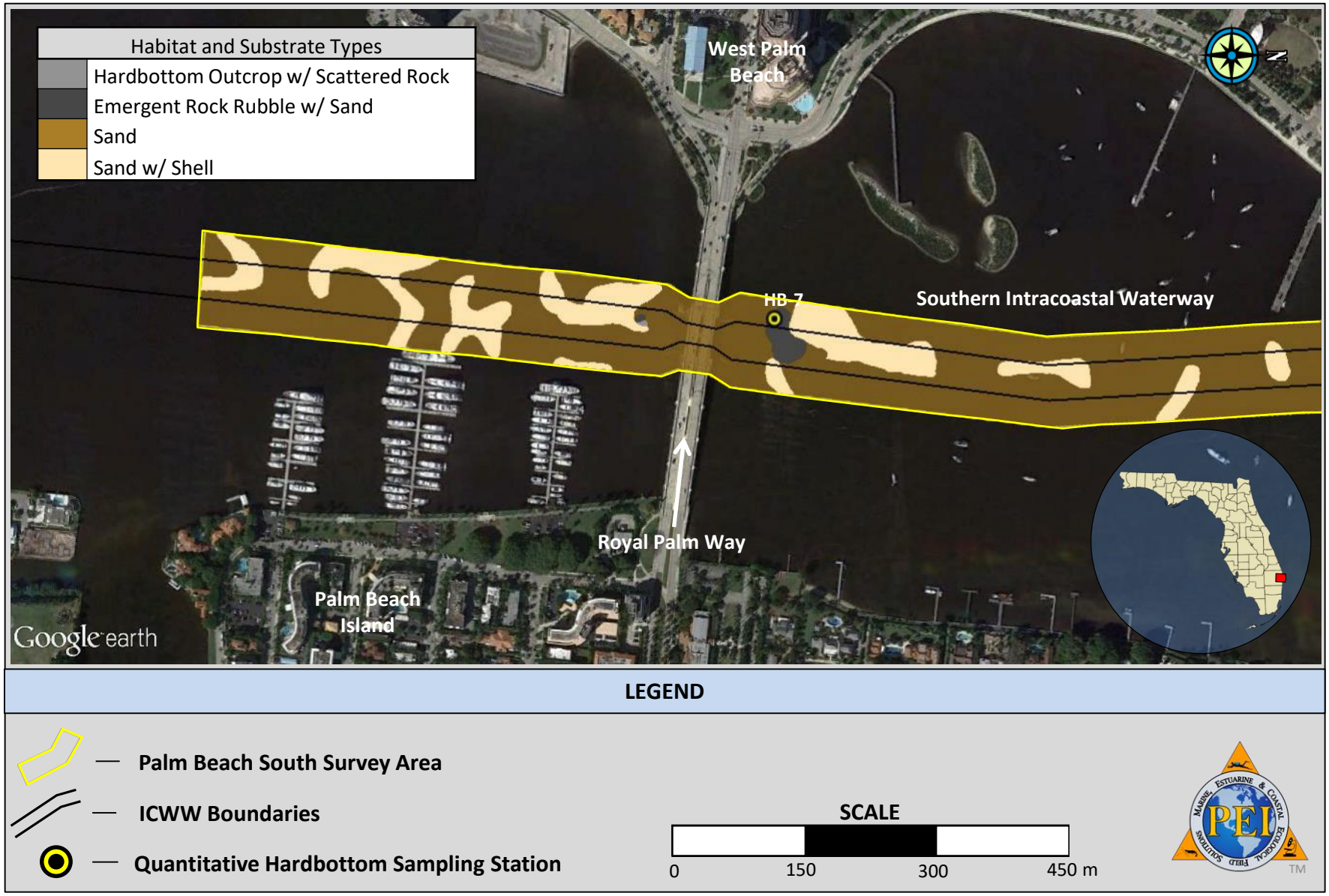

Figure 14 Hardbottom habitat and substrate types mapped in the Southern ICWW survey area during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

67% (65,527.7 meters^2 (16.2 acres)) occurring in the 30.5-meter (100-foot) buffer area and 33% (32,461.6 meters^2 (8.0 acres)) occurring within the channel boundaries. More seagrass resources were observed in the Northern ICWW channel than in the Palm Beach Channel. This may be due in part to the deeper water depths that occur in Palm Beach Channel. Also, the section of ICWW surveyed during the benthic assessment has had a relatively low frequency of disturbance. This area of the ICWW was dredged between 1961 and 1966 with additional maintenance dredging occurring near the north end of the project area within Cuts P-36 and P-37 in 1968 and 1988, respectively (Paul DeMarco (USACE), personal communication, 23 August 2016). Seagrass density was low to moderate, depending on location, and occurred in both continuous and discontinuous patches. Three species of seagrass were identified along the Northern ICWW including paddle grass (*H. decipiens*), shoal grass (*H. wrightii*), and Johnson's seagrass (*H. johnsonii*). Seagrasses occurred in both single and mixed species beds/patches. Paddle grass (*H. decipiens*) was the dominant species occurring most frequently and with the largest total delineated area of 80,245.9 meters^2 (19.8 acres) of which 61.5% (49,330.8 meters^2 (12.2 acres)) was delineated in the 30.5-meter (100-foot) buffer area and 38.5% (30,915.1 meters^2 (7.6 acres)) was delineated within the channel. Paddle grass (*H. decipiens*) with Johnson's seagrass (*H. johnsonii*) was the next most common habitat classification with 11,251.4 meters^2 (2.8 acres) of which 86% (9,704.9 meters^2 (2.4 acres)) occurs within the 30.5-meter (100-foot) buffer area and 14% (1,546.5 meters^2 (0.4 acres)) occurs within the channel. Shoal grass (*H. wrightii*) was only observed in mixed seagrass habitats and comprised the lowest delineated areas when combined with paddle grass (*H. decipiens*) (1,366.0 meters^2 (0.3 acres)) and in combination with paddle grass (*H. decipiens*) and Johnson's seagrass (*H. johnsonii*) (2,998.0 meters^2 (0.7 acres)). Shoal grass (*H. wrightii*) was not observed within the channel.

Hardbottom

Scientists identified three (3) classifications for hardbottom habitat along the Northern ICWW and two (2) hardbottom classifications in the Southern ICWW. **Table 1** provides a list of delineated habitat classifications and the total area for each habitat. **Figure 9** is an index for **Figures 10** through **14** which provide maps of the habitats and marine resources delineated in the survey area along the ICWW. More hardbottom was delineated in the Northern ICWW (8,848.0 meters^2 (2.2 acres)) than the Southern ICWW (6,592.7 meters^2 (1.6 acres). Emergent Rock Rubble with Sand was the most common classification of hardbottom in the Northern ICWW with a total delineated area of 6,030.0 meters^2 (1.5 acres) with 57% (3,434.2 meters^2 (0.9 acres)) occurring in the 30.5-meter (100-foot) buffer area and 43% (2,595.8 meters^2 (0.6 acres)) occurring within the channel. Hardbottom Outcrop with Scattered Rock was the second most abundant hardbottom habitat classification with a total delineated area of 2,131.0 meters^2 (0.5 acres) of which 31% (659.0 meters^2 (0.2 acres)) occurred in the 30.5-meter (100-foot) buffer area and 15% (328.0 meters^2 (0.1 acres)) was delineated within the channel. The remaining 54% (1,144.0 meters^2 (0.3 acres)) was part of a hardbottom habitat that started within the 30.5-meter (100-foot) buffer area and continued beyond the ICWW survey area boundaries (**Figure 10**). Hardbottom outcrops were comprised of semi-contiguous coquinoid limestone rock with scattered rocks, sand, and shell materials. The least abundant hardbottom classification in the Northern ICWW survey area was Hardbottom Ledge Habitat with a total delineated area of 687.0 meters^2 (0.2 acres) with 43% (292.2 meters^2 (0.1 acres)) occurring in the 30.5-meter (100-foot) buffer area and 57% (395.0 meters^2 (0.1 acres)) occurring within the channel. Hardbottom Ledge Habitat was only observed at the north end of the ICWW, just south of the Port of Palm Beach. Emergent Rock Rubble with Sand was the most common classification of hardbottom in the Southern ICWW with a total delineated area of 6,535.0 meters^2 (1.6 acres) with 25% (1,645.0 meters^2 (0.4 acres)) occurring in the 30.5-meter (100-foot) buffer area and 75% (4,890.0 meters^2 (1.2 acres)) occurring within the channel. The only other hardbottom classification identified in the Southern ICWW was

Hardbottom Outcrop with scattered rock, 100% (57.7 meters^2 (0.01 acres)) of which occurred within the 30.5-meter (100-foot) buffer area. Representative photos have been provided in the **ATTACHMENT**.

4.1.2 Palm Beach Channel

The secondary survey area included the Palm Beach Channel which parallels the west shoreline of Palm Beach Island from the Port of Palm Beach south 2,575 meters (1.6 miles) where it reconnects with the ICWW adjacent to the Rybovich Boat Yard and Superyacht Marina (**Figure 2**). The total area surveyed along Palm Beach Channel including the channel and channel slope with 30.5-meter (100-foot) buffer areas positioned on either side of the channel was 260,695 meters^2 (64.4 acres), of which 60% (156,646 meters^2 (38.7 acres)) occurred within the 30.5-meter (100-foot) buffer area and 40% (104,049 meters^2 (25.7 acres)) occurred within the channel and channel slope. The exact date of the most recent maintenance dredge in Palm Beach Channel is unknown, but the channel was deeper than the ICWW with water depths ranging from 2.7 to 8.8 meters (9.0 to 29.0 feet) and an average depth of 5.7 meters (18.6 feet). Substrate consisted of a combination of sand, silty-sand, coarse sand, sand with shell, and coarse shell. During the benthic assessment field survey, Pinnacle's field team observed less vessel traffic in Palm Beach Channel than in the adjacent ICWW Channel.

Seagrass

Both seagrasses and hardbottom habitats were delineated during the assessment survey along Palm Beach Channel. **Table 1** provides a list of delineated habitat classifications and the total area for each habitat. **Figure 9** is an index for **Figures 15** and **16** which provide maps of habitats delineated along the Palm Beach Channel. Seagrass density was low to moderate and occurred in both continuous and discontinuous patches. Paddle grass (*H. decipiens*) was the only seagrass species observed along the Palm Beach Channel with a total delineated area of 45,524.6 meters^2 (11.2 acres) of which 74% (33,475.9 meters^2 (8.3 acres)) occurred in the 30.5-meter (100-foot) buffer area and 26% (12,048.7 meters^2 (3.0 acres)) occurred within the channel. Delineated seagrass habitat along Palm Beach Channel was 53% less than the total seagrass resources documented along the ICWW. In addition to the larger survey area along the ICWW, other potential contributing factors for lower delineated seagrass habitats along the Palm Beach Channel may include deeper water depths, more recent dredge activities, or a combination of these factors.

Hardbottom

Three (3) classifications for hardbottom habitat were identified along Palm Beach Channel: Hardbottom outcrops with Scattered Rock, Emergent Rock Rubble with Sand, and Hardbottom Ledge Habitat. A portion of the Rybovich Artificial Reef was delineated in the 30.5-meter (100-foot) buffer area near the south end of Palm Beach Channel, but was not included with the hardbottom habitat classifications. **Table 1** provides a list of delineated habitat classifications and the total area for each habitat. **Figure 9** is an index for **Figures 15** and **16** which provide maps of habitats delineated along the Palm Beach Channel. Emergent Rock Rubble with Sand was the most common classification with a total delineated area of 15,517.5 meters^2 (3.8 acres) of which 31% (4,788.5 meters^2 (1.2 acres)) occurred in the 30.5-meter (100-foot) buffer area and 69% (10,729.0 meters^2 (2.7 acres)) occurred within the channel. Hardbottom Outcrop with Scattered Rock was the second most abundant habitat classification with a total delineated area of 1,688.0 meters^2 (0.4 acres) of which 85% (1,428 meters^2 (0.4 acres)) occurred in the 30.5-meter (100-foot) buffer area and 3% (44.0 meters^2 (0.01 acres)) occurred within the channel. The remaining 216 meters^2 (0.1 acres) was part of a hardbottom habitat at Sample Station HB-10 that started within the 30.5-meter (100-foot) buffer area and continued beyond the Palm Beach Channel survey area boundaries (**Figure 15**). Hardbottom

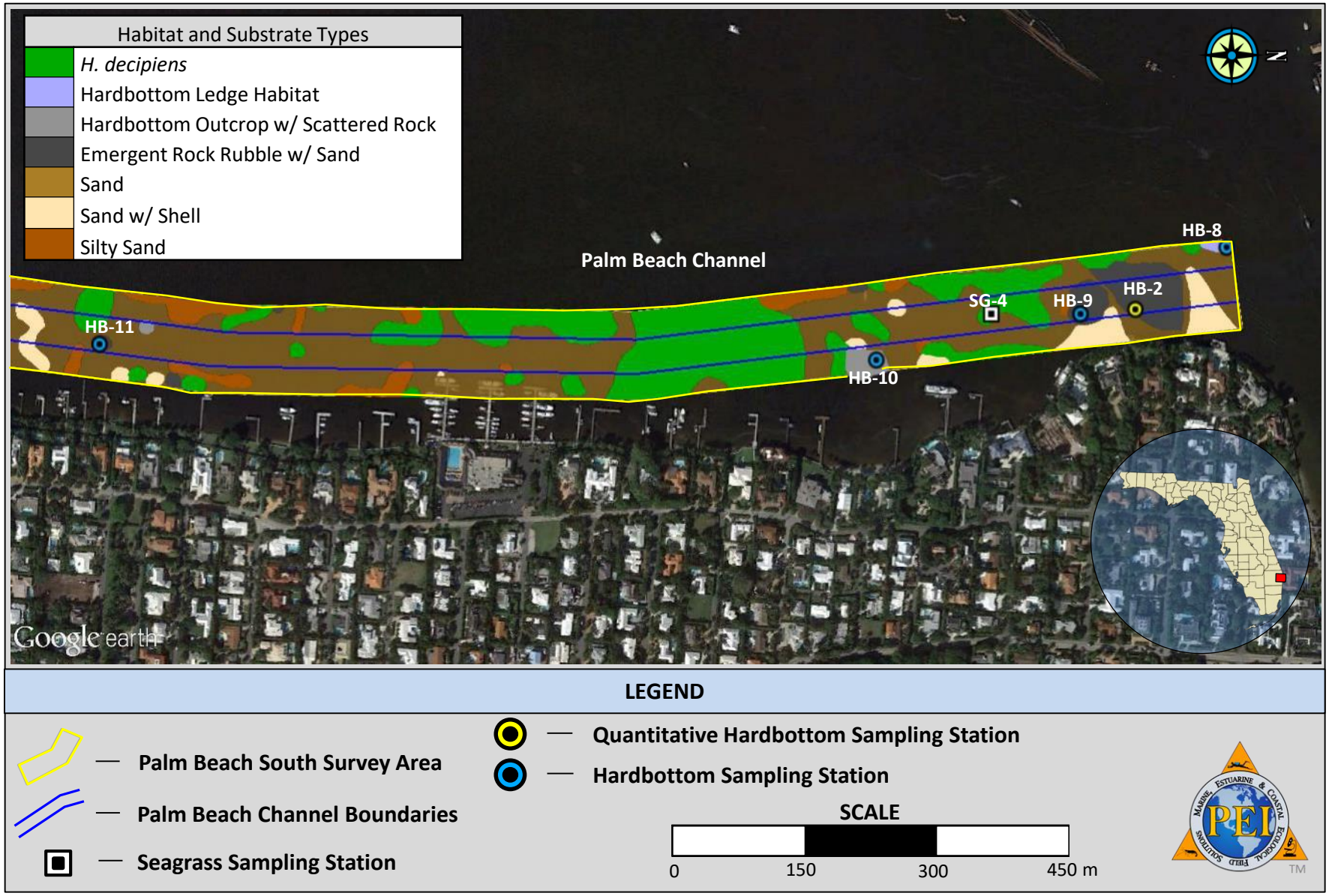

Figure 15 Seagrass, hardbottom habitat, and substrate types mapped in the Palm Beach Channel survey area during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

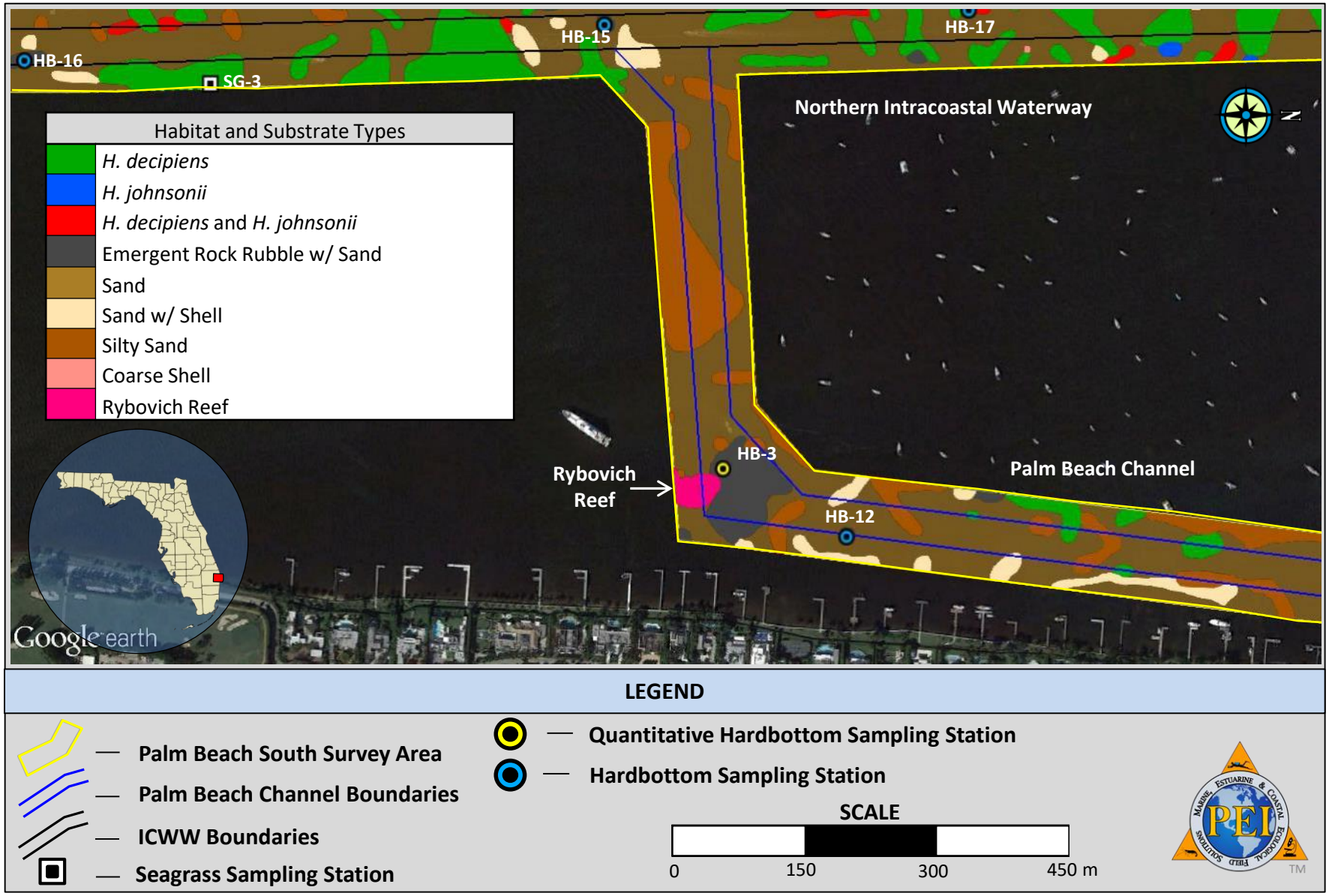

Figure 16 Seagrass, hardbottom habitat, and substrate types mapped in the Palm Beach Channel and Northern ICWW survey areas during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

Ledge Habitat (368.0 meters^2 (0.09 acres) was identified in the 30.5-meter (100-foot) buffer area near the north end of Palm Beach Channel and adjacent to the Port of Palm Beach. The exposed hardbottom ledge was likely uncovered when the Port was originally dredged. Hardbottom outcrops were comprised of semi-contiguous coquinoid limestone rock with scattered rocks, sand, and shell materials. Hardbottom habitats were generally colonized with macroalgae, sponges, hydroids, and corals. A portion (1,700.0 meters^2 (0.4 acres)) of the artificial reef identified in the 30.5-meter (100-foot) buffer area along Palm Beach Channel is constructed of various anthropogenic materials including concrete road barriers, a sunken barge, and miscellaneous concrete debris. It is unknown whether the reef was constructed as mitigation for a specific project. Carman Vare (Palm Beach County Environmental Resource Management (PBCERM) - Artificial Reefs Division) reported that a portion of the Rybovich Reef may have been constructed to mitigate a project for the Town of Palm Beach (personal communication, 2 August 2016). Representative photos have been provided in the **ATTACHMENT**.

4.2 Quantitative Data

4.2.1 Seagrass

Quantitative data collected during Phase II was used to determine seagrass percent cover, frequency of occurrence, density (shoots/meter^2), and blade length. Data were collected *in situ* along two (2) modified belt-transects, each consisting of a reel tape extending to 10 meters (32.8 feet), deployed at seven (7) randomly selected sample stations (**Figure 8**). Percent cover was determined using a modified Braun-Blanquet (1932) method. Frequency of occurrence was determined by counting the number of sub-cells in each sample quadrat containing seagrass. Seagrass densities were determined using a shoot count method and blade lengths were measured in millimeters.

During quantitative sampling along the ICWW three (3) species of seagrass were identified: paddle grass (*H. decipiens*), Johnson's seagrass (*H. johnsonii*), and shoal grass (*H. wrightii*). Paddle grass (*H. decipiens*) was the most common seagrass species observed and was documented at all six (6) ICWW sample stations. Johnson's seagrass was frequently observed outside of and adjacent to the survey area, but was present at only two (2) of the ICWW quantitative sample stations. Shoal grass (*H. wrightii*) was observed in low numbers and was observed at only one (1) sample station. Seagrass percent cover values at the remaining sample stations were below the average percent cover for the entire survey area. Two (2) of the highest occurrences of seagrass percent cover were documented at ICWW seagrass Sample Stations SG-6 and SG-3 (**Table 2**: 29.35% and 28.5%). Sample stations exhibiting the highest percentage of seagrass cover had substrate consisting predominantly of sand and/or silty-sand. Seagrass habitats were limited in areas with a combination of strong tidal currents and loose sand material due to sediment transport. Sand waves, indicative of strong tidal currents and moving sediment, were occasionally encountered in the south portion of the ICWW survey area where no seagrasses were identified. Paddle grass (*H. decipiens*) was the only seagrass species identified along Palm Beach Channel. Sample Station SG-4 had the lowest percent cover with 5.0%. Seagrass at Sample Station SG-4 appeared healthy and had relatively clear water conditions during incoming and high tidal cycles.

Scientists determined seagrass frequency of occurrence by examining each quadrat and counting the total number of 10 x 10-centimeter (3.9 x 3.9-inch) sub-cells within each 1.0-meter^2 (10.8-feet^2) quadrat containing seagrass. An average frequency of occurrence (%) for all quadrats sampled at each station has been provided in **Table 3**. Seagrass frequency of occurrence was highest along the ICWW at Sample Stations SG-3 (95.3%) and SG-6 (86.7%) and reflects the percent cover data collected from each of these

Table 2. Seagrass percent cover data collected during the benthic assessment and resource survey along the ICWW and Palm Beach Channel (PBC) in Lake Worth Lagoon, Palm Beach County, Florida. Note: No seagrass was observed within the boundaries of the Southern ICWW survey area.

Station		Percent Cover (%)					
		Halophila decipiens	*Halophila johnsonii*	*Halodule wrightii*	Macroalgae	Sponge	Invertebrates
Northern ICWW	SG-1	13.74	-	-	1.68	-	0.89
	SG-2	14.43	0.43	-	8.33	-	1.48
	SG-3	28.50	-	-	1.65	0.10	1.10
	SG-5	8.40	-	-	1.30	0.10	0.80
	SG-6	29.35	2.25	0.90	1.60	-	1.05
	SG-7	10.85	-	-	1.20	-	0.80
Northern ICWW Average		17.54	1.34	0.90	2.63	0.10	1.02
PBC	SG-4	5.00	-	-	1.40	0.05	1.60
Total Combined Survey Area Average		15.76	1.34	0.90	2.50	0.04	1.11

Table 3. Average seagrass frequency, density (shoots/meters^2), and blade length data collected during the benthic assessment and resource survey along the ICWW and Palm Beach Channel (PBC) in Lake Worth Lagoon, Palm Beach County, Florida. Note: No seagrass was observed within the boundaries of the Southern ICWW survey area.

Station		Frequency of Occurrence (%)				Density (shoots/meters^2)				Blade Length (millimeters)		
		Hd	*Hj*	*Hw*	*total*	*Hd*	*Hj*	*Hw*	*total*	*Hd*	*Hj*	*Hw*
Northern ICWW	SG-1	59.50	-	-	59.50	5.12	-	-	5.12	15.83	-	-
	SG-2	72.50	4.70	-	73.10	8.72	0.62	-	4.67	15.90	15.06	-
	SG-3	95.30	-	-	95.30	11.90	-	-	11.90	21.50	-	-
	SG-5	68.90	-	-	68.90	3.80	-	-	3.80	14.77	-	-
	SG-6	86.70	3.40	0.40	88.10	15.30	0.66	0.14	5.37	18.37	17.78	107.17
	SG-7	56.90	-	-	56.90	7.16	-	-	7.16	19.50	-	-
Northern ICWW Average		73.30	4.05	0.40	73.63	8.67	0.64	0.14	6.34	17.64	16.42	107.17
PBC	SG-4	22.90	-	-	22.90	1.50	-	-	1.50	17.20	-	-
Total Combined Survey Area Average		66.91	1.19	0.06	67.21	7.84	0.19	0.02	2.68	17.58	16.42	107.17

Hd = Halophila decipiens
Hj = Halophila johnsonii
Hw = Halodule wrightii

stations. Higher frequencies at Sample Stations SG-1 (59.5%), SG-2 (72.5%), SG-5 (68.9%), and SG-7 (56.9%) may reflect the sparse yet wide distribution of seagrasses at these stations. The average frequency at Sample Station SG-4 (22.9%) in Palm Beach Channel was relatively low and somewhat reflective of percent cover and density values.

Seagrass densities in the Northern ICWW and Palm Beach Channel survey areas were relatively low, but generally reflect the overall conditions in Lake Worth Lagoon. Paddle grass (*H. decipiens*) had the two (2) highest densities observed in the Northern ICWW survey area with 11.9 shoots/meter^2 at Sample Station SG-3 and 15.3 shoots/meter^2 at SG-6 (**Table 3**). Johnson's seagrass (*H. johnsonii*) had low densities and occurred at Sample Stations SG-2 (0.62 shoots/meter^2) and SG-6 (0.66 shoots/meter^2). Shoal grass (*H. wrightii*) was observed in the ICWW 30.5-meter (100-foot) buffer area at Sample Station SG-6 with a density of 0.14 shoots/meter^2. The lowest density for *H. decipiens* occurred in Palm Beach Channel at Sample Station SG-4 with 1.5 shoots/meter^2.

Blade lengths were collected from seagrass occurring in each quadrat and recorded in millimeters. Average blade length measurements had little variation within species (**Table 3**). The longest average blade length for paddle grass (*H. decipiens*) occurred at Sample Station SG-3 with a length of 21.50 millimeters. The shortest average blade length for paddle grass (*H. decipiens*) occurred at Sample Station SG-5 with a length of 14.77 millimeters. Blade lengths may have been influenced by environmental conditions including silty sedimentation, water quality and low light availability, epiphytic growth on seagrass blades and fluctuations in salinity with freshwater input from heavy rains and discharges from drainage canals.

Potential Environmental Factors Influencing Seagrass Habitat

The low percent cover, frequency of occurrence, and density values for seagrass in Palm Beach Channel and specifically at Sample Station SG-4 may be due, in-part, to the deeper water depth at that particular sample station (8.8 meters (29 feet)). Water depths can be a limiting factor for seagrass growth by reducing ambient light levels reaching the substrate surface (Short, 1987 and Koch, 2001). Other factors which may influence lower seagrass percent cover values may include differences in substrate quality, blade-shading via epiphytes, water quality and/or turbidity in the water column and fresh water runoff (Gallegos et al., 2009 and Koch, 2001). Pinnacle (2012) conducted seagrass studies in Lake Worth Lagoon immediately prior to and following Tropical Cyclone Isaac in August 2012 and documented impacts to seagrasses that may have resulted from large discharges of freshwater during the storm. Freshwater discharges were more than normal during the 2013 wet season and estimates of seagrass cover had declined from previous years (Orlando et al., 2016). Orlando et al. (2016) provided a summary of seagrass mapping in Lake Worth Lagoon that suggested frequent discharges of large amounts of freshwater into coastal estuaries following heavy rainfall in South Florida during the winter and spring of 2016 may have contributed to the lower seagrass cover observed during the benthic assessment and resource survey. Several freshwater drainage canals (i.e., C-51, West Palm Beach; C-16, Boynton Canal; and C-17, Earman River) empty directly into Lake Worth Lagoon. The C-51 canal is located 6.1 kilometers (3.8 miles) south of the southernmost end of the survey area. Water levels and discharges through the C-51 canal are controlled by the USACE and the South Florida Water Management District. The canals also deposit muck and pollution that contribute to lower water quality conditions in Lake Worth Lagoon.

4.2.2 Hardbottom

Quantitative data was collected at sample station locations in hardbottom habitat delineated during Phase I data collection. Data included still photographs appropriate for quantitative analysis of hardbottom community composition and structure collected along modified belt-transects ranging in length from 20 meters (65.5 feet) to 24 meters (78.7 feet). The camera was mounted on a framer at a fixed height of 40 centimeters (15.7 inches) above a 0.25-meter^2 (2.7-feet^2) quadrat. Non-overlapping photos were collected along the entire length of each transect at seven (7) randomly selected hardbottom sample stations. **Figure 9** is an index for **Figures 10** through **16** which show the location of quantitative hardbottom stations sampled during the benthic assessment survey. Photos were analyzed using CPCe software to determine the percent cover of benthic resources colonizing hardbottom habitat in the survey area. Percent cover data has been presented in **Table 4**. Hydroids were identified as the most common biota colonizing hardbottom habitat in the ICWW and Palm Beach Channel survey areas (**Table 4**: 8.68% and 8.86%). Macroalgae was the second most abundant marine resource colonizing hardbottom in the ICWW (3.18%) and Palm Beach Channel (5.07%) survey areas. Percent cover values for sponges in the ICWW ranged from 0.21 to 5.54% and in Palm Beach Channel from 2.85 to 11.21%. The highest sponge cover (11.21%) occurred on Emergent Rock Rubble with Sand at Sample Station HB-2. This sample station was positioned close to the Lake Worth Inlet and frequented by strong tidal currents. Stony corals (scleractinia) were observed colonizing hardbottom habitats in the Northern ICWW and Palm Beach Channel survey areas, but with low percent cover. No stony corals were identified in the Southern ICWW survey area. Of the two octocoral species that were identified during the survey the white telesto (*Carijoa riisei*) was the most common with 0.38% cover. Hardbottom communities are considered EFH and important for benthic colonizers including corals, sponges, macroalgae, and other marine resources. Hardbottom is also important for fish spawning, breeding, feeding, and protection from predators.

Stony corals were observed at several hardbottom habitats delineated in the survey area (**Table 5**). Data collected for corals included species identification, colony size, and location. **Figure 17** is an index for **Figures 18** through **27** which show the location of mapped corals at hardbottom sample stations where stony corals were identified and mapped. Coral data (**Tables 6** and **7**) was organized according to species and colony size classification. A total of 15 stony coral species and two octocoral species were identified during the benthic survey. The most common species of stony coral identified during the survey was in the genus *Siderastrea* and included both *S. siderea* and *S. radians*. White telesto (*Carijoa riisei*) was the most common octocoral identified during the survey. Stony corals were further categorized according to specific size classifications including less than five (5) centimeters, five (5) to 10 centimeters, and greater than 10 centimeters (**Tables 6** and **7**). Most corals (916 colonies) were classified as less than 5 centimeters. A total of 298 corals fit into the 5 to 10 centimeter size classification and 41 corals had colony dimensions greater than 10 centimeters. Palm Beach Channel had nearly 75% more corals than the Northern ICWW survey area. This may be because the total delineated hardbottom in the Northern ICWW ((8,848.0 meters^2 (2.2 acres)) was roughly half of the hardbottom habitat in Palm Beach Channel ((17,573.5 meters^2 (4.3 acres)). Over 1,000 corals were identified in the Palm Beach Channel survey area and 72% of those corals were less than five (5) centimenters. The largest stony coral colonies identified during the survey included two (2) ivory bush corals (*Oculina diffusa*), each measuring 21.0 centimeters in diameter and observed within the 100-foot buffer area at Sample Stations HB-5 and HB-10.

Occasionally habitats and associated resources delineated in the survey area also extended across the survey area boundary. These habitats were mapped and characterized to provide as complete assessment of the habitat and associated resources as possible. Some hardbottom habitats covered multiple channel

Table 4. Percent cover data determined from Coral Point Count (CPCe) analysis of photo quadrats collected on hardbottom habitat located along the ICWW and Palm Beach Channel (PBC) in Lake Worth Lagoon, Palm Beach County, Florida.

Category		Percent Cover by Station (%)								
		Northern ICWW			Southern ICWW		ICWW Average	PBC		PBC Average	Combined Average
		HB-1	HB-4	HB-5	HB-6	HB-7		HB-2	HB-3		
Biota	Ascidian	0.74	1.06	1.41	-	-	1.07	2.54	0.21	1.38	1.19
	Carijoa riisei	-	-	0.54	0.21	-	0.38	-	-	-	0.38
	Hydroid	7.09	14.47	13.09	7.29	1.48	8.68	3.81	13.91	8.86	8.73
	Macroalgae	5.82	3.09	0.33	3.48	-	3.18	5.07	5.06	5.07	3.81
	Oculina diffusa	-	-	0.65	-	-	0.65	-	0.11	0.11	0.38
	Siderastrea radians	-	0.11	0.11	-	-	0.11	-	-	-	0.11
	Sponge	1.06	0.21	5.54	2.96	2.33	2.42	11.21	2.85	7.03	3.74
Substrate	Emergent Rock Rubble with Sand	-	33.83	-	40.76	18.41	31	18.82	24.55	21.69	27.27
	Hardbottom Outcrop with Scattered Rock	56.93	-	38.87	-	-	47.9	-	-	-	47.90
	Sand	28.36	47.23	38.65	45.30	77.78	47.46	58.56	53.32	55.94	49.89

Table 5. A list of stony corals and octocorals identified at hardbottom habitats delineated within the ICWW and Palm Beach Channel survey areas.

Taxa	Northern ICWW Stations									Southern ICWW Stations		Palm Beach Channel Stations						
	HB-1	HB-4	HB-5	HB-13	HB-14	HB-15	HB-16	HB-17	HB-18	HB-6	HB-7	HB-2	HB-3	HB-8	HB-9	HB-10	HB-11	HB-12
Octocorals																		
C. riisei	NP	P	P	NP	NP	NP	NP	NP	NP	P	NP	P	P	NP	NP	NP	NP	NP
Leptogorgia sp.	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	P	NP	NP	NP	NP	NP
Stony Corals																		
C. arbuscula	No stony corals observed	NP	P	NP	NP	No stony corals observed	No stony corals observed	NP	No stony corals observed	No stony corals observed	No stony corals observed	P	NP	NP	NP	P	No stony corals observed	No stony corals observed
D. labyrinthiformis		NP	P	NP	NP			NP				P	NP	NP	NP	P		
F. fragum		NP	NP	NP	NP			NP				NP	NP	NP	NP	P		
M. cavernosa		NP	P	NP	NP			NP				P	NP	NP	NP	NP		
O. diffusa		P	P	P	P			P				P	P	NP	P	P		
P. americana		P	P	P	NP			NP				P	P	P	P	P		
P. astreoides		NP	P	NP	NP			NP				NP	NP	NP	NP	NP		
P. clivosa		NP	NP	NP	NP			NP				NP	NP	NP	NP	P		
P. strigosa		NP	P	NP	NP			NP				NP	NP	NP	NP	P		
S. radians		P	P	P	P			NP				P	P	P	P	P		
S. siderea		NP	P	P	NP			NP				P	P	NP	P	P		
Siderastrea sp.		NP	P	NP	NP			NP				P	NP	NP	NP	NP		
S. bournoni		NP	P	NP	NP			NP				P	NP	NP	NP	P		
S. intersepta		NP	P	P	NP			NP				P	P	NP	NP	NP		
T. coccinea		NP	NP	NP	NP			NP				P	NP	P	P	NP		

P = Present

NP = Not Present

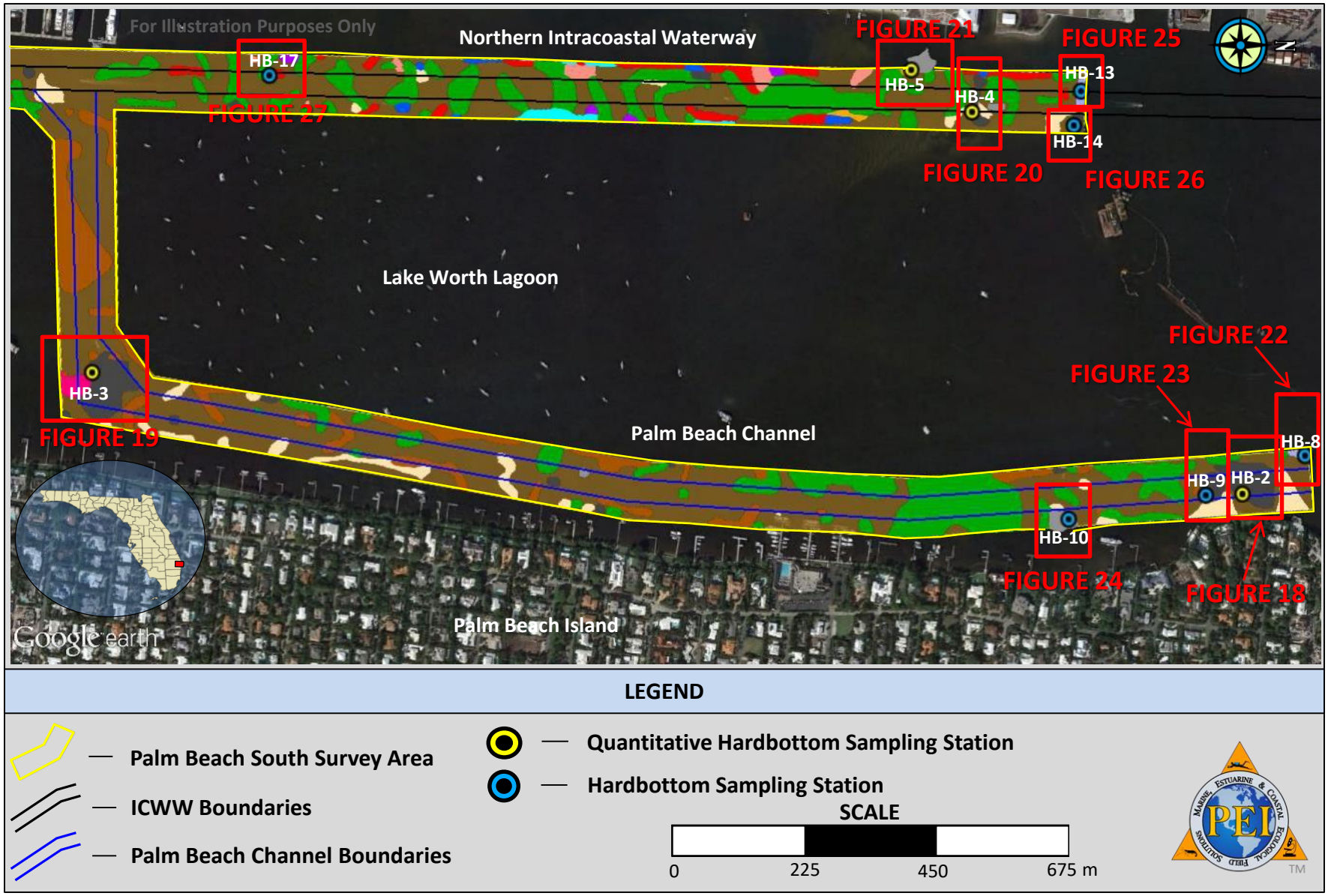

Figure 17 An index for figures showing hardbottom habitats where hard corals were observed and mapped in the Palm Beach Channel and Northern ICWW survey areas during in the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

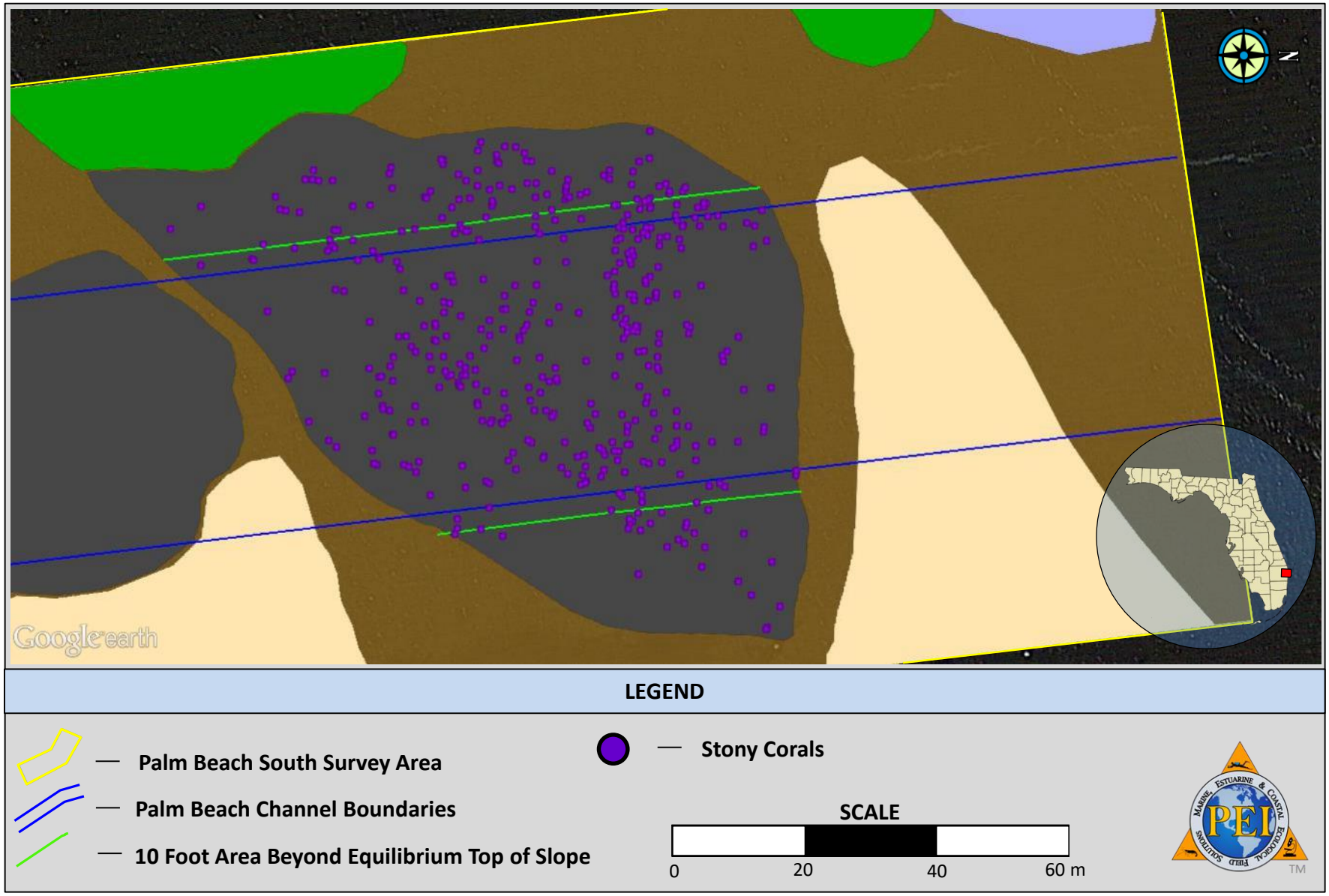

Figure 18 Stony corals mapped at Sample Station HB-2 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

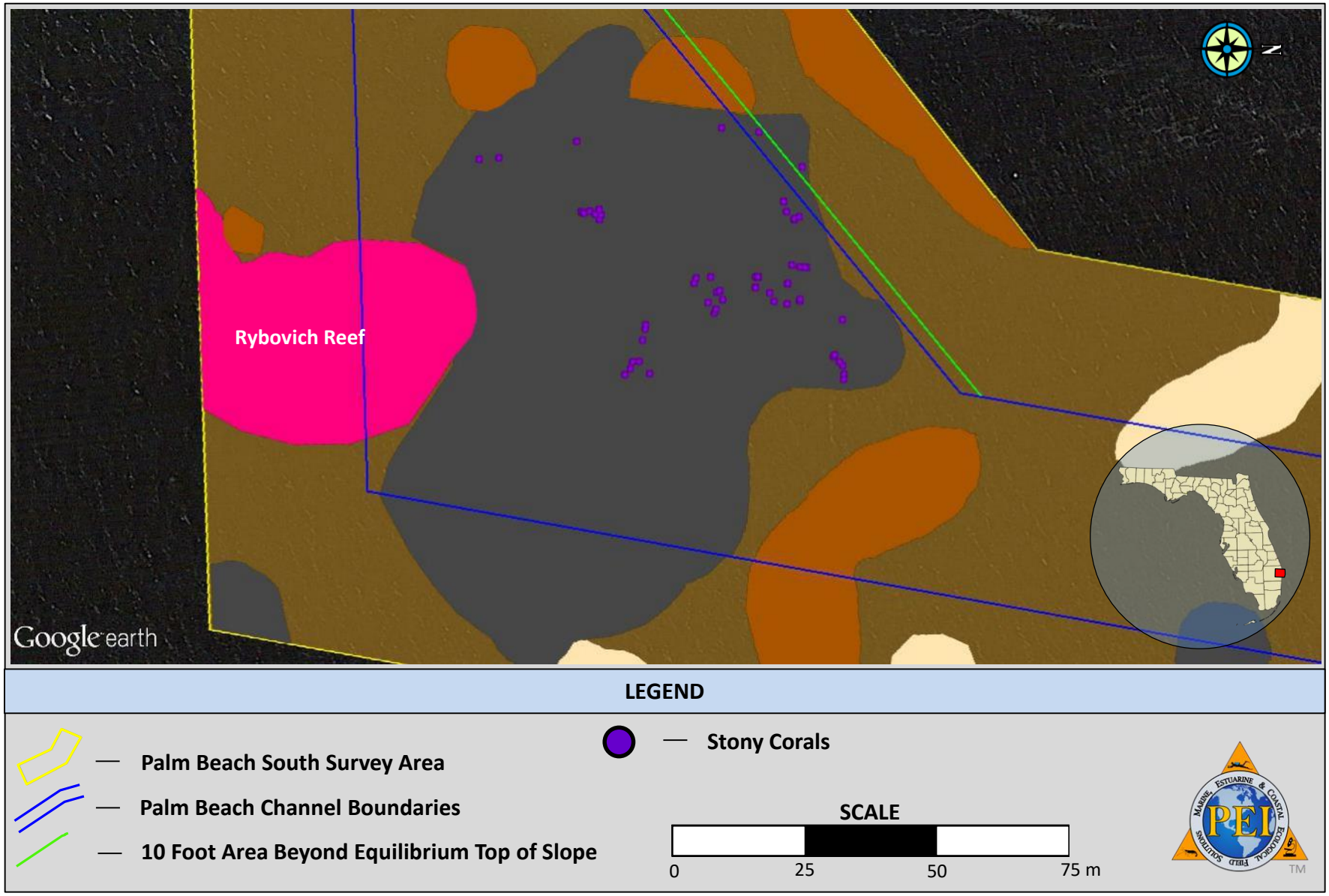

Figure 19 Stony corals mapped at Sample Station HB-3 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

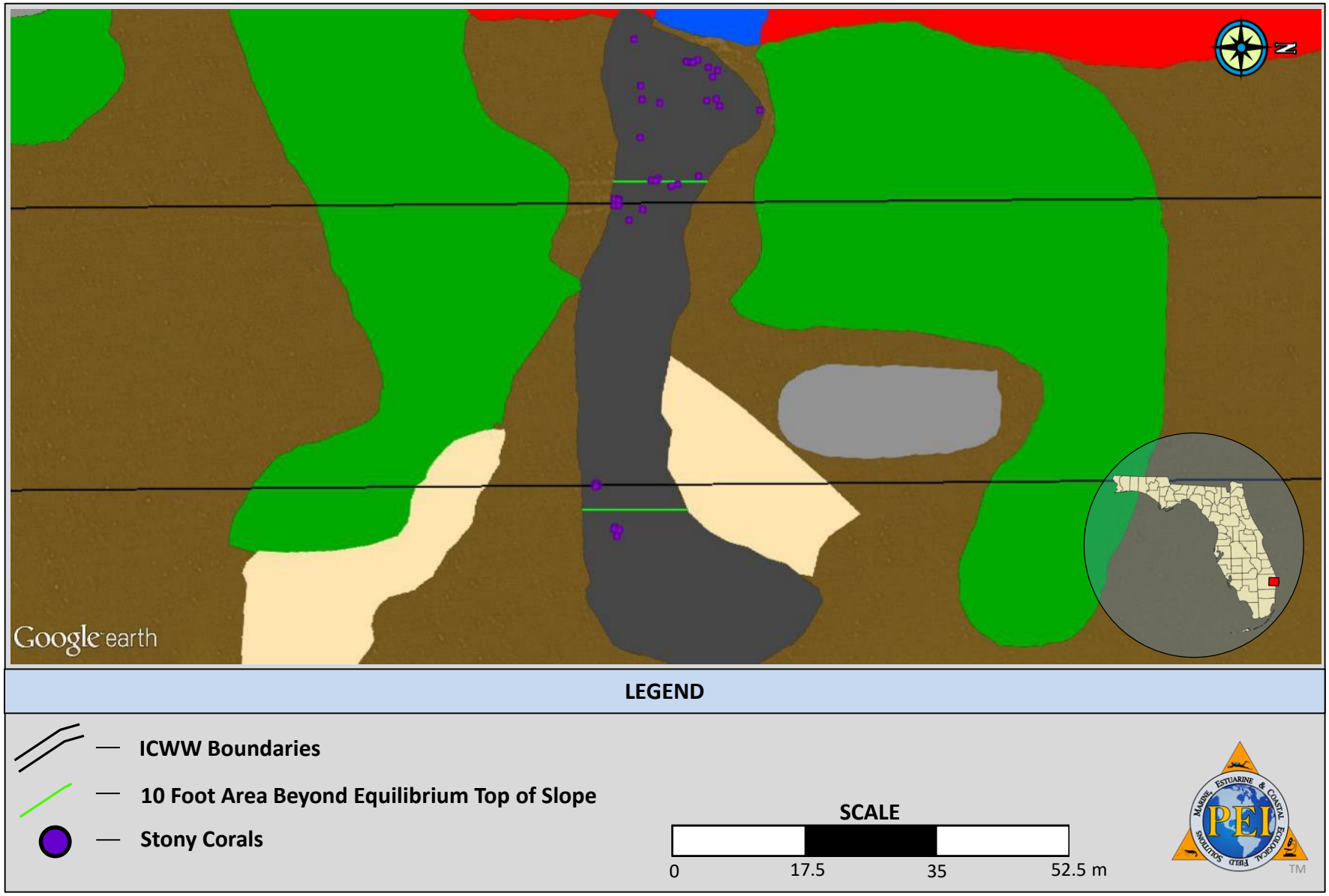

Figure 20 Stony corals mapped at Sample Station HB-4 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

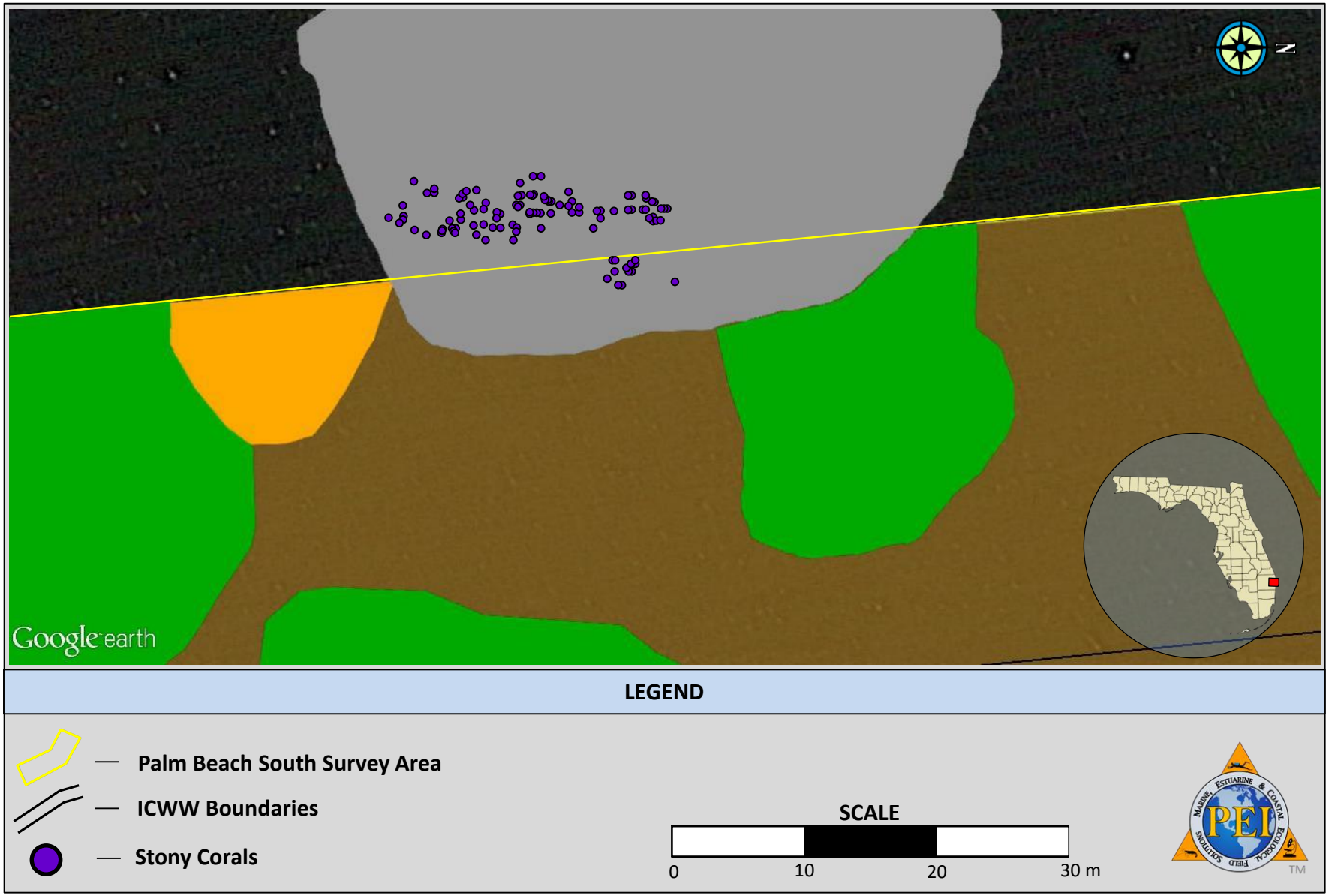

Figure 21 Stony corals mapped at Sample Station HB-5 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

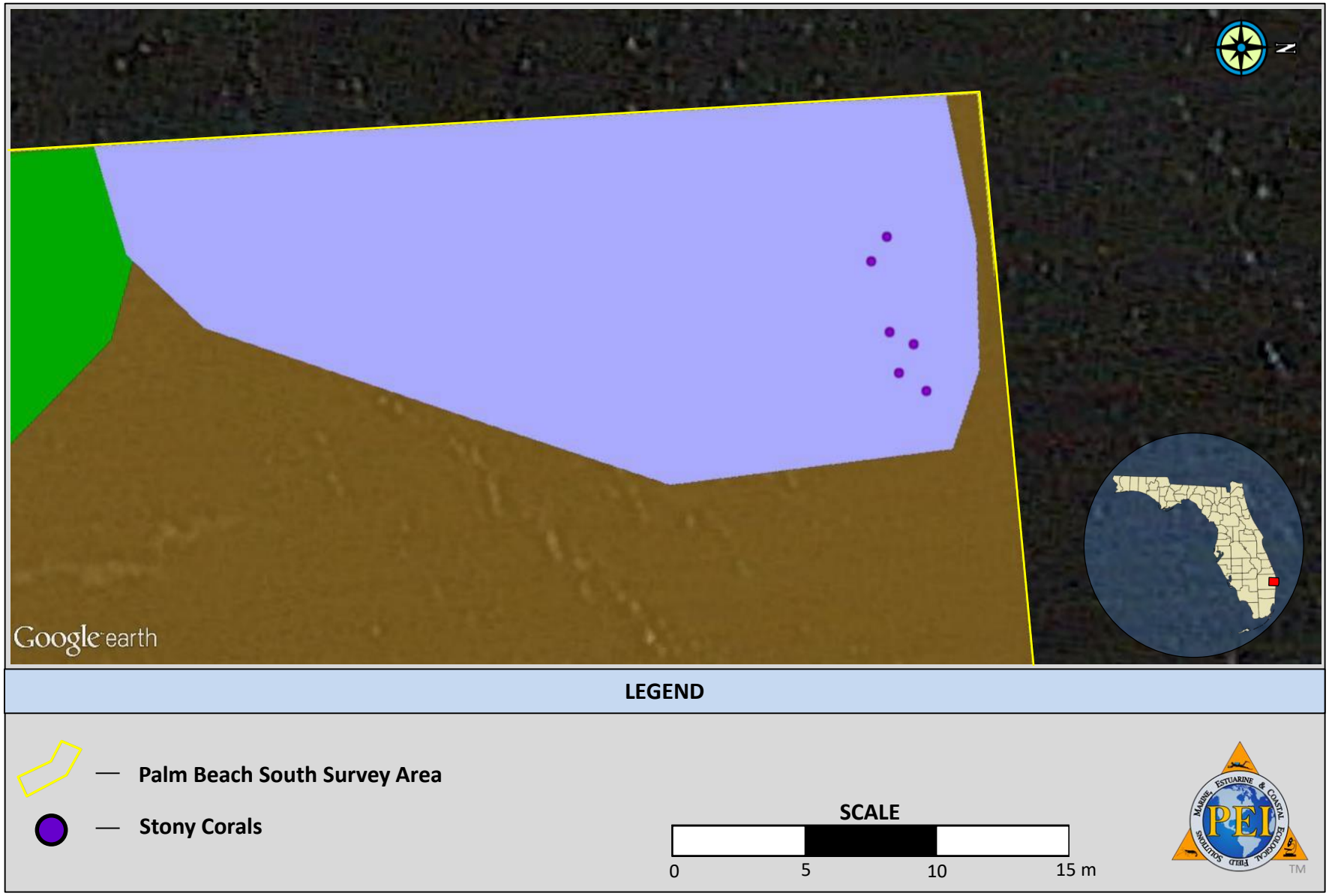

Figure 22 Stony corals mapped at Sample Station HB-8 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

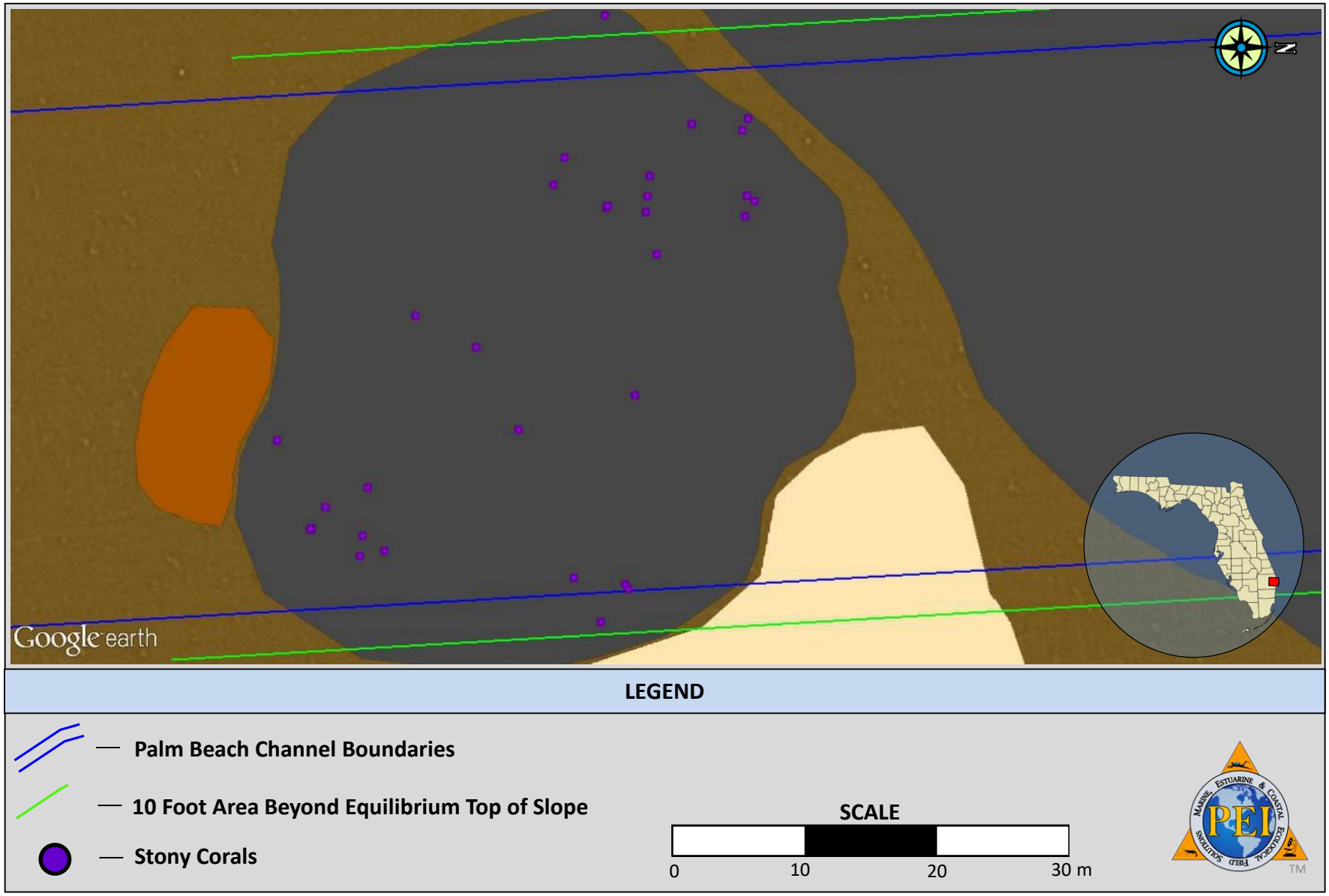

Figure 23 Stony corals mapped at Sample Station HB-9 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

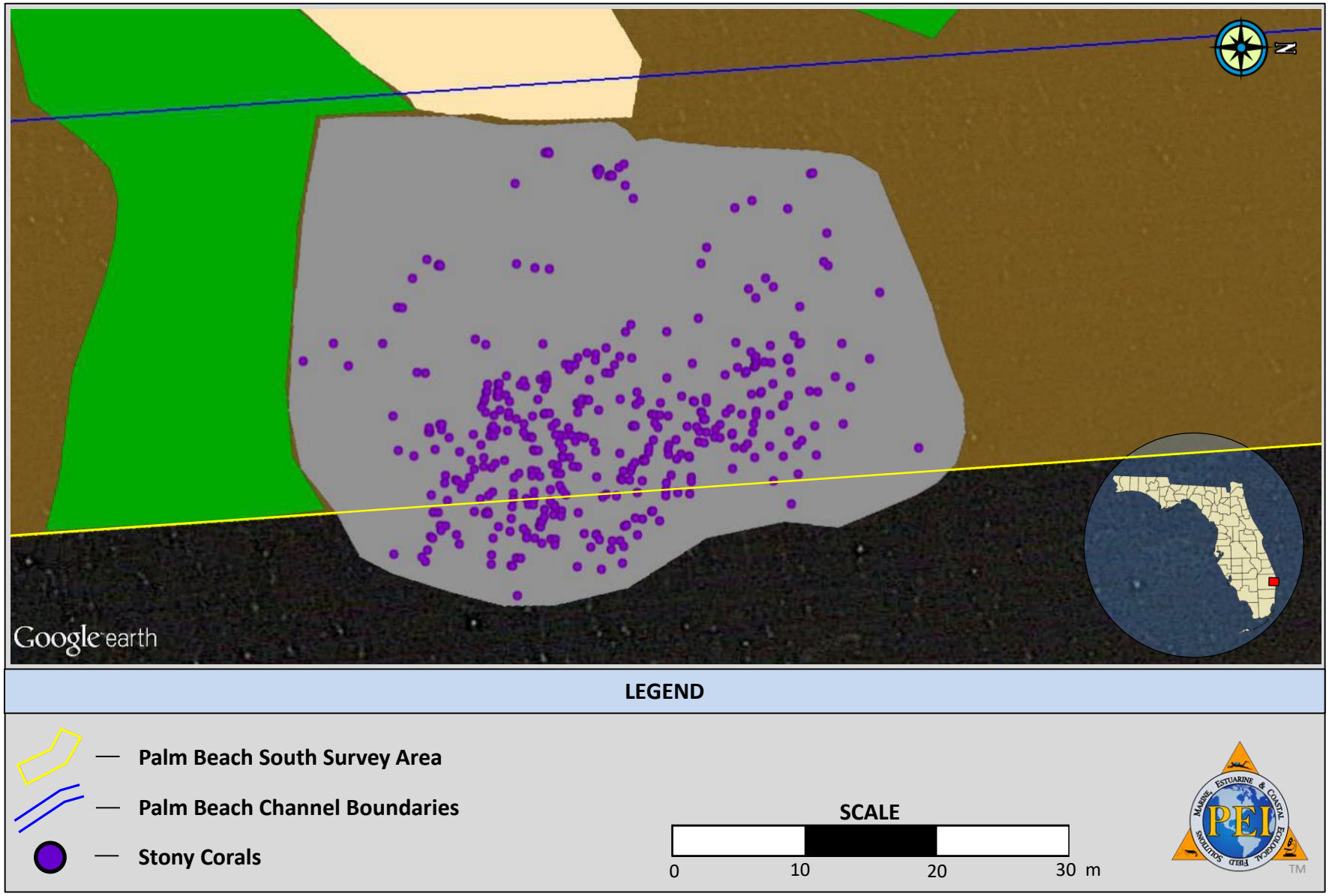

Figure 24 Stony corals mapped at Sample Station HB-10 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

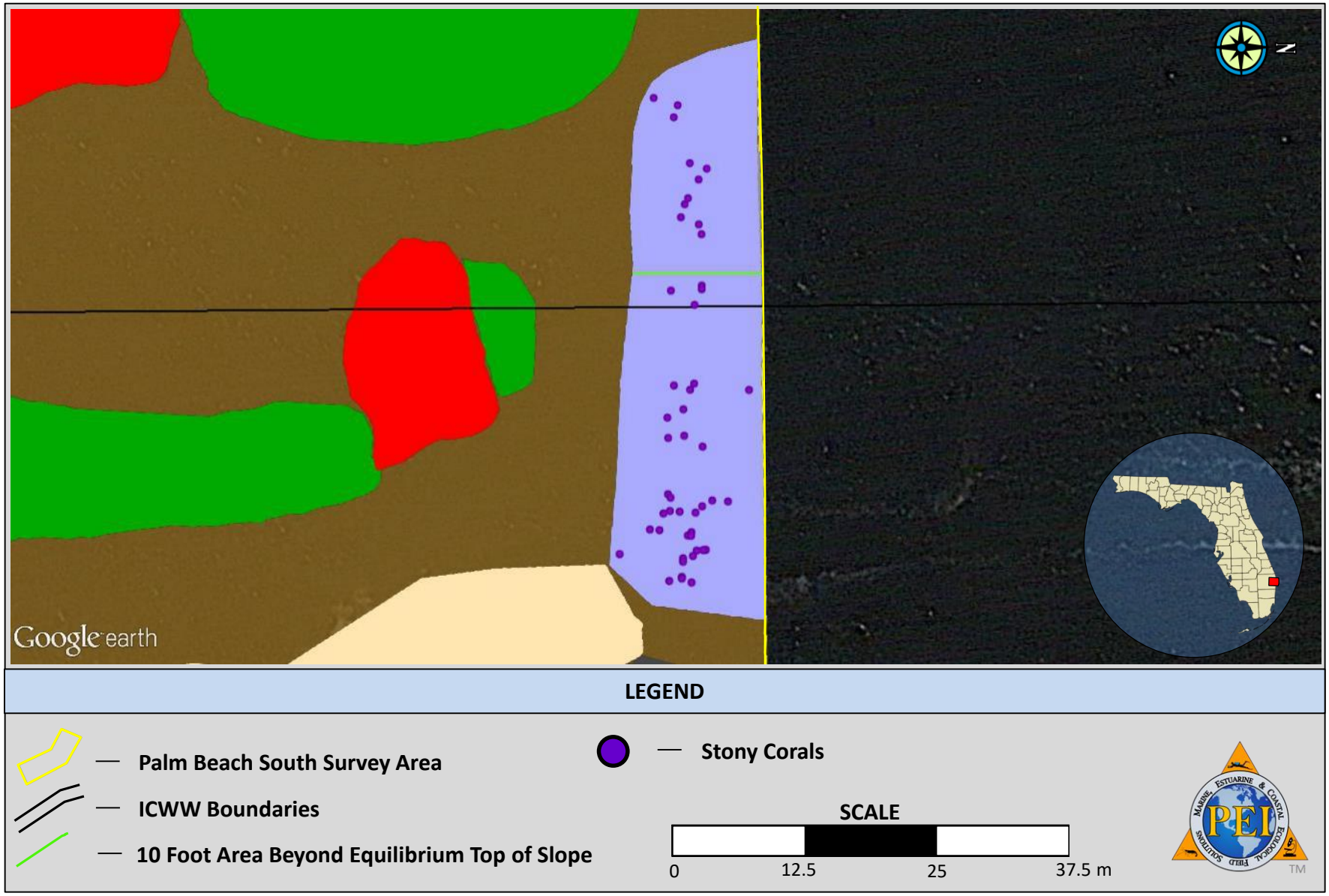

Figure 25 Stony corals mapped at Sample Station HB-13 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

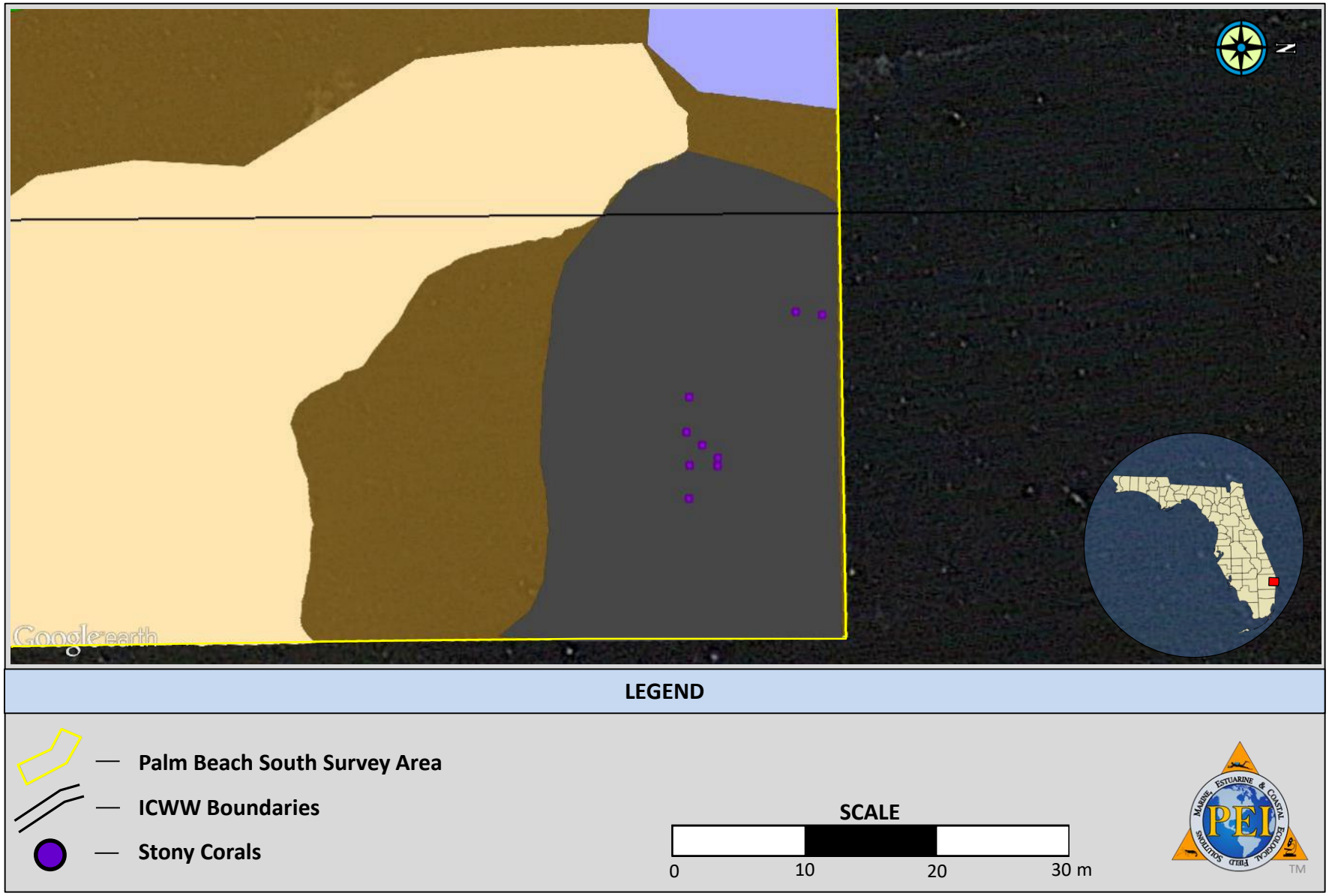

Figure 26 Stony corals mapped at Sample Station HB-14 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

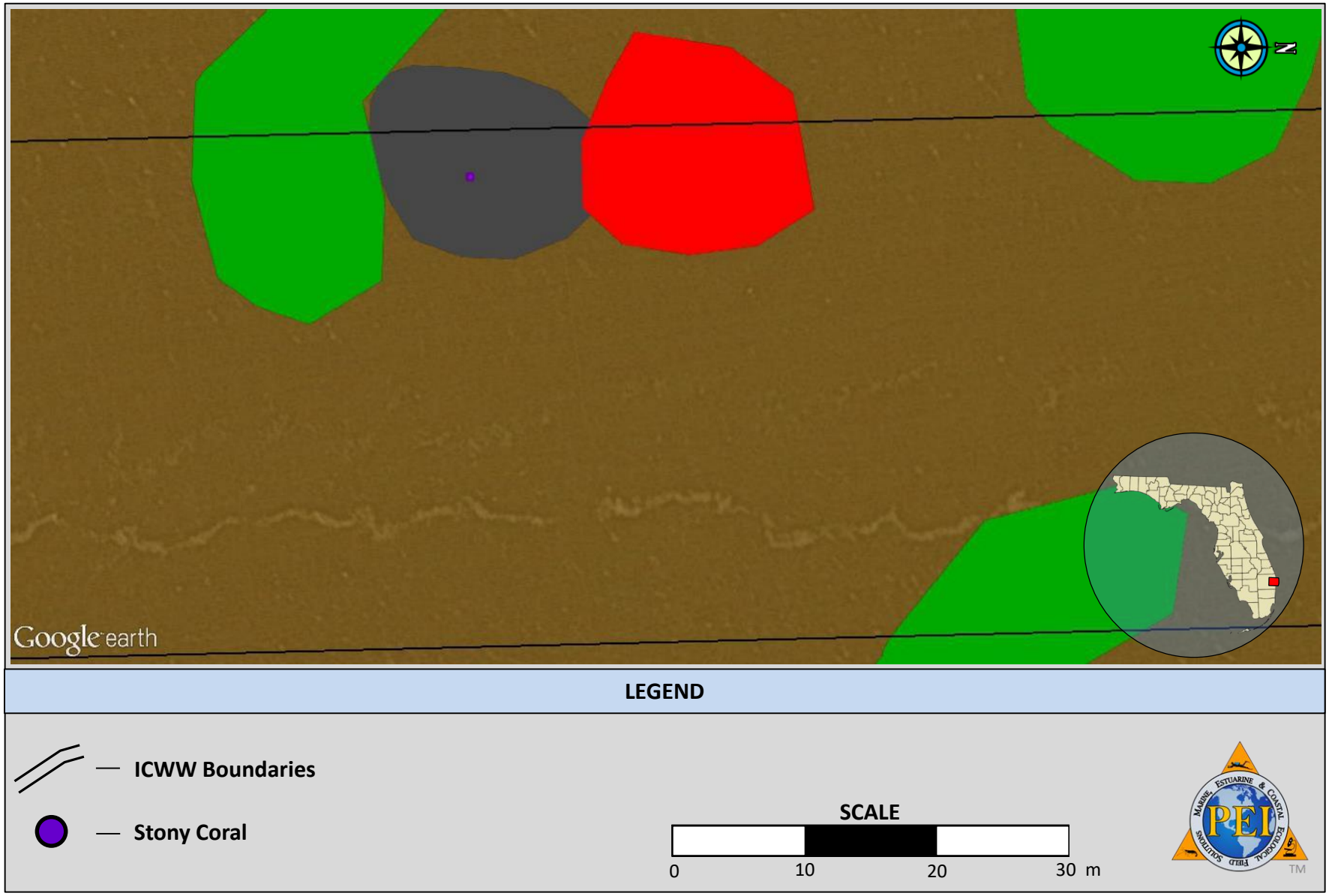

Figure 27 Stony coral mapped at Sample Station HB-17 during the benthic assessment and natural resource survey in Lake Worth Lagoon near West Palm Beach, Florida. Image credit: Google Earth, 2016

Table 6. Stony coral identification and size classification for hardbottom habitat in the ICWW survey area. Note: Stony corals were only observed within the survey area boundaries in the Northern ICWW.

Taxa	Northern ICWW Stations															
	Channel*				10-ft Buffer				100-ft Buffer				Outside Survey Area			
Stony Corals	Size Class				Size Class				Size Class				Size Class			
	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2
ICWW Station HB-4																
O. diffusa	NP				NP				0	2	0	142.09	No Stony Corals Present Outside of Survey Area			
P. americana	1	0	0	12.56	NP				NP							
S. radians	7	0	0	40.04	8	4	0	182.18	14	6	1	437.36				
ICWW Station HB-5																
C. arbuscula	No Stony Corals Present in Channel				No Stony Corals Present in 10-ft Buffer				NP				0	1	0	19.63
D. labyrinthiformis									NP				0	1	0	28.26
M. cavernosa									NP				2	0	0	4.31
O. diffusa									1	1	2	573.84	1	0	0	415.27
P. americana									2	0	0	13.35	3	0	0	1.77
P. astreoides									NP				0	0	1	113.04
P. strigosa									NP				0	1	0	19.63
S. radians									2	0	0	15.70	5	1	0	55.15
S. siderea									0	3	0	77.72	33	5	1	352.39
Siderastrea sp.									8	1	0	68.15	44	3	0	259.50
S. bournoni									1	2	0	76.02	7	6	0	324.70
S. intersepta									0	1	0	28.26	1	0	0	9.62

P = Present

NP = Not Present

*Includes channel and the channel slope

Table 6. Continued.

Taxa	Northern ICWW Stations															
	Channel*				10-ft Buffer				100-ft Buffer				Outside Survey Area			
Stony Corals	Size Class				Size Class				Size Class				Size Class			
	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2
ICWW Station HB-13																
O. diffusa	1	1	2	292.81	NP				NP				No Stony Corals Present Outside of Survey Area			
P. americana	1	0	0	1.77	NP				1	0	0	0.79				
S. radians	32	2	1	313.41	4	0	0	17.66	7	3	0	101.66				
S. siderea	1	0	0	4.91	NP				2	0	0	13.35				
S. intersepta	2	0	0	25.12	NP				NP							
ICWW Station HB-14																
O. diffusa	No Stony Corals Present in Channel				No Stony Corals Present in 10-ft Buffer				0	1	0	28.26	No Stony Corals Present Outside of Survey Area			
S. radians									4	3	0	144.44				
ICWW Station HB-17																
O. diffusa	0	0	1	314.00	NP				NP				NP			

P = Present

NP = Not Present

*Includes channel and the channel slope

Table 7. Stony coral identification and size classification for hardbottom habitat in the Palm Beach Channel survey area.

Taxa	Palm Beach Channel Stations															
	Channel*				10-ft Buffer				100-ft Buffer				Outside Survey Area			
Stony Corals	Size Class				Size Class				Size Class				Size Class			
	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2
PBC Station HB-2																
C. arbuscula	1	0	0	3.14	NP				NP				No Stony Corals Present Outside of Survey Area			
D. labyrinthiformis	1	0	0	12.56	NP				1	1	0	36.31				
M. cavernosa	NP				0	1	0	22.05	NP							
O. diffusa	9	9	2	679.13	1	0	0	3.14	1	3	0	165.05				
P. americana	13	5	0	277.55	NP				6	0	0	28.53				
S. radians	151	42	0	2167.15	31	11	0	504.11	82	15	0	1055.68				
S. siderea	57	6	1	843.73	7	2	0	160.01	3	2	0	109.60				
Siderastrea sp.	4	0	0	3.14	NP				NP							
S. bournoni	0	0	2	568.34	NP				0	0	1	153.86				
S. intersepta	1	0	0	15.90	NP				NP							
T. coccinea	NP				4	8	0	298.50	1	1	0	35.33				
PBC Station HB-3																
O. diffusa	4	4	0	144.05	NP				NP				No Stony Corals Present Outside of Survey Area			
P. americana	13	0	0	31.20	1	0	0	0.79	1	0	0	3.14				
S. radians	23	3	1	294.77	NP				NP							
S. siderea	10	2	0	94.23	NP				NP							
S. intersepta	2	0	0	19.04	NP				NP							
PBC Station HB-8																
P. americana	No Stony Corals Present in Channel				No Stony Corals Present in 10-ft Buffer				2	0	0	19.63	No Stony Corals Present Outside of Survey Area			
S. radians									2	1	0	42.39				
T. coccinea									0	1	0	19.63				

P = Present
NP = Not Present
*Includes channel and the channel slope

Table 7. Continued.

Taxa	Palm Beach Channel Stations															
	Channel*				10-ft Buffer				100-ft Buffer				Outside Survey Area			
Stony Corals	Size Class				Size Class				Size Class				Size Class			
	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2	< 5 cm	5 - 10 cm	> 10 cm	Area cm^2
PBC Station HB-9																
O. diffusa	1	2	0	63.78	NP				NP				No Stony Corals Present Outside of Survey Area			
P. americana	1	0	0	12.56	1	0	0	4.91	NP							
S. radians	16	1	0	200.96	NP				0	1	0	19.63				
S. siderea	4	3	0	127.37	NP				NP							
T. coccinea	2	0	1	232.27	NP				NP							
PBC Station HB-10																
C. arbuscula	No Stony Corals Present in Channel				No Stony Corals Present in 10-ft Buffer				1	3	0	146.55	NP			
D. labyrinthiformis									1	0	0	15.90	NP			
F. fragum									2	0	0	30.65	NP			
O. diffusa									34	46	15	4869.30	4	19	7	2435.66
P. americana									21	1	0	158.13	NP			
P. clivosa									NP				0	1	0	22.05
P. strigosa									2	1	1	165.23	0	1	0	38.47
S. radians									138	0	0	709.80	23	11	0	474.59
S. siderea									28	38	0	1420.34	8	2	1	235.50
S. bournoni									2	3	0	93.81	NP			

P = Present

NP = Not Present

*Includes channel and the channel slope

features including: within the channel and channel slope, the 3 meter (10 foot) area beyond the equilibrium top of slope, and the 30.5-meter (100-foot) buffer area. Corals identified at Sample Station HB-5 were colonizing hardbottom habitat characterized as Hardbottom Outcrop with Scattered Rock. Hardbottom habitat at Sample Station HB-5 overlapped the border along a portion of the ICWW 30.5-meter (100-foot) buffer area. A portion of the hardbottom habitat with corals occurred within the 30.5-meter (100-foot) buffer area and continued outside of the 30.5-meter (100-foot) buffer area. Due to the unique circumstances and proximity of these resources to the proposed project area, the corals were identified, measured, and mapped (**Figure 21**). Hardbottom habitat at sample station HB-2 extended across the width of the Palm Beach Channel and into portions of the adjacent 30.5-meter (100-foot) buffer area. Occasionally habitats and associated resources delineated in the survey area also extended across the survey area boundary. These habitats were mapped and characterized to provide as complete assessment of the habitat and associated resources as possible.

Potential Environmental Factors Influencing Hardbottom Habitat

The Gulf Stream Current flows northward carrying tropical nutrient-rich oceanic water northward along the South Florida Coast. The Gulf Stream is contributed, in part, to the presence of corals colonizing the relic reefs offshore Palm Beach County by transporting coral gametes and planula larvae. The Gulf Stream Current meanders like a river and is periodically close enough to Lake Worth Inlet to allow clear ocean water to enter Lake Worth Lagoon during diurnal flood tides. As the clear ocean water enters Lake Worth Lagoon it is constantly mixing with brackish tannin-rich water discharged via freshwater drainage canals. The further the tide penetrates the estuary the more mixing occurs. The clearest water with adequate salinity occurs closer to the Inlet which is near the Northern ICWW survey area. The clear ocean water provides favorable conditions for coral growth with adequate light availability and salinity conditions. Clear ocean water, however rarely reaches the Southern ICWW survey area. The absence of stony corals in the Southern ICWW survey area may be due, in-part, to lower water quality, increased nutrient levels and other pollutants, limited light availability through the water column, prolonged salinity fluctuations resulting from stormwater runoff or any combination of these factors. Freshwater discharges into coastal estuaries following heavy rainfall in South Florida and the resulting effects on seagrass and other marine biota have been documented in Lake Worth lagoon (Orlando et al., 2016). Several freshwater drainage canals (i.e., C-51, West Palm Beach; C-16, Boynton Canal; and C-17, Earman River) empty directly into Lake Worth Lagoon. The C-51 canal is located 6.1 kilometers (3.8 miles) south of the southernmost end of the survey area. Water levels and discharges through the C-51 canal are controlled by the USACE and the South Florida Water Management District. The canals also deposit muck and pollution that contribute to lower water quality conditions in the Lagoon and sedimentation loads on corals.

4.3 Qualitative Data

During the benthic assessment and resource survey scientific divers conducted *in situ* identifications to the lowest practical identification level (**Table 8**). General biota identified *in situ* included macroalgae such as green algae (*Caulerpa sertularoides, Caulerpa prolifera, Acetabularia* sp., *Halimeda* sp., and *Udotea* sp.), red algae (*Gracilaria* sp., *Acanthaphora* sp., and Rhodophyta [turf algae]), and brown algae (*Dictyota* sp.). Additional benthic resources include multiple sponges (*Ircinia* sp., *Cliona* sp., *Aplysina* sp., and *Niphates* sp.), stony corals (*Siderastrea siderea*, *Siderastrea radians,* and *Solenastrea bournoni*), stone crab (*Menippe mercenaria*), spiny lobster (*Panulirus argus*), and echinoderms (*Oreaster reticulatus*, *Diadema antillarum*, and *Isostichopus bandionotus*). A total of forty (40) fish species were identified during the survey including common snook (*Centropomus undecimalis*), French angelfish (*Pomacanthus paru*), hogfish (*Lachnolaimus maximus*), mangrove snapper (*Lutjanus griseus*), and rock hind (*Epinephelus*

adscensionis). Sightings of bottlenose dolphins (*Tursiops truncatus*) were common during the survey. Two species of sea turtle were observed during the field survey: green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*). Representative photos have been provided in the **ATTACHMENT**.

Table 8. Comprehensive list of marine resources observed during the benthic assessment and resource survey along the ICWW and Palm Beach Channel (PBC) in Lake Worth Lagoon, Palm Beach County, Florida.

Common Name	Scientific Name	ICWW Stations											PBC Stations			Survey Area
		Northern									Southern					
		SG-1	SG-2	SG-3	SG-5	SG-6	SG-7	HB-1	HB-4	HB-5	HB-6	HB-7	SG-4	HB-2	HB-3	
Algae																
Green Algae	**Chlorophyta**															
Green Algae	*Caulerpa* sp.				x		x				x	x				x
Green Algae	*Penicillus sp.*															x
Green Blade Algae	*Caulerpa prolifera*	x	x		x	x	x						x			x
Green Calcareous Algae	*Halimeda sp.*				x											
Green Fan Algae	*Udotea* spp.															x
Green Feather Algae	*Caulerpa sertulariodes*	x	x		x											x
Green Fibrous Algae	*Caulerpa verticilata*															x
Mermaid's wineglass	*Acetabularia sp.*				x											
Brown Algae	**Phaeophyta**															
Brown Branching Algae	*Dictyota* sp.		x	x		x								x	x	
Red Algae	**Rhodophyta**															
Filamentous Red Alage	Rhodophyta	x	x	x		x										
Red Alage	*Acanthophora*sp.		x	x	x											
Red Algae	*Gracilaria* sp.	x	x	x	x	x							x			
Red Turf Algae	Rhodophyta			x	x	x					x		x			
Marine Plants																
Johnson's Seagrass	*Holophila johnsonii*		x			x										
Paddle Grass	*Holophila decipiens*	x	x	x	x	x	x						x			
Shoalgrass	*Halodule wrightii*					x										
Porifera																
Barrel Sponge	*Xestospongia* sp.									x						
Black Ball Sponge	*Ircinia* sp.									x				x		
Boring Sponge	*Cliona* sp.							x	x	x				x		
Chicken Liver Sponge	*Chondrilla* sp.									x	x			x		
Encrusting Sponge	*Placospongia* sp.									x				x	x	
Green Finger Sponge	*Iotrochota birotulata*													x		
Orange Boring Sponge	*Cliona delitrix*									x					x	
Rope Sponge	*Aplysina* sp.														x	
Rope Sponge	*Niphates* sp.							x	x	x	x			x	x	x
Unidentified Branching Sponge	Porifera		x	x												
Unidentified Encrusting Sponge	Porifera											x				

X = Present

Table 8. (Continued).

Common Name	Scientific Name	ICWW Stations											PBC Stations			Survey Area
		Northern									Southern					
		SG-1	SG-2	SG-3	SG-5	SG-6	SG-7	HB-1	HB-4	HB-5	HB-6	HB-7	SG-4	HB-2	HB-3	
Cnidaria																
Hydrozoa																
Algae Hydroids	*Thyroscyphus* sp.							x	x		x			x	x	x
Hydroids (multiple species)	Hydrozoa	x	x	x	x			x	x		x		x	x	x	x
Anthozoa																
Burrowing Anemone	Ceriantharia	x	x					x							x	x
Corkscrew Anemone	*Bartholomea annulata*		x							x						x
Giant Anemone	*Condylactis gigantea*													x		x
Octocorallia																
Sea Whip	*Leptogorgia* sp.														x	
White Telesto	*Carijoa riisei*								x	x	x			x	x	x
Zoanthidae																
Mat Zoanthid	*Zoanthus* sp.									x				x		
Sponge Zoanthid	*Parazoanthus parasiticus*									x						
Scleractinia																
Blushing Star Coral	*Stephanocoenia intersepta*									x						x
Golf Ball Coral	*Favia fragum*															x
Great Star Coral	*Montastrea cavernosa*									x				x		
Grooved Brain Coral	*Diploria labyrinthiformis*									x				x		x
Hidden Cup Coral	*Phyllangia americana*									x					x	x
Ivory Bush Coral	*Oculina diffusa*									x				x	x	x
Knobby Brain Coral	*Pseudodiploria clivosa*															x
Lesser Starlet Coral	*Siderastrea radians*								x	x						x
Massive Starlet Coral	*Siderastrea siderea*									x				x	x	x
Mustard Hill Coral	*Porites astreoides*									x						
Orange Cup Coral	*Tubastraea coccinea*													x		x
Smooth Star Coral	*Solenastrea bournoni*									x				x		
Starlet Coral	*Siderastrea* sp.									x						
Symmetrical Brain Coral	*Pseudodiploria strigosa*									x						x
Tube Coral	*Cladocora arbuscula*									x				x		x
Ctenophora																
Comb Jelly	*Mnemiopsis leidyi*		x								x					

X = Present

Table 8. (Continued).

Common Name	Scientific Name	ICWW Stations											PBC Stations			Survey Area
		Northern									Southern					
		SG-1	SG-2	SG-3	SG-5	SG-6	SG-7	HB-1	HB-4	HB-5	HB-6	HB-7	SG-4	HB-2	HB-3	
Annelida																
Bearded Fireworm	*Hermodice carunculata*	x						x		x			x	x		x
Christmas Tree Worm	*Spirobranchus* sp.									x				x		
Feather Duster Worm	Sabellidae	x	x		x			x	x		x	x			x	x
Horseshoe Worm	Phoronida	x	x			x	x						x			
Tube Worms (multiple species)	Polychaeta			x	x									x	x	
Arthropoda																
Banded Coral Shrimp	*Stenopus hispidus*									x						
Caribbean Spiny Lobster	*Panulirus argus*							x		x				x		x
Florida Stone Crab	*Menippe mercenaria*							x		x				x		x
Giant Hermit Crab	*Petrochirus diogenes*							x		x				x		
Hermit Crabs (multiple species)	Paguroidea		x							x			x	x		
Horseshoe Crab	*Limulus polyphemus*									x						x
Mantis Shrimp	Stomatopoda			x						x			x			
Shrimp	Caridea	x	x													
Swimming Crab	*Achelous* sp.	x										x				x
Swimming Crab	Portunidae									x						
Crabs (multiple species)	Brachyura											x				x
Yellowline Arrow Crab	*Stenorhynchus seticornis*							x	x				x		x	
Ectoprocta																
Branching Bryozoans	Cheilostomata									x					x	
Encrusting Bryozoans	Cheilostomata									x				x	x	
Bryozoans (multiple species)	Cheilostomata												x			
Mollusca																
Florida Fighting Conch	*Strombus alatus*		x			x							x			x
Helmet Conch	*Cassis* sp.															x
Horse Conch	*Pleuroploca gigantea*															x
Rough Fileclam	*Lima scabra*									x						
Snails (various Species)	Gastropoda			x			x									

X = Present

Table 8. (Continued).

Common Name	Scientific Name	ICWW Stations											PBC Stations			Survey Area
		Northern									Southern					
		SG-1	SG-2	SG-3	SG-5	SG-6	SG-7	HB-1	HB-4	HB-5	HB-6	HB-7	SG-4	HB-2	HB-3	
Echinodermata																
Brittle Stars (multiple species)	Ophiuroidea	x	x			x										
Cushion Sea Star	*Oreaster reticulatus*			x				x						x	x	x
Lined Sea Star	*Luidia clathrata*		x													x
Long-spined Sea Urchin	*Diadema antillarum*													x		x
Pencil Urchin	*Eucidaris tribuloides*									x			x	x		
Purple-spined Sea Urchin	*Arbacia punctulata*									x			x	x		
Sea Cucumber	*Holothoria* sp.							x							x	
Sea Cucumber	*Isostichopus bandionotus*							x							x	x
Urchin	Echinoidea												x			x
West Indian Sea Egg	*Tripneustes ventricosus*									x						x
Chordata																
Black Tunicate	*Ascidia nigra*							x	x	x	x	x		x	x	x
Bulb Tunicate	*Clavelina* sp.									x				x		
Colonial Ascidians	*Eudistoma* spp.									x						x
Fishes																
Atlantic Spadefish	*Chaetodipterus faber*									x	x				x	x
Atlantic Guitarfish	*Rhinobatos lentiginosus*															x
Bandtail Puffer	*Sphoeroides spengleri*							x	x	x	x	x		x	x	x
Barjack	*Caranx ruber*									x					x	x
Blenny	Clinidae	x	x		x	x		x	x	x		x	x	x	x	x
Blue Angelfish	*Holcanthus bermudensis*														x	x
Bluehead Wrasse	*Thalassoma bifasciatum*									x						
Cardinalfish	Apogonidae									x						
Checkered Puffer	*Sphoeroides testudineus*														x	x
Common Snook	*Centropomus undecimalis*									x					x	x
Cubbyu	*Equetus umbrosus*													x		x
Doctor Fish	*Acanthurus chinrugus*									x				x		x
Dusky Damselfish	*Stegastes fuscus*									x				x		
French Angelfish	*Pomacanthus paru*							x		x	x			x		x
French Grunt	*Haemulon flavolineatum*							x		x						x

X = Present

Table 8. (Continued).

Common Name	Scientific Name	ICWW Stations											PBC Stations			Survey Area
		Northern									Southern					
		SG-1	SG-2	SG-3	SG-5	SG-6	SG-7	HB-1	HB-4	HB-5	HB-6	HB-7	SG-4	HB-2	HB-3	
Fishes (continued)																
Goby (multiple species)	Gobiidae									x				x	x	
Great Barracuda	*Sphyraena barracuda*							x		x				x	x	x
Grey Angelfish	*Pomacanthus arcuatus*							x	x					x	x	x
Gray Triggerfish	*Balistes capriscus*								x	x	x					x
Hogfish	*Lachnolaimus maximus*									x				x		
Jawfish	*Opistognath* sp.					x									x	
Jacknife fish	*Equetus lanceolatus*													x		x
Lane Snapper	*Lutjanus synagris*							x			x	x				x
Lionfish	*Pterois volitans*							x						x	x	
Mangrove Snapper	*Lutjanus griseus*										x					x
Nurse Shark	*Ginglymostoma cirratum*										x					
Ocean Surgeonfish	*Acanthurus bahianus*										x			x		
Pipefish	Syngnathidae					x	x									
Porkfish	*Anisotremus virginicus*							x	x	x	x	x		x	x	x
Rock Hind	*Epinephelus adscensionis*							x	x	x	x	x		x	x	x
Sergeant Major	*Abudefduf saxatilis*							x		x						x
Scorpionfish	*Scorpaena* sp.							x	x	x					x	
Shark	Carcharhinidae															x
Sheepshead	*Archosargus probatcephalus*									x	x	x			x	x
Slippery Dick	*Halichoeres bivittatus*										x	x			x	x
Spanish Hogfish	*Bodianus rufus*									x					x	x
Spotfin Butterflyfish	*Chaetodon ocellatus*							x		x					x	
Spottail Pinfish	*Diplodus holbrookii*									x						x
Spotted Eagle Ray	*Aetobatus narinari*													x		x
Spotted Moray	*Gymnothorax moringa*									x						
Tomtate	*Haemulon aurolineatum*									x		x				x
White grunt (juvenile)	*Haemulon plumieri*									x						x
Yellow Stingray	*Urobatis jamaicensis*	x						x		x						x
Marine Mammals and Turtles																
Common Bottlenose Dolphin	*Tursiops truncatus*															x
Green Turtle	*Chelonia mydas*															x
Loggerhead Turtle	*Caretta caretta*															x

X = Present

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ATTACHMENT

REPRESENTATIVE PHOTOS

Photo 1. During Phase I of the assessment survey, divers equipped with underwater communications identified seagrass and hardbottom resources while being towed behind a surface support vessel.

Photo 2. A view of the surface support vessel and the survey area, located along the Intracoastal Waterway (ICWW) in Lake Worth Lagoon.

Photo 3. A 1-meter^2 quadrat set up along a 10-meter transect, used to collect quantitative seagrass data including frequency of occurrence, density, and percent cover .

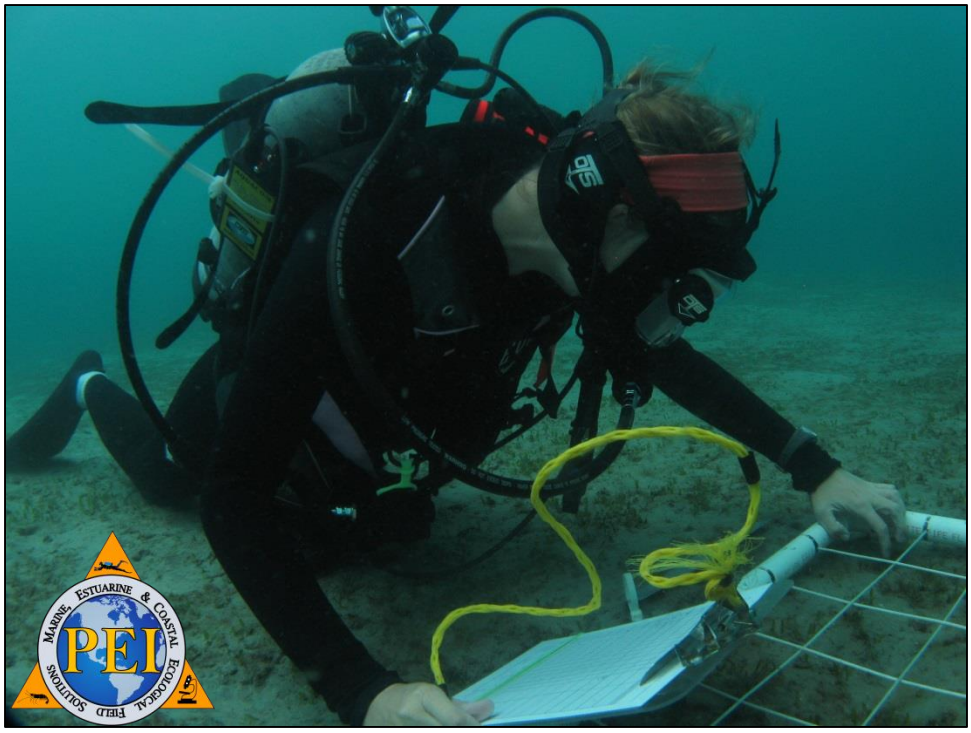

Photo 4. A scientist collects Braun-Blanquet data at Sample Station SG-1.

Photo 5. A close-up of paddle grass (*Halophila decipiens*) at Sample Station SG-1.

Photo 6. Quantitative data was collected for two 10-meter transects at each seagrass sampling station.

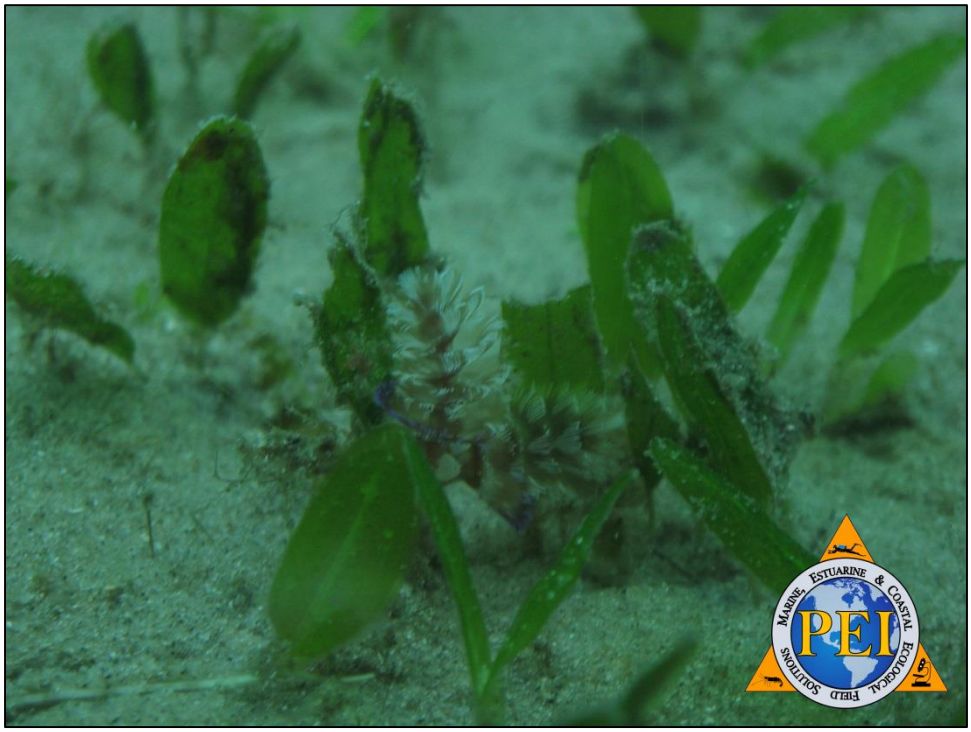

Photo 7. A horseshoe worm (Phoronida) located amongst blades of paddle grass (*Halophila decipiens*) at Sample Station SG-1.

Photo 8. A bearded fireworm (*Hermodice caruncalata*) observed while collecting quantitative seagrass data at Sample Station SG-4.

Photo 9. A scientist counts seagrass shoots to determine seagrass density (shoots/meter^2) at Sample Station SG-5.

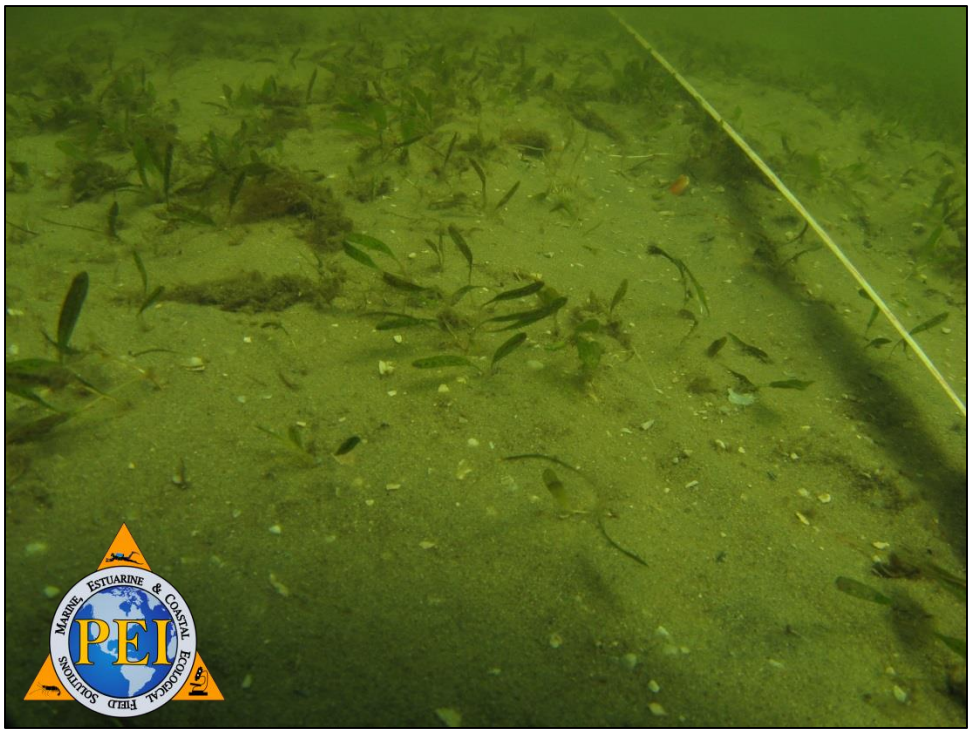

Photo 10. Johnson's seagrass (*Halophila johnsonii*) at Sample Station SG-6.

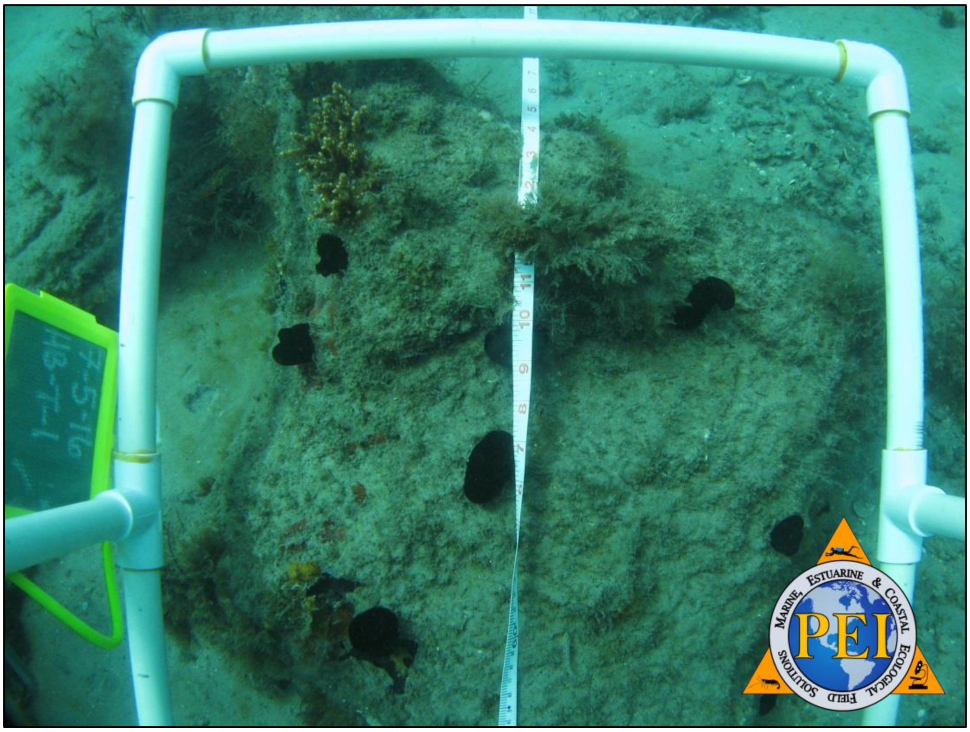

Photo 11. A 0.25-meter^2 quadrat was used to take photographs at a fixed distance above the substrate along hardbottom transects. Photographs were then analyzed using CPCe software to determine percent cover of substrate and biota.

Photo 12. Overview of hard bottom topography at Sample Station HB-1.

Photo 13. Black tunicates (*Ascidia nigra)* within photo quadrat on hard bottom at Sample Station HB-1.

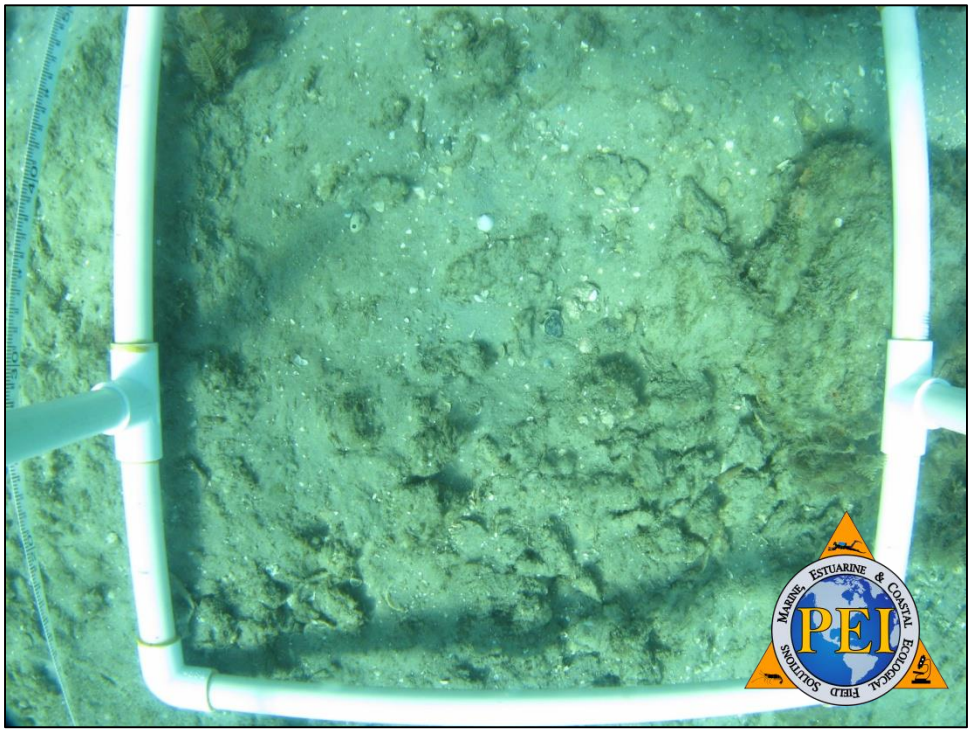

Photo 14. Emergent rock and rubble within photo quadrat at Sample Station HB-4.

Photo 15. Sponges, hydroids, and tunicates colonized hard bottom at Sample Station HB-4. A scientist points out juvenile lesser starlet corals (*Siderastrea radians*).

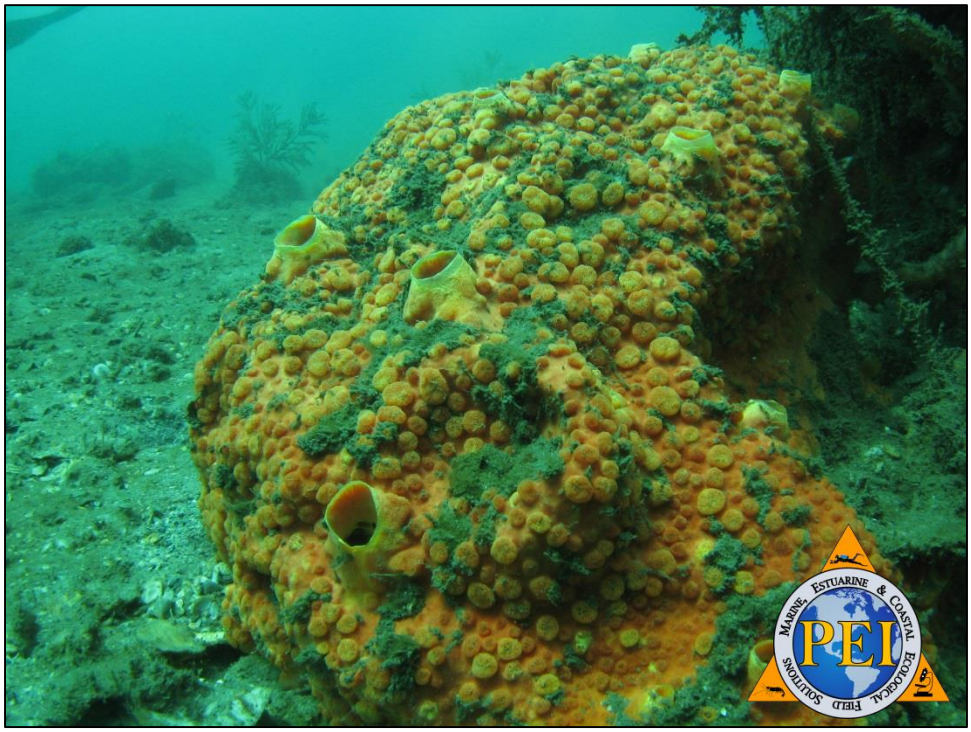

Photo 16. A close-up of the red boring sponge (*Cliona delitrix*) at Sample Station HB-3.

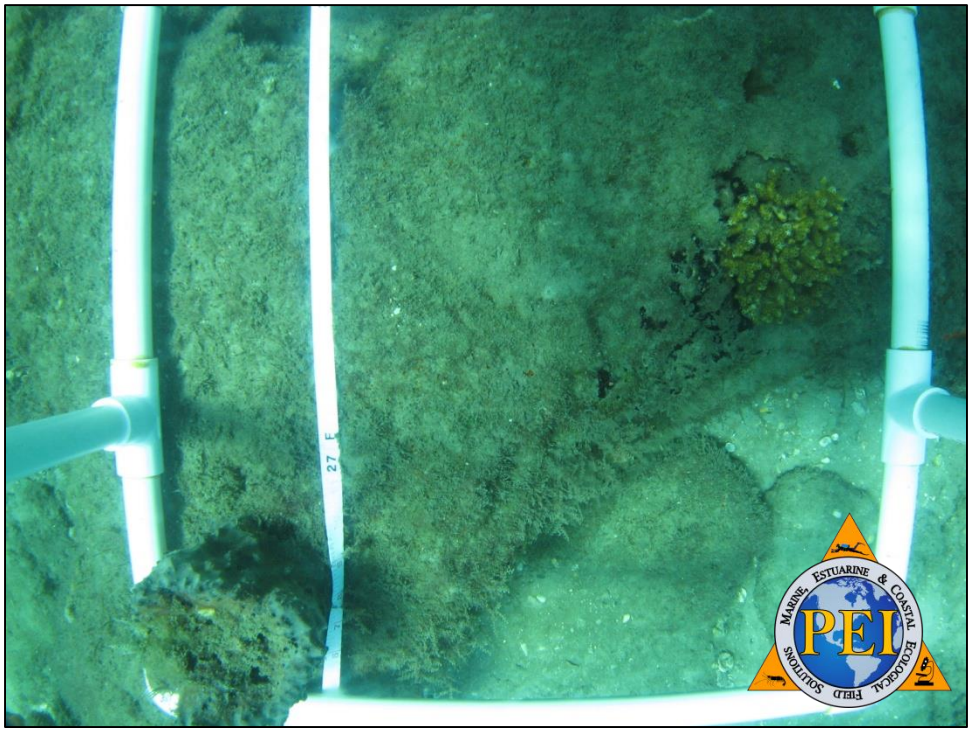

Photo 17. Ivory bush coral (*Oculina diffusa*) and ball sponge (*Ircinia* sp.) observed in photo quadrat at Sample Station HB-5.

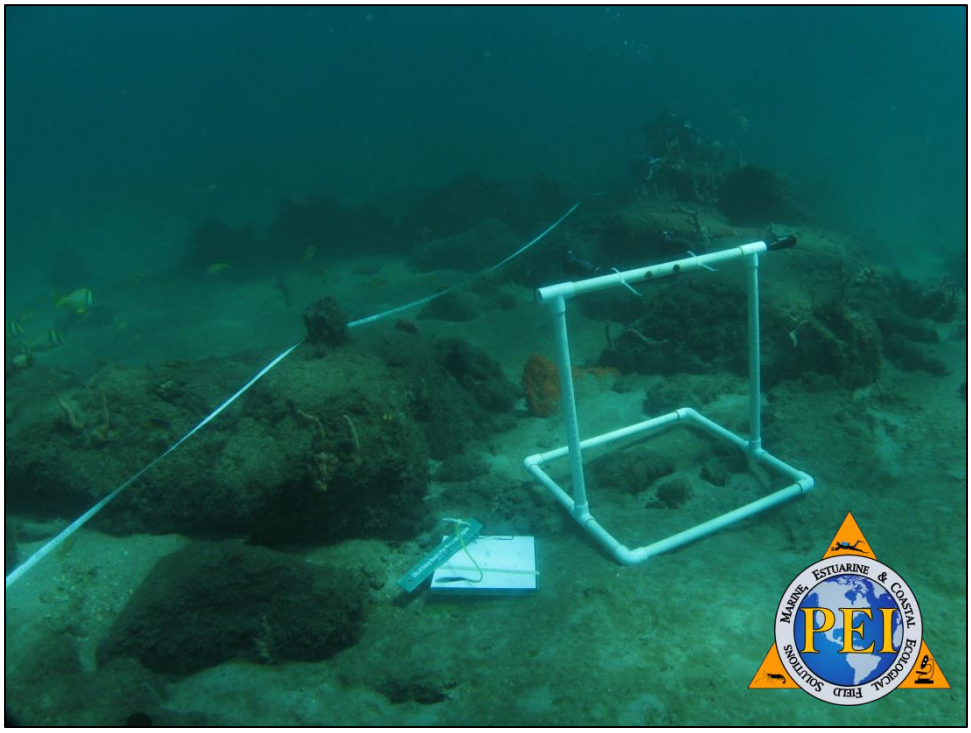

Photo 18. Representation of transect and photo quadrat set-up within Sample Station HB-5.

Photo 19. A scientist measures an ivory bush coral (*Oculina diffusa)* colony at Sample Station HB-5.

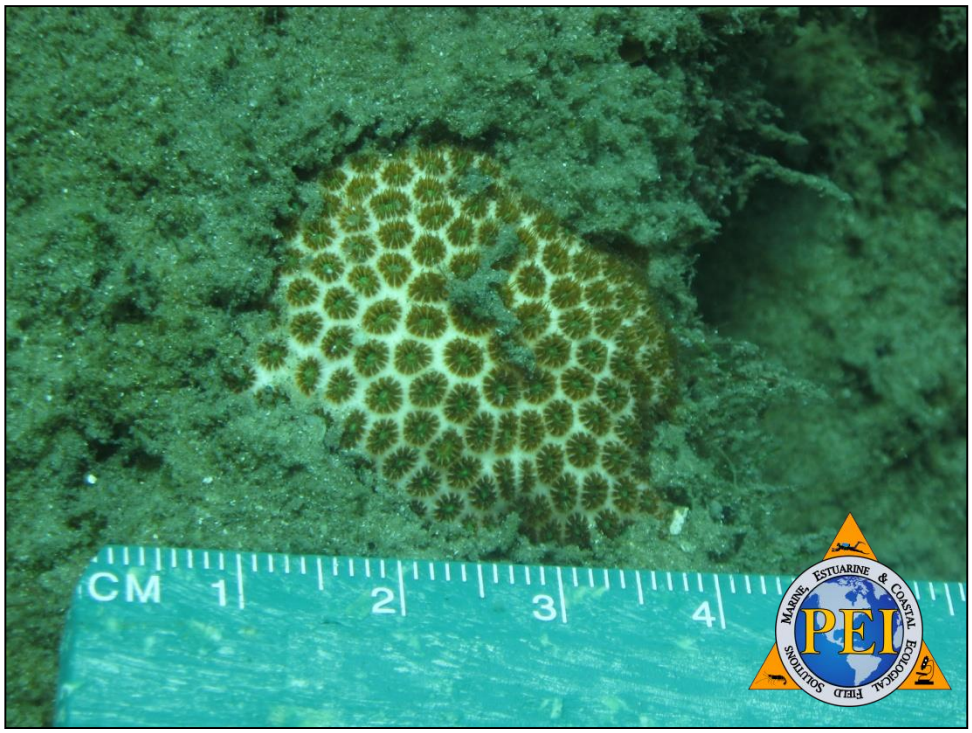

Photo 20. A blushing star coral (*Stephanocoenia intersepta*) observed at Sample Station HB-5.

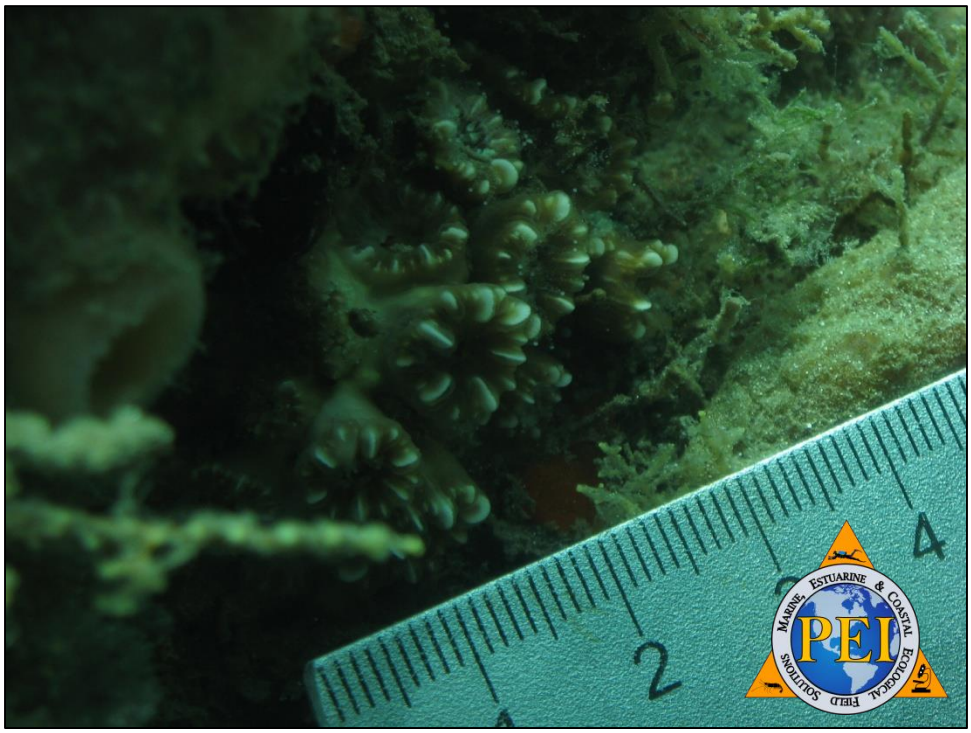

Photo 21. Scientist measuring hidden cup coral (*Phyllangia americana*) at Sample Station HB-5.

Photo 22. Yellow stingray (*Urobatis jamaicensis*) and West Indian sea egg (*Tripneutes ventricosus*) observed along the benthic habitat at Sample Station HB-5.

Photo 23. Aggregations of porkfish (*Anisotremus virginicus)* and sergeant majors (*Abudefduf saxatilis*) were observed at Sample Station HB-5.

Photo 24. View of quantitative transect and quadrat set-up at Sample Station SG-4.

Photo 25. A scientist collects quantitative seagrass data at Sample Station SG-4.

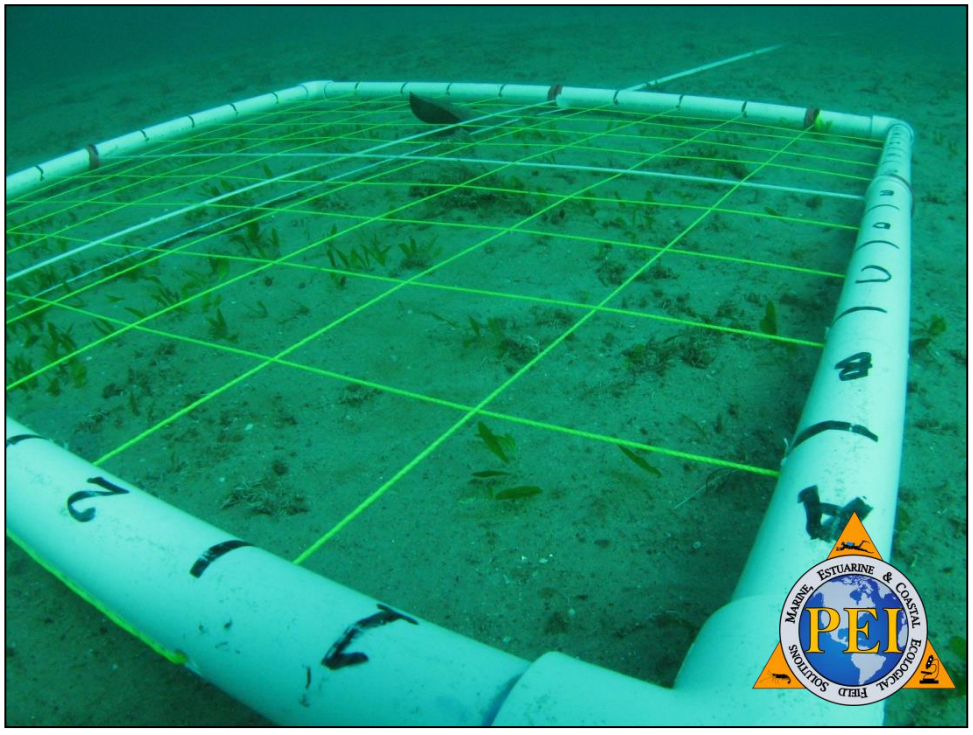

Photo 26. Close up view of quantitative seagrass survey quadrat with paddle grass (*Halophila decipiens*) at Sample Station SG-4.

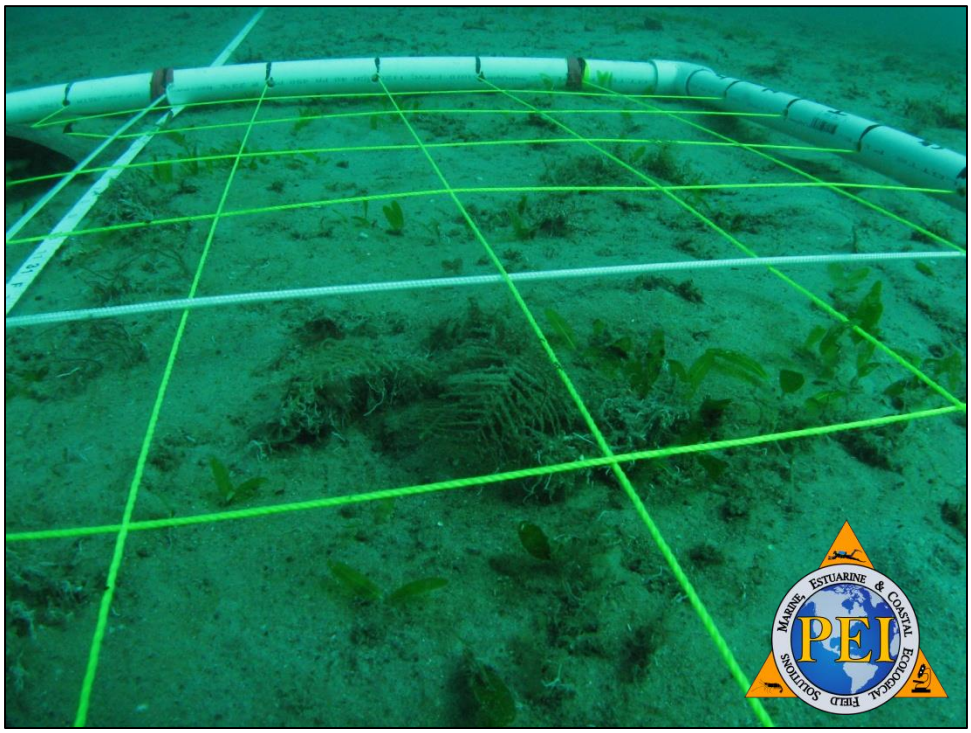

Photo 27. Paddle grass (*Halophila decipiens*) and hydroids at Sample Station SG-4.

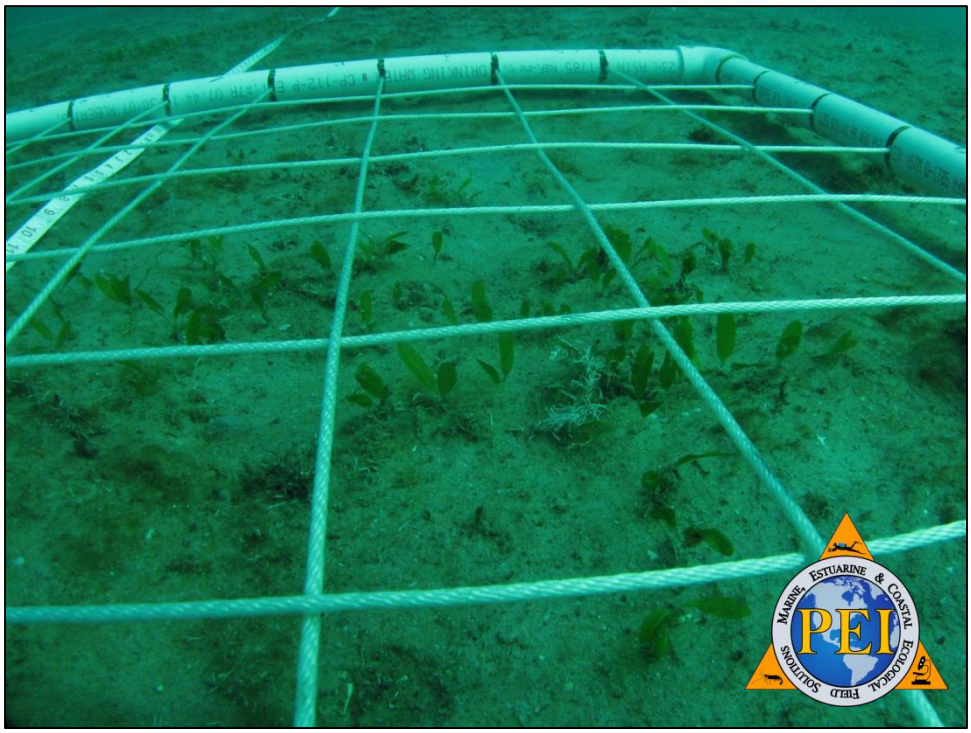

Photo 28. Paddle grass *(Halophila decipiens*) within a quantitative seagrass quadrat at Sample Station SG-6.

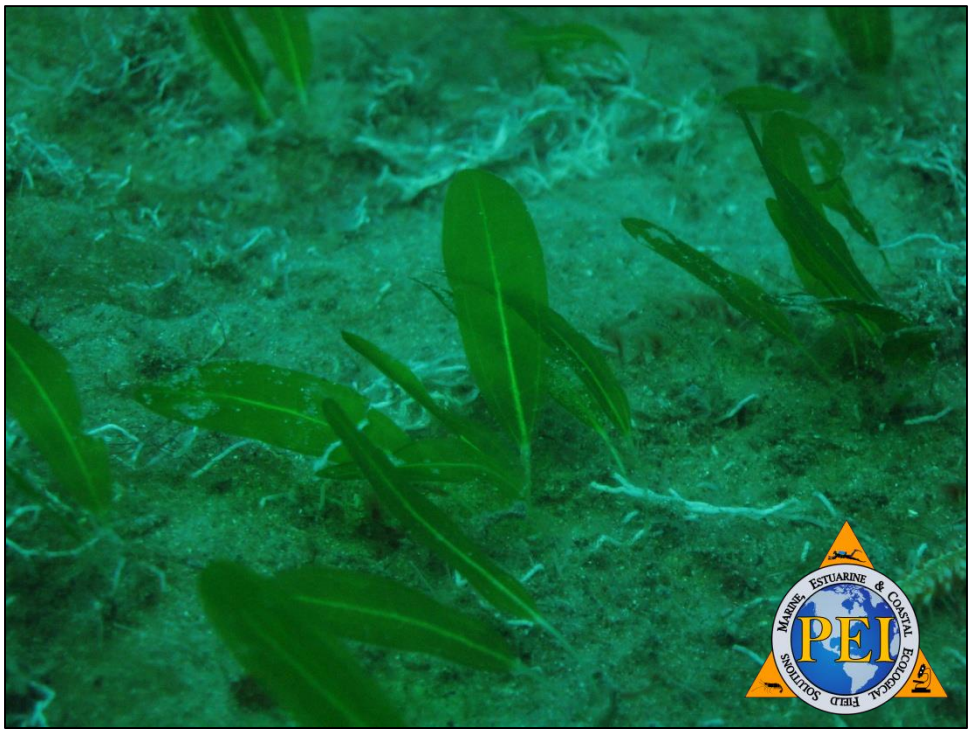

Photo 29. Close up view of paddle grass (*Halophila decipiens)* at Sample Station SG-4.

Photo 30. Rock and rubble with a shell/sand substrate at Sample Station HB-2.

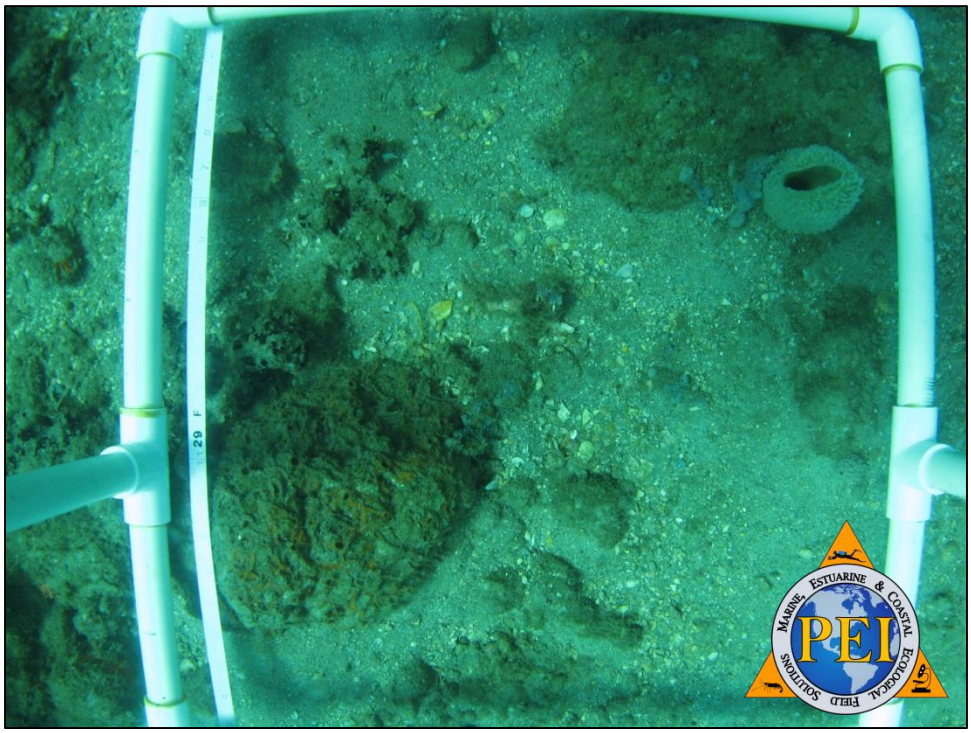

Photo 31. Encrusting sponge and vase sponge observed within a photo quadrat at Sample Station HB-2.

Photo 32. Rope sponges and small juvenile massive starlet coral (*Siderastrea siderea*) observed at Sample Station HB-2.

Photo 33. Adult grey angelfish (*Pomacanthus arcuatus)* and juvenile French angelfish (*Pomacanthus paru*) observed along with a variety of sponges colonizing Emergent Rock Rubble with Sand habitat at Sample Station HB-2.

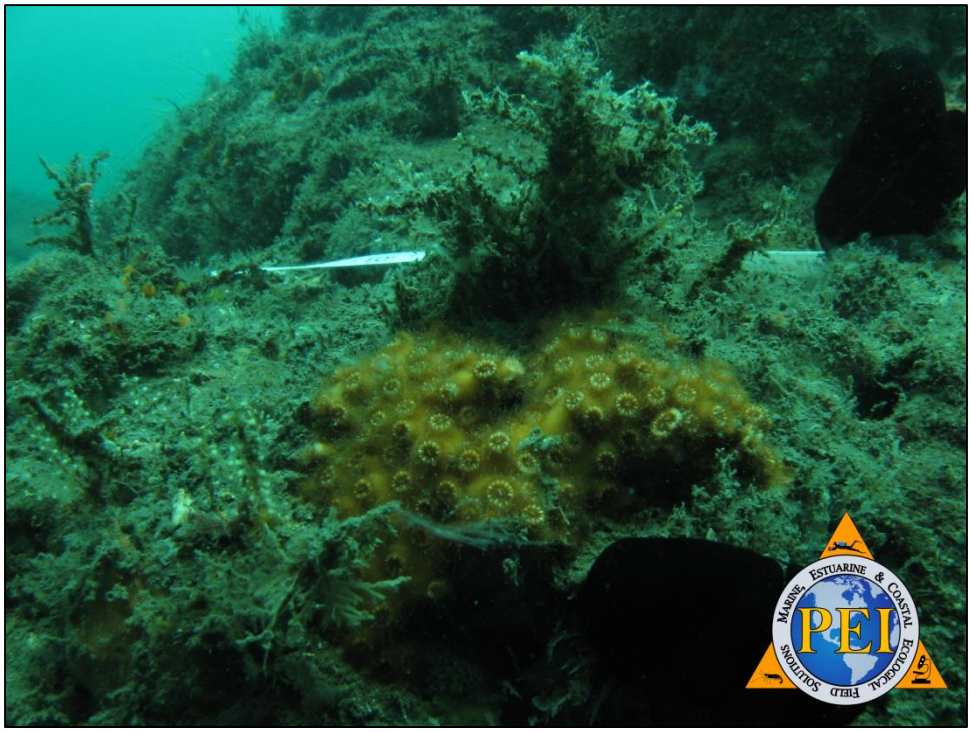

Photo 34. Ivory bush coral (*Oculina diffusa)* observed at Sample Station HB-3.

Photo 35. Overview of benthic topography at Sample Station HB-3.

Photo 36. Multiple rope sponge species were observed colonizing rubble at Sample Station HB-3.

Photo 37. Sand and shell substrate at Sample Station HB-3.

Photo 38. Cushion sea star (*Oreaster reticulatus*) observed at Sample Station HB-3.

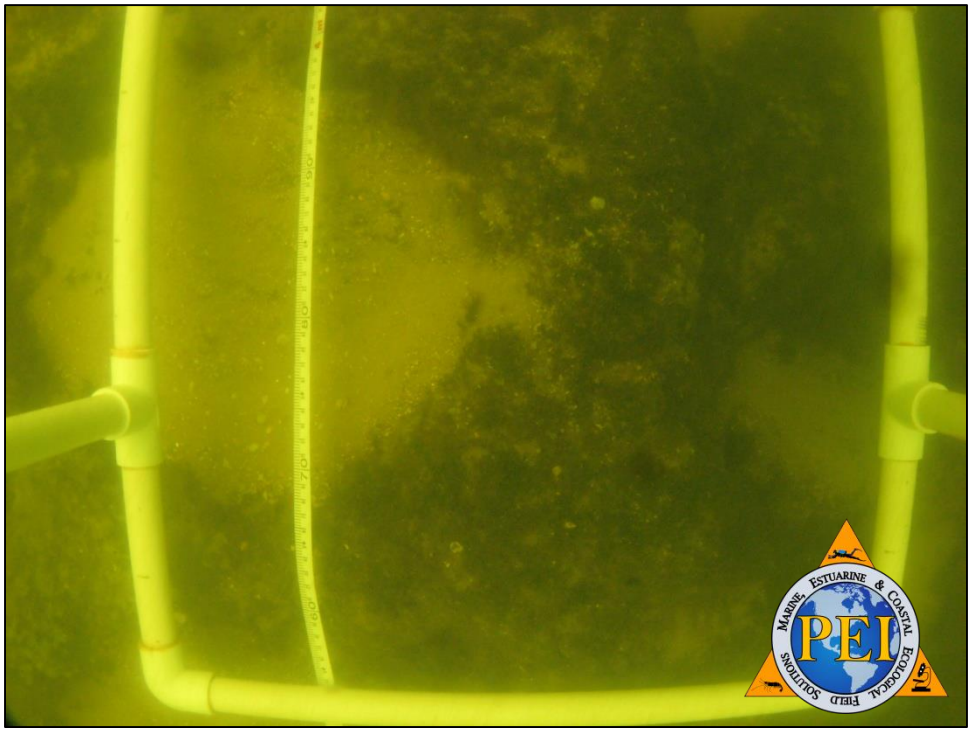

Photo 39. Hardbottom outcrop at Sample Station HB-6.

Photo 40. Sponge communities observed at Sample Station HB-6.

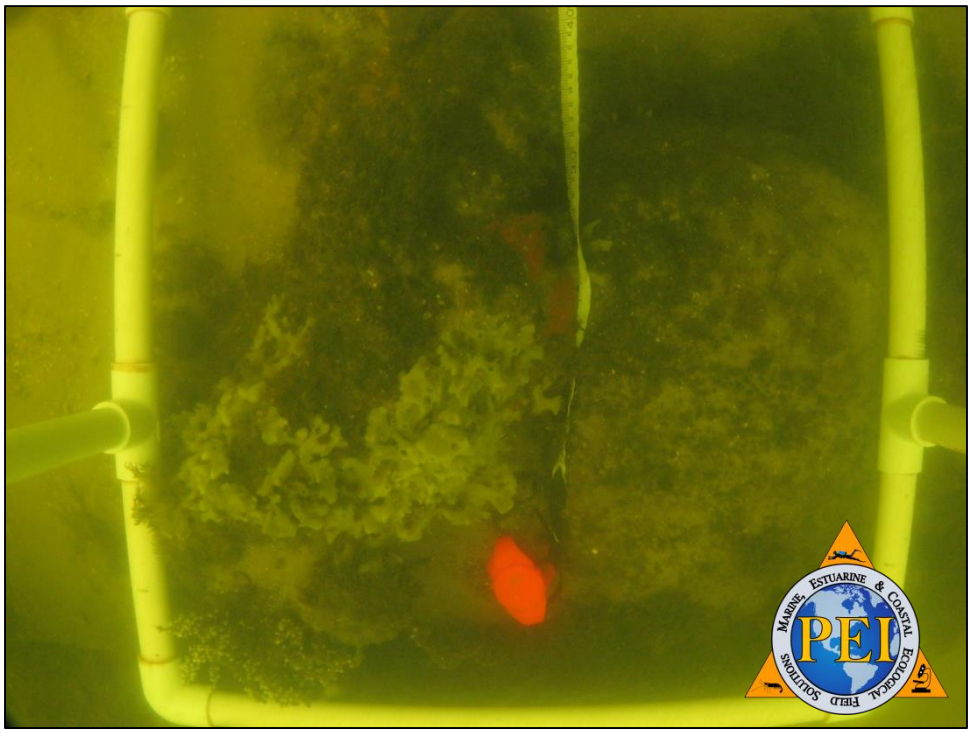

Photo 41. Sponge and hydroid communities observed at Sample Station HB-6.

Photo 42. Rock and rubble substrate at Sample Station HB-7.

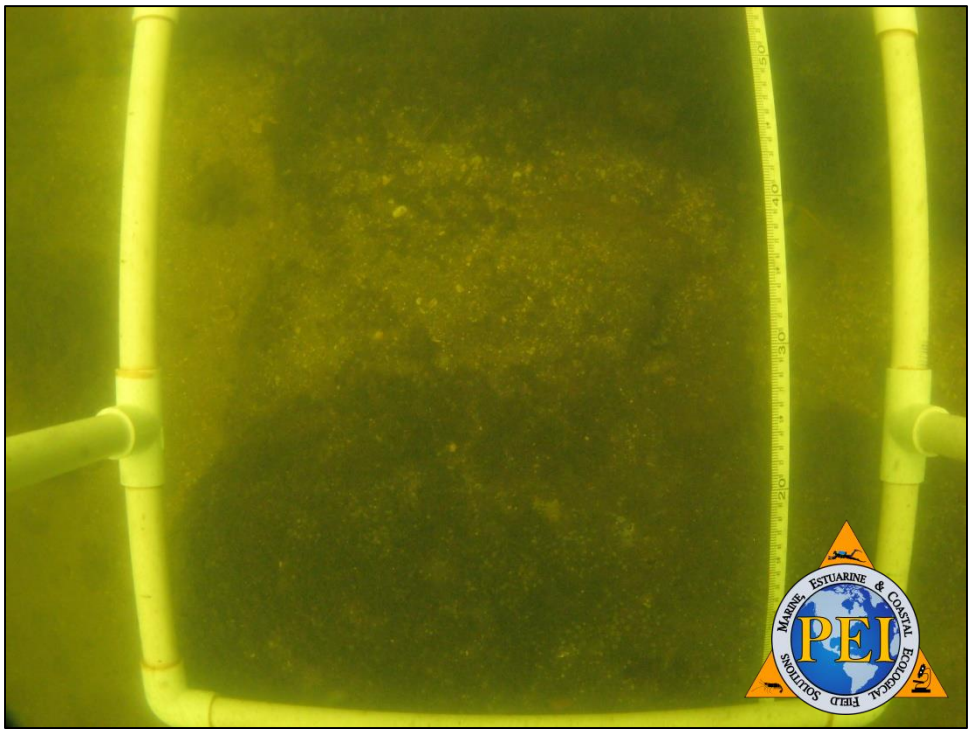

Photo 43. Rock and rubble substrate at Sample Station HB-7.

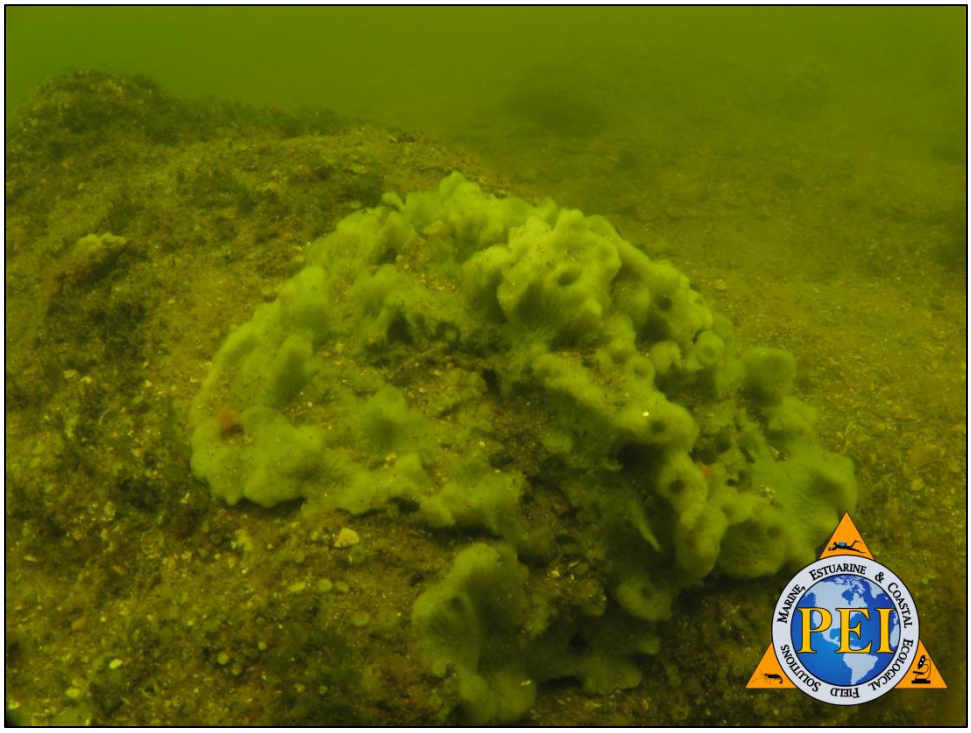

Photo 44. Sponge observed colonizing rock rubble at Sample Station HB-7.