



“Turtle Tows”:

Monitoring Protocol For Assessing In-Water Effects of Beach Construction on Sea Turtle Populations Along Nearshore Reef Habitats

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Abstract

There has been a considerable effort to document and protect populations of endangered green turtles along the shores of Southeast Florida. Most conservation efforts have been focused towards nesting females and hatchling success upon the beaches, however, little has been done to investigate ‘in-water’ juvenile (3-5 yr old; <65 cm SCL) green turtle populations that are also critical to the species as a whole. As juvenile green turtles recruit to coastal waters, they undergo a dietary shift from omnivory to herbivory, and aggregate to patches of benthic macroalgae or seagrasses found along the nearshore reefs of South Florida. Following beach restoration projects, the possibility of compromising these nearshore hardbottom substrates through sediment coverage still remains. Coastal Planning & Engineering, Inc. (CPE), along with Florida Atlantic University, was selected by Broward County to perform the ‘Turtle Tow’ monitoring protocol and establish a GIS database of sea turtle populations along the county’s nearshore reef tracts. Surveys in 2003 and 2004 have provided two consecutive juvenile population estimates, before construction of the Broward County Shore Protection Project. An annually updated database must be implemented in order to assess any effects that beach renourishment activities may have on resident sea turtle populations, and to determine if these effects cause either temporary fluctuations or long-term variation in the population dynamic.

Introduction

Green turtle hatchlings migrate offshore and spend 3-5 years as pelagic stage juveniles, feeding and growing in the open ocean. They then return to shallow coastal waters as sexually immature “dinner-plate” sized (<65 cm SCL) turtles (Musick and Limpus, 1997). As juvenile green turtles aggregate along the nearshore southeastern coast of Florida, they gradually complete a dietary shift from omnivory to herbivory, feeding upon macroalgae and seagrass (Limpus and Walter, 1980; Limpus *et al.*, 1994). Recent studies have shown that juvenile greens exhibit home ranging behavior and foraging site fidelity, as they may be observed at any one site on a daily basis, and when displaced, return to the same site (Seminoff *et al.*, 2002; Makowski *et al.*, in review). This feature of their ecological behavior suggests, at any one time and place, systematic observations will provide an accurate estimate of overall population size and its variation within a local region.

Conservation efforts, such as the Florida SNBS (Statewide Nesting Beach Survey) and INBS (Index Nesting Beach Survey) Programs, have been focused towards nesting females and hatchling success (NMFS and USFWS, 1991), however, little has been done for nearshore juvenile green turtle populations. Until recently, there have been no systematic or quantitative studies available to determine turtle abundance along any of the South Florida reef systems. However, a paper (Makowski *et al.*, in press) describes the ‘Shark Fishing’ survey technique that can estimate the abundance and distribution of juvenile green turtles in shallow water developmental habitats. In this study, we apply the ‘Shark Fishing’ technique to establish the ‘Turtle Tow’ monitoring protocol, which allows for the observation of juvenile green turtle populations along shallow (2-6 m deep)

reef habitats in South Florida (Broward County, eastern Atlantic coast, USA). Once positional data of juvenile populations are recorded and incorporated into a GIS Turtle Database (GTD), the foundation for a comprehensive reef index will be established and populations of immature greens can be monitored from season to season.

The ‘Turtle Tow’ monitoring protocol will pinpoint where juvenile turtles are concentrated in space before sea turtle managers can adequately protect these populations. In particular, beach renourishment projects pose a real threat when sand is pumped from offshore borrow sites to the beach. Following these beach restoration projects, the possibility remains of compromising nearshore hardbottom substrates through sediment coverage. If the abundance of nearshore hardbottom substrates becomes limiting for juvenile green turtles, such a loss can have a devastating effect on the population structure. These surveys become essential for estimating such losses, and for devising sound strategies to mitigate against their effects. The ‘Turtle Tow’ monitoring protocol will allow us to obtain an overall estimate of sea turtle populations along essential reef resources in Broward County, Florida, before and after beach construction. Conservation managers will be able to see where green turtles are aggregating along specific hardbottom resources, and whether these juvenile populations are remaining static or are fluctuating on an annual basis. With such knowledge, managers will be better positioned to protect specific reef patches, and the juvenile sea turtles that depend upon them at this stage of their development.

Methods

Study Area

The Broward County shoreline is subdivided into three Segments (I, II, and III), two of which were surveyed for juvenile green sea turtles populations. Segment II is 18.3 km in length, and extends from Hillsboro Inlet to Port Everglades Inlet. Segment III is 13.3 km in length, and extends from Port Everglades Inlet to the Broward County/Miami Dade County Line. Surveys were conducted over nearshore hardbottom resources in shallow (≤ 8 m) coastal waters during the summer months (May – July) of 2003 and 2004.

Survey Procedures

The ‘Turtle Tow’ monitoring protocol consists of a modified ‘Shark Fishing’ technique (Makowski *et al.*, in press) carried out in both the pre- and post-construction phase. The ‘Shark Fishing’ technique is a towed diver surveying method that determines the abundance and distribution of sea turtle populations without disturbing or handling the turtles (Makowski *et al.*, in press). Single strip transects were located and plotted over the nearshore reef habitat, parallel to shore and adjacent to the beach construction area. Following the plotted transect vector, surveys were performed once in a northern direction and once in a southern direction, and always on different days. Two in-water observers were towed approximately 8 m behind a slowly moving (1.5-2.0 knots) research vessel. The in-water observers visually scanned the area directly below and to the left (port observer), and directly below and to the right (starboard observer), as far as

water clarity allowed (typically, ≤ 6 m to each side). Towed divers reported turtle sightings to on-vessel personnel, who then took a locational fix for that site. After being located, the turtles usually swam in a perpendicular direction away from the boat, decreasing the chances of being recounted. Control sites are established to obtain a proper statistical variation analysis of the study area. Tows in opposite directions at each site help normalize the data for future comparisons and analysis. Turtles are never touched or put at risk.

GIS Analysis

The GIS Turtle Database (GTD), a spatial-controlled interface, was established to work with the recorded turtle positional data. Turtle sightings were recorded on a lap-top computer that was simultaneously linked to satellites with a Trimble Differential Global Positioning System (DGPS) beacon. HYPACK® MAX software, PC-based Windows software for planning, conducting, editing, and publishing hydrographic surveys, stored turtle positional data, as well as the date and time of the observation. Other data (e.g., weather conditions, underwater visibility, activity of turtle) were added later as descriptive identifications for each turtle. All turtle sightings were then plotted on nearshore laser airborne depth sounder (LADS) contour maps, using ArcView versions 8.3 and 9.0 GIS software.

Results

All observed turtles were identified by external appearance as juvenile green turtles (*Chelonia mydas* L.).

In 2003, the two directional surveys yielded an identical number of sightings (north to south, n = 48 turtles; south to north, n = 48 turtles). All of the turtles were seen over nearshore reef habitats within Segment II and Segment III of Broward County, Florida. Turtles were observed as either resting on the bottom, swimming slowly over the reef, or breathing at the surface. During the north to south survey, most (34 out of 48, or 71%) juveniles were sighted within Segment II (Hillsboro Inlet to Port Everglades Inlet). The remaining 14 turtles (29%) were observed within Segment III (Port Everglades Inlet to Broward County/Miami-Dade County Line). During the south to north survey, most juveniles (32 out of 48, or 67%) were again sighted within Segment II. The remaining 16 turtles (33%) were observed within Segment III (Table 1).

In 2004, the two directional surveys yielded a similar number of sightings (north to south, n = 35 turtles; south to north, n = 42 turtles). Again, all turtles were observed over nearshore hardbottom resources as either resting on the bottom, swimming slowly over the reef, or breathing at the surface. During the north to south survey, most (22 out of 35, or 63%) juveniles were sighted within Segment II. The remaining 13 turtles (37%) were observed within Segment III. During the south to north survey, most juveniles (27 out of 42, or 64%) were again sighted within Segment II. The remaining 15 turtles (36%) were observed within Segment III (Table 1).

All turtle sightings were successfully incorporated into an ArcView GIS template and then archived into the GIS Turtle Database (GTD) (Figure 1). The GTD allows a user to navigate to any juvenile turtle sighting, while supplying accurate coordinate-plane locations and descriptive information for each observation (Figure 2).

Discussion and Conclusions

This study's objective was to provide an appropriate protocol measure for estimating juvenile green turtle population density along the nearshore reefs of Broward County, Florida, before and after construction of the Broward County Shore Protection Program. The 'Turtle Tow' monitoring protocol is an effective, turtle-friendly approach for detecting juvenile green turtle populations on nearshore worm-rock reef habitats in Southeast Florida. The data obtained during our late spring/early summer surveys proves to be the most opportune time to record these population density estimates, as it coincides with the time of season when green turtles establish strict home ranges, in which they traverse daily (Wershoven and Wershoven, 1988; Makowski *et al.*, in review). This hypothesis is supported by the similar number of turtles observed during both the northward and southward directed efforts (Table 1).

Makowski *et al.* (in press) reported the results from a similar 'Shark Fishing' survey over two consecutive summers along the nearshore reefs of Palm Beach County, Florida. During the summer of 2001, 62 juvenile green turtles were observed along an approximately 12 km length of reef habitat. A 2002 survey of the same reefs during the following summer resulted in higher ($n = 79$) turtle densities, with no sea turtles seen over sandy bottoms of equal depth. During the Broward County 'Turtle Tows', the data

obtained in 2004 provided an estimate (mean of ~ 39 turtle sightings; average N to S [n = 35] and average S to N [n = 42]) that was somewhat lower than the 2003 estimates (mean of ~ 48 turtle sightings; average N to S [n = 48] and average S to N [n = 48]). Obtaining these accurate estimates of natural variation within the juvenile populations allows conservation managers the ability to pinpoint adverse impacts of beach construction, and thus distinguish statistically between an actual impact and a chance effect.

By initiating the ‘Turtle Tow’ monitoring protocol in 2003 and 2004, Coastal Planning & Engineering, Inc., along with Florida Atlantic University, have provided two consecutive pre-construction population estimates. It can be reported with certainty that there remains a substantial population of juvenile green turtles within Segments II and III of Broward County, Florida. Thus far, the variation between the estimates for the two survey years (< 20%) provides a reasonable baseline for comparing pre-construction with post-construction monitoring events.

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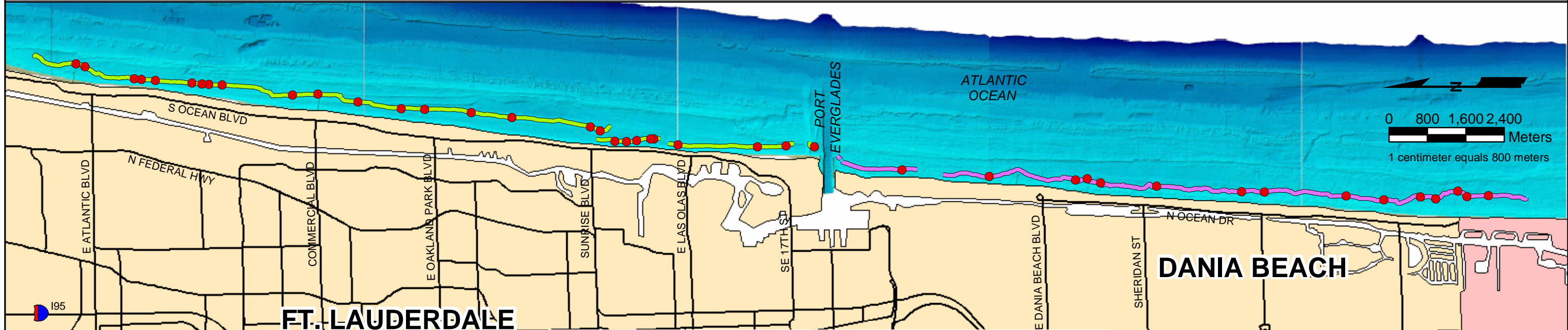
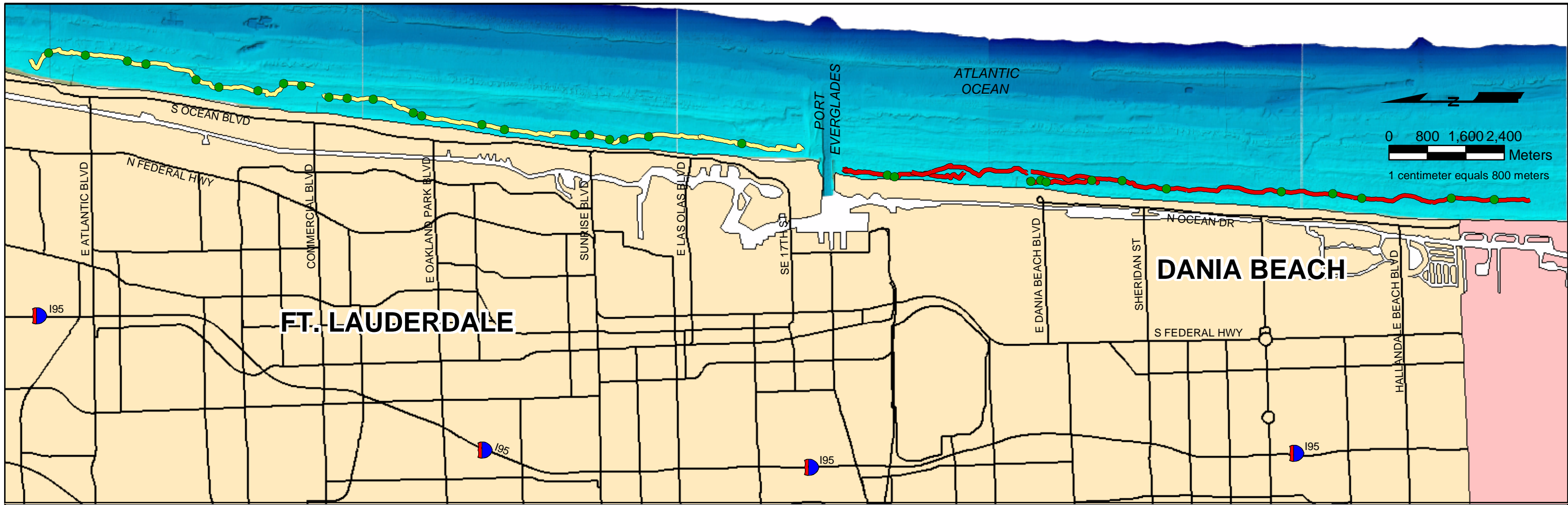
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Table 1. Summary table of juvenile green turtle populations in Broward County, Florida.

Broward County Juvenile Green Turtle Populations

		No. of Turtle Sightings				
Pre- Construction	YEAR	SEGMENT II (N TO S SURVEY)	SEGMENT II (S TO N SURVEY)	SEGMENT III (N TO S SURVEY)	SEGMENT III (S TO N SURVEY)	AVG. POPULATION DENSITY
		2003	34	32	14	16
	2004	22	27	13	15	39
Post- Construction						
	2005	TBA	TBA	TBA	TBA	TBA
	2006	TBA	TBA	TBA	TBA	TBA



NOTES:
 1. MAP ABOVE, NORTH TO SOUTH SURVEY.
 2. MAP BELOW, SOUTH TO NORTH SURVEY.

LEGEND

2004 TURTLE SIGHTINGS

● 2004 SEA TURTLE SIGHTINGS (N TO S)

2004 TURTLE SIGHTINGS

● 2004 SEA TURTLE SIGHTINGS (S TO N)

DIRECTION NORTH TO SOUTH

— SEGMENT 2
 — SEGMENT 3

DIRECTION SOUTH TO NORTH

— SEGMENT 2
 — SEGMENT 3

**BROWARD COUNTY, FLORIDA
 2004 SEA TURTLE SURVEY
 SEGMENTS 2 & 3**

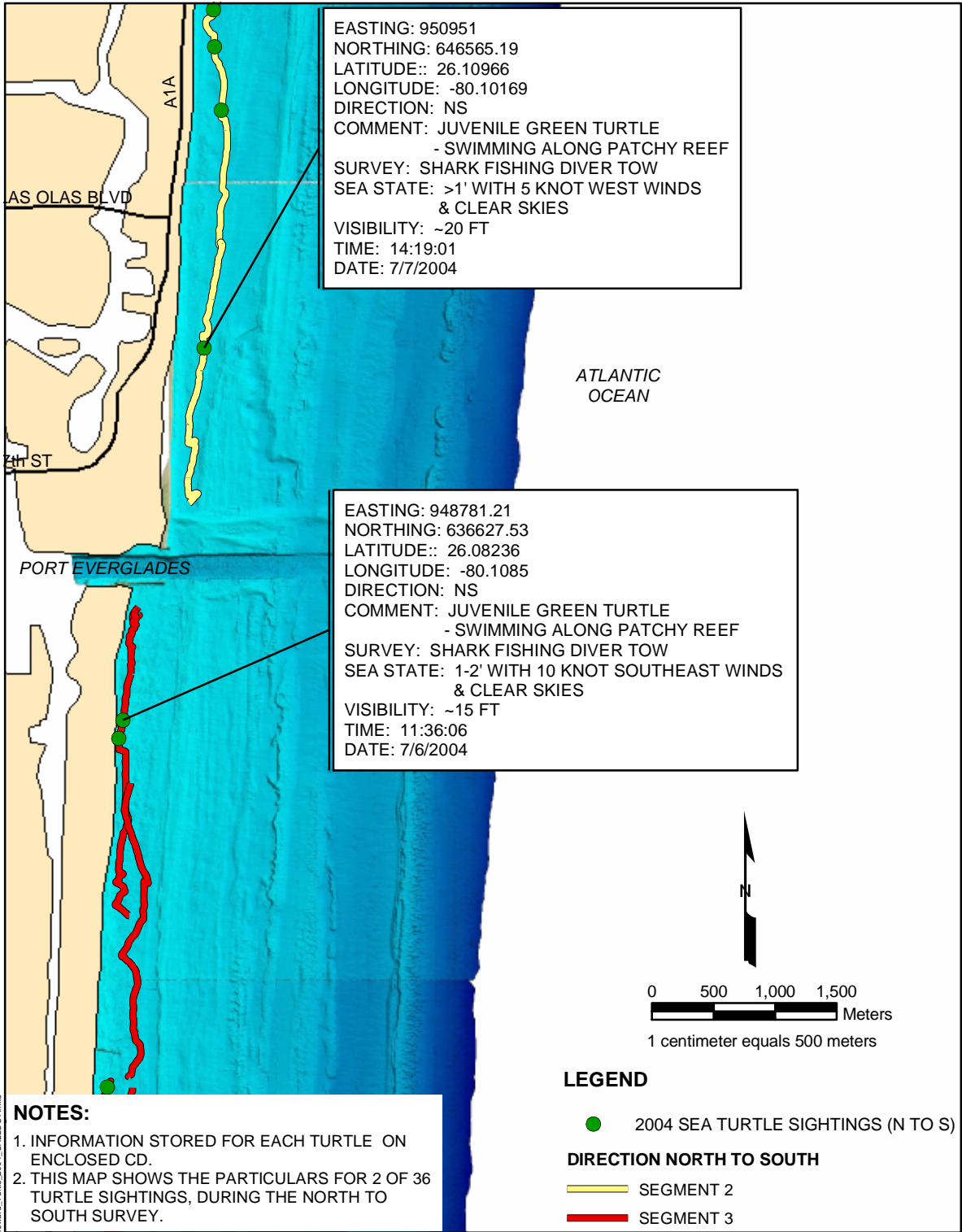


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FIGURE 1



NOTES:

1. INFORMATION STORED FOR EACH TURTLE ON ENCLOSED CD.
2. THIS MAP SHOWS THE PARTICULARS FOR 2 OF 36 TURTLE SIGHTINGS, DURING THE NORTH TO SOUTH SURVEY.

<p>COASTAL PLANNING & ENGINEERING, INC. 2481 N.W. BOCA RATON BLVD. BOCA RATON, FL 33431 PH.(561)391-8102 FAX. (561)391-9116</p>	<p>TITLE: BROWARD COUNTY, FLORIDA 2004 SEA TURTLE SURVEY SURVEY POINT DATA</p>		
	<p>DATE: 07/28/04</p>	<p>BY: DNR</p>	<p>COMM NO: 5350.09</p>

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