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OBSERVATIONS ON THE SITE FIDELITY OF BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*) IN THE INDIAN RIVER LAGOON, FLORIDA

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ABSTRACT: *Between July 1996 and October 2001, 190 boat-based photo-identification surveys were carried out on the population of bottlenose dolphins (*Tursiops truncatus*) in Florida's Indian River Lagoon. Survey effort varied geographically across and within study years, but was relatively high and consistent (number of surveys = 158, 83%) between 1998 and 2001 in the primary study area (PSA) between Sebastian Inlet in the north to Ft. Pierce Inlet in the south. A total of 336 dolphins were photographically identified, with 149 of these individuals found in the PSA. Evidence for short term fidelity within the IRL was derived from an analysis of 67 dolphins sighted eight or more times. The average site fidelity ratio for these more frequently sighted dolphins was 91%. Further, 57% of these dolphins were sighted in each of their five (45%) or four (12%) possible sighting years. Evidence for even longer-term site fidelity of 20 y comes from continued sightings across the five-year study period of 11 dolphins marked with freeze brands between 1979 and 1981. In the aggregate, these photo-identification data suggest that a more geographically extensive survey strategy, over a longer time scale is needed to assess important details of the population structure of IRL bottlenose dolphins.*

Key Words: Bottlenose dolphins, *Tursiops truncatus*, Indian River Lagoon, photo-identification, site fidelity

SEVERAL discrete population stocks of common bottlenose dolphins (*Tursiops truncatus*) are hypothesized to occur along the Atlantic seaboard. The inshore stock structure of these dolphins, however, has yet to be fully resolved, as existing data are insufficient to allow separation of potentially locally resident bottlenose dolphins found in bays and estuaries from the coastal stock in the western North Atlantic (Hohn, 1997; Waring et al., 1999). Recent research, however, has provided evidence

that resident populations do exist in inshore waterways, including those found in the Stono River Estuary near Charleston S.C, and in the St. Johns River near Jacksonville, FL (Caldwell, 2001; Zolman 2002). Bottlenose dolphins within the Indian River Lagoon (IRL), which extends along Florida's central east coast 250 km from Ponce de Leon Inlet south of Daytona Beach to Jupiter Inlet north of West Palm Beach, have been periodically studied using marking and photo-identification methodologies since the late 1970s, and are also hypothesized to contain elements of a resident population (Fig. 1).

Between 1977 and 1979, 134 bottlenose dolphins were collected and freeze-branded in the northern portion of the IRL (Odell and Asper, 1990). Boat-based tracking and identification studies were carried out on these dolphins between 1981 and 1982 to determine the status of the freeze brands. Eighty-one of the original 134 freeze-branded dolphins were later encountered, 60 were resighted exclusively in the Indian River, and three had moved into the adjacent Mosquito Lagoon. At least one was sighted as far south as the Sebastian Inlet. Additional photo-identification studies were later carried out between 1991 and 1995 in the northern portion of the IRL, but the time scale for most of these studies was relatively short (6 mo–12 mo) making it difficult to evaluate the site fidelity of photographed dolphins (Rudin, 1991; Spellman, 1991; Booth, 1993; Fick, 1995).

In the current study, photo-identification data collected on bottlenose dolphins in the IRL between 1996 and 2001 were examined for evidence of site fidelity. A secondary goal of this research was to determine useful survey guidelines for future photo-identification studies on the population structure and distributional characteristics of these dolphins. The current and planned future research on IRL bottlenose dolphins has both local and regional significance. Regionally, this research was intended to make a contribution to the understanding of the population structure of these bottlenose dolphins. Thus far, the IRL is the southern-most Atlantic seaboard population to be evaluated.

At a more local level, the Indian River Lagoon was designated in 1990 as a component of the National Estuary Program, one of 17 such programs established by the Environmental Protection Agency (NEP, 2004). Each National Estuary Program is charged with creating and implementing a Comprehensive Conservation and Management Plan (CCMP) that addresses all aspects of environmental protection for the estuary, including issues such as water quality, habitat, living resources, and land use. The IRL CCMP is based on a scientific characterization of the estuary, and is developed and approved by a broad-based coalition of stakeholders including five county governments, two water management districts, the Florida Department of Environmental Protection, the U.S. Fish and Wildlife Service, the Florida Coastal Zone Management Program, NASA National Park Service, the Florida Institute of Technology, and the Marine Resources Council. The CCMP establishes priorities for action, research, and funding, and serves as a blueprint to guide future decisions and activities related to the estuary.

There is good reason to be concerned about the welfare of IRL dolphins. For the years 1993–2000, dolphin strandings in the IRL represented approximately 40% of reported bottlenose dolphin strandings along the east coast of Florida (Stolen, 2002).

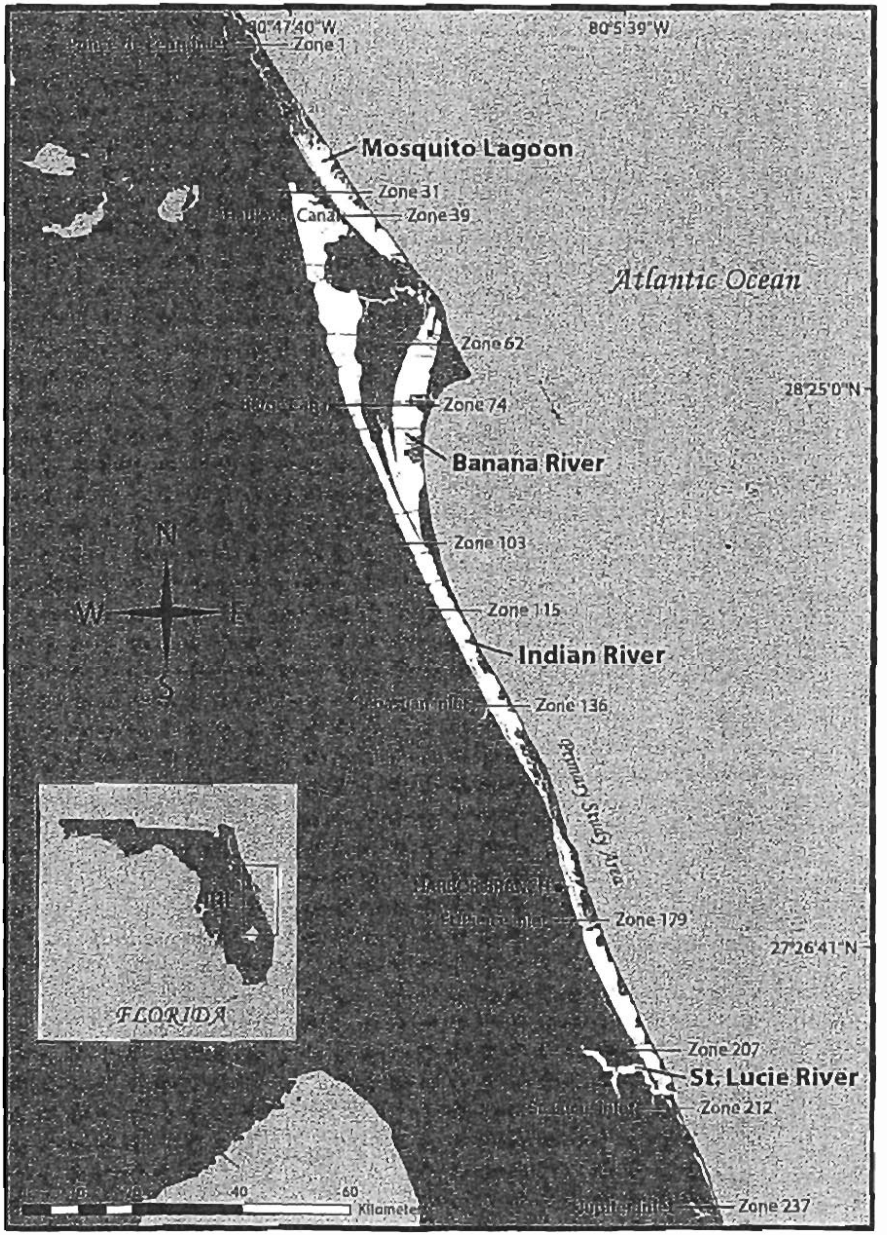

FIG. 1. Indian River Lagoon study area.

Further, a recent analysis of pathologic findings in 17 stranded IRL dolphins showed a high prevalence of infectious/inflammatory disease. Dermatologic disease was present in nine cases and the combined histologic pattern of skin, lymphoid and other lesions suggested a state of altered immunologic homeostasis and subsequent

immunologic dysfunction (Bossart et al., 2003). Further, photographically documented dermal lesions among IRL dolphins suggest a varied assortment of disorders with infectious (e.g., lobomycosis), toxic (e.g., contact dermatitis) and direct human-related (e.g., propeller trauma, fisheries interactions) etiologies (Mazzoil et al., 2003). These and related observations have prompted investigators to initiate a five-year health assessment of IRL dolphins (Bossart and Fair, 2002; Bossart et al., 2003; Mazzoil et al., 2003). The site fidelity data analyzed in the current study, as well as continued photo-identification monitoring of this population, provides information needed to interpret the role that local environmental influences have on the health of IRL dolphins.

METHODS—*Study area and survey coverage*—The photo-identification study area was within the IRL, which extends 250 km from Ponce De Leon Inlet in the north to Jupiter Inlet in the south (Fig. 1). Between July 1996 and September 2001, 190 photo-identification surveys were conducted, with the greatest number (n = 158, 83%) and most extensive coverage occurring between 1998 and 2001 (Fig. 2). Most surveys were concentrated within the Indian River (n = 180) from its northern extreme to the St. Lucie Inlet in the south. A limited number of surveys extended into the Banana River (n = 6) and Mosquito Lagoon (n = 4), as well as the Barge Canal (n = 5), which connects the Indian River North to the Banana River. Three surveys were also carried out within the St. Lucie River, including the North and South forks.

The section of the IRL covered during individual surveys varied considerably in location and length, as did the frequency of surveys, across the study period. Survey coverage (effort) during the study period was quantified by partitioning the IRL into 1-km latitude zones. The highest sampling frequency occurred between the Sebastian and Ft. Pierce Inlets (zones 136–179) and this range was designated as the primary study area (PSA) (Fig. 1). The mean sampling frequency for PSA zones was 64.6 (SD = 17.72). Surveys in the Indian River north of the PSA sampled zones 31–135. Within this northern section of the Indian River, zones 31–114 were sampled an average of 5.0 times (SD = 2.85), while zones 115–135 averaged 20.2 (SD = 2.34). Surveys in the Indian River south of the PSA sampled zones 189–237. Within this southern section of the Indian River, zones 180–212 were sampled an average of 23.2 times (SD = 3.91), while all zones between 213 and 237 were sampled five times.

Photographic survey procedure and data analysis—A variety of survey vessels ranging from 6 to 8 m in length and powered by outboard motors were deployed to conduct photo-identification surveys. During surveys the vessel motored along the middle of the Intracoastal Waterway at about 17 km/h while searching for dolphins. This survey route provided visual access to shallow (< 3 m), as well as deeper (≥ 3 m) sections of the IRL across its entirety. Survey speed was lowered as needed, however, to accommodate to water, weather and visibility conditions, as well as when operating in designated manatee zones. When in wider sections of the IRL, the survey vessel speed was slowed or periodically stopped to allow on-board observers to scan for the presence of dolphins.

When dolphins were sighted, the survey vessel slowed and then stopped when close enough to make initial estimates of group size, as well as to collect additional information on the sighting time and GPS location, environmental conditions, and behavior. Once initial sighting information had been recorded, the vessel maneuvered closer to the group and individual dorsal fin notch patterns were photographed with 35-mm and digital motor driven cameras, and a 100–400mm telephoto lens. Between 1996 and 1999, Kodak 64 or 200 ASA Kodachrome slide film was used. Subsequently, dorsal fin photography was accomplished with a Canon digital camera system (EOS D2000 and EOS 1D) (Mazzoil et al., 2004). In all cases, attempts were made to photograph every dolphin within a group. Initial estimates of group size were revised as necessary and contact with the group was maintained until photographic effort was completed. Identical procedures were repeated as the research vessel resumed travel on the survey route and as additional dolphins were encountered. Field and photo-identification protocols and definitions closely followed those outlined in the Sarasota Dolphin Research Program Field Techniques and

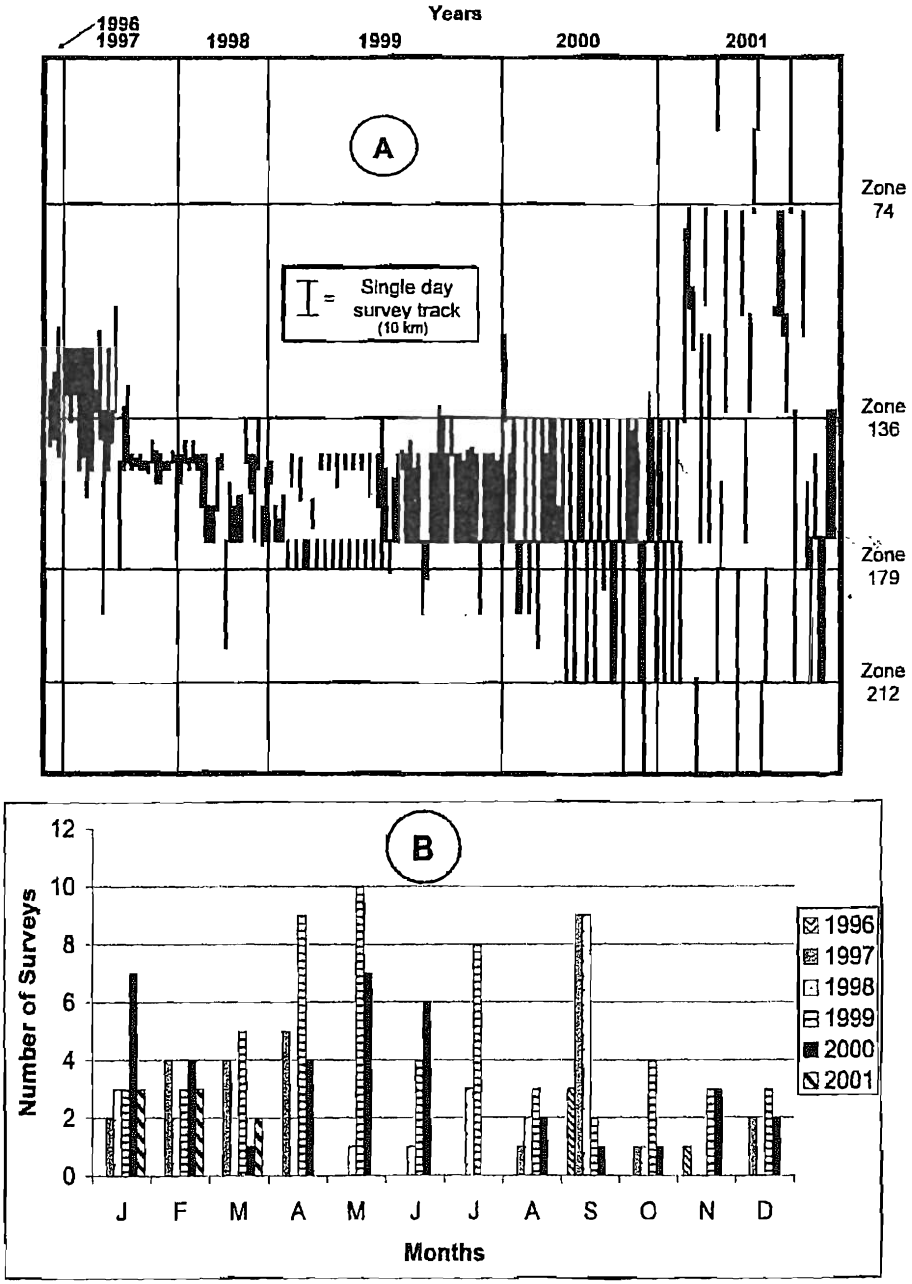

FIG. 2. Photo-identification survey coverage within the Indian River component of the IRL expressed as: A (top)—the location and distance covered during Indian River surveys across years. Additional surveys were carried out in the Mosquito Lagoon, Banana River, Barge Canal and the north and south forks of the St. Lucie River (see Fig. 1 and text for details). B (bottom)—the distribution of surveys by month across years.

TABLE 1. Sighting ID, frequency, period and location for dolphins freeze-branded by Odell and Asper (1990) in the IRL between 1977 and 1979.

	Sighting		
ID#	Frequency	Period	Location (Zone)
1	2	2001	IRL105–IRL109
2	5	1998–2000	IRL170–IRL203
3	2	1997–2000	IRL021–IRL030
4	1	2001	IRL069
5	29	1996–2001	BR097–IRL171
6	26	1996–2001	BR097–IRL171
7	1	2000	IRL130
8	3	2001	IRL081–IRL084
9	1	2001	IRL069
10	1	2001	BR097
11	5	2000–2001	IRL064–IRL202

Photo-identification Handbook (Urian and Wells, 1996). Sighting and environmental data recorded on paper forms in the field were later entered into a customized MS Access database after each survey was completed.

Sorting, matching and cataloging—The laboratory analysis of all dorsal fin images closely followed the procedures described by Mazzoil and co-workers (2004) and are briefly summarized. Clear photographs of distinctively marked dorsal fins were sorted by recognizable notch patterns, and the best photograph of each dolphin was selected as the "type photograph" to which all other photographs were compared (matching and cataloging). Subsequently, only unambiguous matches with the type photograph were accepted as re-identifications of known individuals. If a distinctly marked dolphin could not be matched to an existing type photograph, it was added to the catalog as a newly identified individual.

RESULTS—During the 190 photo-identification surveys conducted in the IRL across the 5-yr study period 4,339 dolphins were encountered, 17,350 digital and slide film photographs were taken, and 336 individuals were photographically identified. Evidence for short term fidelity within the IRL was derived from an analysis of 67 dolphins sighted eight or more times across the study period. Site fidelity ratios were derived by dividing the number of years in which each of these dolphins was sighted by the total number of survey years it could have been sighted. Identified dolphins recovered dead by the Southeastern United States Marine Mammal Stranding Network were eliminated from further analysis. For this site fidelity analysis, photographic sightings from 1997 were combined with those from 1996, which included only five surveys in which dolphins were observed. The criterion of 8 or more sightings was selected for this analysis in order to allow individuals to have one or more sightings within the same year while still showing evidence for sightings in all five possible years. The average site fidelity ratio for these more frequently sighted dolphins was 91%. Further, 57% of these dolphins were sighted in each of their five (45%) or four (12%) possible sighting years. Evidence for even longer-term site fidelity comes from continued sightings across the five-year study period of 11 dolphins marked with freeze brands between 1977 to 1979 (Odell and Asper, 1990) (Table 1).

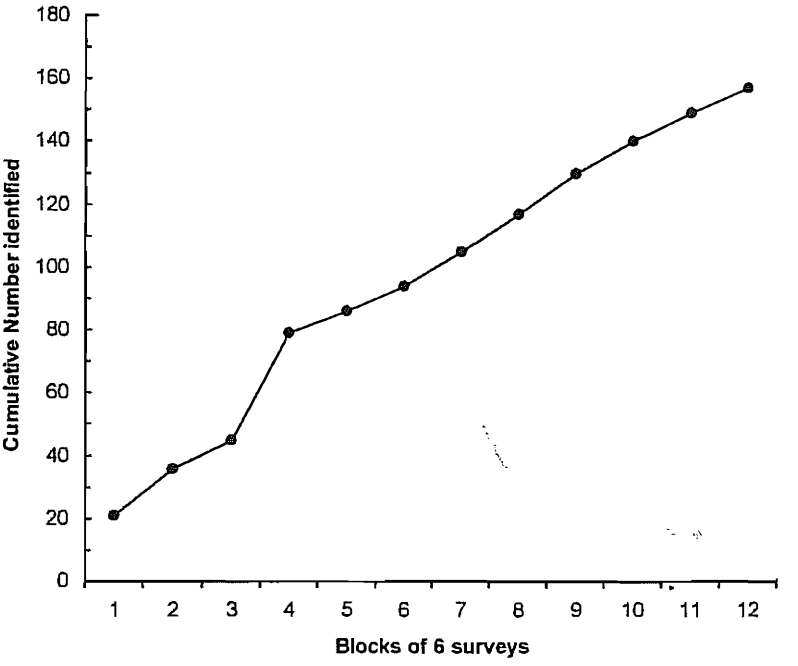

FIG. 3. Rate of discovery for individual dolphins identified in the primary study area between 1998 and 2001 across blocks of 6 surveys.

In the following analyses, group size and photographic sighting data, including rate of discovery and sighting frequency were summarized for PSA surveys between 1998–2001 when survey effort was most extensive and most even (Figs. 1 and 2). A total of 425 groups were observed, and group size averaged 4.0 (SD = 3.20), ranged between one and 28, with the most frequently observed group size having two (24%) individuals, followed by groups of one (18%) and three (15%).

A total of 149 individuals were photographically identified in the PSA. The rate at which new dolphins were added to the photographic catalog showed the expected high rate of discovery during initial surveys, which continued to rise across the entire study period (Fig. 3). Sighting frequencies for individual dolphins photographed within the PSA averaged 4.8 (SD = 3.72) and ranged from 1 to 16 (Fig. 4). The highest sighting frequencies were between 1 to 4 (60%) and 17% of these 149 dolphins were photographed only one time. In spite of the lower and more variable survey coverage in other IRL regions, many of the 149 dolphins sighted in the PSA were also photographed south of the PSA (n = 50, 34%) and north of the PSA (n = 45, 30%), including in the Banana River (Fig. 1).

DISCUSSION—The current study adds to the early findings of site fidelity reported by Odell and Asper (1990), and provides the first substantive evidence supporting the hypothesis that some, and possible many, bottlenose dolphins in the IRL are residents of this extensive inland waterway. The time scale for this evidence extends

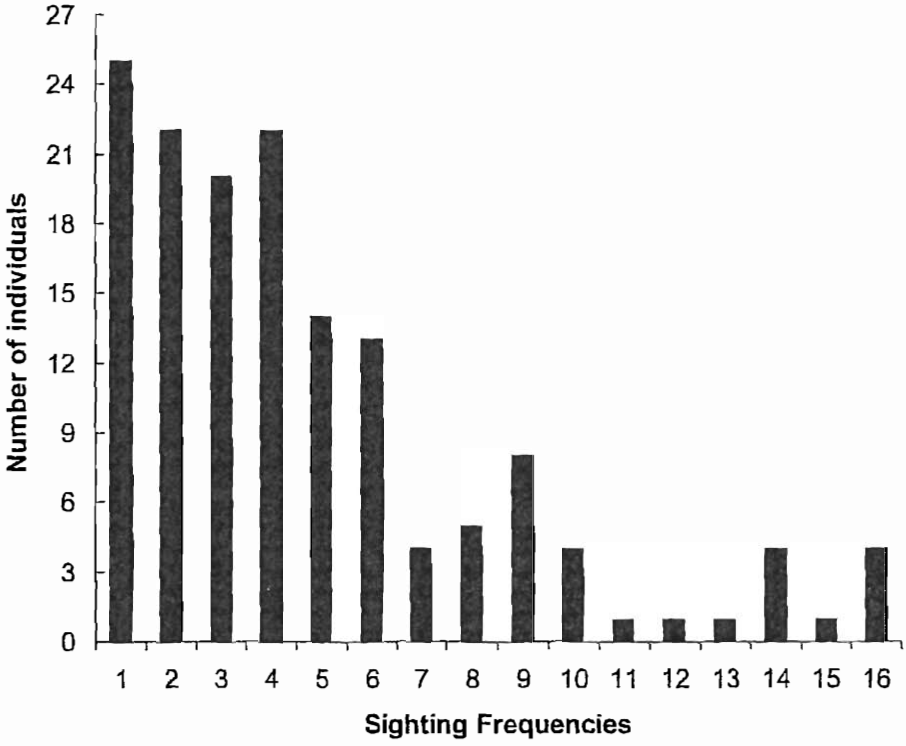

FIG. 4. Sighting frequencies for individuals identified in the primary study area between 1998 and 2001.

over a 5 yr period for many of these dolphins, while for those dolphins freeze-branded between 1977–1979 and photographed in this study, the scale extends over a 20 yr period. These data, which show strong evidence for site fidelity, are similar to those reported for several other inland waterway sites along the eastern Atlantic seaboard to the north, near Jacksonville, FL and Charleston, SC which also showed evidence for site fidelity (Caldwell, 2001; Zolman, 2002), are important for several reasons. At a regional level, the accumulated evidence for site fidelity among inland waterway dolphins on the eastern Atlantic seaboard suggests that these dolphins should be managed as separate stocks, and points to the need to better understand their abundance and distribution, as well as biotic and abiotic factors that may impact on these variables.

The high incidence of mortality among IRL dolphins and recent evidence for a variety of infectious/inflammatory diseases, including the presence of dermal lesions, emphasizes the need for additional research on the IRL bottlenose dolphin population (Stolen, 2002; Bossart et al., 2003; Mazzoil et al., 2003). The average group size of IRL dolphins ($\bar{X} = 4.0$) is among the smallest reported for inland waterway populations, and suggests an important interplay between the foraging and

predator (sharks) defense needs of these dolphins (Connor et al., 2000; Campbell et al., 2002).

Because continued photo-identification studies will play an important role in understanding the stock structure of these dolphins, as well as in the interpretation of environmental impacts on their health, the current data were reviewed to determine the necessary parameters of such work. The positive slope of the rate of discovery curve for the 1998–2001 PSA study area suggests that the limited geographic range of this area is insufficient to sample the IRL population (Fig. 3). Similarly, while a total of 336 individuals were identified across all of the IRL areas surveyed, only 149 individuals were photographically identified within the PSA between 1998–2001, despite a high effort in this area over the study period. Further, a high proportion of these PSA dolphins were photographed to the north as well as to the south of this area. Finally, the high proportion of PSA dolphins with low sighting frequencies, considered along with the strong evidence for site fidelity within the entire IRL data set, suggests the need for a survey strategy with a broader geographic scope covering the entire expanse of the IRL (Figs. 2 and 4). Finally, the time scale of these future studies must be sufficient to reveal the details of both seasonal and annual variations in their abundance and distribution.

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